ENHANCING MONETARY ANALYSIS

Monetary analysis has a prominent role in the ECB's monetary policy strategy. On the basis of the robust long-run relationship between monetary growth and inflation, it focuses on the assessment of medium to long-term trends in price developments. Over time, the tools used by ECB staff to conduct the monetary analysis have necessarily evolved. In a continuous process of refinement, they have been both updated – as new data become available and methodological advances are made – and extended to address the new challenges to the analysis thrown up by shocks to and structural changes in the financial sector and the whole economy.

In mid-2007 – before the onset of the financial crisis had revived general interest in money, credit and financial developments – the Governing Council decided to give additional impetus to this ongoing evolutionary process of tool refinement by endorsing a research programme to enhance the ECB's monetary analysis. This article describes the results of this agenda and discusses how they have helped improve and deepen the contribution of monetary analysis to monetary policy decisions in the pursuit of the ECB's primary objective of maintaining price stability in the euro area over the medium term.

1 INTRODUCTION

Monetary analysis has a prominent role in the ECB's monetary policy strategy, as one element of the two-pillar framework for the assessment of risks to price stability in the euro area.

The two pillars – the economic analysis and the monetary analysis – constitute distinct, but complementary, perspectives on the inflation process, which are used to organise and assess incoming data, structure deliberations and, ultimately, guide monetary policy decisions aimed at maintaining price stability. By including monetary analysis, the ECB's strategy ensures that important information stemming from money and credit, typically neglected in conventional cyclical forecasting models of the economy, is considered in the formulation of monetary policy decisions, thus ensuring a "full-information approach".

A monetary policy strategy that pays due attention to the implications of monetary developments for inflation trends helps maintain the appropriate medium-term orientation of monetary policy. Conducting a monetary analysis ensures policy discussions give due consideration to underlying nominal developments, thus providing a nominal anchor for the overall framework and thereby helping to maintain the focus on the mandate of price stability. The ECB's strategy assigns monetary analysis the role of facilitating a cross-check, from the medium to long-run perspective, of the assessment of risks to price stability.

The central tenets of the ECB's monetary analysis (recalled in Section 2) have remained unchanged since the introduction of the single monetary policy in 1999: the goals and overall approach exhibit a high degree of continuity. By contrast, the tools used by the ECB to conduct its monetary analysis have continually evolved. In part, this evolution reflects improvements in the availability of data, methodological advances and their implementation, and the benefits of "learning-by-doing" over the first decade of the ECB's existence. At the same time, tools have been introduced to address the new challenges to the analysis of monetary developments that were not foreseen at the outset, such as the exceptional portfolio shifts into monetary assets observed in 2001-03.

In mid-2007 the Governing Council decided to give additional impetus to this evolutionary refinement of the analytical tools by endorsing a research programme to enhance the ECB's monetary analysis. Further momentum for this agenda was provided by the onset of the global financial crisis in the second half of 2007, which reinvigorated central banks' interest in money, credit and, more generally, financial

developments. This article describes the results of the research agenda and the consequent improvements in the ECB's monetary analysis and its support of monetary policy decisions.[1]

2 THE SCOPE AND NATURE OF THE ECB'S MONETARY ANALYSIS

The role of monetary analysis in the ECB's monetary policy strategy is founded on the well-documented link between trends in monetary growth and inflation. There is compelling empirical evidence showing that, at lower frequencies, i.e. over medium to longer-term horizons, inflation shows a robust positive association with monetary growth. This positive association has been established both across countries and across monetary regimes.[2] Importantly, monetary growth is found to lead inflation at low frequencies, although the closeness of this link may differ in intensity over time and according to circumstances. In particular, the low frequency link between monetary growth and inflation becomes most clearly visible in an environment of material low frequency movements in money and prices and is, conversely, less visible in the absence of such movements. These observations have two important implications for central banks. First, the low frequency component of monetary growth is instrumental in identifying longer-term inflation trends. Second, identifying the low frequency signal in monetary developments, which is relevant for longer-term risks to price stability, is more challenging than merely observing the trend of the growth rate of a specific monetary aggregate.[3]

At the same time, analysing higher frequency monetary developments in the context of a broad-based and comprehensive framework for monetary analysis helps policy-makers to assess and understand shorter-term macroeconomic and financial phenomena, which may give rise to risks to price stability over the longer-run if ignored. The detailed analysis of monetary dynamics provides useful information about financing conditions and the financial structure, as well as the condition and behaviour of banks, which can be critical for understanding the transmission mechanism and, more broadly, the state of the business cycle. The insights gained from this dimension of monetary analysis have proved to be particularly valuable in tailoring the ECB's monetary policy response to the most recent financial crisis. Furthermore, the analysis of monetary dynamics helps policy-makers to put asset price developments into perspective and to form a view regarding the possible build-up of financial imbalances. In this respect, the ECB's monetary pillar can be seen as an appropriate approach to the challenges faced by all central banks in looking beyond standard forecasting horizons, notably when confronted by inflated asset prices and evolving financial imbalances. The empirical link between monetary developments and evolving imbalances in asset and credit markets implies that the two-pillar strategy, with the important role assigned to monetary analysis, may enable these imbalances to be detected at an early stage and ensure a timely, forward-looking response to the implied risks to financial, economic and price stability.

The ECB's monetary analysis combines a suite of econometric tools for model-based assessment and detailed institutional analysis. The former includes empirical money and credit demand models, statistical filters, and forecasting, as well as medium-scale structural models. The institutional analysis entails, inter alia, a comprehensive examination of bank balance sheet data, including the components and counterparts of and sectoral contributions to monetary aggregates.

1 A comprehensive presentation of the research conducted is provided in Papademos, L. and Stark, J. (eds.), *Enhancing monetary analysis*, ECB, Frankfurt am Main, 2010.
2 See, for instance, Benati, L., "Long-run evidence on money growth and inflation", *Working Paper Series*, No 1027, ECB, Frankfurt am Main, March 2009.
3 For a more detailed discussion and references to the academic literature, see Chapter 1 in Papademos, L. and Stark, J. (eds.), op. cit.

The multifaceted nature of monetary analysis means that its implications cannot be easily subsumed into a single indicator or model that simultaneously simplifies the presentation of the analysis and retains the necessary comprehensive assessment of monetary developments. This has certainly been the ECB's experience in the practical conduct of monetary analysis in the dozen years since the start of the single monetary policy. Accordingly, and in line with the experience of other forms of macroeconomic analysis – not least the ECB's economic analysis – and comparable forecasting exercises at other central banks, the ECB's monetary analysis will continue to rely on a suite of tools and models.

At the same time, the development and maintenance of tools that support any analysis oriented towards deriving policy-relevant assessments is necessarily a continuous process. The past decade – a period characterised by continuous financial innovation and structural changes in the financial system – gradually revealed shortcomings in the analytical toolbox of the ECB's monetary analysis. Given the importance of monetary analysis, including for the understanding of macroeconomic dynamics and the monetary policy transmission mechanism, it was deemed necessary to address these shortcomings.

3 THE AVENUES OF THE "ENHANCING THE MONETARY ANALYSIS" RESEARCH AGENDA

The recognition of the existence of areas in the ECB's monetary analysis toolbox where further systematic research efforts were warranted led the Governing Council to endorse in July 2007 a research agenda to enhance its monetary analysis.[4] This decision predated the emergence of tensions in global financial markets and was aimed at enriching the tools available within the existing framework and monetary policy strategy.

Four main avenues of research were identified:

1. improving models of euro area money demand;
2. developing money-based indicators of risks to price stability;
3. incorporating money and credit in structural empirical general equilibrium models;
4. exploring the role of money and credit in asset prices and extending the framework for cross-checking and risk analysis.

The following sub-sections set out the rationale for each of the specific avenues of research and outline the main results of the analytical work undertaken.

3.1 IMPROVING MODELS OF EURO AREA MONEY DEMAND

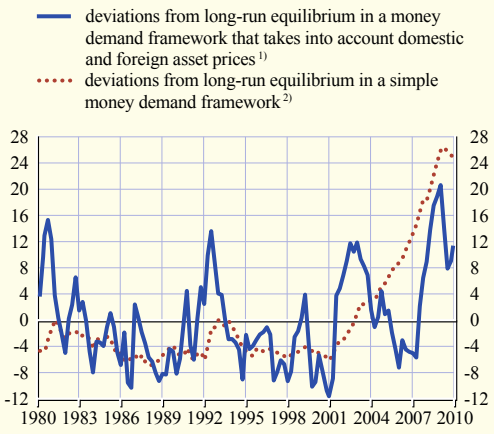
The episode of exceptional portfolio shifts into euro area M3 on account of the heightened economic and financial uncertainty during the period 2001-03 stretched the workhorse money demand specifications available at the time. Eventually, standard statistical tests indicated that these money demand models had become unstable (see Chart 1).

For the purposes of real-time policy preparation, ECB staff froze the parameters of the existing models and introduced judgemental adjustments to the M3 series to account for the portfolio shifts that the conventional models failed to capture.[5] Such an approach helped to structure the real-time assessment of monetary developments during this challenging period. Yet the ad hoc nature of the judgemental adjustments was clearly inadequate as a long-term solution.

4 See Stark, J., "Enhancing the monetary analysis", speech at the conference "The ECB and its Watchers IX", Frankfurt am Main, September 2007 (available at: http://www.ecb.europa.eu/press/key/date/2007/html/sp070907_1.en.html).
5 See the article entitled "Monetary analysis in real time", *Monthly Bulletin*, ECB, October 2004.

Chart 1 Long-run money demand relationships from money demand models

(percentages of the stock of M3)



Source: ECB calculations.
1) Based on the model presented in De Santis, R.A., Favero, C.A. and Roffia, B., "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability", *Working Paper Series*, No 926, ECB, Frankfurt am Main, August 2008.
2) Based on the model presented in Calza, A., Gerdesmeier, D. and Levy, J., "Euro area money demand: Measuring the opportunity costs appropriately", *IMF Working Paper Series*, No 179/01, IMF, Washington D.C., 2001.

While narrowly defined money demand stability is not a precondition for the meaningful conduct of monetary analysis, instabilities in the money demand models used at that time clearly indicated that the models needed to be refined in order to codify and systematise the judgemental adjustments.[6] The natural starting point for enhancing euro area money demand models was therefore clear. Model extensions that allow for portfolio shifts into and out of monetary assets were required. With regard to modelling this behaviour, additional arguments had to be incorporated into the conventional money demand specification by placing money demand within a broader context of portfolio choice and accounting for the impact of uncertainty.

More specifically, this has entailed investigation of a richer set of explanatory variables, notably wealth, and a broader set of opportunity costs, including yields on foreign assets (see Box 1 entitled "Money demand and housing wealth"). It has also involved the modelling of money demand in frameworks that feature multiple long-run relationships, rather than modelling money demand in isolation from other portfolio allocation decisions. A parallel stream of work has sought to analyse money-holding behaviour at the sectoral level. This analysis has established that sectoral money holdings differ in their interaction with their macroeconomic determinants, but stable relationships with these economic variables can be found. Finally, another strand of analytical work related to money demand focused on applying the Divisia approach for the compilation of euro area monetary aggregates.[7] This approach weighs the components included in the aggregate according to the estimated monetary services they offer and thereby obtains a measure of money that in principle is not affected by portfolio considerations.

Improvements made in the area of money demand models have restored the ability to explain euro area monetary developments in a formal, statistically stable money demand framework and have therefore led to a deeper understanding of the causes of monetary growth. The improvements demonstrate that the real-time assessment of monetary developments by ECB staff over the past challenging decade can be embodied in money demand models in a manner that meets the standards imposed by a battery of econometric tests. Moreover, these results represent an important – but, perforce, ex post – validation of assessments made by monetary analysis since the introduction of the euro.

At the same time, the new vintage of money demand models has not made the interpretation of traditional monetary policy indicators – such as "money gaps" or "monetary overhangs" – simple. In the enhanced models, the interpretation

6 For instance, the quantitative estimates of the impact of the exceptional portfolio shifts in 2001-03. For more details, see the box entitled "Approaches to identifying and estimating portfolio shifts into and out of M3", *Monthly Bulletin*, ECB, January 2005.

7 For a methodological exposition of the Divisia approach in a monetary union setting, see Barnett, W.A., "Multilateral aggregation-theoretic monetary aggregation over heterogeneous countries", *Journal of Econometrics*, Vol. 136(2), pp. 457-482, 2007.

of monetary developments is dependent on an assessment regarding the sustainability of wealth and asset price developments. Inclusion of additional arguments in money demand specifications has therefore complicated the assessment and presentation of the implications of monetary developments for risks to price stability.

Moreover, through the enhancement of the money demand models, it has become apparent that no single model can be expected to provide a fully satisfactory explanation of monetary developments at all times. In this respect, a robust and comprehensive monetary analysis needs to consider different models, the prominence of which may vary depending on the dominant forces driving monetary developments.

Identifying stable specifications of euro area money demand is a significant achievement. However, as experience over the past decade has amply demonstrated, it would be unrealistic to view the new vintage of money demand models as invulnerable to the impact of new financial innovations and other structural changes. Hence, there is a need for a continuing effort to explain and interpret monetary developments: the results of the agenda to enhance monetary analysis do not mark the end of this effort. Yet the likelihood of a re-emergence of instabilities in the future should not be viewed negatively. On the contrary, the statistical breakdown of money demand models can support policy analysis. If, in particular, this breakdown is due to changes in money supply behaviour, it would most likely be linked to risks to price stability. In this sense, indications of instability of money demand models trigger increased efforts to understand the fundamental forces responsible for this instability and to focus on the behaviour of the "money-creating" sector.

Box 1

MONEY DEMAND AND HOUSING WEALTH

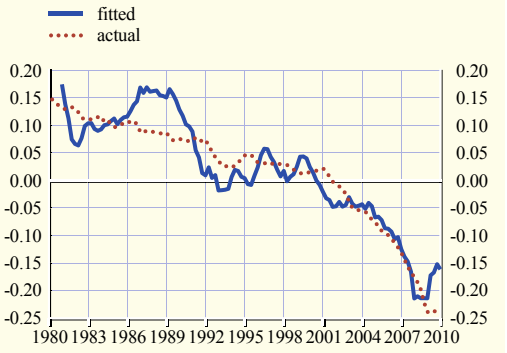
Building on the real-time assessment of portfolio shifts into monetary assets,[1] the agenda to enhance monetary analysis has developed a new generation of money demand models that extend conventional specifications to include asset prices and wealth, thus placing money demand in a broader context of portfolio choice. The inclusion of such arguments in the determination of money holdings has a long tradition in monetary theory.[2]

De Santis et al. (2009)[3] analyse the effects of international portfolio allocation on euro area money demand. Beyer (2009)[4] focuses on the role played by the evolution of housing wealth in explaining the demand for euro area M3 over the past decade. In the money demand equation of the model, real balances adjust to excess long-run money demand and are positively related to excess real wealth growth. The latter shows the relevance of wealth effects in money demand. This wealth effect is complemented by a substitution effect. The substitution channel of wealth is embedded in the long-run real money equilibrium relationship itself. There, real wealth is negatively related to the level of real money balances.

1 See the article entitled "Monetary analysis in real time", *Monthly Bulletin*, ECB, October 2004.
2 See, for example, Friedman, "The quantity theory of money: A restatement", in Friedman, M. (ed.), *Studies in the Quantity Theory of Money*, University of Chicago Press, Chicago, 1956; and Brainard, W. and Tobin, J., "Pitfalls in financial model building", *American Economic Review,* Vol. 58(2), May 1968, pp. 99-122.
3 See De Santis, R.A., Favero, C.A. and Roffia, B., "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability", *Working Paper Series,* No 926, ECB, Frankfurt am Main, August 2008.
4 See Beyer, A., "A stable model for euro area money demand: revisiting the role of wealth", *Working Paper Series,* No 1111, ECB, Frankfurt am Main, November 2009.

Looking at the data, those wealth effects are crucial for explaining money demand. On the one hand, the strength of M3 growth that was observed in the first half of the previous decade and that has led to a break in trend velocity is associated with a rise in housing wealth. Yet on the other hand, during the financial crisis housing wealth and the growth of M3 declined sharply.

Actual M3 income velocity and a fitted measure based on Beyer (2009)



Sources: ECB and Beyer (2009) updated.

More specifically, using vector error correction model (VECM) techniques that are standard in the literature and using data for the period 1980-2007, Beyer establishes empirically stable long-run relationships among money, prices, income, housing wealth and interest rates in the euro area. These estimated relationships have remained stable (on the basis of the standard statistical tests) out of sample, even in the face of the financial crisis that emerged in mid-2007. As can be seen from the chart, this model can broadly explain the evolution of the M3 income velocity observed in the euro area over the past decade.

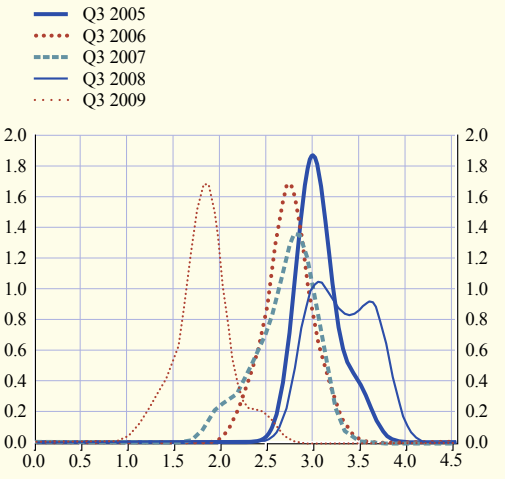
Moreover, the model can be used to produce conditional projections of inflation and money growth, which form a benchmark against which to compare observed monetary developments in real time.

3.2 DEVELOPING MONEY-BASED INDICATORS OF RISKS TO PRICE STABILITY

Money-based inflation risk indicators are a convenient way to summarise and synthesise the information of the detailed monetary analysis, for both internal and external communication, by mapping it onto an outlook for risks to price stability. The information stemming from money of relevance to the assessment of risks to price stability is embedded in the persistent or lower-frequency component of those developments. These risk indicators are geared towards providing an outlook for average inflation over a medium-term horizon, acknowledging that monetary developments cannot be expected to provide indications for inflation rates at a particular point in time in the future (as provided by the economic analysis). This is done by exploiting the leading indicator properties of money for inflation that are revealed at low frequencies.

Chart 2 Risk dispersion of money-based inflation indicators on average for the period six quarters ahead

(x-axis: annualised percentage changes of the HICP; y-axis: probability densities)



Source: ECB estimates.
Notes: A normal kernel estimator is used in the construction of the risk dispersion measure. The quarter denotes the end of the sample used to derive the indicators.

From the outset, a variety of money-based inflation risk indicators have been employed in the analysis, each using a different measure of money or credit growth or underlying monetary expansion.[8] Chart 2 provides a summary of the readings from the set of indicators used, illustrating the dispersion of the signals from the individual indicators. Until the onset of the financial turmoil, these indicators, collectively, had performed reasonably well and had been fairly unbiased estimators of inflation when considering, for instance, the larger and downward errors made by commercial forecast providers. This notwithstanding, following the start of Stage Three of EMU they tended, at times, to exhibit excess volatility, which made their indications difficult to interpret and communicate.[9]

Against this background, it was recognised that these indicators could be enhanced to better reflect the notion of persistence that is embodied in the robust longer-term relationship between money growth and inflation. The identification of the need for such improvements gave rise to a second avenue in the research agenda to enhance monetary analysis.

In order to address the shortcoming that the inflation risk indicators at times exhibited excess volatility, the research conducted was oriented towards rendering the indicator models more robust. Experience suggests that it is often the simpler tools that provide this robustness. It was also recognised that it is unlikely that a single indicator will outperform all others at all times. In this respect, robustness can be viewed as deriving from the ability to cut across a set of different tools and indicators when gauging inflationary risks.

The analytical efforts made with regard to this avenue have improved the tools available for constructing such money-based risk indicators. More specifically, the enhancement has given rise to extensions of the bivariate setting that move in three main directions: i) from bivariate to multivariate models, exploiting large data sets such as factor models; ii) from models where the information stemming from money is extracted from its growth rate to models where it is (also) extracted from its level relative to its economic determinants; and iii) from linear to non-linear models, for instance by introducing the notion of regime switching (see Box 2, "Monetary developments as indicators of inflation"). Overall, the work undertaken has adapted techniques successfully employed for assessing real economic developments to the requirements of monetary analysis. The increased sophistication in the tools implies that monetary analysis is better placed to exploit all the relevant information in order to derive the persistent and common part of money and inflation.

8 For more details, see the box entitled "Inflation forecasts derived from monetary indicators", *Monthly Bulletin*, ECB, March 2005.

9 See Fischer, B., Lenza, M., Pill, H. and Reichlin, L., "Money and monetary policy: the ECB experience 1999-2006", in Beyer, A. and Reichlin, L. (eds.), *The role of money: money and monetary policy in the 21st century*, ECB, Frankfurt am Main, 2008, pp. 102-175.

Box 2

MONETARY DEVELOPMENTS AS INDICATORS OF INFLATION

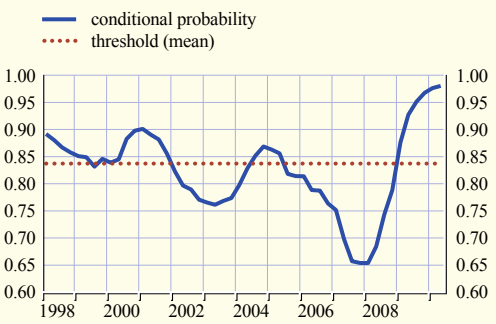
In recent years inflation in the euro area (and elsewhere) has become more difficult to forecast. By implication, the predictive power of money (and other economic variables) with regard to future inflation has declined. In large part, this reflects the success of monetary policy in stabilising inflation rates at levels consistent with price stability. Through maintaining low and stable inflation rates by exploiting the information in indicator variables, the reduced-form indicator properties of these variables for inflation have diminished and/or become blurred.

However, this does not imply that monetary developments can now be safely ignored when it comes to formulating monetary policy decisions. On the contrary, it is precisely because previous monetary policy decisions have appropriately embodied the information stemming from money that the reduced-form information content of money has diminished.

As a result, the danger exists that if monetary dynamics were to go off track, inflation could shift from the current benign regime of price stability to a new and persistently high (or low) inflation regime.

Conditional probability of the euro area staying in a low inflation regime

(probability densities)



Sources: Amisano and Fagan (2010) updated.
Notes: The horizontal axis refers to the latest observation available at the time the risk assessment is conducted. The low inflation regime features average inflation of 1.6%.

In a recent paper, Amisano and Fagan (2010)[1] explore such considerations using a non-linear model that allows for distinct regimes and thereby permits persistent shifts in inflation trends to be captured better than in conventional linear models. They propose a model in which the inflation process is characterised by two states: a high and a low inflation regime. The probability of shifting from one regime to another is endogenous within the model and derives from a smoothed measure of money growth. Using Bayesian techniques, the model is applied to the euro area, Germany, the United Kingdom, Canada and the United States using data from the 1950s to the present.

This approach therefore embodies two key elements. First, the estimation sample includes periods of greater inflation volatility (and, by implication, less successful monetary policy-making) than in recent years. Since both inflation and monetary growth are more variable over this sample than seen during Stage Three of EMU, these data reveal more about the underlying relationship between money growth and inflation. Second, the technique employed focuses on more persistent changes in inflation developments (essentially shifts in the average rate of inflation), thereby concentrating on the low frequency relationship between money and inflation. This is more robust than the relationship at higher frequencies, where many other factors also influence price developments.

Model estimates suggest that a smoothed measure of broad money growth (corrected for real-time estimates of trend velocity and potential output growth) has valuable leading indicator properties for switches between inflation regimes. In this framework, money growth therefore provides an important early warning of risks to price stability.

As an illustration, the chart shows the model's estimates – derived from the evolution of monetary growth – of the probability of the euro area remaining in a low inflation regime. To offer a reference for comparison, the horizontal line shows this probability computed at "neutral" monetary conditions (i.e. with monetary growth at its sample mean). On the basis of the money growth indicator, the chart shows that risks to price stability over the medium term increased steadily between early 2005 and end-2007, but have decreased subsequently given the deceleration in monetary dynamics seen over the past three years.

1 See Amisano, G. and Fagan G., "Money growth and inflation: a regime-switching approach", *Working Paper Series,* No 1207, ECB, Frankfurt am Main, June 2010.

3.3 INCORPORATING MONEY AND CREDIT IN STRUCTURAL GENERAL EQUILIBRIUM MODELS

Extracting the implications of monetary developments for future inflation, as discussed in Section 3.2, can benefit from a better understanding of the process by which inflation is determined. In general, this understanding relies on developing a structural view of the economic behaviour determining the interaction between price-setting, spending and monetary and financial decisions. Over the past two decades, significant progress has been made in formulating dynamic general equilibrium models of monetary policy and price developments that embody a rigorous characterisation of agents' decisions, including the constraints they face and the information set they use. In order to allow monetary developments to play a meaningful role in inflation determination, these models have been recently extended to embody financial frictions and a banking sector. The resulting models allow for a more structural interpretation of money and credit developments, which fosters a theoretically consistent and empirically coherent understanding of the role of money in the economy (see Box 3 entitled "Monetary developments and macroeconomic dynamics: a structural interpretation").

Of course, the significant benefits implied by such an approach do not come without cost. Notably, conclusions and insights derived from dynamic general equilibrium models are "model-specific". In other words, the analysis relies on the validity of the underlying theoretical assumptions describing the behaviour of firms, households, financial intermediaries and policy-makers. That said, the empirical performance of the latest vintage of models in explaining macroeconomic time series has been good and often comparable with that of purely statistical models. This lends support to the view that the underlying model structure does capture important features of economic behaviour.

Analysis using dynamic general equilibrium models complements the interpretation of monetary developments on the basis of money demand models in three ways. First, it provides another perspective on the forces driving the monetary data. One of the challenges faced by monetary analysis is to disentangle transient movements in monetary data that do not pose risks to price stability (e.g. pure portfolio shifts) from less benign monetary phenomena that should not be left unchecked by the central bank. A structural model is a natural candidate to perform such a filtering exercise. The structure of the model provides the necessary restrictions to identify the structural shocks driving macroeconomic, monetary and financial variables. Having obtained an estimate of the structural shocks, it is possible, for instance, to compute a measure of "underlying" money that excludes the identified portfolio shifts.

Second, analysis based on general equilibrium models provides insights into the transmission of monetary and financial shocks to price formation and, more broadly, macroeconomic developments. This is useful for establishing regularities that can be exploited in the real-time analysis to assess the extent and timing of the risks to price stability stemming from the monetary sphere. Structural general equilibrium models that incorporate an active role for money and credit offer a formal and disciplined approach to explaining the money-holding decisions of households and firms. For example, these models provide insights into the interactions between monetary aggregates and other variables through households' portfolio choices and banks' decisions about the provision of credit and means of payment. Thus, such models ultimately entail the investigation of the transmission mechanism through which the evolution of money and credit can influence price developments. Analysis based on general equilibrium models has regularly been used to corroborate the interpretations derived from other more partial equilibrium (money and loan demand) and institutional analyses.

Third, these models – unlike their reduced-form counterparts – can be used to simulate the impact of alternative scenarios and projected trajectories for monetary and financial variables on inflation and the macroeconomy. The structural nature of the models lends itself to counterfactual experiments. In this sense, the models provide a technical input into the Governing Council's cross-checking, which is the aim of the fourth avenue discussed below.

Box 3

MONETARY DEVELOPMENTS AND MACROECONOMIC DYNAMICS: A STRUCTURAL INTERPRETATION

Most new generation structural general equilibrium models treat monetary and financial factors as a "veil". Consequently, monetary and financial factors do not represent an independent source of shocks affecting real economic activity and inflation, and do not alter the transmission of shocks originating outside the monetary/financial sector. In contrast to many other models of this type, Christiano, Motto and Rostagno (2007 and 2010)[1] develop a dynamic general equilibrium model of the euro area that includes an explicit analysis of money-holding decisions and a liquidity-creating banking sector. This allows for the definition of a broad array of monetary and credit aggregates and can thus address issues of relevance to the ECB's monetary analysis.

The first key finding of their empirical analysis is that the size and composition of banks' balance sheets – which in the model are themselves the result of business decisions by banks interacting with households' and firms' demand for bank assets and liabilities – can amplify or dampen macroeconomic fluctuations depending on the nature of the shocks buffeting the economy. The second key finding is that shocks originating in the money creation activity of banks can become an independent source of macroeconomic fluctuations.

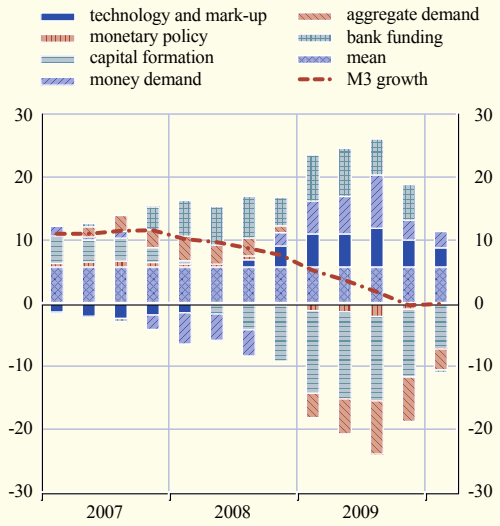
To illustrate some of the uses of the model – particularly how the model can provide a coherent picture of the shocks affecting macroeconomic, monetary and financial variables and of the transmission mechanism of such shocks – Charts A to C display M3 growth, GDP growth and inflation. The focus is on the period covering the financial crisis. In the charts, the data point for each quarter is decomposed into the contributions stemming from the structural shocks identified by the model. To ease exposition, shocks are grouped according to the economic dimension and/or policy function that they have an impact on: consumption, capital formation, technology and mark-up, bank funding, pure money demand and monetary policy. Each category is represented by a bar of a different colour. In each quarter the sum of the bars gives the actual data point (dashed-dotted line).

Starting with real-side shocks, the charts distinguish between aggregate demand shocks (see the bars labelled "aggregate demand") and supply-side shocks (see the bars labelled "technology and mark-up"). Aggregate demand shocks have been closely associated with the deceleration and subsequent fall in GDP growth, inflation and M3 growth. Collectively, these shocks capture retrenchment in total consumption and the negative

1 See Christiano, L.J., Motto, R. and Rostagno, M., "Shocks, Structures or Policies? The Euro Area and the US After 2001", *Journal of Economic Dynamics and Control*, Vol. 32(8), pp. 2476-2506, 2007; and Christiano, L.J., Motto, R. and Rostagno, M., "Financial factors in economic fluctuations", *Working Paper Series*, No 1192, ECB, Frankfurt am Main, May 2010.

Chart A Decomposition of M3 growth

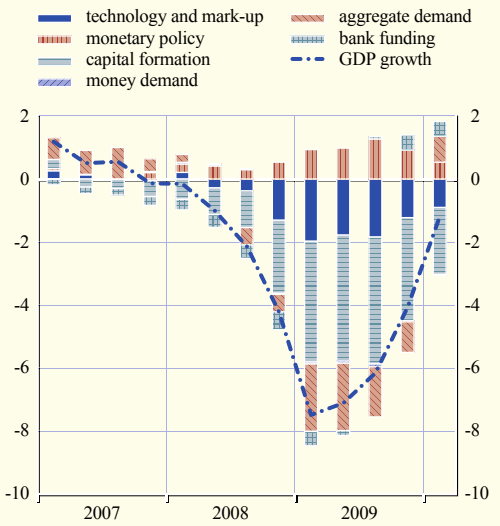
(annual percentage changes; percentage points)



Sources: ECB and ECB calculations.
Notes: The dashed-dotted line indicates M3 growth. Each data point is broken down into the contribution from the shocks identified by the model.

Chart B Decomposition of GDP growth

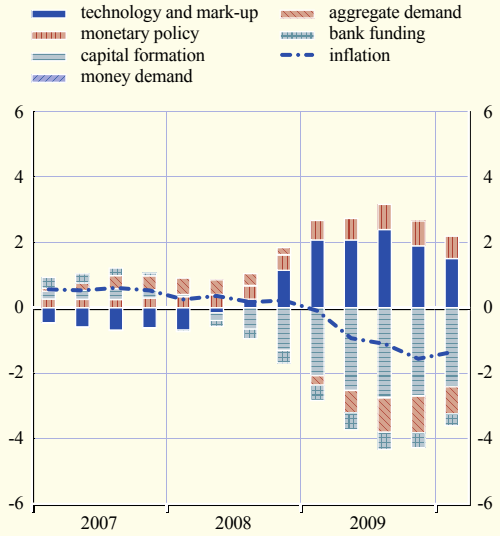
(annual percentage changes; percentage points)



Sources: ECB and ECB calculations.
Notes: The dashed-dotted line indicates the deviation of real GDP growth in per capita terms from its long-run growth path (1.5%). Each data point is broken down into the contribution from the shocks identified by the model.

Chart C Decomposition of GDP deflator inflation

(annual percentage changes; percentage points)



Sources: ECB and ECB calculations.
Notes: The dashed-dotted line indicates the deviation of inflation rates from the model's mean. Each data point is broken down into the contribution from the shocks identified by the model. As the results are derived from a closed-economy model, the chart displays GDP deflator inflation.

contribution from net foreign demand, which is accounted for in the model as an exogenous component of aggregate demand. Supply-side shocks have contributed pro-cyclically to the deceleration and subsequent fall in GDP growth, with an opposite effect on inflation and M3 growth.

Moving to shocks that originate in the monetary and financial sphere, the charts display the contribution of three different categories of shocks. First, shocks perturbing "capital formation" have exerted the most significant downward impact on GDP growth, inflation and M3 growth. These shocks modify realised and anticipated excess returns on capital investment and thereby induce changes in a range of asset prices, in the demand for credit and in banks' lending attitudes through collateral and risk assessment effects. A dominant component in the "capital formation" category is a shock influencing the assessment of lending and borrowing risk – also likely to capture confidence effects.

Second, "bank funding" shocks include factors that in the model directly influence banks' ability to access funds and their liquidity transformation activity. According to the model, banks – faced with the drying-up of unstable sources of funding – have responded in two ways: they have made considerable efforts to increase their deposit base and they have increased their precautionary holdings, partly by shedding assets and deleveraging, to withstand possible further deterioration of wholesale markets. This is manifested in the charts by the positive contribution of this category of shocks to M3 growth and a negative contribution to GDP growth and inflation. It is worth noting that, since the end of 2009, this category of shocks has changed sign, becoming of late a source of GDP growth. Third, pure "money demand" shocks correspond to portfolio shifts that are approximately neutral vis-à-vis the macroeconomy but exert a considerable impact on M3 developments.

Finally, "monetary policy" has been the only force providing support to GDP growth over the period. This has also helped to counteract downside risks to price stability. The negative contribution of monetary policy to M3 growth over the last few quarters is explained by the initial boosting effect on M3 growth associated with the policy rate cuts initiated in the last quarter of 2008. This pattern of response to policy accommodation is consistent with empirical evidence uncovered in vector autoregression analyses, which have shown that policy accommodation exerts an immediate boosting effect on M1 and an initial contractionary effect on M3 growth.

3.4 EXPLORING THE ROLE OF MONEY AND CREDIT IN ASSET PRICES AND EXTENDING THE FRAMEWORK FOR CROSS–CHECKING AND RISK ANALYSIS

MONEY, CREDIT AND ASSET PRICES

The ECB's monetary analysis framework allows for the fact that monetary imbalances may not, in the first instance, manifest themselves directly in consumer price dynamics but may instead be associated with developments in asset markets. The link between monetary and credit developments and asset prices has a long tradition in economic theory and is well documented in the empirical literature. Therefore, when forming a view on the underlying rate of monetary expansion, the possible implications of monetary developments for asset price dynamics need to be considered carefully. Research conducted in the context of the agenda to enhance the ECB's monetary analysis has shown that the relationship between money, credit and asset prices is of an episodic nature, in the sense that excessive developments in money and credit are associated with asset price boom/bust cycles. This work stream has resulted in the development of early warning systems for asset price booms/busts based on the information embedded in money and credit (see the article entitled "Asset price bubbles and monetary policy: revisited" in this issue of the Monthly Bulletin). The integration of these systems into the monetary analysis toolbox allows the formalisation of the assessment of the implications of monetary developments for asset prices and the recognition of the existence of transmission mechanisms through asset price developments to consumer price inflation.

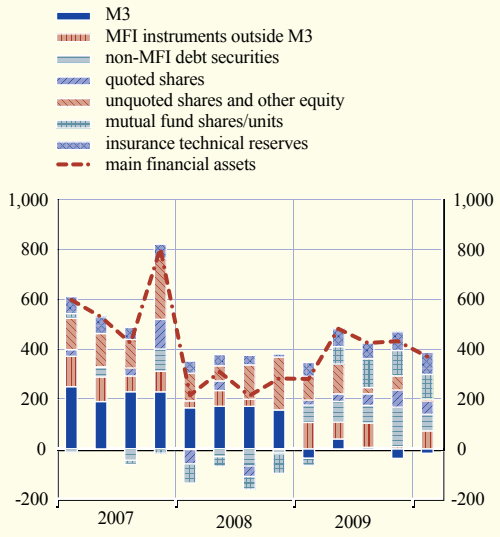
CROSS-CHECKING

"Cross-checking" the macroeconomic indications provided by economic analysis and monetary analysis lies at the heart of the ECB's monetary policy strategy. It is eminently a policy-maker's activity, but technical work can assist the exercise. In the context of the agenda to enhance the monetary analysis, one approach to technical cross-checking was to deepen the sector-based analysis of financial flows to reconcile financial information with the baseline aggregate scenario implicit in real sector projections.

Analysis based on the financial accounts can, on the one hand, complement and enrich monetary analysis based on MFI balance

Chart 3 Financial investment of the money-holding sector

(quarterly flows in EUR billons; adjusted for seasonal effects)



Sources: ECB and ECB estimates.

sheets in the context of considering portfolio behaviour and financing decisions across a broader set of financial instruments and across a wider spectrum of financial intermediation channels (see Chart 3). On the other hand, the analysis of financial transactions and balance sheets, in conjunction with real variables and asset prices, in the context of the consistent sectoral framework of the integrated Euro Area Accounts (EAA) can provide empirical evidence to underpin the study of the monetary transmission mechanism. The financial crisis has also underlined the need to monitor balance sheet indicators and the interlinkages between economic sectors, such as households, MFIs and general government.

4 IMPLICATIONS FOR THE CONDUCT OF MONETARY ANALYSIS IN THE POLICY PROCESS

The extensive work carried out in the context of these four avenues of research has improved and enriched the analytical tools and techniques available for assessing monetary developments. Following the enhancement, there are now several stable models available, for instance, to investigate money demand. This plurality offers different, complementary views on the determinants of money growth and reflects the view that in a complex and changing environment, a single model cannot provide the most relevant analysis at all times.

The combined effect of these enhancements is that the analysis of monetary data is now based on a more comprehensive toolkit. The use of a larger number of models and tools raises the question of how to synthesise and communicate key messages. At the same time, the multitude of available approaches ensures that the idiosyncrasies of the interpretations made on the basis of individual tools and techniques are filtered out in the analytical process. The upshot is that the common, and thus core, messages from the analysis are brought more clearly to the fore. The robustness that this imparts to the conclusions and the greater technical sophistication of the analysis inspire more confidence in the assessment of monetary developments with regard to the risks to price stability.

The essential contribution of the monetary analysis to this assessment lies in the identification of the inflation trend and in the provision of early indications regarding changes in this trend, rather than the calculation of point forecasts of inflation at a given horizon. This assessment is normally adjusted in a slow and gradual manner. However, should a drift in the trend of inflation materialise without being perceived by policy-makers, then the correction of this drift could impose large adjustment costs on the economy. The ECB's monetary analysis is now in a better position to provide early indications of an unanchoring of the inflation regime. For instance, the message from the simple bivariate leading indicator models is now complemented by and compared with the indications provided by a non-linear regime-switching model for inflation. A further example of the improvement in gauging the nominal trends in the economy is provided by

the modelling of money demand across sectors. This has fostered the understanding of the different speed of portfolio adjustment of firms and households, as well as the different relative importance of money-holding motives for these sectors. This analysis has thus strengthened the ability to detect underlying trends in aggregate money measures.

Simultaneously, the enhancement of monetary analysis has also improved the understanding of the functioning of the transmission mechanism. This advance has proved valuable during the financial turmoil, as banks' balance sheets have been an important channel of propagation of shocks. Indeed, the detailed analysis of monetary dynamics can provide insights with regard to the cyclical developments of financing conditions, the credit channels of monetary policy transmission and the situation of banks. The disentangling of the different driving forces that have an impact on loan developments has facilitated the identification and calibration of the necessary monetary policy measures. This is because the appropriate policy response to a lower demand for loans, for instance, reflecting a deterioration in borrowers' balance sheets differs from a response to a lower supply of loans resulting from strains on banks' balance sheets and market dislocations affecting the cost of funds. In particular, changes to official interest rates should be appropriate to implement monetary policy in cases in which demand is the main factor driving loan developments. By contrast, the provision of a sufficient amount of liquidity, potentially complemented by further government measures, such as the provision of guarantees on bank debt and capital injections, would be warranted in the face of constraints on the capacity of banks to provide loans.

The improved analysis of monetary dynamics has also helped policy-makers to put asset price developments into perspective and to form a view regarding the possible build-up of financial imbalances. In particular, money and credit aggregates are strongly influenced by and have an impact on the dynamics of asset markets. The development of a better understanding of this link inevitably leads to a more elaborate assessment of whether asset price movements are sustainable and how they propagate through the economy, providing additional insights to monetary policy-makers.

The wealth of information generated by the monetary analysis is also used to identify the key uncertainties in the trajectories of monetary and financial variables. These are then used to calibrate monetary and financial scenarios that identify risks to the baseline short to medium-term outlook stemming from the economic analysis. This risk assessment can then also feed back into the assessment of the underlying trend of monetary expansion and its impact on inflation trends.

5 CONCLUSION

Taking an overview of the work conducted over the past three years, a number of themes emerge that illustrate how the ECB's monetary analysis has been improved. First, the enhancements made have allowed the codification of institutional knowledge in economic models, as illustrated by the improvement in money demand equations for euro area M3. Second, the technical refinement of the tools used has allowed the exploitation of state-of-the-art techniques, as demonstrated for instance by the use of regime-switching models for the construction of money-based inflation risk indicators. Third, the models improved and developed in the context of this agenda have allowed a more structural interpretation of monetary developments and of the transmission of innovations in money growth to price dynamics. Fourth, consideration of the interaction between money, credit and asset prices and, ultimately, the relationship with consumer prices has become a more prominent element of the monetary analysis and has been formalised. Fifth, a systematic scenario analysis has been introduced that allows the consideration of risks around the baseline projections on the basis of different assumptions for monetary and financial variables.

The enhancements made have been incorporated into the regular monetary analysis and have proven valuable for monetary policy. In this respect, the timing of the enhancements has been particularly opportune given the challenging environment created by the turmoil in financial markets.

Overall, the enhancements mark significant progress for the conduct of monetary analysis and its ability to serve as an input into policy decisions. This progress built on the tools previously available, thus emphasising continuity in the main aspects of the analytical framework. The primary role of monetary analysis remains firmly centred on assessing risks to price stability. Looking ahead, the enhancements also provide a sound basis for further enrichment. In this respect, it should be recognised that efforts to improve an analytical toolkit should never be considered concluded. Indeed, the tools that are used by monetary analysis and the data set considered is likely to require refinement over time. These needs will have to be addressed in order to maintain the relevance of the policy assessment based on monetary information.