Monetary growth and its determinants in recent years

To detect medium to long-term inflationary risks early, the Eurosystem undertakes a complex monetary analysis which centres on M3, as the growth of this monetary aggregate is particularly closely linked to consumer price inflation. Precise knowledge of the factors driving monetary dynamics is therefore especially valuable for assessing future price risks.

Monetary growth has many possible causes. The components and counterparts of the money stock consequently need to be analysed carefully in the context of the consolidated balance sheet of the banking sector. In the euro area, a strong rise in loans to the private sector has dominated for years. This has also manifested itself in the relatively high explanatory power of housing price developments in the money demand estimate for annual M3 growth. In addition, vector autoregressive (VAR) analyses show that monetary growth in the past two-and-a-half years has also tended to have been boosted by higher short-term interest rates, since they have made the M3 components that are remunerated at close to market rates more attractive. These expansionary effects of interest rate policy on M3, however, are quantitatively relatively small and temporary. In the long run, interest rate hikes dampen monetary growth.

Monetary growth in the context of the consolidated balance sheet

Monetary variables: good indicators of longer-term inflationary risks

In the Eurosystem's stability-oriented monetary policy strategy, monetary analysis forms the basis for assessing longer-term price risks.[1] In this context, the Eurosystem has been using a whole range of analytical methodologies for quite some time now.[2] These include *inter alia* monetary inflation forecasts in which the average inflation rate over a given period is predicted on the basis of monetary variables. Such forecasts are noticeably more accurate than forecasts which do not include monetary variables, particularly over time periods of more than two years.[3]

No mechanistic monetary-based inflation forecasts

It is generally evident that indicator models based on the growth of broad money, ie M3, are particularly well suited to detecting future longer-term inflationary risks early.[4] However, short-term influences can temporarily distort the information value of monetary data for future price developments. These may include not only purely statistical distortions such as those caused by end-of-month, end-of-quarter or end-of-year effects, but also somewhat longer-lasting factors. Although the associated changes in the money stock may well have economic causes, they need not necessarily have any lasting price effects. Monetary growth therefore must not be employed mechanistically in the monetary policy decision-making process. Rather, it is imperative that the "underlying monetary dynamics", which are especially closely related to longer-term inflation developments, be identified.

Loans to private sector most important source of money creation in euro area

In seeking to determine these underlying monetary dynamics, monetary analysis, in a first step, examines the various sources of money creation. It is a good idea to base this on the consolidated balance sheet of the banking (or, to be precise, the MFI) sector.[5] Such an analysis focuses particularly on loans to domestic enterprises and individuals, developments which have traditionally made a prominent contribution to monetary growth in the euro area and are also generally closely related to the private sector's aggregate expenditure. Focusing too much on this counterpart, however, would be overly simplistic. As a case in point, the Bundesbank discovered back in the 1980s and early 1990s that major shifts in international exchange rates meant that the only way to assess the underlying monetary dynamics in Germany meaningfully was to look not only at private

1 For information on how monetary analysis fits into the Eurosystem's monetary policy strategy, see Deutsche Bundesbank, Ten years of monetary policy cooperation in the Eurosystem, Monthly Report, April 2008, p 15 ff.
2 A comprehensive overview of new developments in the Eurosystem's monetary analysis framework is provided in B Fischer, M Lenza, H Pill and L Reichlin, Money and Monetary Policy: The ECB Experience 1999-2006, in A Beyer and L Reichlin (eds), The Role of Money – Money and Monetary Policy in the Twenty-First Century, Proceedings of the Fourth ECB Central Banking Conference, 9-10 November 2006, ECB, Frankfurt am Main, pp 102-175.
3 See M Scharnagl and C Schumacher, Reconsidering the role of monetary indicators for euro area inflation from a Bayesian perspective using group inclusion probabilities, Deutsche Bundesbank Research Centre, Discussion Paper, Series 1, Economic Studies, No 09/2007.
4 See B Hofmann (2008), Do Monetary Indicators Lead Euro Area Inflation?, ECB Working Paper No 867.
5 Monetary financial institutions (MFIs), the sector that creates money in the euro area, include not only banks but also money market funds. The consolidated balance sheet of the MFI sector compares M3 and its components with the MFIs' other balance sheet items (especially loans to domestic non-banks and foreign borrowers, securities portfolios and MFIs' longer-term liabilities), with pure interbank assets and liabilities netted against one another ("consolidated"). The consolidated balance sheet thus represents MFIs' business with domestic non-banks and non-residents.

loans but also at banks' net external asset position and trends in monetary capital formation at banks. In periods when the D-Mark was appreciating sharply, foreign borrowers repaid their obligations to domestic enterprises more quickly. At the same time, it became more attractive for residents increasingly to borrow abroad to meet their financing requirements rather than to take up loans with domestic banks. During such periods, therefore, moderate domestic credit growth was generally accompanied by large inflows of funds from abroad and thus by a sharp rise in German banks' net external assets. The domestic banking sector's total lending business was, during these periods, a much better indicator of trends in monetary growth than lending alone – at least while domestic monetary capital formation showed no striking changes.[6] The same was also temporarily true of the euro area as a whole when strong inflows of funds from abroad noticeably boosted M3 growth in the 2001-03 and 2006-07 periods.[7]

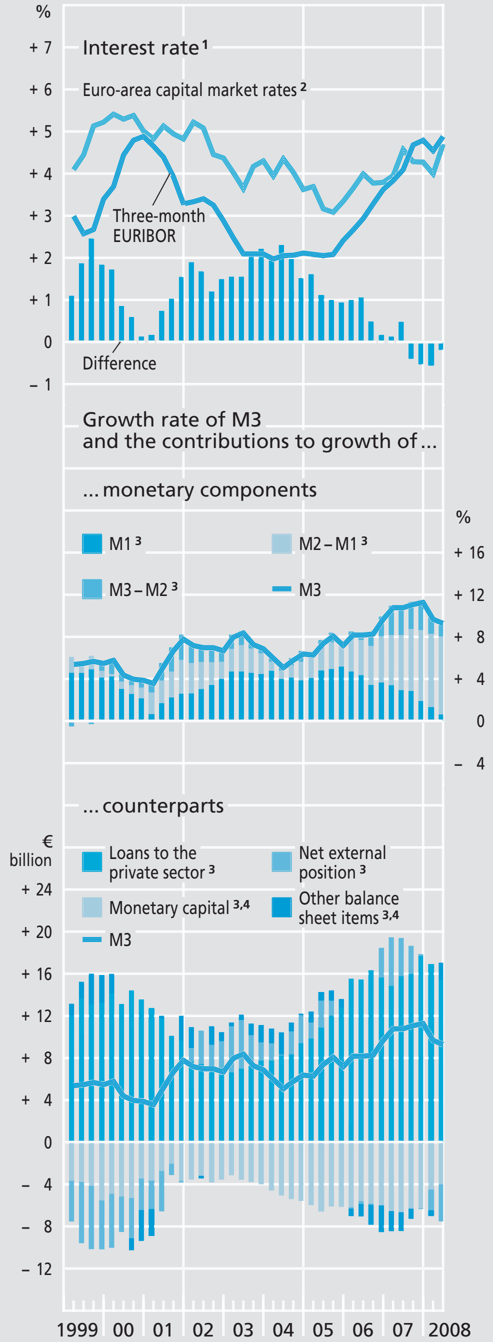
Periods of unusual portfolio shifts

The money stock is also affected by shifts between short-term and longer-term bank liabilities, ie shifts between the money stock and what is known as monetary capital. Such shifts between the various types of bank deposits and credit institutions' securitised liabilities (money market paper and long-term

6 See J Reischle (2001), The role of the analysis of the consolidated balance sheet of the banking sector in the context of the Bundesbank's monetary targeting strategy prior to Stage Three, in H-J Klöckers and C Willeke (eds), Monetary analysis: Tools and applications, ECB, Frankfurt am Main, pp 165-185.
7 See European Central Bank, The external dimension of monetary analysis, Monthly Bulletin, August 2008, pp 71-84.

Interest rate and monetary dynamics

Seasonally adjusted, quarterly



1 Not seasonally adjusted. — 2 GDP-weighted yields on ten-year government bonds. — 3 Calculated from cumulative 12-month change. — 4 All other things being equal, an increase dampens M3 growth.

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bank debt securities) within an interest rate cycle are quite normal; if the yield curve steepens, the longer-term bank liabilities contained in monetary capital become more attractive, whereas if the yield curve is flat or even inverted, investors prefer more liquid vehicles for investing with banks. However, irrespective of the prevailing interest rate situation, unusual portfolio shifts in favour of money stock components always present particular challenges when interpreting monetary data. Experience has shown that this is particularly common in times of high financial market uncertainty, such as in the 2001-03 period, when a lengthy slide in stock prices combined with geopolitical tensions had put a visible damper on investors' willingness to invest in the longer term. As a result, not only did monetary capital formation take place at a slower pace during this period, but domestic enterprises and individuals also sold large volumes of securities to non-resident investors. The proceeds were invested in liquid M3 components at domestic banks. The effect of these large inflows of funds from abroad on the consolidated balance sheet of the banking system was a strong rise in the banking system's net external assets. The price risks generated by money created in this fashion are usually lower than, for instance, money created by borrowing.

Limits of monetary analysis geared to consolidated balance sheet

On the whole, the analysis of the consolidated balance sheet reveals key information on the sources of money creation which can be used to assess inflationary risks. Price risks usually vary depending on whether dynamic monetary growth is caused by strong credit expansion or extensive portfolio shifts as a result of uncertainty. However, econometric methods are needed in order to clearly identify the underlying economic causes of the developments in the balance sheet counterparts to the money stock. Only then can the contribution made by, for instance, interest rates, income levels or geopolitical risks to monetary growth be assessed. Generally, money demand estimations are the basis on which the monetary growth rate is decomposed into its macroeconomic determinants.

Analysing monetary growth using money demand functions

Information value of money demand estimations

Money demand functions usually cite transactions motives and general portfolio considerations as reasons why non-banks hold money. In traditional specifications, nominal gross domestic product (GDP, which measures the total volume of transactions in an economy) and capital market rates or other measures of the opportunity costs of holding money are the decisive macroeconomic explanatory factors. In addition, account is taken of the fact that, in the short run, deviations from the longer-term relationship may occur; these are, however, remedied by means of an adjustment process. Money demand approaches simultaneously capture these short-run dynamics and the long-run relationship using an error correction approach.[8]

8 See A Calza, D Gerdesmeier and J Levy (2001), Euro Area Money Demand: Measuring the Opportunity Costs Appropriately, IMF Working Paper No 01/179 or G Coenen and J-L Vega (2001), The Demand for M3 in the Euro Area, Journal of Applied Econometrics, No 16(6), pp 727-748.

Signs of instability in traditional money demand equations

Since 2001, such econometric analyses of money demand in the euro area have increasingly been detecting signs that the hitherto stable long-run relationships between money, income and interest rates no longer exist in the same form as before. These standard money demand models are certainly unable to come up with a satisfactory explanation for the continued strong growth of money in recent years.

Money demand estimations which make allowances for uncertainty ...

In relatively recent studies on money demand, the weaknesses of the standard specification of the demand for money in explaining current monetary trends have led to the inclusion of additional explanatory factors. For the 2001-04 period, the traditional approaches have been amended to include variables which are intended to reflect the degree of macroeconomic uncertainty and thus represent the risk involved in investing in alternative forms of finance such as fixed-interest securities or stocks.[9] These approaches have been very successful in capturing the pronounced portfolio shifts of households from stocks into safe, liquid investment vehicles in the aftermath of the global stock market slump of 2001 and during the period of high geopolitical uncertainty. However, they do not provide a satisfactory explanation for the strong rise in the money stock since mid-2004.

... or differences in yields

In an alternative approach, holding money is seen as part of a more complex portfolio decision. This approach seeks to explain the holding of money not through portfolio shifts caused by uncertainty but rather as a yield-driven investment decision.[10] To this end, it takes into account not only GDP but also domestic and foreign capital market and stock market yields. While this approach effectively explains the strong rise in M3 in 2006 and 2007, which was also reflected in high inflows of funds from abroad in the consolidated balance sheet, for earlier periods it records implausibly large residuals from the long-run money demand.

Money and assets

However, these extensions fail to come to grips with another key cause of the strong rise in the money stock over the past four years: they do not take sufficient account of the fact that, since mid-2004, borrowing in the euro area has accelerated significantly, which was largely the result of booming housing markets in many euro-area countries. Including housing variables in the demand for money can help bridge the gap between money creation and money holding. A lasting rise in the holding of money is caused by the fact that money holding is influenced not only by the substitution relationship between money and other forms of investment but also the complementarity between monetary components and other asset variables. Increases in total wealth will typically induce the private sector to hold a larger stock of money.

9 See C Greiber and W Lemke, Money Demand and Macroeconomic Uncertainty, Deutsche Bundesbank Research Centre, Discussion Paper, Series 1, Economic Studies, No 26/2005, and K Carstensen (2003), Is European Money Demand Still Stable?, Institute for World Economics, Working Paper No 1179, Kiel.
10 See R A De Santis, C Favero and B Roffia (2008), Euro area money demand and international portfolio allocation, ECB Working Paper No 926.

Decomposition of the annual growth rate of M3 into its determinants

Percentage points

Item	2006				2007				2008	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Real GDP	0.55	0.59	0.69	0.80	0.83	0.91	0.94	0.86	0.86	0.78
GDP deflator	1.98	1.99	1.96	1.71	2.11	2.19	2.21	2.23	2.12	2.42
Long-term interest rate	0.77	0.59	0.27	– 0.06	– 0.16	– 0.24	– 0.32	– 0.40	– 0.53	– 0.51
Housing prices	2.99	2.93	2.86	2.75	2.64	2.53	2.42	2.25	1.91	1.47
Fundamentals	6.29	6.10	5.79	5.20	5.43	5.39	5.26	4.94	4.37	4.16
Shocks 1	1.65	2.61	2.35	4.06	4.96	5.21	6.25	7.08	6.54	5.79
M3 2	7.94	8.71	8.14	9.26	10.38	10.60	11.51	12.02	10.91	9.95

1 Calculated as the deviation of the M3 growth rate explained by fundamentals from the official annual M3 growth rate. — **2** Calculated on the basis of quarterly averages for the seasonally adjusted M3 index series.

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Housing variables as explanatory factors for money demand

In standard money demand studies, GDP is not only a transactions variable but also a proxy for total wealth. However, there are now many signs that GDP is not satisfactory as an approximation of total wealth. This is especially true of the post-2001 period, when assets and incomes started to diverge noticeably owing to the boom in housing prices in some euro-area countries and the highly volatile stock markets. A recent study by Greiber and Setzer (2007) cites, among other things, trends in euro-area housing prices and housing wealth to explain the strong monetary growth over the past few years.[11] Strong growth in housing prices in the euro area will probably have had a key impact on banks' lending behaviour, since higher housing prices improve real estate owners' collateral and thus give them easier access to loans. If these effects are taken into account, a stable long-run money demand relationship can be established for both the euro area and the United States. The reverse also appears to hold, namely that an expansionary monetary policy promotes the development of the housing market by improving financing conditions and thereby boosting demand for real estate.

Decomposition of the components of M3 growth ...

In principle, money demand studies can also be used to gain an idea of the importance specific explanatory factors have for monetary developments. The table on this page

11 See C Greiber and R Setzer, Money and Housing – Evidence for the euro area and the US, Deutsche Bundesbank Research Centre, Discussion paper, Series 1, Economic Studies, No 12/2007. For a brief description of this study, see Deutsche Bundesbank, The relationship between monetary developments and the real estate market, Monthly Report, July 2007, pp 13-24.

uses the money demand equation developed by Greiber and Setzer (2007) to decompose the annual M3 growth rate into its driving factors. According to this, the house price developments of the past few years explain up to 3 percentage points of the annual M3 growth rate. Despite a noticeable cooling in housing price growth, they recently still contributed 1½ percentage points to M3 growth. In addition, price trends (as measured by the GDP deflator) made a significant contribution to monetary growth, namely 2½ percentage points in the second quarter of 2008, while, other things being equal, long-term interest rates dampened monetary growth.

... leaves scope for additional explanatory factors

When decomposing M3 growth, it also becomes evident, however, that current monetary developments cannot be fully explained even when housing prices are taken into consideration. From mid-2006 to the end of 2007, the percentage of the monetary growth rate that can be explained by non-fundamental factors ("shocks") has increased continuously. Though the recent slight weakening of the monetary dynamics has resulted in this percentage falling back again somewhat since the beginning of the year, the above-mentioned fundamental factors currently still explain less than 50% of total annual M3 growth. This can probably be attributed in part to a strong increase in leveraged mergers and acquisitions, of which the macroeconomic factors observed for this analysis take no account, as well as the substantial yield-driven inflows of funds from abroad referred to above.

M3 growth rates and central bank rates*

* For the period prior to 1999, the securities repurchase rate of the Deutsche Bundesbank is used to approximate the central bank rate; from 1999, the interest rate on main refinancing operations (from July 2000 the minimum bid rate) is used.

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Note that the fact that high monetary growth can be explained using a money demand function does not necessarily mean that it is not associated with inflationary risks. If, for instance, an economy's production capacity is overstretched and/or interest rates are exceptionally low, this may explain strong monetary growth, but it is still associated with high price risks for the economy.

Econometric analysis of the relationship between the Eurosystem's interest rate policy and monetary growth

Interest rate hikes and monetary growth correlated

Essentially, the strong monetary growth may also have been encouraged by the ongoing rise in short-term interest rates. Monetary growth accelerated in line with the rate hikes passed by the ECB Governing Council from the end of 2005. These rate hikes resulted in a flatter term structure and rendered short-term investments more attractive compared with longer-term exposures. Historically, monetary dynamics during the current period of rising interest rates displays the most parallels with monetary growth during the period of interest rate increases from June 1988 to August 1992. Then as now, strong growth in M3 went hand in hand with central bank rate hikes. The fact that periods of rising interest rates need not necessarily be accompanied by higher monetary growth is evident from the period from October 1999 to December 2000, when the interest rate rose and monetary growth weakened.

Looking at the developments of the past three years, the correlation observed between money market rates and trends in the money stock could also reflect the fact that increasing inflation risks as a result of strong monetary growth prompted the monetary authorities to tighten monetary policy incrementally.

VAR model as standard instrument for analysing monetary policy transmission

A comprehensive econometric analysis of the effects of interest rate changes on the money stock must not, *a priori*, dismiss any of these possible correlations and causal relationships. This is easier to achieve using a vector autoregressive (VAR) model than under simple regression approaches and is one reason why VAR models are now a standard instrument in the empirical analysis of the dynamic effects of monetary policy shocks. One characteristic of VAR models is that, as far as possible, all the explanatory variables used are themselves explained by this approach. Looking at the issue in hand, this means that both the effects of interest rate changes on the other variables and the determinants of the rate move itself are captured simultaneously. Another reason why VAR models are applied widely is that they allow the dynamic response of macroeconomic variables to a one-off change in the decisive variables (the so-called impulse) to be simulated and illustrated using what are known as impulse response functions. An impulse or shock is defined as the unexpected part of a monetary policy measure (central bank rate change), which economic agents have therefore not taken into consideration in their plans.

Monetary adjustment dynamics ...

The impulse response functions estimated using the VAR model show that the money stock (here measured by M3) initially rises in response to a one-off increase of 50 basis

Specification of the VAR model

In keeping with the standard specification of the money demand function, the model contains the following endogenous variables: nominal M3, real gross domestic product (GDP) as a measure of the real transaction volume in the goods markets, the GDP deflator which proxies the general price level in the economy as a whole, the nominal three-month money market rate as a control variable for the own rate of return on M3, the nominal interest rate on ten-year euro-area government bonds as a measure of the opportunity costs of holding money, and real household housing wealth, which – among other things – proxies the volume of transactions carried out by non-banks in asset markets.[1] In addition, the VAR specification is enlarged to include two exogenous variables: the nominal US three-month rate for Treasury bills, which represents external monetary influences, and the commodity price index, which is an indicator of external inflationary pressure.[2] All variables are modelled in levels.[3] The analyses are based on quarterly data and are performed for the period from the fourth quarter of 1986 to the second quarter of 2007.[4] The shocks to the system are identified by means of a Cholesky decomposition, which implies that shocks affect the economy in a preordained chronological way. It may therefore be assumed that the shocks to the GDP deflator, real household housing wealth, the short-term and long-term interest rate and nominal M3 do not affect real GDP contemporaneously, but in a deferred manner. By contrast, M3 is allowed to respond to shocks to all other system variables instantaneously.

The impulse responses generated by our VAR model are robust to different orderings of the endogenous variables: simulations of alternative recursive structures of the economic shocks have no net overall impact on the pattern of the impulse responses. The estimates, moreover, show patterns of impulse responses which are plausible and largely consistent over time even if the sample length and the beginning and endpoints are shifted. The initially positive reaction of nominal M3 to a contractionary interest rate shock is stronger if the quarterly data for the first half of 2007 are included; this is compatible with the observed pronounced comovement of interest rates and the acceleration of monetary growth during this phase.

1 Household housing wealth is included on the basis of the findings in C Greiber & R Setzer, Money and Housing – Evidence for the Euro Area and the US, Deutsche Bundesbank Discussion Paper Series 1, No 12/2007, who find a close relationship between housing wealth/prices and monetary developments over the past few years. — **2** The inclusion of commodity prices is based on ideas presented by C A Sims (1992), Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy, European Economic Review 36 (5), pp 975-1000, and C A Sims & T Zha (1995), Does Monetary Policy Generate Recessions?, Yale University. In these studies, the authors point out that commodity prices represent a key indicator of inflationary pressure, to which the central bank reacts by raising interest rates. If commodity prices were not included, the fact that commodity prices are positively correlated with both the rate of inflation and the short-term interest rate would cause the price level to react positively to the (fuzzily identified) monetary policy shock. This is known as the "price puzzle". — **3** For more on this topic, see the arguments presented by C A Sims, J H Stock & M W Watson (1990), Inference in Linear Time Series Models with Some Unit Roots, Econometrica 58, pp 113-144. — **4** The starting point was set at 1986 in order, among other things, to pay due regard to findings in the literature that some key macroeconomic time series underwent a structural break in the mid-1980s (see eg A McCallum & F Smets (2007), Real wages and monetary transmission in the euro area, Kiel Working Papers No 1360, and F Altissimo, M Ehrmann & F Smets (2006), Inflation persistence and price-setting behaviour in the euro area, ECB Occasional Paper Series No 46).

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points in short-term interest rates, before moving to the expected downward trend from the fifth quarter onwards and, in the long run, converging towards the zero line, which describes the situation the variables would be in had there been no shock.[12] This initially positive response of the nominal money stock to a rate hike can be explained by temporary portfolio shifts. Higher short-term interest rates at first render the short-term investments contained in M3 more attractive than longer-term exposures, leading to a temporary increase in the money stock. The medium-term decline in the money stock then reflects, as generally expected, the fall in demand for credit and the concomitant drop in the creation of money.

... and other macroeconomic variables' response to an interest rate shock

Real GDP initially drops in response to an interest rate shock, bottoms out after some five quarters, but then converges towards zero after approximately ten quarters, demonstrating that the effect of monetary policy on real growth is neutral in the long term. Overall, the impulse response function of real GDP displays a "J"-shaped curve, which is consistent with the results of past analyses.

Interest rates' response curve is also consistent with expectations. The short-term interest rate initially reflects its own positive shock and falls continuously in the first six quarters. It then stagnates below the zero line for some time before gradually converging back towards zero.

Following a contractionary interest rate shock, the long-term rate initially rises, but then drops after approximately two quarters before bottoming out in the fifth quarter and moving back to the zero line in the long term. The initial rise in the long-term interest rate can be explained by the expectations hypothesis regarding the term structure, which holds that long-term interest rates essentially represent an average of expected future short-term interest rates. The subsequent decline can presumably be attributed to the dampening effect that the contractionary interest rate shock has on the economy. A comparison of the long-term and the short-term interest rate movements shows that a central bank rate hike also affects the term structure. Initially, the short-term interest rate rises more than the long-term rate, which triggers the portfolio restructuring mentioned above.

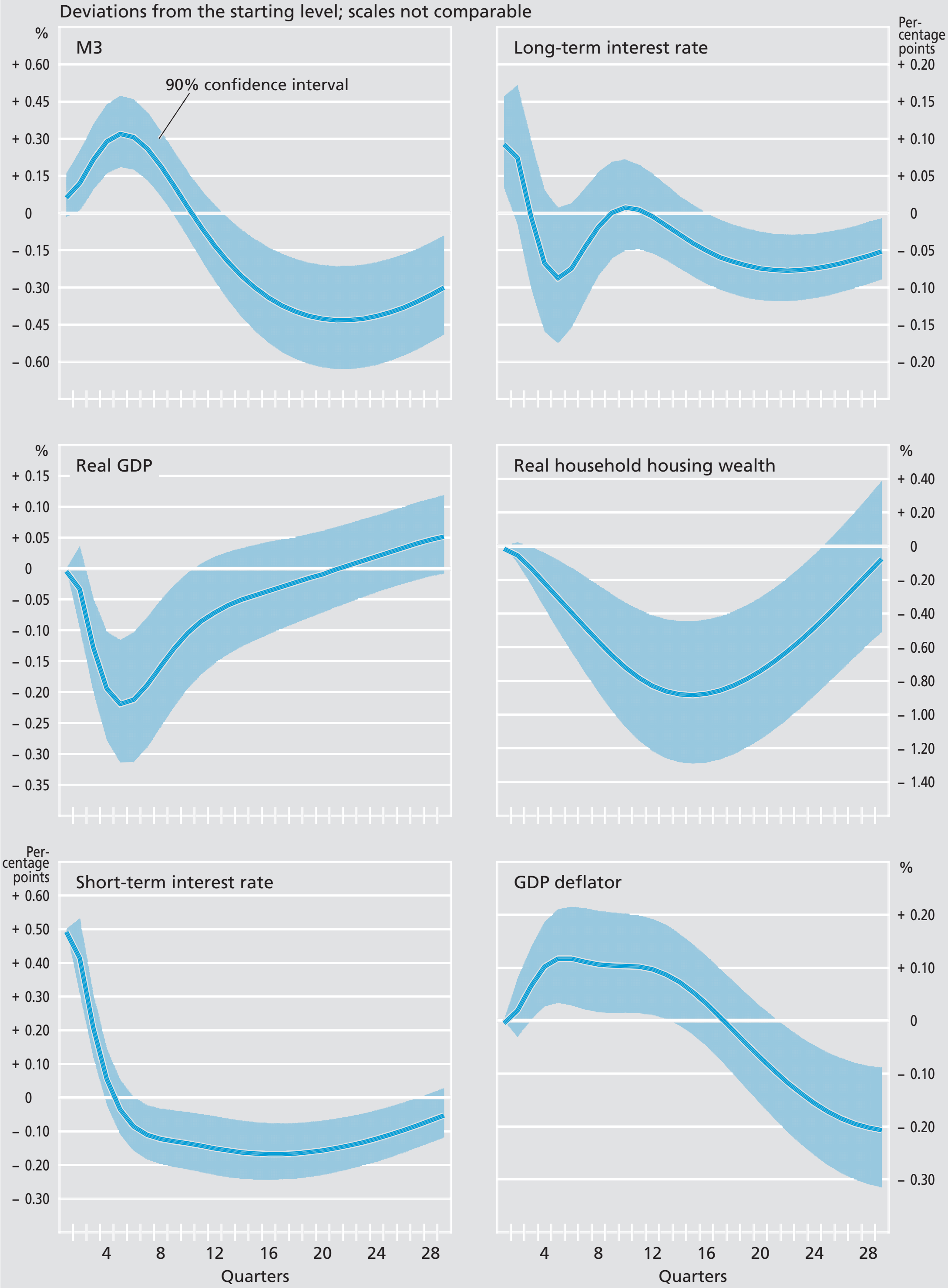
Real housing wealth declines in response to a contractionary interest rate impulse, in an overall "U"-shaped pattern. The impulse response function of real housing wealth therefore backs up both theoretical expectations (higher short-term rates make refinancing more expensive, tending to lead to lower housing demand and lower housing prices) and the results of other analyses.[13]

The GDP deflator initially rises in response to a contractionary interest rate shock and does not start to fall until approximately the fifth

12 The corresponding 90% confidence bands were calculated using 2000 standard bootstrap replications. For a more detailed description and discussion of the results of the approaches described in the following, see B Blaes, Analysing monetary policy transmission in the euro area – evidence from VARs and FAVARs, Deutsche Bundesbank Research Centre, Discussion Paper, Series 1, Economic Studies, forthcoming.
13 See C Greiber and R Setzer (2007), op cit.

VAR: the impulse response functions of selected indicators*

Deviations from the starting level; scales not comparable



* Responses to a simulated one-off 50 bp increase in the short-term interest rate in a vector autoregressive (VAR) model.

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quarter.[14] In the long term, monetary policy displays the expected negative response to the price level. M3 and the price level therefore display fairly similar reactions to a shock to short-term interest rates.

Interest rate hikes boost monetary growth only temporarily

The resulting impulse response functions therefore largely confirm the theoretically derived expectations about the qualitative effects of monetary policy. In terms of monetary growth, which is of particular interest here, the results suggest that the money stock initially increases in response to a contractionary interest rate shock (a one-off rate hike) and only displays the anticipated downward trend in the medium to long term. However, this initial stimulating effect of monetary policy on the money stock should not be overestimated. At their peak, the interest rate hikes carried out from December 2005 contributed less than 1¼ percentage points to the monetary growth of recently just under 9½%. Of late, the interest rate rises of the past have already been dampening monetary growth slightly.

In the recent debate on the analysis of the monetary transmission process, it has increasingly been noted that both central banks and financial market players have much more information at their disposal when making decisions than is reflected in standard VAR models. The scientific literature on this topic points out that the omission of variables that are relevant for central banks' decision-making process in the VAR approach may result in a distorted estimate of the non-systematic component of monetary policy, potentially calling into question the conclusions of the VAR model.[15] In addition, the literature notes that representing the underlying dynamics of some fundamental macroeconomic variables (eg inflation) using only one indicator is insufficient if its meaningfulness is impaired by measurement errors or other statistical problems.[16] In view of these considerations, the robustness of the results derived using the VAR model will, in the following, be verified against a broader analytical framework, particularly in terms of the dynamic structure of monetary developments.

Modification of VAR model using factors

This is effected with the aid of a factor augmented vector autoregressive (FAVAR) approach. The FAVAR model represents a modification of the VAR model in which selected variables are replaced by so-called "factors", which are extracted from a large dataset beforehand using factor analysis techniques. The advantage of the FAVAR model over parsimonious VAR model variants is that all potentially relevant variables can be taken into consideration at once. Therefore, the FAVAR model largely avoids distorted estimates as a result of neglected information (omitted vari-

14 The literature attempts to provide a theoretical explanation for the GDP deflator's initially positive response to a contractionary interest rate shock (see literature on the cost channel of monetary transmission, eg E Gaiotti and A Secchi (2006), Is There a Cost Channel of Monetary Policy Transmission? An Investigation into the Pricing Behavior of 2000 Firms, Journal of Money, Credit and Banking 38, pp 2013-2037).
15 See B S Bernanke, J Boivin and P Eliasz (2005), Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) Approach, The Quarterly Journal of Economics 120 (1), pp 387-422.
16 See also J Boivin and D Giannoni (2006), DSGE Models in a Data-Rich Environment, NBER Working Paper No 12772, and J Boivin, M Giannoni and B Mojon (2008), Macroeconomic Dynamics in the Euro Area, NBER Macroeconomics Annual 2008. As euro-area data were synthetically aggregated up until 1999, the measurement error problem will probably be even more important here.

able bias).[17] The FAVAR model consequently permits a large number of additional variables – including, for example, the components and counterparts of the money stock – to be included in the estimate and their response to monetary measures to be analysed. This allows further insights into the reasons why the money stock initially responds positively to a restrictive interest rate shock.

Analysis including all potentially relevant variables

The estimates are based on a dataset comprising 65 macroeconomic time series for the euro area and were carried out for the observation period from the fourth quarter of 1986 to the fourth quarter of 2006. The body of data was provided by the European Central Bank's area-wide model database (AWM data) and reflects a broad range of economic activity in the euro area.[18] Given the motivation for this study, we have added a few monetary variables (M1, M2, M3, M3 corrected, monetary capital, MFI loans and global money).[19]

FAVAR model results largely confirm VAR results

The results are largely in line with expectations regarding the qualitative effects of monetary policy.[20] They therefore confirm the results of the VAR approach outlined above. Interestingly, there are no temporary positive price reactions using the FAVAR model. This outcome consequently supports the objection raised by several authors[21] that using a single indicator to represent inflation dynamics – this was the GDP deflator in the small VAR model version used above – may be insufficient.[22]

Monetary dynamics under the FAVAR approach

As with the VAR model, nominal M3 initially rises (albeit with weak statistical significance) in response to a one-off positive impulse to the short-term interest rate before showing the expected falling pattern from roughly the fifth quarter and trending towards the zero line in the long run. This confirms the result of the VAR approach. Comparing the reaction of M3 with the impulse response function for the M3 series corrected for portfolio restructuring in the years 2001 to 2003, it is evident that the initial upward response of nominal M3 is probably largely based on portfolio reallocations. The greater attractiveness of short-term investments as a result of the interest rate hike temporarily resulted in a noticeable increase in liquidity. The impulse response function for M1 provides more evidence for this idea: the liquid, non-interest-bearing (cash) or low-interest (overnight deposits) monetary assets contained in M1 initially react negatively to a one-off interest rate shock, thus raising the opportunity costs of holding cash, though the medium to long-term effect proves not to be significant.

17 The quality of the estimate depends on how well the extracted factors summarise the available information (ie the data set).
18 For a detailed description of AWM data, see G Fagan, J Henry and R Mestre (2001), An Area-Wide Model (AWM) for the Euro Area, ECB Working Paper No 42.
19 All time series (with the exception of interest rates) were logarithmised and, where necessary, differentiated to maintain the stationary pattern. As the time series' different scales could impair factor extraction, all series were also standardised to mean zero and variance one.
20 See B Blaes, op cit for more details on the specifications and results.
21 See, for example, C A Sims (1992), op cit.
22 Besides the GDP deflator, the FAVAR model also takes into account other price indicators such as HICP, the consumption deflator, the global GDP deflator and the gross investment deflator.

The FAVAR model of monetary policy transmission

The fundamental idea of the FAVAR approach rests in merging the large amount of macroeconomic data into a small number of variables (also known as factors) and then in using them for analytical purposes in a VAR model.[1] With these ideas in mind, let it be assumed in the following that the (N x 1) vector of macroeconomic time series X_t can be represented as a linear combination of the (K x 1) vector of unobserved vectors F_t (K relatively small, $K << N$) and an observed factor R_t, which represents the interest rate variable, such that

(1) $X_t = \Lambda^f F_t + \Lambda^r R_t + e_t$,

where Λ^f is a (N x K) matrix of factor coefficients (factor loadings). Λ^r is the (N x 1) vector with the coefficients of the observed factor R_t, and e_t is the (N x 1) vector of error terms with mean zero and which are possibly serially and mutually weakly correlated. Equation (1) implies that the dynamics of each individual time series in the vector X_t are driven by the common factors (F_t, R_t) and an idiosyncratic component e_t, though e_t can also contain measurement error.

It is additionally assumed that the common factors (F_t, R_t) show the following dynamic process,

(2) $\Phi(L) \begin{bmatrix} F_t \\ R_t \end{bmatrix} = v_t,$

where $\Phi(L) = I - \Phi_1 L - ... - \Phi_d L^d$ is the matrix of the lag polynomials of order d. The error term v_t is mean zero with covariance matrix Ω_v. Equation (2) represents the VAR model in (F_t, R_t).

The FAVAR model used here is estimated in a two-step procedure. The first step is to identify the factors, the second to estimate the VAR model. The relevant monetary policy shock is identified using a Cholesky decomposition under the assumption that the monetary policy shock has only a lagged impact on the unobserved factors F_t.

In the first step of the analysis, K common factors $\hat{C}(F_t, R_t)$ are estimated from all available time series X_t.[2] For now, the fact that the short-term interest rate R_t, in keeping with the assumption, represents an observed factor shall be disregarded. Since each and every linear combination which underlies the estimated principal components $\hat{C}(F_t, R_t)$ now also contains the observed factor R_t, it is not possible to clearly identify the policy shock recursively. Therefore, the next step is to adjust the estimated factors $\hat{C}(F_t, R_t)$ for the influence of the observed factor R_t. To this end, a distinction is made between the variables that do not react in the same quarter to the policy shock and the variables that may react contemporaneously to a policy shock; a vector $\hat{F}_t^S$ of the principal components is subsequently extracted from the former category. Since these factors, by definition, are not contemporaneously correlated with the observed factor R_t, the impact of the observed factor R_t can be calculated without bias using the following multiple regression,

(3) $\hat{C}(F_t, R_t) = b_S \hat{F}_t^S \ + \ b_R R_t \ + \ \varepsilon_t,$

where b_S is the coefficient matrix of the unobserved factors, b_R the coefficient vector of the observed factor and ε_t a vector of the random variables with mean zero and covariance matrix Ω_ε. The unobserved factors $\hat{F}_t$ can be calculated by subtracting the (quantitative) effect of the observed factor R_t estimated in equation (3) from $\hat{C}(F_t, R_t)$. The VAR model in $\hat{F}_t$ and R_t can then be estimated consistently and the policy shock can be clearly identified recursively with the selected ordering of the factors (R_t as the last element of the monetary transmission chain).

In this study, the number of factors is determined on the basis of a selective comparison of VAR model quality characteristics. In the preferred specification, eight factors are extracted, accounting together for around 80% of the total variance in the data studied. The estimate of the FAVAR model in equation (2), using the identified factors, is then obtained as

(2') $\Phi(L) \begin{bmatrix} \hat{F}_t \\ R_t \end{bmatrix} = v_t,$

with $\Phi(L) = I - \Phi_1 L - \Phi_2 L^2$ as the matrix of the second-order lag polynomials and $\hat{F}'_t = (\hat{F}_{1t}\ \hat{F}_{2t}\ \hat{F}_{3t}\ \hat{F}_{4t}\ \hat{F}_{5t}\ \hat{F}_{6t}\ \hat{F}_{7t})$.

The impulse response functions for the relevant variables in X_t can be calculated as follows,

(4) $IAF_X^h = \sum_{f=1}^{7} \hat{\Lambda}^f I\hat{A}F_{\hat{F}}^h + = \hat{\Lambda}^r I\hat{A}F_R^h$,

where $\hat{\Lambda}^f$ $(f = 1, ..., 7)$ and $\hat{\Lambda}^r$ indicate the factor coefficients estimated according to equation (1), $I\hat{A}F_{\hat{F}}^h$ and $I\hat{A}F_R^h$ and are the impulse response functions of the factors calculated on the basis of the FAVAR model in equation (2') and h indicates the observation horizon (28 quarters). The corresponding 68-percent confidence bands for the impulse responses are calculated using the standard bootstrap procedure with 1000 replications of equations (1), (2') and (4).[3]

1 The following ideas are based on B S Bernanke, J Boivin and P Eliasz (2005), Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) Approach, The Quarterly Journal of Economics 120 (1), pp 387-422. — **2** The factors are estimated with the aid of the static principal components method presented by J H Stock and M W Watson (2002), Macroeconomic Forecasting Using Diffusion Indexes, Journal of Business and Economic Statistics 20 (2), pp 147-162. — **3** Note that it is quite commonplace in the FAVAR model literature to set the confidence bands at 68% (see G Lagana & A Mountford (2005), Measuring Monetary Policy in the UK: A Factor-Augmented Vector Autoregression Model Approach, Manchester School 73 (S1), pp 77-98; J Boivin & M Giannoni (2008), Global Forces and Monetary Policy Effectiveness, NBER Working Paper Series No 13736).

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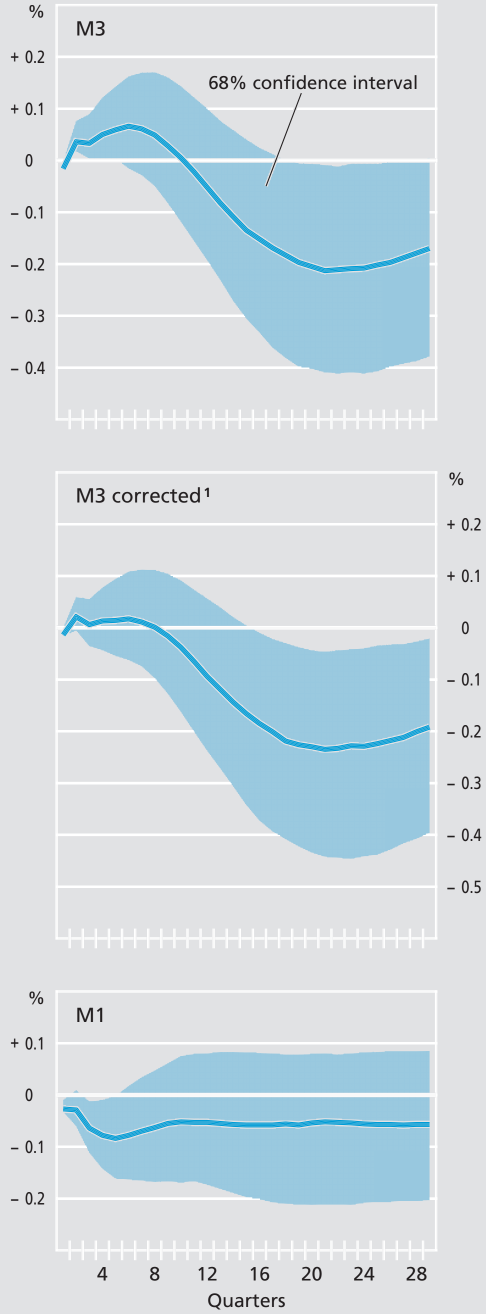
Conclusion

Overall, monetary growth is determined by numerous factors whose importance may vary over time. An analysis based on the MFI sector's consolidated balance sheet helps ascertain whether the increase in the money stock in terms of the balance sheet counterparts is the result more of a corresponding increase in banks' asset business or is associated with a particularly weak longer-term propensity to invest with credit institutions (monetary capital formation) on the part of non-banks. Both sources of money creation have been shaping monetary trends since the introduction of the euro. From 2001 to 2003, uncertainty resulted in extensive portfolio restructuring; since mid-2004, credit-driven monetary growth has dominated. Distinguishing such causes has implications for monetary policy. Whereas portfolio restructuring as a result of uncertainty is likely to have a lesser impact on consumer prices, a largely credit-driven increase in the money stock is greater cause for concern about stability.

What contribution macroeconomic fundamentals such as income and the interest rate situation actually make to monetary growth can only be established on the basis of empirical research. Recent studies have shown, for example, that housing variables have, in the past few years, become important for explaining money demand. However, even this approach can currently only account for around 50% of monetary growth. Nevertheless, the long-term correlation appears to be

FAVAR: the impulse response functions of selected indicators *

Deviations from the starting level



* Responses to a simulated one-off 50 bp increase in the short-term interest rate in a factor augmented vector autoregressive (FAVAR) model. — 1 M3 corrected for the effect of portfolio shifts caused by uncertainty.

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masked by temporary and constantly changing short-term influences.

Among other things, the VAR model shows that the effects of interest rate changes on monetary trends display alternating signs. Interest rate increases initially promote monetary growth, but exert a dampening influence in the longer term. One important explanation for this dynamic monetary response could be that broad monetary aggregates temporarily benefit from a flatter (or even inverted) term structure before the more restrictive monetary policy dampens bank lending in the longer term, in turn strengthening monetary capital formation. The temporary effect of an interest rate increase in upping the money stock should therefore not be overrated. For example, the rate hikes carried out since December 2005 boosted monetary growth by no more than 1¼ percentage points at their peak. Recently, the interest rate rises of the past have already been dampening monetary growth slightly.