EUROPEAN CENTRAL BANK

EUROSYSTEM

ENHANCING MONETARY ANALYSIS

EDITORS

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FOREWORD

Monetary developments have successfully helped to guide monetary policy decisions in the euro area from the outset of Monetary Union. Nonetheless, among both academics and market practitioners the prominent role of monetary analysis in the ECB's monetary policy strategy has remained a topic of intense, and at times controversial, debate. Much of this debate has focused on *whether* monetary analysis should be assigned a prominent role in policy decisions, rather than on *how* that analysis should be conducted, presented and interpreted in practice.[1]

Events over the past decade, culminating in the financial crisis of 2007-10 and its aftermath, have surely provided a definitive answer to the first question. Financial imbalances reflected in the evolution of sectoral balance sheets – and thus in monetary and credit aggregates – lie at the heart of any plausible account of contemporary financial and macroeconomic developments. Over recent years, understanding such imbalances and their implications has proved essential both when forming an assessment of the prevailing risks to price stability over the medium term and when monitoring the economic outlook. As a result, throughout the world, central banks and academics are rediscovering that an understanding of money and credit developments is a crucial input to the formulation of monetary policy. No longer can any central bank afford to neglect monetary analysis. In this regard, its already well-established monetary analysis stands the ECB in good stead.

With the first question answered, attention has naturally shifted to the second issue: *how* to conduct monetary analysis. This book seeks to address that challenge, while recognising from the outset that the conclusions reached cannot be definitive, not least because the financial crisis itself and its consequences over time may affect how to assess and interpret monetary data.

Monetary analysis is used, first and foremost, to identify risks to price stability, especially at longer horizons. The relevance of such considerations for a central bank with the mandate to maintain price stability over the medium term is self-evident. Experience over many decades has demonstrated that successfully conducting monetary analysis is a challenging and complex task: statistical methods, econometric models and economic interpretations must be continuously refined and updated in the face of constant structural change in the financial sector and beyond. As reflected throughout this book, the conduct of monetary analysis therefore has to be understood as a dynamic and evolutionary process.

In consequence, any account of the current conduct of monetary analysis is inevitably a snapshot, and thus incomplete in an important respect. For the value of monetary analysis should be seen not only in the richness and accuracy of its account of *current* developments and its assessment of *prevailing* risks to price stability over the medium term, but also in whether it prompts the correct questions and succeeds, in due time, to orient further research in a direction appropriate for *future* policy analysis and decisions.

[1] For a discussion of these issues, see Beyer and Reichlin (2008) and the papers cited therein.

In mid-2007 – before financial tensions first became manifest in global money markets – the Governing Council of the ECB decided to embark upon a research programme to enhance the ECB's monetary analysis. The prescience of that decision is now apparent. While the financial crisis was not the trigger for this agenda, it has subsequently acted as an important catalyst for the ensuing work on the role of financial and monetary developments in monetary policy transmission.

The programme set up in 2007 identified four main avenues for research,[2] which created the organisational framework for the enhancement of monetary analysis reported in the remainder of this book: (a) improving models of euro area money demand; (b) developing money-based indicators of risks to price stability; (c) incorporating money and credit in structural general equilibrium models; and (d) extending the framework for cross-checking between the ECB's economic and monetary analyses.

One common theme of the research pursued across these four avenues is an attempt to identify with greater precision the persistent (or lower-frequency) developments in money that – on the basis of historical experience over several centuries and across many countries – have proved robustly related to the evolution of the price level. In this respect, enhancement of the monetary analysis over recent years embodies important elements of *continuity* with the long-established focus of such analysis on underlying trends in money and prices. *Deepening* this traditional approach by developing new tools to explore the relationship between monetary trends and underlying price level dynamics has proved central to our agenda.

Yet it is well-understood that the co-movement of money and price trends over longer horizons does not necessarily imply causation, either in one direction or the other. Enhancing the monetary analysis has therefore entailed an investigation of the transmission mechanism through which the evolution of money and credit can ultimately influence price developments. In turn, such considerations require an insight into the portfolio decisions of households, firms and banks, which are themselves closely related to economic and financial market developments, especially the evolution of asset prices. Through these means, factors driving money supply can be better distinguished from those driving money demand. In short, research pursued by ECB staff has sought a more structural or behavioural interpretation of monetary developments. This has involved a *broadening* of the analysis to encompass the interaction of monetary variables with a wider set of economic and financial factors, both at the traditional longer horizons and at higher frequency, such as over the business cycle.

Enhancing the monetary analysis therefore does not entail a choice between broadening and deepening. On the contrary, such developments are natural complements, rather than substitutes. Exploiting the symbiotic relationship between broadening and deepening to develop a genuine enhancement has proved a key element in making the progress achieved in the research agenda.

[2] See Stark (2007).

These insights have proved particularly relevant in the context of studying the interactions between monetary developments and asset prices, which run in both directions. Our research has demonstrated that money and credit aggregates are strongly influenced by the dynamics of asset markets. If we seek to understand the links between underlying trends in money and consumer prices, we must form a view on whether the asset price developments that condition this link are sustainable. Yet our research also suggests that asset price dynamics can, on occasion, be driven by surges in credit or money. Understanding monetary and credit conditions and their impact on asset markets is thus crucial to assessing the sustainability of asset prices.

Deepening our analysis of monetary trends therefore requires a broadening of our analysis to the impact of money and credit on asset prices. And vice versa. Viewing asset price dynamics through the lens of monetary developments helps to integrate them into an overall framework directed towards the achievement of the ECB's primary objective, namely price stability in the medium term.

More generally, the development of structural general equilibrium models that embody a role for money and credit has complemented the other methods used to identify the origin and nature of shocks driving money, credit and, ultimately, price developments. Using these models to identify the idiosyncratic shocks to money (within the overall set of shocks affecting prices) has confirmed or, on occasion, led to a more precise assessment of underlying money growth. Reciprocally, whenever the regular detailed analysis of monetary developments has identified factors that may affect the transmission mechanism of monetary policy, such factors have been introduced – albeit in a stylised way – into scenarios constructed using these structural general equilibrium models. In turn, the scenarios allow the impact of such factors on money, credit and price developments to be quantified. The results of the scenarios may influence the overall assessment of underlying monetary trends and medium-term risks to price stability. Again, broadening the set of models used to analyse money and credit developments has facilitated the deepening of monetary analysis. And this deepening has been made possible by first considering critically, and then developing further, models originally developed to support economic analysis.

Experience during the financial crisis has vindicated our overall approach. Monitoring of longer-term trends in money has helped to maintain the necessary medium-term orientation of monetary policy, at a time when short-term pressures threatened to dominate. However, identifying these underlying trends has been complicated by the impact of the financial crisis on the soundness of banks, on their behaviour and, ultimately, on the evolution of the monetary and credit data itself. Indeed, an important channel of propagation during the crisis has been via bank balance sheets, which have therefore deserved close monitoring in their own right. In this context, structural models embodying a role for money, credit and banks in the propagation of financial shocks, the scenarios produced using such models, and the increased availability of euro area flow-of-funds data have all served to capture and explain the feedbacks between financial stress and its macroeconomic consequences.

Given the dynamic and evolutionary nature of the process, in taking stock of where we stand with the enhancement of monetary analysis, one naturally adopts a Janus-like perspective: one face looking back to the past; the other looking forward to the future.

Looking back, it is striking how progress achieved through the research agenda to enhance monetary analysis has supported continuity with the original articulation of the ECB's strategy. For example, in describing how monetary analysis would inform monetary policy decisions, the very first issue of the ECB's Monthly Bulletin emphasised that interest rate changes would not respond mechanically to innovations in the monetary data. Rather, such innovations would prompt further analysis to assess whether they had implications for future price developments.[3] Moreover, even in the period before the introduction of the euro when the ECB's monetary policy strategy was being designed, it was always foreseen that the close monitoring of monetary developments would provide a framework for assessing and addressing asset price misalignments.[4]

Recent research results need to be read in this broader context. They should be understood as fleshing out the analytical framework for conducting monetary analysis (and ultimately for formulating monetary policy decisions), rather than as representing a break with the long, distinguished and successful tradition of such analysis at many leading central banks, including at the ECB.

At the same time, *looking forward*, it is important to recognise that both experience over the first decade of Monetary Union and the financial crisis of recent years have revealed the need to broaden and deepen the framework for monetary analysis. And the continual process of financial innovation and structural change implies that gaps have emerged and will keep emerging in our statistics, models and tools. These gaps need to be filled if the analysis and the policy decisions which rest upon it are to be made more robust. Our tools and models will also need to be refined to reflect our evolving assessment of the strengths and weaknesses of other approaches and inputs to monetary policy-making.

As a result, the enhancements presented in this book are not the final word. Developing a better understanding of the behaviour of monetary and credit aggregates and their influence on the economy has given rise to new questions and challenges which will influence our future work on both monetary analysis and other approaches. Reciprocally, improvements in other approaches will again need to be considered from the perspective of monetary analysis, both to cross-check their results and to maintain the encompassing nature of a robust monetary policy strategy. Such is the nature of progress. Such is also the nature of science. And such should be the nature of a robust monetary policy strategy if it is to ensure effectiveness, accountability and transparency.

3 See ECB (1999).
4 See European Monetary Institute (1997).

This book presents a new generation of models and tools for monetary analysis.[5] As novel challenges emerge and this generation is found wanting, further enhancements to the monetary analysis will be required. One generation begets another. Nonetheless, reporting on enhancements to the monetary analysis makes our approach transparent and reveals the significant improvement that has been achieved thus far. Even if "perfecting" the monetary analysis remains a chimera, the enhancements achieved represent both continuity with the past and a sound basis for enrichment in the future.

* * *

The remainder of the book is structured as follows. Chapters 1 and 2 offer a broad overview of monetary analysis, describing its analytical foundations and practical implementation at the ECB respectively. This first part develops a number of general themes that inform the subsequent discussion. The remaining chapters (3 to 7) explore in more detail the research avenues pursued by ECB staff members as part of the enhancing monetary analysis research agenda: money demand, risk indicators, structural models, asset price dynamics, and the flow of funds. Each of these chapters is associated with a set of annexes, which summarise the underlying technical work and refer to the relevant working papers and academic publications that are likely to be of interest to the expert reader.

Thanks are due to the many central bank staff members (both in the Eurosystem and beyond) who commented on the material presented in this book at a series of expert meetings held in Frankfurt between 2007 and 2009. Moreover, the chapters have benefited from the comments of leading academics and central bank experts at a colloquium organised by the ECB in April 2010.

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[5] In so doing, it builds upon previous publications describing the tools and framework of monetary analysis at the ECB. See Masuch et al. (2001) and Fischer et al. (2008).

REFERENCES

Beyer, A. and Reichlin, L. (2008), *The role of money: money and monetary policy in the 21st century*, ECB.

European Monetary Institute (1997), *The single monetary policy in Stage Three: elements of monetary policy strategy*.

ECB (1999), "The stability-oriented monetary policy strategy of the Eurosystem", *Monthly Bulletin*, January, pp. 39-50.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008), "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, pp. 102-175.

Masuch, K., Pill, H. and Willeke, C. (2001), "Framework and tools of monetary analysis", in Klöckers, H-J. and Willeke, C. (eds.), *Monetary analysis: tools and applications*, ECB, pp. 117-144.

Stark, J. (2007), "Enhancing the monetary analysis", speech at the conference *The ECB and its watchers IX* (available at: http://www.ecb.europa.eu/press/key/date/2007/html/sp070907_1.en.html).

I GENERAL THEMES

CHAPTER 1

THE ROLE OF MONEY IN THE ECONOMY AND IN CENTRAL BANK POLICIES

1 INTRODUCTION[1]

Inflation is ultimately a monetary phenomenon. A vast number of studies confirm the close link between money growth and inflation over longer horizons. It is therefore natural for central banks with price stability objectives to pay close attention to the evolution of money aggregates and other variables closely associated with them (including, in particular, the main counterpart to money, credit). The analysis of monetary data can provide policy-makers with an important signal of mounting risks to price stability. Such a signal complements the information about risks to price stability revealed by indicators used in forecasting inflation at horizons of a few quarters, such as relative prices, measures of capacity utilisation, or cost pressures. While the signal in monetary developments may be hard to extract at times because of the short-term volatility of monetary aggregates, it is nevertheless an essential piece of information for policy-makers, complementing information provided by other indicators about inflation expectations. In short, monetary analysis can help central banks fulfil their institutional mandate to maintain price stability.

At the European Central Bank (ECB), monetary analysis plays an important role in both internal analysis and external communication. The ECB's mandate and primary objective is to preserve price stability over the medium term. In the pursuit of its primary objective and in guiding its decision-making, the Governing Council is assisted by two distinct, yet complementary and mutually reinforcing, approaches to organising and evaluating the relevant information: the "economic analysis" and the "monetary analysis". It is important to understand that the organisation of the analysis of the risks to price stability around these two forms of analysis is motivated by the need for policy-makers to allow for various channels of monetary transmission and by the practical difficulties of integrating these channels in a satisfactory and reliable way within a single quantitative modelling framework.[2]

These difficulties arise from the multifaceted nature of monetary phenomena and the time horizon-dependent nature of their signalling properties. At medium

1 This chapter was prepared by Giacomo Carboni, Boris Hofmann and Fabrizio Zampolli. Helpful comments by Charles Goodhart, David Laidler, Philippe Moutot, Massimo Rostagno and Mike Wickens and able research assistance by Alexis Loublier are gratefully acknowledged. The views expressed are those of the authors and not necessarily those of the ECB or Eurosystem.

2 See Section 6 of this chapter for a more complete description of the ECB's monetary policy strategy.

to longer-term horizons, monetary phenomena provide information regarding underlying inflationary or disinflationary forces. The close statistical coherence between trends in money growth and inflation makes monetary analysis an important element of policy-makers' assessment of future risks to price stability. At shorter time horizons, a close correlation between monetary factors and the appreciation of risk in the financial markets can emerge. Monetary analysis can hence also provide valuable signals about the state of confidence and the degree of fragility of the financial system.

It is important to appreciate that policy-makers' attention to monetary phenomena is always motivated by their primary task of identifying medium to long-term trend developments in the price level. The connection between monetary conditions and such trends works through both direct and indirect transmission channels. The direct channel is what can be described as the classical quantity theoretic association between liquidity conditions and the price level. This channel emphasises the role of money as a medium of exchange and temporary store of purchasing power. The indirect channel establishes a link between liquidity and the price level through the impact that liquidity exerts on financing constraints and on asset prices – notably, the pricing of financial risk. The dynamics of asset prices and risk valuation influence wealth and confidence and, ultimately, prices and the economy at large. By working through this avenue, financial instability may ultimately threaten price stability.

This multifaceted nature of money is the focus and the main theme of this chapter. Contrary to the representation given by several commentators in the past, money should not be seen simply as a "veil" or a modelling "afterthought" which passively reflects developments and shocks originating in the real side of the economic system. Its changing role and evolving patterns of interactions with the rest of the economy is as much a challenge for analysts as an asset for policy-makers, who can extract a wealth of signals and scenarios from a careful monitoring of monetary developments. The "two-pillar" strategy of the ECB should be viewed as a pragmatic way to turn a challenge into an asset in the policy-makers' analytical toolkit.

The aim of this chapter is to spell out the reasons why monetary analysis is relevant in the conduct of monetary policy and to explain why it plays an important role in the strategy of the ECB. At the same time, the chapter aims to explain why monetary analysis cannot be summarised in one single model and hence represents a continuous commitment for central banks to enhance monetary research. To this end, the chapter is structured as follows. Section 2 looks at how money has evolved into the forms that are in use today and in what sense it has always played and will continue to play an essential role in the economy. Section 3 presents the conceptual basis for the analysis of the interrelationship between the nominal quantity of money balances, the general price level and the level of economic activity: the quantity theory of money. After briefly discussing its historical origins, the section discusses the central tenets of the quantity theory and derives its key macroeconomic implications. Section 4 presents and discusses the empirical evidence of the key long-run empirical implication of the quantity theory, the proportional link between money growth and inflation. Section 5 discusses the theoretical contribution about the role of money over the business cycle in a historical perspective. With no ambition of providing an exhaustive treatment of this vast topic, the emphasis rests instead on briefly illustrating selected contributions that have exerted special influence on the theory and the practice of monetary policy. Section 6 briefly outlines the role of money in the ECB's monetary policy strategy.

2 MONEY AND ITS ROLE IN THE ECONOMY

2.1 MONEY'S VARIOUS FUNCTIONS

The salient characteristic that distinguishes money from other (storable) goods is the fact that it is promptly accepted by all or most individuals in exchange for goods and services that the bearer wants to consume (or for the assets that she or he wants to hold). Traditionally, the justification for money as a *medium of exchange* is associated with its role in overcoming the inefficiencies of pure barter when there is no "double coincidence of wants". The classic argument is that for a trade to take place both parties need to hold goods that the other wants to consume or use as an aid to production – that is, both goods need to be present at the same time and in the same place. It normally takes time and effort to make sure that such pairing actually occurs.[3] Alternatively, one party can acquire a good that he does not need but that he believes is more likely to be accepted in future transactions. So, for example, if one wants to exchange fruit for fish, he might exchange fruit for – say – wheat, if he believes that fishermen are more likely to be in need of wheat than fruit.[4] If there is a particular commodity – e.g. silver or gold – that is more generally acceptable than other commodities because of some intrinsic properties, such as low-cost storability and easy recognisability, then the costs of exchange could be less than for pure barter, and such a commodity will assume the status of "commodity money". Such an object could even be completely devoid of any intrinsic value – that is, it might have no use in consumption or production – and still be generally accepted. Present-day currency is one such good and is called "fiat money".

A second function that money has traditionally served in actual economies is the *store of value*. By allowing agents to save part of their income today for being spent in the future, money plays the important role of carrying purchasing power over time. How effectively it does so depends primarily on the inflation rate prevailing in the economy. Historically, episodes of high inflation have caused agents to use alternative assets for holding wealth, up to the extreme events in which money has ceased to be used even for transaction services. Among these other assets serving the purpose of store of value, there are, for example, gold, bonds, stocks, land and real estate. Clearly, across such assets there is a degree of substitutability, which depends on their relative opportunity costs and is likely to vary over time and according to circumstances. Notably, the demand for money may well fluctuate when financial and macroeconomic risks emerge in the

3 In other words, trade is not frictionless.
4 This is for example the idea of saleability in Menger's analysis (1892).

economy, as a result of precautionary motives. That other assets can be equally used as a store of value makes this feature non-peculiar to money, understood as a commodity or a token specifically devoted to facilitating economic trade.

Also the third function of money, namely that of a *unit of account*, is not peculiar to money. Money is the nominal scale that measures the values of goods in the economy. In fact, the exchange of goods in an economy could be performed on the basis of their relative prices; but for a number N of goods in the economy there are as many as (N*N–1)/2 relative prices to be compared. Alternatively, one could simply express the prices of N–1 goods in terms of one good, the *numeraire*. While in principle there is no reason for the latter good being at the same time the medium of exchange, in practice this has been the case. The rationale for this is that, in so doing, the extra conversion of prices expressed in units of account into units of medium of exchange is not necessary.

2.2 MONEY(S) AND BANKS

Notably, while several objects or moneys usually can perform the various functions defined above, not all moneys are the same – or, in other words, they are not all perfectly substitutable. Moneys differ in terms of acceptability, convenience of use, and security in payment, and such characteristics may vary depending on the circumstances. They also differ in the trustworthiness of their issuer, or the "quality" of its balance sheet, and how effectively their holding in circulation can be influenced by the policy-maker. From this point of view, one may distinguish between "outside money" and "inside money", depending on whether the money is issued by the public sector or the private sector.

"OUTSIDE MONEY"

Banknotes and coins – or in short, currency – are normally the most secure form of money. They are issued by the central bank and/or government, which vouches for their general acceptability and the stability of their purchasing power. Equally safe are the deposits held at the central bank, normally available only to banks. Banks use them both as a means to settle payments among themselves and as a reserve to meet unusual demands for withdrawals of currency by their depositors. Along with the currency in circulation, the deposits held at the central bank constitute the so-called "monetary base", "central bank money" or "outside money".[5] This money is usually "legal tender", which means that any potential creditor is obliged by law to accept it in settlement of any debt.[6] Even more importantly, the universal (and voluntary) acceptance of a currency also depends on how credible in the eyes of the money-holders the monetary authority is in fulfilling its (explicit or implicit) promise to maintain the real value of the currency by avoiding a generalised increase in monetary prices. This credibility usually depends on the objective of the central bank and

[5] It is known as "outside" money to highlight the fact that it is created by the public sector as opposed to the private sector (and could be in principle controlled more easily) or as "high-powered" money to stress the fact that it constitutes the basis of the entire monetary pyramid whereby banks – by operating a fractional reserve system – create a volume of media of exchange that is a multiple of the money created by the central bank.

[6] Importantly, the exact definition of "legal tender" may differ from country to country.

the degree of independence that a central bank enjoys from government interference.[7] It is by managing the monetary base that the central bank is able in normal circumstances to steer the short-term interest rates that banks charge when lending to each other and that, in turn, affect the interest rates that influence the spending decisions of households and firms.

"INSIDE MONEY"

Deposits issued by private banks, which are what most individuals and companies have access to, are held for the safety and the convenience that they offer over currency. Not only are they less subject to the risk of theft, but they also offer the convenience of a range of payment options, such as cheques (now less common than in the past), debit and credit cards, and electronic transfers. Other types of securities are also used as a means of payment – for example, certain IOUs issued by private non-financial corporations and widely traded on financial markets (commercial paper), or units in money market funds. The overall amount of money in circulation is, to a large extent, determined by the behaviour of banks and the (profit-seeking) behaviour and interaction of a myriad of private agents. Money created by private institutions is called "inside money" to highlight the fact that it is generated from inside the private sector. Most commercial banks have evolved from simple safe keepers of money and facilitators of payments in the Middle Ages into the institutions specialised in granting loans to households and firms that we know today.[8] Loans are normally granted for some length of time, while deposits can in principle be redeemed at any time or at short notice. Even when deposits have a longer maturity, the term is usually less than the average maturity of the loans that they contribute to financing. Given that inside money is debt generated by one private agent in favour of another, what is a debt for one agent is a credit for another agent, and so in aggregate these claims net to zero.

Along with currency in circulation, privately issued deposits at short to medium-term maturities are called "broad money". Given that a large fraction of the total is "inside money", over which the government or the central bank has normally only indirect and imperfect influence, broad money by reflection cannot be reliably controlled unless very strict rules are imposed on the private sector. Nevertheless, "broad money" is relevant because it is associated with the total resources available in the economy for the purchase of goods and services and non-monetary assets (such as equities and housing for example).

7 Accordingly, some countries have built institutional mechanisms to prevent fiscal laxity and to insulate the central bank from political pressures. For instance, the Stability and Growth Pact has the purpose of preventing fiscal laxity in the euro area and within the European Union more generally and should be seen as essential and complementary to the independence of the ECB in making the common currency a success. To the extent that the central bank is credible in its promise to maintain price stability, domestic currency will be widely accepted as a stable and safe means of payment. If not, the population may accept currency issued by a foreign government which enjoys such a reputation. Currency substitution is a well-known phenomenon in countries devoid of credible monetary institutions. In other words, money as a claim on real resources is not free of risk, because of an unexpected rise in inflation.

8 For a brief introduction to the origins of banking, see e.g. Millard (2007); Millard and Saporta (2007).

MONEY SUPPLY

The money supply process can be described via a simple money multiplier model:

$$M = mB \quad (1)$$

Here m is the money multiplier and B is the amount of "high-powered" money controlled by the monetary authority. M is a broad monetary aggregate. The money multiplier, m, is a function of the ratio of bank deposits (D) to reserves (R) and the ratio of currency (C) to deposits: $m=(1+C/D)/(R/D+C/D)$.[9] Under the presumption of a stable and predictable link between the amount of money issued by the central bank, B (outside money), and the money created by the banking sector (inside money), the money supply could be regarded as largely exogenous and hence under the control of the monetary authorities.

However, as recently pointed out by Goodhart (2010), a major drawback of the money multiplier approach to money supply analysis is its entirely mechanistic character, which does not offer an account of the behaviour of the central bank, private banks or the private sector money-holders. The pace of financial deregulation and financial innovation over the last few decades has certainly challenged the notion of a stable money multiplier. Also, in times of crisis, money multipliers may prove to be highly unstable and hence may be a poor guide to predicting the effect of monetary policy measures on the money supply. This has become manifest during the global financial crisis, where the massive expansion of base money by central banks was not reflected in the development of broader monetary aggregates because of a collapse of money multipliers when banks were hoarding reserves.

A number of recent academic contributions implicitly or explicitly suggest measures of monetary liquidity that extend beyond the traditional broad monetary aggregates. The theoretical contributions by Kiyotaki and Moore (2002, 2008) on the role of money in the economy (which are discussed in more detail in Sections 2.3 and 5.3.2 of this chapter) propose that inside money can be defined as any asset or paper that can be readily sold in the market and circulates as a means of short-term saving. According to this view, not only currency and bank deposits would constitute money, but also other paper for which highly liquid markets exist, in particular Treasury bills, but possibly also private paper like commercial paper. From that perspective, the notion that the constitution of monetary liquidity varies over time with institutional change in the financial sector, financial innovation and the stability of the financial system is further reinforced.

The recent contributions of Adrian and Shin (2008a, b; 2009) suggest that the relevance of different measures of monetary liquidity for asset price gyrations depends on financial structure and may therefore vary from country to country

9 The money multiplier is derived from the identities for M and B. More specifically, $M=D+C$ and $B=R+C$. Dividing both identities first by D and then dividing the identity for M by the identity for B yields the money multiplier function.

and over time as a result of structural change in the financial sector. The bottom line of Adrian and Shin's analysis is that aggregate liquidity is given by the aggregate balance sheet of the financial sector, which reflects the "risk capacity" of financial sector balance sheets. This implies that domestic bank credit would be an appropriate measure of monetary liquidity if the financial sector's assets are primarily composed of domestic bank loans and debt securities, i.e. if other assets and other financial institutions played little role. On the other hand, broad money would be a good proxy of the financial sector's aggregate balance sheet if banks constitute the bulk of the financial sector and if the items included in broad money represent the bulk of banks' liabilities. This implies that broad monetary aggregates are probably good approximations for the financial sector's liquidity provision to the economy in bank-based financial systems, but less so in market-based financial systems. Adrian and Shin substantiate this point by showing empirically that the balance sheet growth for non-bank financial institutions is an important determinant for a number of key US financial market risk premia. Adrian and Shin's analysis also has implications for the relationship between global monetary developments and the dynamics of domestic asset markets. If domestic financial investors borrow significantly abroad (e.g. via carry trades) or if foreign investors significantly invest in the domestic economy, global indicators of monetary liquidity will gain relevance for domestic asset price gyrations.

2.3 WHY MONEY IS ESSENTIAL: THE INEFFICIENCY OF BARTER AND "LACK OF TRUST"

The emergence of money, either in the form of commodity or fiat money, is traditionally associated with the presence of frictions in pure trading activity, ultimately related to the absence of a "double coincidence of wants". Such an insight dates back at least to the early systematic analysis of money and its role in the economy. For instance, in 1875 Jevons observed:[10] "The first difficulty in barter is to find two persons whose disposable possessions mutually suit each other's wants. There may be many people wanting, and many possessing those things wanted; but to allow of an act of barter, there must be a double coincidence, which will rarely happen."

And around two decades later, Menger (1892) also noted: "Even in the relatively simple and so often recurring case, where an economic unit, A, requires a commodity possessed by B, and B requires one possessed by C, while C wants one that is owned by A – even here, under a rule of mere barter, the exchange of the goods in question would as a rule be of necessity left undone."

Despite these early intuitions and subsequent refinements, a rigorous investigation of the role played by money through formal theoretical models proved elusive until the second half of the 20th century.

By building on an overlapping generations model following Allais (1947), Samuelson (1958) formalises a role for money in facilitating the transfer of

10 See Jevons (1875).

resources between agents and over time. Intuitively, in an economy with two cohorts, representing the young workers and the old retired respectively, money serves the purpose of medium of exchange of a non-storable consumption good between young producers and old consumers, and a store of value for the former. Admittedly, that transfers across generations can also be performed via other means, for instance social security, makes money not essential in such a model economy. Nor is it essential in the environment considered by Bewley (1980), in which agents make use of money to insure against idiosyncratic shocks in the absence of other types of contracts. Instead, if efficient contracts were available, it would often result in better allocations than in the monetary equilibrium.[11]

THE INEFFICIENCIES OF BARTER

More recently, significant achievements have been accomplished, for instance, by Kiyotaki and Wright (1989, 1991, 1993). Their analysis of the exchange process based on search frictions and differentiated goods has been extremely useful in clarifying which conditions or properties a good or a contract needs to possess for it to assume the role of medium of exchange.

In an economy populated by individuals who cannot consume the goods which they produce and do not have the certainty of meeting with the individual who possesses the good that they desire, the acceptance and hence the value of commodity and fiat money arise as the coherent outcome of the rational and non-cooperative behaviour of a myriad of trading individuals.[12] Introducing fiat money in a commodity money economy raises agents' welfare. Its existence is also crucial in the development and expansion of markets and in the increase of an economy's overall productivity: specialisation makes barter more costly for producers and hence makes money even more helpful.[13]

The existence of an equilibrium with fiat money is also remarkably robust to changes in important properties of the object that is candidate to be accepted as the medium of exchange. For instance, a fiat-money equilibrium continues to exist even if transaction costs of fiat money are larger than those of commodity trading.[14] Likewise, a fiat-money equilibrium emerges even if the rate of return on money is less than the rate of return on storing real assets or when fiat money is taxed.[15]

11 For a collection of these and other early attempts at establishing micro-foundations for money holding, see Kareken and Wallace (1980).

12 In technical jargon, such an outcome is known as the "Nash equilibrium".

13 There is a sizeable literature that has followed the main contributions of Kiyotaki and Wright (1989). Ritter (1995) deals with the transition from barter to fiat money, emphasising the importance of a government that can commit to restraining money supply. Williamson and Wright (1994) focus on the imperfect information that buyers have about the quality of the goods available for trade. The presence of money induces agents to produce high-quality output since a producer is more willing to trade high-quality output for cash than for a good of unknown quality. It goes beyond the scope of this chapter to provide a comprehensive review of this literature. For a survey, see e.g. Rupert et al. (2000) and Wallace (1998).

14 Intuitively, the larger transaction costs are offset by the higher probability of conducting a trade with a trader endowed with money than a trader in possession of commodities only.

15 Within the artificial trading environments studied by Kiyotaki and Wright, the role of liquidity and its relationship with money is also clarified: liquidity is measured by the time it takes on average to execute a trade. Money is the most liquid asset.

"LACK OF TRUST"

More broadly, the existence of money does not even necessarily rest on the presence of physical trading frictions per se. In principle, for trading to take place merely through credit, or through the credible exchange of a promise, it is crucial that traders know each other, and adequate "punishments" can be enforced to deter traders from not honouring their promises. In fact, commitment or enforcement of contracts is only partial, and knowledge of the history of individuals necessary to ascertain the likelihood that they will keep their promise is also limited.[16] This means that, while some significant amount of trade does take place through credit, money cannot be completely dispensed with. Such lines of argument effectively place the lack of trust among agents at the basis of the emergence of money in the economy, as vividly expressed by Kiyotaki and Moore: "evil is the root of all money".[17] In essence, the lack of trust explains why credit cannot be unlimited – that is, why borrowing constraints exist – and why creditors need to be compensated through higher interest rates compared with the relative safety of government bonds – that is, why liquidity and credit premia exist. It also explains why money may be preferred to – or, better, coexists with – other assets even if it yields a lower return than them, as the difference in returns (liquidity premium) compensates the holder for the time and effort it takes to "monetise" the asset at a "fair" price (money being the most liquid of assets in the sense defined above). It finally rationalises why banks are needed to facilitate the flow of resources from savers to debtors by screening and monitoring their behaviour, especially when borrowers are small and little known.

On the basis of the insights described above, rather than focusing on physical trading frictions, Kiyotaki and Moore (2002), for instance, formalise the emergence of money as a result of a limited degree of commitment in a context of lack of trust. Specifically, limited commitment manifests itself in two types of liquidity constraint. The first is the *borrowing constraint*: an agent can borrow only up to a certain fraction of his future earnings that he can credibly commit to repay. The second liquidity constraint is the so-called *re-saleability constraint*: a creditor who has a claim on an agent's resources may be able to sell only a fraction of this claim to other agents as a result of limited *multilateral* commitment.[18] Notably, the endogenous value of an intrinsically useless asset (e.g. privately issued paper and fiat money), as well as the value of other assets, turn out to be related in equilibrium to different degrees of "tightness" in the borrowing and re-saleability constraints. As the borrowing constraints become tighter – in other words, where there is an imperfect ability of some agents to bilaterally commit – the re-saleability constraint starts to matter, with the implication that the intertemporal transfer of resources from one agent to another

16 For a recent formalisation of these ideas, see e.g. Kocherlakota (1998, 2004). In the models reviewed above, barter occurs among anonymous individuals. Thus, the possibility of credit is assumed away.

17 See Kiyotaki and Moore (2002).

18 In this context, the lack of a double coincidence of wants does not arise from a mismatch between the goods that each agent produces and the ones he wants to consume. Instead, it arises from a temporal mismatch between the time at which an agent wants to consume and the time at which the same agent has the resources available to offer in exchange (so that the good traded could in principle be the same).

might be hampered. Under these circumstances, the introduction of liquid paper – money – "speeds up" the economy. By providing the means for short-term saving, it diverts resources away from inefficient storage, thus helping to raise investment and output.[19]

Models micro-founding the emergence of money via search and matching frictions and lack of trust-type frictions have recently also been used to analyse the role of money in the macroeconomy. This will be discussed in Section 5.3.2 of this chapter.

3 THE QUANTITY THEORY OF MONEY[20]

The considerations of the previous section illustrate that money is normally valued in equilibrium, usually raises agents' welfare, and ultimately stimulates economic prosperity. However, this generally beneficial effect of the *existence* of money on economic prosperity does not imply that there is also a positive link between the *quantity* of money in circulation and economic performance.

The nature of the link between the nominal quantity of money circulating in the economy and the economy's performance is the subject of one of the longest-standing paradigms of macroeconomic theory: the quantity theory of money. Historically, the intuitions about the quantity theory of money date at least as far back as Copernicus (1517) and Bodin (1568). However, the first clear statement of the quantity theory was made by the Scottish philosopher and economist David Hume. In the mid-18th century, with reference to variations of commodity money, he observed that: "Now, what is so visible in these greater variations of scarcity or abundance in the precious metals, must hold in all inferior changes. If the multiplying of gold and silver fifteen times makes no difference, much less can the doubling or tripling them. All augmentation has no other effect than to heighten the price of labour and commodities; and even this variation is little more than that of a name. In the progress towards these changes, the augmentation may have some influence, by exciting industry; but after the prices are settled, suitably to the new abundance of gold and silver, it has no manner of influence" (Hume, 1752).

While stating that variations in the quantity of money supplied have over the long run no other effects than increasing prices, Hume notes that, over shorter horizons, such variations may cause changes in real output; ultimately any increase in real output that follows a rise in the money supply can only be temporary.

19 Interestingly, because it needs to be held until maturity, the illiquid paper is exchanged at lower prices than the liquid paper: that is, the liquid paper commands a *liquidity premium* in equilibrium. Such a liquidity premium arises even in the absence of risk; indeed, the model is deterministic and what gives rise to liquidity needs is only the fact that the investment and production cycles of different agents do not coincide temporally.

20 For a more detailed exposition, see Friedman (1987).

3.1 THE BUILDING BLOCKS OF THE QUANTITY THEORY

In essence, the statement by Hume defined the major terms of the debate within monetary economics in the centuries to come, providing de facto the first lucid exposition of the quantity theory of money. The quantity theory of money is in essence a theory of the interrelationship between the nominal quantity of money balances, the general price level and the level of economic activity. The three building blocks of the quantity theory are:

1) the quantity equation;

2) the mostly supply-determined, exogenous character of nominal money;

3) long-run neutrality.

THE QUANTITY EQUATION

The quantity equation is an identity equating the stock of money in circulation to the flow of economic transactions or economic activity. The income form of the quantity equation is given by:

$$Mv = Py \tag{2}$$

This identity states that the total stock of money, M, times its velocity, v, which measures the per-period turnover of the money stock, must equal the nominal value of final output (or nominal income), Py, where y is a measure for real income (e.g. real GDP) and P is a corresponding price index (e.g. GDP deflator).[21] Equation (2) is a pure identity that does not, by itself, allow any economic inference. For this, the identity must be combined with theoretical hypotheses.

THE MOSTLY EXOGENOUS CHARACTER OF NOMINAL MONEY

The second building block of the quantity theory is the presumption, or rather observation, that changes in nominal money are mostly supply-driven, or exogenous, so that the quantity equation (2) manifests a causal link going from the stock of nominal money balances M on the left-hand side to the right-hand-side variables P and y.

The quantity theory of money is importantly also a theory of the factors that affect the aggregate demand for money. The income version of the quantity theory stresses the role of money as a temporary store of purchasing power,

[21] The income version of the quantity theory thus focuses on transactions for final goods and services rather than all transactions. It hence excludes all intermediate transactions and all transactions in securities and assets. The transactions form of the quantity equation, formulated by Newcomb (1885) and Fisher (1911), relates the stock of money in circulation to the flow of all economic transactions: $Mv=PT$. Here, T is a measure of real economic transactions, including goods and services purchases, but also transactions in securities and assets, while P is a price index based on the prices of all these transactions. The ambiguity of the transactions concept and of the corresponding price level has proven hard to resolve for empirical applications, and for that reason the economics profession has focused on the income version of the quantity theory (Friedman (1987)).

which is assumed to be a function of the volume of potential purchases proxied by income.[22] This becomes more obvious when equation (2) is rewritten as:

$$M = kPy \tag{3}$$

This is known as the *Cambridge cash-balance* equation (Pigou (1917)) where k is simply the inverse of income velocity v in the identity (2) or can be treated as the desired ratio of money to nominal income that individuals wish to hold.

Clearly, if (3) describes the determinants of the demand for money, another equation describing how nominal money is supplied is needed in order to arrive at a closed framework for the analysis of monetary developments and their macroeconomic implications. This is usually done by modelling money supply via the money multiplier approach discussed in Section 2.2.

The quantity theory postulates that changes in the nominal money stock are primarily driven by changes in the money supply, on the grounds that "changes in ... money demand tend to proceed slowly and gradually or to be the result of events set in train by prior changes in supply, whereas, in contrast, substantial changes in the supply of nominal balances can and frequently do occur independently of any changes in demand", which in turn implies that "substantial changes in prices or nominal income are almost always the result of changes in the nominal supply of money" (Friedman (1987), p. 4). The presumption that nominal money is primarily driven by changes in money supply implies that money is largely exogenous, which in turn means that the causal link underlying the quantity equation goes from changes in money to prices and real income rather than conversely.[23]

LONG-RUN NEUTRALITY

The hypothesis of the long-run neutrality of money is the third building block of the quantity theory. It elucidates how the effect of an increase in M on nominal income Py will be distributed between P and y. The long-run neutrality hypothesis states that an increase in M will in the long run be associated with a proportional increase in P, while real income and other real variables will remain unchanged. A change in money thus ultimately represents a change in the unit of account (the general price level) which leaves other variables unchanged in the same way as changing the standard unit to measure distance (e.g. from kilometres to miles) would not modify the actual distance between two locations. In other words, money is a veil in the long run. The levels of real income and employment are assumed to be ultimately determined by real factors, including technological progress and productivity growth, the growth of the labour force and all aspects of the institutional and structural framework of the economy, e.g. the flexibility of goods and labour markets, tax policies and the quality of education.

22 The emphasis on the usefulness of money as a temporary store of value implies that the income version of the quantity theory also pertains to broader definitions of money.

23 This is the key difference between the quantity theory and the real bills doctrine, which takes the price level as exogenous and regards money as passive. For a more detailed juxtaposition of the quantity theory and the real bills doctrine, see Fuerst (2008).

The recognition that, over the long run, a substantial increase in the quantity of money causes a substantial increase in the general price level, with no effect on real output, motivated the famous dictum by Friedman that "inflation is always and everywhere a monetary phenomenon".[24] In its strongest form (see e.g. Lucas (1980)) this prediction is also often stated as saying that over the long run changes in the growth rate of money should simply be accompanied by an increase in inflation *on a one-to-one basis*.

3.2 SUMMING UP: THE KEY IMPLICATIONS OF THE QUANTITY THEORY

To summarise, the above considerations point to three main implications of the quantity theory of money:

1) In the long run, there is a proportional link between money growth and inflation and no link between money growth and real variables.

2) In the short run, changes in money are also temporarily reflected in real quantities and relative prices.

3) Money is the causal, or active, variable in these short and long-run relationships.

The following two sections review how these central implications of the quantity theory are reflected in the modern empirical and theoretical economics literature.

4 MONEY AND PRICES

4.1 THE EMPIRICAL EVIDENCE

THE LONG-RUN LINK BETWEEN MONEY GROWTH AND INFLATION

The first key implication of the quantity theory is that, in the long run, money growth should be proportionally linked to the rate of inflation, while the correlation with real economic activity should be zero. The empirical literature strongly supports this prediction. From a methodological point of view, two strands of the empirical literature on the long-run quantity theoretic implications can be broadly distinguished: (1) studies using large cross-sections of individual country data; and (2) studies based on very long runs of time-series data for individual countries.

Studies using cross-country data explore the correlation between sample averages of money growth and inflation, based on simple chart-based correlation analysis and pooled or panel regressions.[25] The evidence produced by these

[24] See e.g. Friedman and Schwartz (1963). Hazzlitt (1947) made a similar remark in a Newsweek article: "The basic cause of inflation, always and everywhere, lies in the field of money and credit."

[25] See e.g. Vogel (1974), Lothian (1985), Dwyer and Hafer (1988, 1999), McCandless and Weber (1995), Rolnick and Weber (1997), De Grauwe and Polan (2005), Frain (2004), Lothian and McCarthy (2009) and Dwyer and Fisher (2009).

studies suggests that, in fiat monetary systems, the correlation between money growth and inflation is high and close to proportional when the analysis is based on a sufficiently large number of countries (i.e. also including high-inflation countries) and a sufficiently long sample period (i.e. also including high-inflation episodes). Some of these cross-country studies also address the link between money growth and real economic growth.[26] The evidence on this link suggests that real GDP growth and money growth are uncorrelated, in line with the notion of long-run neutrality of money.

McCandless and Weber (1995) is probably the most widely referenced and most influential of these cross-country studies. Lucas (1996) reproduced their scatter plots in his Nobel Prize lecture, and we do the same in Chart 1. The chart plots the average growth rate of money against the average increase in the general price level, measured by the CPI, and the average increase in real income, measured by real GDP, in a sample of 110 countries over the period 1960-90. The main messages of these scatter plots are as follows. First, there is a strong positive, essentially one-to-one, correlation between average money growth and average price inflation, as shown by observations clustering around the 45-degree line. Second, there is virtually no correlation between average money growth and average income growth, as illustrated by observations lying around a horizontal line. These charts therefore provide strong prima facie evidence in support of the central long-run implications of the quantity theory.

The cross-country evidence further suggests, however, that the link between money growth and inflation may not be fully invariant to the monetary policy regime. Rolnick and Weber (1997) show that the money growth-inflation correlation is considerably lower under commodity money standards, which have been characterised by low inflation, than under fiat money standards, which are characterised by higher inflation rates across countries. In a similar vein, De Grauwe and Polan (2005) suggest that over the post-WWII period (i.e. under fiat monetary standards) the correlation between money growth and inflation is considerably reduced, or even fully disappears, when only low-inflation countries are included in the empirical analysis.[27] This conclusion is, however, not undisputed, as there are a number of cross-country studies suggesting that the money growth-inflation link remains intact also in cross-sections of low-inflation countries.[28]

26 See e.g. Lothian (1985) and McCandless and Weber (1995).

27 They define low-inflation countries as countries with an average inflation rate of less than 10%.

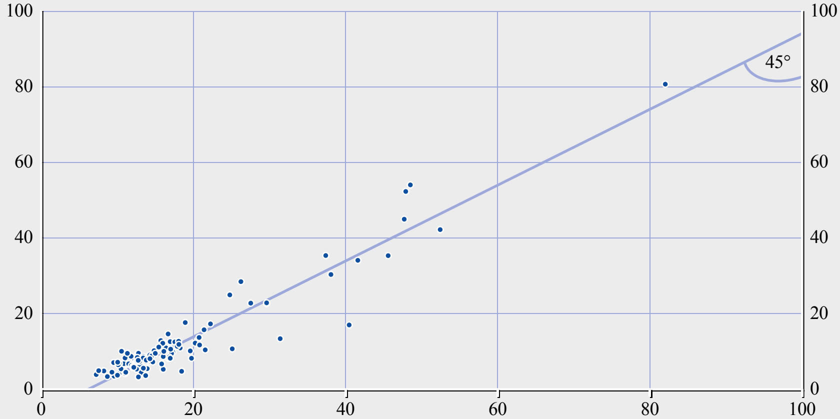
28 See e.g. Issing et al. (2001), Frain (2004) and Lothian and McCarthy (2009). From a conceptual perspective, McCallum and Nelson (2010) have pointed out that testing the quantity theoretic proportionality hypothesis based on cross-country averages of inflation and money growth is potentially flawed in principle if cross-country differences in velocity and output trends are not taken into account. Indeed, if long-run real growth rates and velocity trends vary widely across countries, then country observations would not cluster around the 45-degree line even if the quantity theory would hold true. In panel regression-based analyses of the money growth-inflation link, cross-country differences in trend output growth and velocity trends can, in principle, be taken care of by including country fixed effects.

Chart 1 Money growth, inflation and long-run neutrality

(money growth and inflation: a high, positive correlation)

Average annual rates of growth in M2 and in consumer prices during 1960-90 in 110 countries

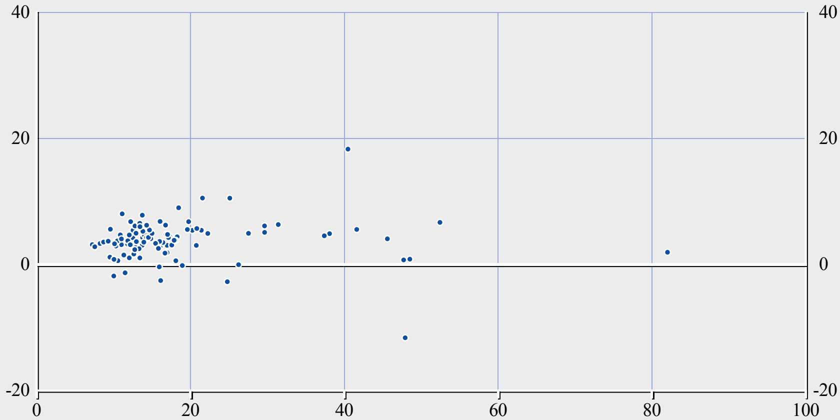
x-axis: money growth
y-axis: inflation



(money and real output growth: no correlation)

Average annual rates of growth in M2 and in real output (nominal GDP deflated by consumer prices) during 1960-90 in 110 countries

x-axis: money growth
y-axis: real output growth



Source: McCandless and Weber (1995).

Studies based on individual-country time-series analysis have also produced strong evidence in support of the existence of a long-run proportional link between money growth and inflation. The seminal paper of this strand of literature is Lucas (1980). He shows, based on scatter plots of filtered data, that there is a one-for-one relationship between the low-frequency (i.e. persistent or "long-run") component of money growth and inflation in the United States over the period 1955-75. More recently, the academic debate about the prominent role given to monetary aggregates in the ECB's assessment of medium to long-run risks to price stability has inspired a revival of the empirical assessment of the long-run link between money growth and inflation. Based on extended Phillips curve specifications,[29] spectral analysis[30] and cointegration analysis,[31] it has been shown that a proportional long-run link between money growth and inflation exists in the euro area over sample periods covering approximately the last three decades. The same has been shown to hold true over similar sample periods for other major industrialised countries like Japan, Switzerland, the United States and the United Kingdom.[32]

In a recent paper, Benati (2009) uses a dataset with annual data for twelve countries going back to the 19th century and monthly or quarterly data for eleven countries over the post-WWII period. The analysis therefore covers a large range of different monetary regimes in different countries. Based on spectral filters, Benati extracts the long-run trend, or low-frequency component, of money growth and inflation and assesses their co-movement over time. His incipient chart-based analysis suggests that the two series move closely together over time. As an example, Chart 2 reproduces the low-frequency components of broad money growth and inflation for four countries, the United States, Canada, the United Kingdom and Norway, over samples starting in the 19th century (taken from Benati (2009)). The charts demonstrate the close co-movement of the two series over time. At the same time, the charts also suggest, however, that the strength of the correlation may not be completely invariant to the monetary policy regime. In particular, the correlation seems to be weaker for the two low-inflation regimes of the sample, the pre-WWI Gold Standard era and the post-1985 low-inflation regime.

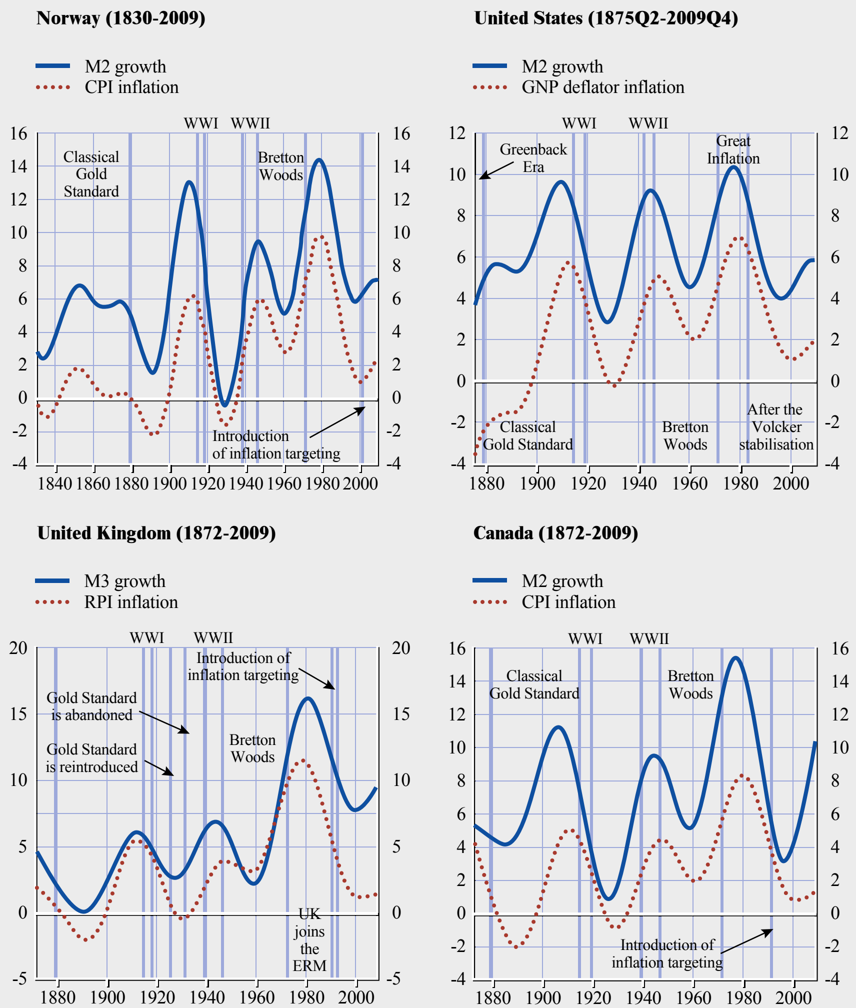
In order to shed more light on the potential time variation in the quantity theoretic long-run nexus, Benati (2009) performs a moving-window analysis with spectral methods. The results of this exercise reveal that while the share of inflation's long-run variance (the spectral coherence) explained by money growth has more or less constantly remained close to one over time, there is considerable variation over time in the coefficient of proportionality (the spectral gain). The pattern that emerges is that the proportionality between money growth and inflation is high in periods of high inflation and low in periods of low inflation, such as the period following the Great Inflation of the 1970s. Similar results are obtained by Sargent and Surico (2008). They revisit the analysis of Lucas (1980) using a longer run of US data spanning the period 1900-2005 and find that Lucas' result of a proportional relationship between money growth and inflation does hold over the sub-sample on which his original study was based, but fails to hold over the full sample and other sub-samples, in particular over the more recent period.

29 See Gerlach (2003, 2004), Neumann (2003) and Neumann and Greiber (2004).
30 See Jaeger (2003), Bruggeman et al. (2005) and Assenmacher-Wesche and Gerlach (2006, 2007, 2008a).
31 See Kaufmann and Kugler (2008) and Carstensen (2007).
32 See Assenmacher-Wesche and Gerlach (2007, 2008a, b) and Assenmacher-Wesche et al. (2008).

THE CAUSAL ROLE OF MONEY IN INFLATION OUTCOMES

Chart 2 also alludes to the causal role of money underlying the long-run link between money growth and inflation. Peaks and troughs in the low-frequency component of money growth tend to lead peaks and troughs in the low-frequency component of inflation by about two to three years. The same pattern is also visible in the other countries covered by Benati's (2009) analysis (see Chart 2 in his paper). This pattern of the lead-lag relationship between money growth and inflation is fully consistent with the seminal work by Friedman (1972), updating his previous work (Friedman (1961)), who documents that "the highest correlation for consumer prices was for money leading twenty months for M1, and twenty-three months for M2" (p. 15). Friedman also notes that these findings only hold on average and that there is considerable variability around the average.

Chart 2 The long-run co-movement of money growth and inflation



Source: Benati (2009).

The latter point warns against trying to use these correlations as a basis for fine-tuning in monetary policy-making.[33]

More formal evidence on the lead of trend money growth over trend inflation is provided in the series of papers by Assenmacher-Wesche and Gerlach (2006, 2007, 2008a, b). Based on band spectrum Granger causality tests, they find that the long-run relationship between money growth and inflation which they have uncovered over the period from 1970 until the present for the euro area and a number of other leading industrialised countries reflects causality going from money growth to inflation rather than conversely.

However, studies focusing on sub-sample stability of the leading indicator property of money growth for inflation tend to produce evidence suggesting that the lead-lag correlation between money growth and inflation has decreased over the low-inflation period prevailing since the mid-1980s, in line with the evidence on the decline in the long-run money growth-inflation correlation over this period. For instance, Friedman and Kuttner (1993) find that when the sample period of their analysis is extended beyond 1980, Granger causality tests fail to reject that money and credit growth do not contain information about future inflation. In a similar vein, Estrella and Mishkin (1997) report evidence suggesting that for the post-1980 period lagged money growth does not significantly enter the inflation equation of a VAR in the United States and also in Germany.[34] More recently, McCallum and Nelson (2010) report evidence showing that the sum of lagged money growth terms in reduced-form inflation equations in Japan and the United States drops considerably when data from the last two or three decades are included.

SUMMING UP THE EVIDENCE

In sum, the empirical literature on the link between money growth and inflation suggests that there is strong evidence of such a link across monetary regimes and that money is the causal variable underlying this link. At the same time, the evidence seems to suggest that the degree of proportionality, as well as the lead-lag correlation between money growth and inflation, are probably not invariant to changes in the monetary regime. More specifically, the long-run link and the lead-lag correlation seem to be weaker in low-inflation regimes.

33 Friedman's work has been revisited by Batini and Nelson (2001), who confirm, using the same methodology, the findings of a lag between changes in monetary aggregates and inflation of one to two years for both the United States and the United Kingdom.

34 The in-sample evidence is, however, not equivocally negative on the evolution over time of the in-sample predictive power of monetary indicators for inflation. For example, Aksoy and Piskorski (2006) suggest that findings of reduced predictive power of money growth might be due to an increasing share of US money held abroad. They show that monetary aggregates adjusted for such foreign money holdings continue to Granger cause inflation also over the post-1980 period, while results based on standard monetary aggregates indeed suggest that money growth indicators do not contain any information for future inflation. In another recent paper, Goodhart and Hofmann (2008) perform panel Granger causality tests for a sample of 18 industrialised countries over a sample starting in the early 1970s assessing the leading indicator property of both money and credit growth. For the full sample they find strong evidence of Granger causality from money to inflation, but not from credit growth to inflation. For a shorter sub-sample starting in the mid-1980s, money growth is not found to enter significantly the inflation equation anymore, while credit growth is found to strongly Granger cause inflation.

4.2 EXPLAINING TIME VARIATION IN THE EMPIRICAL MONEY GROWTH-INFLATION NEXUS

THE LUCAS CRITIQUE

Lucas (1980) interpreted evidence of quantity theoretic proportionality as an empirical regularity which is invariant to structural changes in the economy and changes in policy regimes and that therefore needs to be part of a meaningful macroeconomic model. This conclusion was subsequently challenged by McCallum (1984) and especially Whiteman (1984), who questioned Lucas' method as a valid exercise for testing the quantity theory on the ground that empirical, reduced-form correlations between money growth and inflation are – in principle and ironically – vulnerable to the Lucas critique (1976), and namely to the possibility that the correlation between money growth and inflation could be unstable due to changes in monetary regimes. More specifically, McCallum (1984) and Whiteman (1984) show, based on simple business cycle models with rational expectations, that the empirical correlation between money growth and inflation crucially depends on the parameters governing the money supply process.

While the analysis of McCallum (1984) and Whiteman (1984) suggests that the empirically measurable link between money growth and inflation will vary with the monetary policy regime, it leaves open in which direction the influence goes. This issue has been taken up by more recent research. Estrella and Mishkin (1997) and De Grauwe and Polan (2005) suggest that the signal-to-noise ratio of monetary aggregates is low in low-inflation environments because of the dominant influence of velocity shocks, so that the long-run link between money growth and inflation becomes visible only in periods characterised by pronounced changes in money growth and inflation, as was the case in the Great Inflation. In support of this hypothesis, Benati (2009) shows, based on a standard New Keynesian model, that unexpected shifts in the velocity of money cause, other things equal, a significantly stronger reduction in the long-run correlation between inflation and money growth than in the variability of inflation explained by money growth, which is the pattern of changes in the money growth-inflation nexus he finds when the economy moves from a high to a low-inflation regime. Intuitively, velocity creates a wedge between money growth and inflation that may obfuscate the relationship between money growth and inflation. On the other hand, infrequent outbursts of inflation, caused by excessively loose monetary policy, reveal the one-to-one correlation between the long-run components of money growth and inflation, which during more stable periods would be dwarfed by changes in velocity. In a similar vein, Sargent and Surico (2008) find, based on a simulated DSGE model, that policy regimes that are associated with a monetary policy consistent with low and stable inflation are also characterised by a low empirical low-frequency correlation between money growth and inflation.[35]

Thus, the findings of a time-varying and especially less than proportional relationship between measures of money growth and inflation found in the

[35] For a more practical application of these considerations to the euro area data, see the discussion in Chapter 4 (and especially that in Annex 1 to that chapter).

empirical analyses of the above two studies are not at variance with the quantity theory of money. In fact, the studies by Benati (2009) and Sargent and Surico (2008) can replicate those results using models in which the long-run quantity theoretic link between money growth and inflation is valid by assumption. By taking for granted that the theory is valid, it is simply shown that the empirical validity of the quantity theory cannot rely exclusively on correlations. In other words, statistical correlations might not necessarily reveal the structural "unconditional" nexus that exists between money and inflation because such a nexus is temporarily weakened by a monetary policy regime that systematically controls money growth and stabilises inflation. In this respect, a successful central bank that manages to keep prices stable may paradoxically be confronted with a low correlation between money growth and inflation. But this evidence by itself would not contradict the validity of the quantity theory and hence the importance of paying attention to money growth.

GOODHART'S LAW

Another potential explanation, which is closely related to the Lucas critique, is Goodhart's law, which states that "any observed statistical regularity will tend to collapse once pressure is placed upon it for control purposes" (Goodhart (1975)).[36] In other words, this means that the leading indicator properties of a macroeconomic statistic tend to disappear once monetary policy incorporates that statistic in its policy framework and starts reacting to it in a systematic manner. This could apply to the association between money growth and inflation. Assume that in the past measures of excess money growth did possess predictive power for inflation, e.g. in the run-up to and during the Great Inflation of the 1970s. Further assume that, because of this, the central bank takes the information content of such measures seriously when setting policy, as happened in many countries in the late 1970s and early 1980s. As a consequence of Goodhart's law, it would follow that such measures will over time (partly or fully) lose their forecasting power for inflation, which is, as we have seen, what seems to have happened since the early 1980s.

This reasoning can be illustrated more formally based on an extremely simplified model – borrowed from Woodford (1994) – in which inflation is determined by:

$$\pi_t = m_t + r_t + \varepsilon_t \qquad (4)$$

where π_t, m_t and r_t are inflation, an indicator which affects inflation one-for-one (in this case, money growth), and a policy instrument respectively, and ε_t is a shock to inflation. Furthermore, for the sake of simplicity, assume that the monetary authority perfectly observes m_t. The optimal choice for r_t to minimise the variance of inflation would then be $r_t = -m_t$ (with the monetary authority thus fully reacting to m_t), which would cause inflation to be equal to the shock: $\pi_t = \varepsilon_t$.

36 The argument is a special case of the Lucas (1976) critique, which states more generally that the effects of a policy experiment cannot be assessed based on historical time-series correlations because a change in policy will alter these correlations via its effect on expectations.

Now, suppose that an econometrician wanted to assess the usefulness of m_t as an indicator variable for inflation by running a regression of inflation on m_t. It can be shown that the theoretical value of the regression coefficient in the regression of inflation on m_t is exactly zero, so that the econometrician would conclude that m_t is of no value in assessing inflation prospects, when instead, by assumption, the forecasting power of m_t for future inflation is "hardwired" into the structure of the model. In other words, based on the argument just put forward, the very fact of reacting to the information contained in (excess) money growth will cause such information to disappear. At the same time, reverse Goodhart's law implies that the predictive power of money would return when its information content would again be ignored by policy-makers.

SHIFTS IN VELOCITY

A third potential explanation for a reduced empirical correlation between money growth and inflation are shifts in velocity. Lucas (1988), Reynard (2006) and more recently McCallum and Nelson (2010) suggest that shifts in the velocity of money caused by Fisherian movements in interest rates, and therefore in the opportunity cost of holding money, caused in turn by fluctuations in the trend component of inflation, may account for the departure from the one-to-one relationship between money growth and inflation associated with the quantity theory. In more general terms, the failure to appropriately capture the determinants of money demand, be that because of an inappropriate modelling of the scale variable or of the determinants of velocity, would lead to a blurred measurement of the extent to which actual money growth is in excess of the increase in money demand and hence to a biased estimate of the link between money growth and inflation.

In principle, this problem could be taken care of by appropriately specifying empirical money demand functions. However, this has turned out to be no easy task. In fact, empirical money demand functions are notorious for their instability. Empirical money demand analysis was pioneered in the United States, where sufficiently long time series for exploring aggregate money demand relationships became available back in the 1950s. The results of the early US money demand studies varied widely,[37] but a robust result was that real money balances (narrow and broad) are positively linked to real income and negatively to interest rates over a sample period spanning from 1900 to 1960. Based on the results of sub-sample analysis, it was concluded that money demand was stable. However, not long after these early successes in establishing stable US money demand functions, stability problems emerged. From the mid-1970s until the mid-1980s, empirical M1 demand functions in the United States were subject to stability problems. In the 1970s, conventional M1 demand equations systematically over-predicted actual M1 balances, a phenomenon which Goldfeld (1976) referred to as the case of the "missing money".[38] US M2 demand functions appeared to be stable until the early 1990s, when these functions also started to over-predict the demand

[37] See Meltzer (1963), Laidler (1966a, b) and Chow (1966).
[38] See also Goldfeld and Sichel (1990) for a documentation and discussion of this phenomenon.

for M2.[39] Instability in empirical money demand functions also emerged outside the United States. For instance, Fair (1987) estimated M1 demand functions for 17 countries and found for 13 countries evidence of a structural break in 1973.

This raises an issue of fundamental importance: can the central tenets of the quantity theory still hold true when money demand is not stable? In fact, stability of empirical money demand equations is often put forward as a precondition for the validity of the central implication of the quantity theory that there is a stable long-run link between money and prices. This claim is, however, fallacious, as pointed out by Lucas (1980) and McCallum (1993) and recently reiterated by McCallum and Nelson (2010). Following McCallum and Nelson (2010), the point can be demonstrated by considering a standard specification of the money demand equation that results from utility analysis:[40]

$$log(M_t/P_t) = c_0 + c_1\, log(Y_t) + c_2 R_t + e_t \quad (5)$$

where M is the nominal money stock, P is the aggregate price level, Y is real output (or consumption), R is an interest rate proxying the opportunity cost of holding money and e is an error term.

Since the variables appearing in the money demand function – real money balances, real output and nominal interest rates – are commonly found to be non-stationary and integrated of order one,[41] cointegration analysis has become the standard tool for empirical money demand studies. The finding of cointegration would mean that the error term in the money demand function is stationary, while lack of cointegration would mean that there is a unit root in the error term. Lack of cointegration, or a unit root in the error term, would in turn imply that no stable money demand relationship exists.

Taking first differences of the money demand function yields a first-difference relationship between the growth in real balances, output growth and the change in the interest rate:

$$\Delta\, log(M_t/P_t) = c_1 \Delta\, log(Y_t) + c_2 \Delta R_t + \Delta e_t \quad (6)$$

If the variables in the levels relationship were integrated of order one and not cointegrated, so that also the error term was stationary, the first-difference relationship would still comprise only stationary variables on the right-hand side. This, in turn, implies that also the left-hand-side variable – the growth in real balances – is stationary, or in other words, that there is a stable long-run relationship between money growth and inflation. Thus, the lack of a stable money demand relationship does not, from a conceptual point of view,

39 See Duca (1995), Whitesell (1997), Dotsey et al. (2000) and Carlson et al. (2000).
40 See e.g. McCallum and Goodfriend (1987) and Lucas (1988).
41 A variable is integrated of order one when first differencing yields a stationary transformation. More generally, being integrated of order n means that the variable has to be differenced n times in order to obtain a stationary series.

undermine the central tenet of the quantity theory that there is a proportional long-run relationship between money growth and inflation.

Therefore, money demand instability or infrequent shifts in velocity are unlikely to be the main explanation for the observable drop in the long-run correlation between money growth and inflation. However, at horizons shorter than the very long run, money demand instability will still blur the link between money and prices so that identifying a stable money demand function will be important to establish a norm against which the implications of observable monetary developments for future inflation can be assessed.

5 MONEY AND THE BUSINESS CYCLE

5.1 TRADITIONAL THEORIES ABOUT MONEY, INFLATION AND OUTPUT

The relationships (1)-(3) encompass not only the quantity theory of money but also the LM curve, which features the simplest and most famous formal rendition of Keynesian theory (Hicks (1937)). Specifically, the LM curve defines a positively sloped combination of output and interest rate levels such that the money market is in equilibrium. The relationship between money demand and the interest rate arises as a result of a particular motive for holding money, namely speculative reasons. The intuition is that an increase in the interest rate decreases the prices of bonds, and hence depresses the demand for speculative purposes. At the same time, the income-expenditure theory laid out by Keynes (1936), in its simplest rendition, allows aggregate demand to be expressed as a negative function of the interest rate (IS curve).[42] Taken together, the two functions define aggregate demand. The distinct feature of the Keynesian theory – at least in its early days – rests on taking the price level as a datum largely dependent on institutional factors insofar as the economy is characterised by unemployment.[43]

Admittedly, these assumptions could be thought of as relatively more valid when the analysis focuses on the very short run or when the economy is characterised by ample slack or unemployment, as was certainly the case for the economies observed by Keynes when writing his General Theory. With prices fixed, or slow to adjust, an increase in money supply stimulates the aggregate demand, via its effect on the interest rate, and achieves a higher level of output and employment. Therefore, Keynesian theory had been viewed by many scholars as a challenge to the quantity theory, at least until the advent of double-digit inflation in the 1970s. Indeed, prices were considered, to a significant extent, dependent on institutional factors, even beyond the short run, on condition that economic resources were under-utilised. Accordingly, it was not uncommon to think of unemployment as

42 Keynes (1936) assumed that consumption was a stable function of income, whereas investment was a stable function of the interest rate plus autonomous components.

43 The price level was assumed to be determined as a mark-up on costs, mostly given by wages. Wages in turn were assumed to be rigid and determined by labour contracts and the power of trade unions.

the consequence of insufficient aggregate demand rather than distortions in the functioning of the labour market. A boost in aggregate demand was seen as raising inflationary pressures only if resources were at or close to full utilisation.

While a useful starting point for the analysis of monetary phenomena, the framework given by equations (1)-(3) is *incomplete* for explaining the process of adjustment from the short to the long run, either when interpreted as a quantity theory or when seen through the lens of the Keynesian theory. Even if one were to take velocity as independent of changes in the money supply (or the interest rate), then an extra element would need to be brought into the analysis to explain how an initial change in the money supply (or nominal income) splits up over different time horizons into changes in real output and the price level. This extra element is the Phillips curve (Phillips (1958)), which relates changes in prices to changes in a measure of economic slack (either unemployment or the output gap). Based on this relationship, Keynesian economists also came to believe that there was a stable exploitable long-run trade-off between inflation and the economy's slack.[44] The view of prevailing slack in the economy, together with the belief in the existence of a stable long-run Phillips curve, led "orthodox" Keynesians to recommend the imposition of income and price controls in conjunction with expansionary fiscal and monetary policies.

These views – which represented the economic orthodoxy well into the 1970s – began to be challenged during the 1960s by monetarists such as Friedman who regarded monetary policy as the only effective means for keeping inflation under control. Not only did Friedman provide the empirical and historical studies aimed at showing that inflation was ultimately a monetary phenomenon (Friedman and Schwartz (1963)),[45] he also contributed to disproving the idea of a long-run non-vertical Phillips curve. Along with Phelps (1968), Friedman (1968) (re)introduced the idea of the "natural rate" of unemployment, which was determined by the workings of the labour market and was completely (or largely) independent of monetary forces. Price and wage-setters were ultimately bound to adjust their prices and wages to higher inflation so that any attempt to inflate away unemployment was doomed to failure. The coexistence of high inflation in the 1970s with high and rising unemployment proved Friedman's insights to be right. An initial outburst of inflation could have had many origins, but it ultimately boiled down to monetary policy being accommodative.[46]

44 See Samuelson and Solow (1960). Admittedly, they appeared to believe that the trade-off could also shift in the longer run as a result of policy decisions.

45 Friedman and Schwartz (1963) persuasively argued that the Great Depression was caused by the wrong doctrines followed by the Fed at the start of the 1930s and hence the Fed's mishandling of the financial crisis and money supply after 1931. Although this view is not shared by all, it has come to be accepted by the majority of economists. A good example of its current acceptance is the speech given by Bernanke (2002).

46 The view that the monetary policies pursued by central banks were ultimately responsible for the double-digit inflation experienced during the 1970s in the United States and many other advanced countries has been further strengthened by a recent stream of literature which goes under the heading of "Great Moderation" or "Great Stability". For a general discussion of this issue see, for instance, Bernanke (2004).

Sargent (1971) and Lucas (1972) provide more formal theoretical support for these ideas by showing how the rejection of the natural rate hypothesis ultimately rests on assuming irrational expectations for economic agents. When instead rational expectations are considered, the natural rate hypothesis follows logically. Econometric investigations performed under the assumption of rational expectations gave empirical support to the Friedman-Phelps idea of a long-run vertical Phillips curve.[47] Since then, introducing rational expectations into micro-founded general equilibrium models has been the prominent approach in modelling economic dynamics.[48]

In Lucas (1972), the formalisation of rational expectations not only results in the absence of any long-run trade-off between the quantity of money (and hence inflation) and unemployment; it also implies that, even over the short run, central banks cannot systematically influence real economic activity, as their actions are bound to be perfectly anticipated by economic agents. It is only the unexpected component of monetary policy, operating via inflation *surprises*, that influences real variables. At the root of this channel is the private sector's limited information about the state of the economy and, in particular, the prevailing average price level. Unexpected increases in the price of a given product can therefore be interpreted as resulting from an increase in *either* the relative demand for that product *or* average demand for all products; the former calls for an increase in the production of output, while the latter calls for no change in output. That the associated inference problem correctly attributes some weight to both interpretations implies that real output tends to respond to nominal shocks; crucially, though, such a response does not persist beyond the impact period.

5.2 THE CURRENT MAINSTREAM VIEW

By confronting with the data a stochastic growth model whose cyclical movements result from exogenous shifts in technology, Kydland and Prescott (1982) shaped the research methodology in quantitative dynamic macroeconomics in subsequent decades. Despite being silent, by construction, on the role of monetary policy in the economy, this contribution exerted a deep methodological influence over the current generation of models used to analyse monetary policy.

In this context, an important theoretical paradigm – the New Keynesian approach – rests on dynamic stochastic general equilibrium (DSGE) models built on optimising behaviour of representative agents subject to resource, technological and institutional constraints, i.e. precisely in the spirit of Kydland and Prescott (1982). Notably, this framework is able to provide a description of the process of adjustment linking the short to the long run, which had been missing both from the quantity theory and the early Keynesian theory. In line with the Keynesian tradition, this approach identifies price stickiness as the major friction for monetary policy; the existence of contracts in imperfectly competitive markets prevents firms and workers from adjusting their prices and wages in every

47 See, for instance, McCallum (1976).

48 See Muth (1961) for a seminal contribution in formulating and introducing rational expectations into economic models.

period, and implies that monetary policy affects real output in the short run.[49] But somehow in contrast with much of the Keynesian tradition, it is precisely because prices are sticky that inflation is to be avoided, as it creates real distortions and hence welfare losses.

New Keynesian models also incorporate many of the economic ideas that have emerged since the late 1970s and most importantly the notion of what monetary policy can and cannot do. The dynamic and optimising nature of the model and its internal consistency bring to light crucial issues of the adjustment process that had been neglected or not well specified in the early Keynesian analyses. Among the most important are the role of expectations and the importance of commitment and reputation in policy-making, the difference between nominal and real interest rates, and the difference between short and long-term interest rates. As noted above, the presence of nominal rigidity implies that monetary policy can influence aggregate demand, and hence real output, over the short run, and then control inflation via the expectations-augmented Phillips curve. Over the long run, monetary policy cannot increase output or its growth rate above the natural rate, while it fully determines the average inflation rate. Clearly, larger models providing a richer description and dynamics than the streamlined version just outlined are available.[50] Yet, most models share the unsatisfactory feature that their intrinsic dynamics are relatively limited, as witnessed by the need to incorporate persistent exogenous shocks when trying to fit the data.[51]

A striking difference with the Keynesian tradition is the relatively limited role played by money in the New Keynesian prototype model. Indeed, the latter model can be solved for macro-variables without making any reference to monetary developments. As monetary policy is typically assumed to be implemented by choosing the nominal interest rate, the model simply implies that money adjusts endogenously to achieve equilibrium in the money market. It is interesting to note that, while in principle a policy rule could be defined in terms of money supply, in practice the vast majority of models use a rule for the nominal interest rate.[52]

49 Importantly, when having the opportunity to adjust prices, firms do so optimally.

50 As an example of a medium-sized DSGE model, see for instance the Smets and Wouters (2003) model, estimated on the basis of quarterly euro area data and used at the ECB for monetary policy analysis. In what follows we will briefly review larger-scale models, such as Christiano et al. (2003 and 2008), which are particularly interesting for their explicit formalisation of a role for financial factors, which are ignored in the basic New Keynesian models.

51 Admittedly, recent specifications of New Keynesian models have increased the endogenous persistence mechanism, for instance, by introducing price indexation, including habit persistence, or by replacing the assumption of rational expectations with the one in which agents are assumed to learn about various aspects of the economy. While some of these ideas are admittedly appealing, the issue at stake is the extent to which these mechanisms capture genuine structural characteristics of the economy rather than merely being themselves ad hoc features. Moreover, while allowing for channels of persistence finds clear support in the data, the very same data are poorly informative in discriminating between these alternative channels. A crucial issue is therefore the extent to which such alternative models, which appear to fit the data equally well, have different normative implications in terms of policy prescriptions.

52 See Poole (1970) for an early theoretical investigation of the optimal choice between the interest rate and the money stock as the monetary policy instrument in an IS-LM framework.

This largely reflects the fact that, in many countries, the relationship between money quantity and nominal income has manifested substantial instability since the 1980s, and thus has made the use of monetary aggregates as the policy instrument quite problematic.[53] For the United States, for example, Taylor (1993) finds that, during the period 1987-92, the conduct of monetary policy can be well described by a feedback rule mapping the deviation of inflation from the target, and of output growth from potential, to the nominal interest rate (the so-called Taylor rule). Moreover, Woodford (2003) shows that, under certain conditions, when such an interest rate rule satisfies the principle of increasing the real interest rate in reaction to upward inflationary pressures (Taylor principle), a unique equilibrium emerges where inflation is on target and output at its potential, where the latter is solely determined by real factors.

At first, the fact that a model for conducting monetary policy makes no reference to money may admittedly appear an oxymoron. Nevertheless, this fact is less surprising once it is taken into account that, by construction, money does not have any role to play, as the channels of the transmission mechanism through which it may exert an influence are simply not formalised.[54] Clearly, the degree of detail in the formal description of the transmission mechanism and the monetary policy decision-making process largely depends on the questions being addressed by the analysis. In this respect, the New Keynesian model has proved to be a useful device for understanding, for example, the impact of changes in the systematic component of monetary policy and the role of expectations in the economy's dynamics; it has so far served as a useful "lens" in making these and other significant issues more sharply visible. Nevertheless, the New Keynesian model, at least in its simplified version, has also proved to be "blinkers": it has somehow narrowed the "field of vision" of analysts and practitioners by diverting their attention from the role that money, liquidity and financial intermediation play in the allocation of resources and economic fluctuations.

Historically, ignoring the importance of such channels in central banking has proved to be extremely costly. For instance, there is a widespread consensus that it was precisely the particular response of the banking and financial sectors to various shocks which was the root cause of the Great Depression of the 1930s. And liquidity preference shocks are identified in the analysis by Christiano et al. (2003) as the ones mattering most. Provided this is the case, the failure by the central bank to temporarily accommodate money demand would then have exacerbated even further any initial decline in output. A second example is the Great Inflation of the 1970s. After the contractionary phase resulting from the first oil peak, monetary policy in most countries remained accommodative for too long, thus paving the way for an upward drift in inflation. At the same time, countries that relied more on the medium-term interaction between monetary trends and inflation remarkably did manage to succeed in containing inflationary pressures. Finally, the most recent financial crisis is another clear reminder that crucial questions for the conduct of monetary policy (such as, for instance,

53 See Mishkin (2001) for a discussion.

54 For a detailed discussion of the role of money in the macroeconomy and for monetary policy-making from the perspective of the New Keynesian model, see Woodford (2008).

the role of credit and monetary aggregates, the challenges posed by asset price movements, and the impact of liquidity constraints) cannot be asked sensibly within the current theoretical paradigm. Research aimed at modifying the standard framework to include a meaningful role for money and credit in models typically used for policy analysis and forecasting is one interesting avenue through which dynamic optimising macroeconomics makes contact with the quantity theoretic tradition described above. The next section briefly illustrates selected theoretical attempts.

Box Keynesian and New Keynesian: from the LM curve to a model for monetary policy without money

As mentioned above, in the Keynesian tradition money lies at the centre of the functioning of the economic system. It is the equilibrium relationship in the money market (LM), together with the one in the market for goods and services (IS), that jointly determine the interest rate and the real output in the economy. Specifically, the LM function is related to the interest rate via the speculative demand for money, which together with the transaction and precautionary demand for money represent the three motives for holding money. A higher interest rate, so the argument goes, would imply, ceteris paribus, a lower demand for money as households reallocate their savings towards bonds in response to changes in relative returns. Variations in interest rate expectations, still in the absence of a precise formalisation of their formation process, are thought to shift the demand for money. More broadly, expectations and confidence about the future make demand for money quite unstable. Tobin (1958) formalises some of these insights by showing, for instance, how the demand for money results in equilibrium through agents' maximising their utility taking into account the trade-off between the risk and the expected returns of a given portfolio; the portfolio comprises, for simplicity, only two assets: money and bonds. In this context, money changes play a crucial role in households' adjustments of the composition of their portfolio, and the intensity of such adjustments is influenced by concepts such as the degree of risk and agents' risk aversion.

The essential nucleus of the basic New Keynesian model consists of an intertemporal IS equation (a) and an expectations-augmented aggregate supply equation (b), which are meant to approximate the dynamic behaviour of the economy around the long-run equilibrium. The model is typically closed assuming that the central bank uses a simple rule, such as equation (c), which maps inflation and output (gap) to the short-term nominal rate.

(a) $y_t = E_t y_{t+1} - \sigma(i_t - E_t \pi_{t+1}) + v_t$

(b) $\pi_t = \beta E_t \pi_{t+1} + \alpha(y_t - y_t^*) + \varepsilon_t$

(c) $i_t = \varphi_\pi \pi_t + \varphi_y (y_t - y_t^*) + \omega_t$

Via the Euler equation (a), current income depends on the expected future income and the short-term real interest rate. The presence of output rather than consumption is justified by the fact that the model, in its most simplified version, abstracts from investment and other components of expenditure. Solving equation (a) forward makes

Box Keynesian and New Keynesian: from the LM curve to a model for monetary policy without money (cont'd)

current output a function of the sequence of expected future short-term interest rates – equivalent to an expected long-term interest rate. Via the expectations-augmented Phillips curve, current inflation depends on expected future inflation and the output gap – the difference between current output y_t and the level of output which would prevail were prices flexible y_t^*.[1] Solving (b) forward makes clear that current inflation depends on the (discounted) sum of all expected future output gaps. Despite important differences in the channels of the transmission mechanism and in the degree of reliability for informing policy, most New Keynesian models share the same essential features as regards the role of money. And specifically:

1) money plays only a passive role in the model;
2) despite 1), the model is still consistent with the long-run quantity theoretic link between money growth and inflation;
3) the monetary transmission mechanism is fully represented by the short-term interest rate and is hence very simplistic.

First, absent from the IS curve (a) and the Phillips curve (b), money is normally appended to the model through a money demand equation. As monetary policy is implemented by choosing the short-term interest rate, money becomes endogenous; in practice the central bank needs to ensure that the supply of money matches the demand for money at the interest rate level that it desires to achieve.

Second, because money does not enter any structural equations it may seem that the New Keynesian model is inconsistent with the quantity theory of money. In fact, while adding a money demand equation does not affect the dynamics of the main macro-variables, money growth can still be thought of as serving to pin down the long-run rate of inflation in the economy's steady state.[2]

Third, the monetary transmission mechanism encapsulated by the New Keynesian model is highly stylised, depending merely on the term structure. No other asset price appears in the IS curve, nor does the stock of money or credit. It is unlikely that the details of how money and credit are created and the various asset prices or yields that enter the determination of aggregate demand could be captured simply by the short-term and expected long-term rates. That would be the case, for example, if liquidity and risk premia were to behave in a perfectly synchronised way with the short-term interest rate, or if the economy were free from liquidity constraints and other important transaction costs. Indeed, both monetarists and Keynesians have stressed the importance

1 The Phillips curve equation can be derived either by assuming that firms or workers face the possibility of adjusting their prices or wages only with some probability or incur quadratic costs of adjustment. More broadly, the framework also embodies the idea that variables fluctuate around their "natural" rates, which accords with the Walrasian view of relative price determination. In the streamlined model above, output fluctuates around its natural level. This is defined, as stressed, as the output level that would prevail if prices were perfectly free to adjust and hence reflect the preferences and constraints faced by agents. In the long run, actual variables tend to the long-run values of these natural rates and as such they are free from monetary influences.

2 See e.g. Nelson (2003) and McCallum (2001). Woodford (2008) offers an opposing view (see also the discussion in Chapter 4 of this book).

Box Keynesian and New Keynesian: from the LM curve to a model for monetary policy without money (cont'd)

of the imperfect substitutability among the existing wide range of assets and hence the existence of many channels of transmission operating through a broad range of explicit and implicit yields. Finally, whether the nominal interest rate is set optimally via the minimisation of a loss function or simply follows an ad hoc rule, a central bank is typically assumed to be credible and no explanation is given as to how such credibility is to be maintained. The anchoring of long-term inflation expectations in line with the inflation target or the definition of price stability is, for instance, where monitoring of monetary aggregates in the decision-making process beneficially comes into play.[3]

3 It is clearly possible to modify the basic model to incorporate, for example, a variable inflation target which is unobservable to the private sector and hence needs to be learnt by the latter; see e.g. Erceg and Levin (2003).

5.3 RECENT DEVELOPMENTS

The long-run relationship between money and prices, originally conjectured by Hume and subsequently validated by a myriad of empirical studies, is now so widely accepted that the majority of the formalisations in the literature are consistent with it. But greater controversy surrounds the extent to which monetary aggregates are relevant for the conduct of monetary policy.

As noted above, the prototype New Keynesian model has a strong implication: the quantity of money has no role in monetary policy-making. This section investigates the extent to which the prediction implied by the baseline model survives the introduction of minor and more important amendments, as well as the explicit formalisation of channels which can give a role to the quantity of money and the amount of credit. The section briefly presents recent selected contributions which build their analysis of monetary policy on monetary frictions as opposed to price stickiness, which is the key friction in the standard New Keynesian model. Finally, the section briefly reviews the recent literature on the empirical link between money, credit and asset prices.

5.3.1 MONEY WITHIN THE NEW KEYNESIAN PARADIGM

This section considers the following three dimensions in which money can be formalised within a New Keynesian paradigm:

– first, money can serve as an indicator in a context of uncertainty;

– second, money can be an effective instrument of the monetary policy strategy helping to preserve macroeconomic stability;

– third, money and credit, when explicitly formalised, can play an important, active role in the monetary transmission mechanism.

Money as a "pure" indicator

While money does not have a role to play in the conduct of monetary policy within a prototype New Keynesian model, it can still serve the purpose of a quantity-side indicator of the monetary conditions prevailing in the market. Clearly, such a role is rather limited in models solved under the assumption of fully rational expectations, namely the assumption that every detail of the "true" model is known, and this knowledge is shared by households, firms and the central bank.[55] In reality, however, monetary policy inevitably operates with a great deal of uncertainty: uncertainty about models, parameters, the state of the economy and data.

In such a context, money may provide useful information about, or a proxy for, variables that are unobservable or observable only with a delay. A role for money may hinge, for instance, on the fact that money demand, depending on variables like output, may provide timely information about variables that are measured imperfectly. In essence, this is the intuition behind the contributions of Coenen et al. (2005) and Nelson (2003) inter alia. They formalise a situation in which current output data are measured with error, shocks are not observable, and money demand depends on the *true* output level. In such a context, money has an important informational content for output, provided shocks to money demand are not too large relative to the magnitude of output measurement errors, and money demand is sufficiently stable. Following Svensson and Woodford (2004) and Aoki (2003), Nelson (2003) stresses how optimal policy in this environment calls for the interest rate instrument reacting to monetary indicator variables with a strength that depends on their relative precision. Moreover, when considering a Friedman-Meltzer-type money demand, defined so as to respond to both long-term rates and expected future output, it is shown that the response of the policy instrument to the money growth rate rises substantially.

Not only can money be a useful indicator of the level of aggregate macro-variables, it may also serve an important role when "natural rate concepts" are subject to (persistent) mis-measurement. An extensive literature has documented the large inaccuracy of real-time estimates of potential output, and has analysed the risk for monetary policy arising from an excessive emphasis on such statistics.[56] Notably, when allowing for mis-measurement of natural rate concepts (potential output and the natural real interest rate), Beck and Wieland (2007) also rationalise the inclusion of money in the interest rate rule within a model economy that otherwise does not formalise any short-run direct interaction between money and inflation. Effectively, the inclusion of money offsets the policy bias resulting from persistent mis-measurement of potential output. Finally, the prescribed policy has a cross-checking feature which is interpreted by the authors as consistent with the one advocated by the ECB's monetary policy strategy.[57]

A similar role of money in directly conveying information about natural rate concepts arises when considering a situation in which many financial assets, beside the short-term interest rate, do affect both aggregate demand and money

55 As Sargent has put it "[within the typical rational expectations model] there is a communism of models. All agents inside the model, the econometrician, and God share the same model". See Evans and Honkapohja (2005).

56 See e.g. Orphanides (2001).

57 See Section 6 of this chapter for a description of the ECB's monetary policy.

demand. In such a context, money (or some of its components) may well proxy for those financial assets that are difficult to observe. In an attempt to capture this old monetarist idea,[58] Andrés et al. (2009) introduce portfolio adjustment costs in an otherwise standard New Keynesian framework. The resulting real money demand function is thus characterised by a forward-looking nature so that it can be expressed in terms of expected future natural real rates, as well as of the "standard" money demand variables. By providing information about natural rate concepts, money ends up again playing a prominent role in this model economy – surely more important than the one traditionally identified in the New Keynesian paradigm, namely that of being one among the many (noisy) indicators of the current level of output. When fitting the model to the data, the forward-looking nature of money demand, and hence its informational content, finds strong empirical support for both the United States and the euro area. Hence, portfolio adjustment costs are found to be a significant feature of actual economies.

Money and the conduct of monetary policy

As noted above, there has been until recently a widespread consensus in the monetary policy modelling literature that central bank behaviour can be operationalised in terms of interest rate rules that react to some measures of inflation (and eventually real activity), without any reference to money and credit. Moreover, provided the strength of the policy reaction is sufficient to ensure an increase in the real interest rates in response to inflationary pressures (i.e. the Taylor principle is satisfied), in most specifications of the New Keynesian paradigm the equilibrium is determinate. This means that, on average, inflation is on target and output at its potential. Crucially, though, this conclusion is drawn under the assumption that the exogenously induced fluctuations of the economy are small around the model's steady state. [59]

When considering instead the global set of equilibria – including steady states far from the "virtuous" one in which inflation is on average around the objective of monetary policy – Benhabib et al. (2001), for example, find that active Taylor rules – namely, Taylor rules satisfying the Taylor principle – may well lead to perverse outcomes. Indeed, active Taylor rules may often imply global indeterminacy. In essence, equilibrium dynamics arising in the proximity of the active steady state may well bring the system to the deflationary spiral of the undesirable steady state in which the interest rate instrument becomes ineffective.[60] As illustrated by Benhabib et al. (2002), the liquidity trap equilibrium has a self-fulfilling nature in that agents' expectations about future declines of inflation set in motion a chain of events so that these expectations are confirmed ex post.[61] Under certain conditions, a monetary policy switching from an interest rate rule to

58 See e.g. Brunner and Meltzer (1993); Friedman and Schwartz (1963).

59 Here, therefore, "determinacy" stands for local determinacy of the equilibrium, namely situations when policies and shocks fluctuate within a small neighbourhood around the steady state. See e.g. Woodford (2003), p. 77.

60 Such equilibrium dynamics are found to arise in both sticky price and flexible price baseline models under reasonable calibrations.

61 More precisely, expectations of a decrease in the nominal interest rate are associated with a higher demand for real balances, and hence with an increase in the marginal utility of consumption. As a result, the system tends to move to situations characterised by an inflation rate at possibly negative values, and a nominal rate at the lower bound.

a money growth rule may be effective in avoiding, and eventually escaping from, such a liquidity trap. Intuitively, with nominal interest rates at the lower bound, the central bank can still influence real rates by shaping agents' expectations through the credible commitment to inflating the economy by increasing the money supply. Similarly, Christiano and Rostagno (2001) illustrate, for example, how a standard Taylor rule fails to avoid particularly perverse outcomes of the kind described by Benhabib et al. (2002) within a cash-credit good model economy à la Lucas and Stockey (1983). They prescribe a monetary policy that switches from a standard Taylor rule to a constant money growth rule, once money growth is outside a given range. Interestingly, a credible commitment to monitor money growth and be ready to switch to the policy of constant money growth is sufficient to rule out the possibility of the perverse steady state. A monetary policy of this type is also advocated by Christiano et al. (2007) in a specification that results from minor amendments of the baseline New Keynesian model. More specifically, the amendment consists in formalising a supply-side channel, so that nominal interest rate increases bring about higher costs of production, namely higher costs of labour and inventory financing. When strong, this channel implies that the response of the nominal interest rate prescribed by a Taylor-type rule might fail to stabilise initial (arbitrary) increases in inflation expectations. As the higher interest rates prescribed by the Taylor rule entail greater production costs, it turns out that inflation might in fact increase, thus confirming the initial rise in inflation expectations. In such circumstances, the credible commitment to control money would stabilise the economy. Admittedly, though, as the instability of inflation expectations manifests itself in virtually all macroeconomic variables, controlling any one of these would equally stabilise the system. But, as argued by Christiano et al. (2007), money appears the natural candidate when thinking about variables that a central bank has control over.

The role of monetary developments is not merely confined to avoiding "extremely" bad events. Söderström (2005), for instance, shows how "targeting money growth" leads to improved macroeconomic outcomes in a standard New Keynesian model when monetary policy acts under discretion. In this context, "targeting money growth" means that the central bank's loss function penalises deviations of money growth from a target value, as well as deviations of the output gap and inflation from their respective target levels. In essence, with the growth rate of money linked to changes in interest rates and output, targeting money growth induces additional inertia into the monetary policy, reducing the inefficiencies associated with the discretionary policy conduct, and hence better approximating a policy under pre-commitment.[62] Similarly, Kilponen and Leitemo (2007) find that targeting money growth can help to mimic optimal

[62] The inefficiency of the discretionary policy that arises in this context is not related to a central bank targeting an output level above its potential value, with the associated emergence of an average "inflation bias", as described by Barro and Gordon (1983). Instead, in such a context, the inefficiency of the discretionary policy has to do with the way monetary policy responds to (persistent) shocks, and hence the qualification of "stabilisation bias". Specifically, under a discretionary policy, central banks have the incentive to deviate from the past promises of continuing to respond to (persistent) shocks also in the future; as this conduct is rationally anticipated by private agents, the macroeconomic environment turns out to be more volatile than in the case where central banks were able to act under pre-commitment.

policy under commitment in an otherwise standard New Keynesian model with transmission lags of the monetary policy. Intuitively, targeting money growth introduces history-dependence into the policy, leading to more favourable responses of agents' inflation expectations to various shocks, and hence to improved inflation outcomes.

Money also becomes a main argument of optimal policy when it is regarded as influencing inflation outcomes since optimal policy calls for a response to the determinants of inflation rather than to inflation itself (see Svensson (1997)). For instance, considering a so-called P* framework in which inflation dynamics are related to monetary developments, Svensson (2000) shows that the optimal policy aiming to stabilise inflation around the target does respond to monetary developments, as well as to inflation (forecast) and output. The distinctive feature of the P* framework is that it characterises inflation as a function of the real money gap, namely the difference between current and long-run real balances.[63] De facto, the relationship for inflation can be described as a standard Phillips curve in which the output gap is replaced by the money gap term.

Monetary developments may similarly exert a substantial influence on interest rate decisions once recognising the large degree of uncertainty surrounding the monetary transmission mechanism. In such a context, a central bank aims at policy rules that perform well enough across a wide range of models, and hence are robust to possible model misspecification. Gerdesmeier et al. (2002), for instance, investigate the design of monetary policy rules in the face of the central bank's uncertainty over two different reference models. The first has a New Keynesian flavour, with inflation dynamics being related to deviations of output from its natural level; the second is a P* model. Evidently, monetary policy decisions are affected by monetary developments as long as the second model is not completely disregarded by the policy-maker. More importantly, even when a low probability is attached to the second model, monetary developments may still exert a substantial influence on interest rate decisions due to the high costs of ignoring such developments in the second model.

Money and credit within the monetary transmission mechanism

Despite a widespread recognition of the importance of introducing channels for money and credit into structural models, their formalisation is still at an early stage. Admittedly, over the last years, there has been extraordinary research activity, partly done at, and largely encouraged by, central banks themselves. The absence of a role for money and credit has been perceived by central banks as a major limitation in the ability of available structural models to inform policy decisions. While substantial progress has been achieved, the modelling of money and credit is still highly stylised. However, some important implications for the conduct of monetary policy can already be drawn.

[63] The P* model was originally introduced by Hallman et al. (1991). More recently, Gerlach and Svensson (2003) find that such a model has considerable empirical support in the euro area. A richer description is provided in Chapter 3 of this book.

A natural amendment to the New Keynesian prototype model which brings about a direct role for real balances in aggregate demand and the Phillips curve is to relax the technical assumption of consumption and real balances being separable in the utility function. Intuitively, this standard assumption implies that the marginal benefit of holding real money is independent from the consumption level. Allowing for the more plausible situation in which the marginal benefit of holding real money balances increases with the volume of consumption expenditure implies a direct effect of money on both aggregate demand and supply. When doing so, McCallum (2001) and Woodford (2003) find that under plausible calibrations of structural parameters such a direct channel for money is not quantitatively very important. When estimating a similar specification for the US economy, Ireland (2004) similarly finds a minor direct impact of money on inflation and output dynamics even when controlling for shifts in money demand. More recently, Andrés et al. (2009) confirm this finding for both the US and the euro area economy.

When instead augmenting a monetary business cycle model with a banking sector and financial frictions, Christiano et al. (2003, 2008) find that the interaction between money, demand deposits, and the intermediation role of banks, all amplified by the presence of financial frictions in the entrepreneurial sector, gives rise to important effects of monetary variables on economic activity.[64] In this model economy, banks issue remunerated household deposits, part of which are used by banks to fund working capital loans which are extended to intermediate good producers to allow them to pay labour and capital bills. Labour and capital are also used by banks, in combination with excess reserves, to produce demand deposit services via a standard production function. At the same time, banks also finance part of entrepreneurs' investment by issuing time deposits to households, while the remaining part is financed by entrepreneurs themselves through their own net worth. Borrowing from the formalisation by Bernanke et al. (1999), the rate of return on entrepreneurial investment depends crucially on the realisation of an idiosyncratic productivity shock. When particularly adverse, this shock renders entrepreneurs unable to pay back their debt.[65] In such a model economy, a liquidity preference shock that leads households to accumulate currency by shifting away from demand deposits has a substantial impact on economic activity. By reducing the funding available to entrepreneurs, the contraction of demand deposits has a direct negative impact on investment, and hence on output. Moreover, the presence of frictions in the entrepreneurial sector implies that such an initial decline in investment is then amplified by "second-round effects" originating from the decline of entrepreneurs' net worth. More specifically, net worth decreases as a result of: (i) the decline in the rental rate of capital; (ii) the fall of the aggregate price associated with the liquidity preference shocks, which makes debt payments more expensive in real terms; and (iii) the initial contraction in economic activity. The decline of entrepreneurial net worth in turn brings about a fall in investment, which then

64 This model is discussed in greater detail in Chapter 5.

65 The emergence of bankruptcy, together with the associated monitoring costs, implies that solvent entrepreneurs do pay a premium over the cost of capital, the so-called external finance premium; this premium varies over time in response to various shocks hitting the system.

leads to a drop in output, well beyond what is induced by the direct effect of the liquidity preference shocks alone.

The presence of an articulated production sector and a banking system, together with the formalisation of financial frictions, makes the model by Christiano et al. (2003) a natural "interpretative filter" for investigating the links between real, financial and monetary variables. Indeed, the model has been fitted to the data with the aim of evaluating the effectiveness of alternative monetary policies during the Great Depression, an episode that a widespread consensus views as characterised by deep interactions between money and financial markets, the banking system and the real sector. The estimated model supports this view. In the contraction phase, it is precisely the liquidity preference shock that appears to matter most. By substituting demand deposits for currency*,* households reduce the amount of funding available to entrepreneurs, which then leads to a contraction in the level of investment. Such a direct impact is then magnified by some reinforcing effects. First, the fall in demand for capital drives down the market price of capital. Second, in response to the liquidity preference shock the price level falls, and hence the real value of debt for entrepreneurs tends to increase. Together with the initial slowdown in economic activity, these effects lead to a reduction in entrepreneurial net worth, and hence a further drop in investment and in output. Finally, households' accumulation of currency is partly done at the expense of consumption, contracting aggregate demand, and hence exacerbating further the decline in output.

Using a model specification very similar to the one just described, Christiano et al. (2007) investigate the relative performances of the US Federal Reserve and the European Central Bank when confronted with the historical recessionary episode of 2001. Indeed, it is only within a relatively rich structural model that such a quantitative assessment can be attempted, and "what if" questions can be reasonably addressed. When doing so, it is found that differences in monetary policy actions between the two central banks can be largely rationalised by differences in shocks and economic features. First, while the driving forces of the downturn in both economies were shocks to demand, and to capital producers and entrepreneurs, in the euro area their impact was belated and somehow exacerbated by an adverse dynamic in the technology shock, contrary to the United States in which the latter remained positive. Second, prices and wages in the United States tend to be relatively more flexible, a fact that has major implications for the monetary transmission mechanism and thus for policy decisions.

5.3.2 MICRO-FOUNDING A ROLE FOR MONEY

Despite identifying the importance of a liquidity channel, a model à la Christiano et al. (2003), for example, cannot by construction provide any further details about the origin of such a channel. Their presumption, though, appears to be that what the model identifies as a "liquidity preference shock" is likely to be instead something that is not invariant to monetary policy.

The micro-foundation of liquidity (and money) is instead the main purpose of a recent body of literature stressing the importance of monetary frictions that ultimately explain the endogenous emergence of money in the economy, as discussed in detail in Section 2.2. These types of models have recently also been used to analyse the role of money in the macroeconomy. For instance, in Kiyotaki and Moore (2008), money and liquidity constraints are embedded in a framework related, in spirit, to the types of models that central banks use for their policy analysis.[66]

In such a model economy, entrepreneurs are assumed to invest only when an opportunity arises, with the result that in every period only a fraction of them do invest in physical capital. Being subject to a borrowing constraint, they can only borrow – or, better, issue equities – up to a fraction of their future returns on their investment, so that the remaining fraction of their investment needs to be financed through two sources: equities bought from other entrepreneurs, and fiat money, which exists in fixed supply. Since entrepreneurs are constrained in the amount of equity that they can sell in any given period, money turns out to be more liquid than equities. Now, if the liquidity constraints are "sufficiently tight",[67] money is valued in equilibrium; indeed, whereas entrepreneurs with an investment opportunity hold no money (they will invest everything), entrepreneurs without an investment opportunity do hold money; the reason stems from the fact that they may have an investment opportunity in the future, at which time they will not be able to sell their entire holding of equities previously accumulated. Notice that in this case holding equities is not only risky for the usual reason that their rate of return is correlated with aggregate consumption (aggregate risk); they are also risky because their rate of return contingent on having an investment opportunity is low due to the equities' limited re-saleability (idiosyncratic risk). Money's rate of return is instead independent of whether the entrepreneur will have or not an investment opportunity in the future. Hence, when an investment opportunity arises, the expected rate of return on equity conditional on having an investment opportunity in the next period is lower than the expected return on money.[68]

An economy in which liquidity constraints are "sufficiently tight" is also one in which aggregate capital is less than in the unconstrained economy (since not enough resources are transferred from savers to investors). The expected rate of

66 Their modelling strategy is the same as that employed in the Real Business Cycle literature but the model's flavour is Keynesian in that money is essential for the allocation of resources. Indeed, unlike some of the frameworks mentioned before where agents meet randomly to execute their trade (i.e. search-based models), such a model is based on competitive market-clearing mechanisms, which should make it easier to incorporate money and liquidity into a macroeconomic model.

67 The expression "sufficiently tight" refers to a complicated inequality in which both the degree of tightness of the borrowing constraint and the degree of tightness of the re-saleability constraint appear.

68 The reason why money is liquid in this framework is reminiscent of the analysis in Hahn (1990); indeed the latter points out that the true opportunity cost of holding money is not simply the expected return on alternative non-monetary assets in any contingencies. Instead, it is also the cost of not being able to do what would be optimal in some state of the world. To put it differently, the opportunity cost needs to be netted against the benefit of holding money. This benefit could be enormous in some (perhaps not likely) state of the world or contingencies. Such events in which money is valued more do not have to be "negative" events (such as becoming ill or unemployed); they could also be opportunities for higher profits. Money is a form of insurance, the best form of insurance as it is backed by the government. Ordinary insurance may not be available because of the usual reasons (moral hazard and adverse selection) or it could fail to deliver if the insurer defaults.

return on equity (in the absence of an investment opportunity) is lower than the rate of time preference, and the expected rate of return on money is lower than the expected rate of return on equity (the difference is the liquidity premium – or nominal interest rate).

Interestingly, this model not only provides a structural formalisation of the interactions between money and equity, but also has the potential to explain some asset price "anomalies". First, the low return on money and the existence of a liquidity premium can help rationalise the *low risk-free interest rate puzzle*.[69] Second, workers' decision not to save, ultimately related to the lack of investment opportunities, is consistent with the fact that certain categories of households do not save and with the evidence of *limited financial market participation*. Third, the analysis can help explain the *excess sensitivity* of asset prices and quantities to news. Specifically, a two-way interaction between asset prices and aggregate quantities emerges: the higher asset prices are, the more liquidity becomes available, which induces larger changes in investment and output. This feedback tends to increase the size of the fluctuations of both asset prices and aggregate quantities. Fourth, the theory can go some way towards explaining the association between certain components of money and the price of capital over the business cycle. As repeatedly emphasised by the ECB, important episodes of high M3 growth in the recent past can be explained in an environment in which agents respond to shocks to the price of capital – on the equity market – by massive migrations in and out of money. For example, from 2001 to 2003, the money-holding sector in the euro area shifted a considerable amount of funds from long-term securities into liquid monetary assets. Largely due to higher economic, financial and geopolitical uncertainty, such a portfolio shift resulted from a substantial contraction of the net securities transactions with non-residents, and crucially manifested itself in a sharp increase of M3 growth.[70] Isolating the impact of such an extraordinary portfolio shift is crucial when assessing the implications of monetary developments for risks to price stability.

An alternative approach to formalising a micro-foundation of money and characterising the role of liquidity is to consider non-competitive models; a prominent example is the random matching framework originally introduced by Kiyotaki and Wright (1989) and briefly described above. Within such a framework, Williamson and Wright (2010a, b) investigate what they consider the two major features of the monetary economics literature over the last decades: first, the explicit formalisation of those frictions which give rise to a role for money; and second, the inclusion of banking and financial intermediation. These features characterise, so they argue, the so-called "New Monetarist Economics".

69 The "low risk-free interest rate puzzle" consists of the observation that in order to reconcile the historical low level of the risk-free rate with consumption growth data, the representative agent must be assumed to have a very low risk aversion, at least according to standard models. But a low risk aversion in turn is not compatible with the "equity premium puzzle", namely with the fact that the observed higher returns on equity over government bonds can be "rationalised" only by assuming that individuals have a very high risk aversion. In this respect, the low risk-free interest rate puzzle and the equity premium puzzle can be interpreted as two sides of the same coin.

70 See for example ECB (2004).

Specifically, Williamson and Wright consider a model economy populated by buyers and sellers, who consume and produce a perishable good at different times of the day, and trade money for goods in random bilateral matches at the end of the day. In the absence of recordkeeping, money is valued in equilibrium and is neutral, in that its level does not affect quantities. It is not super-neutral, though, as its growth rate does influence real variables. In line with the monetarist predictions, inflation is determined by the money growth rate and the optimal rule is of a Friedman type, i.e. it calls for deflation at the rate of time preferences. The framework is flexible enough to include additional frictions. For instance, the Keynesian sticky price frictions are considered in both a cashless and a cash/credit economy. Contrary to the predictions of the New Keynesian framework, though, it is stressed that the behaviour of prices in a cash/credit economy is different from in a cashless economy, since in the former prices are linked to the dynamics of monetary aggregates. Finally, when introducing a banking sector, the equilibrium is characterised by an efficient quantity of goods traded in credit transactions, and no storage wasted, contrary to what happens in the absence of banks in periods in which there is no match between certain types of buyers and sellers. As a result, Friedman's prescription of a 100% reserve requirement, preventing de facto banking activity, would lead to a worse equilibrium.

Despite these remarkable achievements, however, models of the micro-foundations of money are currently highly stylised and not yet at a stage of development where they can be taken to the data and used to draw empirical inferences useful for policy. In this respect, rather than providing a framework for conducting monetary policy, they represent a good and promising conceptual platform which can discipline thinking and help penetrate better the multifaceted influences that money can exert on the macroeconomy. Important aspects of the link between money and prices over the short run are only vaguely characterised at the current stage. First, current models fall short in capturing the heterogeneity of agents' situations in which liquidity constraints are unlikely to be continuously binding. When considering two groups of agents, Moutot (2010), for instance, finds that alternative partitions of the total endowment between agents, while clearly not affecting the total amount of goods available in the economy, do instead affect money demand, money velocity and prices. Second, most models lack a satisfactory formalisation of the role of financial intermediation; considering for instance demand deposits and currency as perfect substitutes can lead to misleading conclusions. Third, additional research efforts should be devoted to establishing a connection between the formalisation of the role of money and the inclusion of a legal framework, notably for insolvency and legal tender procedures. Finally, most models abstract from the role played by financial innovation in the decision to hold money.

In conclusion, the changing patterns of influence with which money acts upon the economy and price formation – at times more directly through expansions or contractions in purchasing power, at other times in a more roundabout fashion, through asset prices, liquidity constraints and the pricing of risk – remain largely unexplained.

5.3.3 THE EMPIRICAL LINK BETWEEN MONEY, CREDIT AND ASSET PRICES

Finally, the increased frequency of financial crises and asset price booms and busts over the last two decades has fostered the development of a new strand of empirical studies exploring the indicator properties of money and credit growth for financial crises and asset price dynamics based on event studies or reduced-form regression analysis. From a conceptual point of view, a link between monetary developments and asset prices is usually motivated with general references to the theoretical literature on the broad credit channel and the financial accelerator, the monetarist transmission mechanism (Congdon (2005)), Tobin's portfolio balance model as well as, going further back in history, the debt-deflation theory of Irving Fisher (1932, 1933), the Austrian business cycle theory (von Mises (1912), von Hayek (1931)) and the financial instability hypothesis of Minsky (1982, 1986, 1992) and Kindleberger (1978).

The empirical analysis of the dynamic link between money, credit and asset prices and financial fragility has been pioneered by the Bank for International Settlements (BIS). In 1990, the BIS started to systematically collect cross-country data on key asset prices, in particular data on commercial and residential property prices (BIS (1990)), which formed the basis of many of the subsequent empirical studies on the subject. BIS annual reports and BIS studies also provided first descriptive accounts of their historical dynamics and their correlation with monetary developments (BIS (1993), Borio et al. (1994)).

The empirical literature that has rapidly evolved since then can be divided into three broad strands. The first strand comprises studies that aim to explore the usefulness of money and credit, amongst other variables such as asset prices, interest rates and the economy's cyclical position, as leading indicators for banking crises.[71] A robust finding of this literature is that domestic credit growth is commonly identified as a leading indicator of brewing financial trouble,[72] in particular when it coincides with a boom in equity or property prices.[73]

The second strand of studies focuses on the dynamic interlinkages between monetary dynamics and asset price dynamics. A number of studies have shown that domestic credit growth significantly affects asset prices (Borio et al. (1994)), in particular house prices.[74] More recent studies find that also broad money growth has a significant positive effect on future house prices.[75] Furthermore, there is evidence that the effect of money and credit on house prices is stronger during asset price booms than normally.[76]

71 Banking crises are usually identified as periods characterised by bank failures and/or large-scale government rescue measures for the banking sector.
72 See e.g. Demirgüc-Kunt and Detriargache (1998), Kaminsky and Reinhart (1999), Eichengreen and Arteta (2000), Hardy and Pazarbasioglu (1999), Hutchison and McDill (1999), and Schularik and Taylor (2009).
73 See Borio and Lowe (2002, 2004) and Borio and Drehmann (2009). Demirgüc-Kunt and Detriargache (2005) present a survey of cross-country empirical studies of banking crises.
74 See e.g. Hofmann (2003) and Goodhart and Hofmann (2007, 2008).
75 See Greiber and Setzer (2007), Adalid and Detken (2007), and Goodhart and Hofmann (2008).
76 See Adalid and Detken (2007) and Goodhart and Hofmann (2008).

A third strand of studies focuses on the ability of monetary indicators to signal costly asset price booms[77] or asset price busts.[78] The essence of the results of these studies is that money and credit must be considered important indicators of unsustainable asset price developments. However, which monetary variables must be monitored with priority in order to identify asset price misalignments in a timely way remains an open issue. There is evidence suggesting that domestic broad money is the most relevant indicator (e.g. Adalid and Detken (2007)), while other studies point to domestic credit (Gerdesmeier et al. (2009)). Most recent evidence suggests that global monetary developments are a key leading indicator of domestic asset price bubbles in industrialised countries.[79] As already discussed in Section 2.2, the recent contributions of Adrian and Shin (2008a, b, 2009) suggest that the relevance of different measures of monetary liquidity for asset price gyrations depends on financial structure and may therefore vary from country to country and over time as a result of structural change in the financial sector.

6 THE ROLE OF MONEY IN THE ECB'S MONETARY POLICY STRATEGY

The ECB's monetary policy strategy, which was first announced in October 1998 and confirmed and clarified in May 2003, is composed of two main elements: (1) a quantitative definition of price stability to render the ECB's mandate more precise; and (2) a two-pillar framework structuring the ECB's comprehensive approach to the analysis of risks to price stability in the euro area (see ECB (1999)).

The first element – the quantitative definition of price stability – defines price stability as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2% over the medium term. In May 2003 the Governing Council of the ECB clarified that, in the pursuit of price stability, it aims to maintain inflation rates below, but close to 2%. Price stability is maintained over the medium term. This *medium-term orientation* recognises the futility of attempts to fine-tune inflation or economic activity, which would destabilise the economy as a result of the "long and variable" (and, in particular, not fully predictable) lag in the transmission of monetary policy measures to real activity and, ultimately, price developments.

The second element of the ECB's monetary policy strategy, the two-pillar framework for structuring the available data, defines the ECB's overall approach to analysing and evaluating all information that is relevant for a comprehensive, robust and forward-looking assessment of the risks to price stability. The two pillars represent two complementary perspectives on the determinants of inflation, the *economic analysis* on the one hand, and the *monetary analysis* on the other. The economic analysis aims to identify, with a broad-based approach, risks to

77 See Detken and Smets (2004), Adalid and Detken (2007), and Alessi and Detken (2009).
78 See Helbling and Terrones (2003) and Gerdesmeier et al. (2009).
79 See Alessi and Detken (2009) and Agnello and Schuknecht (2009).

price stability at short to medium-term horizons focusing on the assessment of current economic developments from the perspective of the interplay between supply and demand in the goods, services and factor markets. In this context, the Eurosystem staff macroeconomic projections play a crucial role in structuring and synthesizing a large amount of economic data.[80]

The monetary analysis aims to identify the medium to long-run risks to price stability. Like the economic analysis, the monetary analysis is also broad based, taking into account "developments in a wide range of monetary indicators including M3, its components and counterparts, notably credit, and various measures of excess liquidity" (ECB (2003)). The monetary analysis serves the Governing Council as a cross-check, from a medium to long-run perspective, for the indications coming from the economic analysis, and thereby supports monetary policy decisions based on an overall assessment of the risks to price stability.

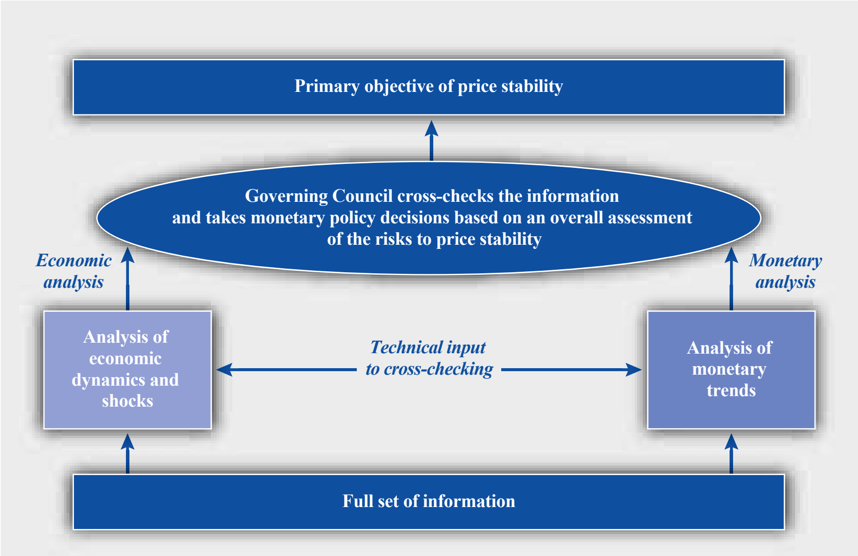
ECB staff provide technical input to the Governing Council's cross-checking in two forms. First, they do so by extracting the medium to long-term trend of monetary growth from headline monetary developments. As the analysis above shows, it is this underlying tendency in monetary growth which manifests the greater degree of econometric coherence with trends in inflation, and thus has the potential to alert policy-makers to the risks of slow-moving but possibly destabilising changes in inflation trends. Second, staff can contribute to the Governing Council's cross-checking with the construction of monetary and financial scenarios, which measure the sensitivity of macroeconomic projections to monetary shocks which can alter the path of money and credit growth relative to that which is implicit in the baseline projections.

The role of monetary analysis in the ECB's monetary policy strategy is primarily founded on the close link between money and prices in the medium to long run. As discussed in Section 4, the medium to long-run lead-lag relationship between money growth and inflation is an important macroeconomic stylised fact. The ECB's monetary analysis hence concentrates on identifying, in real time, the underlying rate of monetary expansion, which is the relevant signal for longer-run risks to price stability.

While filtering out the long-run signal in monetary data that is relevant for trend developments in inflation is the primary purpose of the analysis performed in the context of the ECB's monetary pillar, the scope of the monetary analysis is not confined to this long-run perspective. The detailed analysis of monetary dynamics generates a wealth of information on monetary developments and on the transmission of monetary shocks to price formation. As discussed in Section 5, analysing higher-frequency monetary developments also helps to assess and understand shorter-term macroeconomic and financial phenomena, which may give rise to risks to price stability over the longer run if left unchecked. Monetary

80 The projections are produced under staff responsibility as an input into the deliberations of the Governing Council. Twice a year they are structured as a broad exercise involving not only the ECB but also all the national central banks in the Eurosystem, while the remaining two exercises are carried out by ECB staff.

Chart 3 Monetary analysis and the ECB's two-pillar strategy



Source: ECB.

developments may provide useful information about the state of the business cycle, financing conditions, monetary policy transmission, and the condition and behaviour of banks.

In addition, the analysis of monetary dynamics helps to place asset price developments into perspective and to form a view regarding the possible build-up of financial imbalances. This serves, in turn, to define and calibrate monetary and financial scenarios that are used to identify risks to the baseline short to medium-term outlook stemming from the economic analysis. Finally, all of this can also feed back into the assessment of the underlying trend of monetary expansion. Overall, this process, which is intended to encompass in a structured way as much information as possible, attempts to substitute for the absence of an encompassing model.

In sum, the monetary pillar ensures that longer-term risks to price stability emanating from the longer-run link between money growth and inflation are duly taken into account in the conduct of monetary policy. In this vein, the monetary pillar represents a commitment by the ECB not to disregard any information which can support its pursuit of the price stability objective in the medium term and the establishment of a nominal anchor for the euro area economy. Moreover, the monetary pillar represents a pragmatic solution 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 empirically evident link between monetary developments and evolving imbalances in asset and credit markets implies that the two-pillar strategy, with its important role given to monetary analysis, may enable the detection of these imbalances at an early stage and a response to the implied risks to financial, economic and price stability in a timely, forward-looking, manner. Finally, in an environment of financial turmoil, the detailed analysis of quantitative developments in money and credit contributes to appropriately assessing the financing conditions of the economy and adjustments taking place in the banking sector.

As described in more detail in the following chapters, the ECB's monetary analysis relies on a suite of econometric tools for model-based assessment and detailed institutional analysis. The former includes, inter alia, empirical money and credit demand models, statistical filters, forecasting models, as well as small and medium-scale structural models. The latter entails, inter alia, an encompassing examination of the bank balance sheet data, including the components, counterparts and sectoral contributions to monetary aggregates. The multifaceted nature of monetary analysis implies that it can probably never be fully summarised in one single analytical framework, so that it will continue to rely on a suite of approaches. At the same time, the need to continuously enhance the monetary analysis in order to keep track of structural change in the economy will in all likelihood continue to be a challenge as well as a constant encouragement for scientific advancements in the future. Given that, as we argued before, many of the big policy mistakes of the past were due to a disregard for, or misinterpretation of, monetary developments, this would appear to be an effort worth making for central banks.

REFERENCES

Adalid, R. and Detken, C. (2007), "Liquidity shocks and asset price boom-bust cycles", *Working Paper Series*, No 732, ECB.

Adrian, T. and Shin, H.S. (2008a), "Money, liquidity and monetary policy", in Beyer, A. and Reichlin, L. (eds.), *The role of money: money and monetary policy in the twenty-first century*, ECB, Frankfurt, pp. 56-82.

Adrian, T. and Shin, H.S. (2008b), "Financial intermediaries, financial stability and monetary policy", Staff Report No 398, Federal Reserve Bank of New York.

Adrian, T. and Shin, H.S. (2009), "Money, liquidity and monetary policy", *American Economic Review*, 99(2), pp. 600-605.

Agnello, L. and Schuknecht, L. (2009), "Booms and busts in housing markets: determinants and implications", *Working Paper Series*, No 1071, ECB.

Aksoy, Y. and Piskorski, T. (2006), "U.S. domestic money, inflation and output", *Journal of Monetary Economics*, 53(2), pp. 183-197.

Alessi, L. and Detken, C. (2009), "Real-time early warning indicators for costly asset price boom-bust cycles: a role for global liquidity", *Working Paper Series*, No 732, ECB.

Allais, M. (1947), *Économie et intérêt*, Imprimerie Nationale et Librairie des Publications Officielles, Paris.

Andrés, J., López-Salido, D. and Nelson, E. (2009), "Money and the natural rate of interest: structural estimates for the United States and the euro area", *Journal of Economic Dynamics and Control*, 33(3), pp. 758-776.

Aoki, K. (2003), "On the optimal monetary policy response to noisy indicators", *Journal of Monetary Economics*, 50, pp. 501-523.

Assenmacher-Wesche, K. and Gerlach, S. (2006), "Understanding the link between money growth and inflation in the euro area", *Discussion Paper Series*, No 5683, CEPR.

Assenmacher-Wesche, K. and Gerlach, S. (2007), "Money at low frequencies", *Journal of the European Economic Association*, 5(2-3), pp. 534-542.

Assenmacher-Wesche, K. and Gerlach, S. (2008a), "Interpreting euro area inflation at high and low frequencies", *European Economic Review*, 52(6), pp. 964-986.

Assenmacher-Wesche, K. and Gerlach, S. (2008b), "Money growth, output gaps and inflation at low and high frequency: spectral estimates for Switzerland", *Journal of Economic Dynamics and Control*, 32(2), pp. 411-435.

Assenmacher-Wesche, K., Gerlach, S. and Sekine, T. (2008), "Monetary factors and inflation in Japan", *Journal of the Japanese and International Economies*, 22(3), pp. 343-363.

Barro, R.J. and Gordon, D.B. (1983), "A positive theory of monetary policy in a natural rate model", *Journal of Political Economy*, Vol. 91, pp. 589-610.

Batini, N. and Nelson, E. (2001), "The lag from monetary policy actions to inflation: Friedman revisited", *International Finance*, 4(3), pp. 381-400.

Beck, G.W. and Wieland, V. (2007), "Money in monetary policy design: a formal characterization of ECB-style cross-checking", *Journal of the European Economic Association*, 5(2-3), pp. 524-533.

Benati, L. (2009), "Long-run evidence on money growth and inflation", *Working Paper Series*, No 1027, ECB.

Benhabib, J., Schmitt-Grohé, S. and Uribe, M. (2001), "The perils of Taylor rules", *Journal of Economic Theory*, Vol. 96, pp. 40-69.

Benhabib, J., Schmitt-Grohé, S. and Uribe, M. (2002), "Avoiding liquidity traps", *Journal of Political Economy*, 110(3), pp. 535-563.

Bernanke, B.S. (2002), "On Milton Friedman's ninetieth birthday", speech at the Conference to Honour Milton Friedman, University of Chicago.

Bernanke, B.S. (2004), "The Great Moderation", speech at the Eastern Economic Association meetings, Washington DC.

Bernanke, B.S., Gertler, M. and Gilchrist, S. (1999), "The financial accelerator in a quantitative business cycle framework", in Taylor, J.B. and Woodford, M. (eds.), *Handbook of Macroeconomics*, Elsevier, pp. 1341-1393.

Bewley, T. (1980), "The optimum quantity of money", in Kareken, J. and Wallace, N. (eds.), *Models of monetary economies*, Federal Reserve Bank of Minneapolis.

BIS (1990), *60th Annual Report*.

BIS (1993), *63rd Annual Report*.

Bodin, J. (1568), *Réponse aux paradoxes du sieur de Malestroit*.

Borio, C. and Drehmann, C.M. (2009), "Towards an operational framework for financial stability: "fuzzy" measurement and its consequences", *Working Paper Series*, No 284, BIS.

Borio, C., Kennedy, N. and Prowse, S.D. (1994), "Exploring aggregate asset price fluctuations across countries: measurement, determinants and monetary policy implications", *Working Paper Series*, No 40, BIS.

Borio, C. and Lowe, P. (2002), "Asset prices, financial and monetary stability: exploring the nexus", *Working Paper Series*, No 114, BIS.

Borio, C. and Lowe, P. (2004), "Securing sustainable price stability: should credit come back from the wilderness?", *Working Paper Series*, No 157, BIS.

Bruggeman, A., Camba-Méndez, G., Fischer, B. and Sousa, J. (2005), "Structural filters for monetary analysis: the inflationary movements of money in the euro area", *Working Paper Series*, No 470, ECB.

Brunner, K. and Meltzer, A.H. (1993), *Money and the economy: issues in monetary analysis*, Cambridge University Press, Cambridge, MA.

Carlson, J.B., Hoffman, D.L., Keen, B.D. and Rasche, R.H. (2000), "Results of a study of the stability of cointegrating relations comprised of broad monetary aggregates", *Journal of Monetary Economics*, 46(2), pp. 345-383.

Carstensen, K. (2007), "Is core money growth a good and stable inflation predictor in the euro area?", *Working Paper Series*, No 1318, Kiel Institute for the World Economy.

Chow, G.C. (1966), "On the long-run and short-run demand for money", *Journal of Political Economy*, Vol. 74, pp. 111-131.

Christiano, L. and Rostagno, M. (2001), "Money growth monitoring and the Taylor rule", *Working Paper Series*, No 8539, NBER.

Christiano, L., Motto, R. and Rostagno, M. (2003), "The Great Depression and the Friedman-Schwartz hypothesis", *Journal of Money, Credit and Banking*, 35(6), pp. 1119-1197.

Christiano, L., Motto, R. and Rostagno, M. (2007), "Two reasons why money and credit can be useful in monetary policy", *Working Paper Series*, No 13502, NBER.

Christiano, L., Motto, R. and Rostagno, M. (2008), "Shocks, structure or monetary policies? The euro area and US after 2001", *Journal of Economic Dynamics and Control*, Vol. 32, pp. 2476-2506.

Coenen, G., Levin, A.T. and Wieland, V. (2005), "Data uncertainty and the role of money as an information variable for monetary policy", *European Economic Review*, 49(4), pp. 975-1006.

Congdon, T. (2005), "Money and asset prices in boom and bust", IEA Hobart Paper No 153.

Copernicus, N. (1517), *Memorandum on monetary policy*.

De Grauwe, P. and Polan, M. (2005), "Is inflation always and everywhere a monetary phenomenon?", *Scandinavian Journal of Economics*, 107(2), pp. 239-259.

Demirgüç-Kunt, A. and Detragiache, E. (1998), "The determinants of banking crises: evidence from developing and developed countries", *Staff Papers*, 45, IMF, pp. 81-109.

Demirgüç-Kunt, A. and Detragiache, E. (2005), "Cross-country empirical studies of systemic bank distress: a survey", *Working Paper Series*, No 05/96, IMF.

Detken, C. and Smets, F. (2004), "Asset price booms and monetary policy", *Working Paper Series*, No 364, ECB.

Dotsey, M., Lantz, C.D. and Santucci, L. (2000), "Is money useful in the conduct of monetary policy?", *Economic Quarterly*, 86(4), Federal Reserve Bank of Richmond, pp. 23-48.

Duca, L. (1995), "Sources of money instability", *Economic and Financial Policy Review*, IV, Federal Reserve Bank of Dallas, pp. 2-13.

Dwyer, G.P. and Hafer, R.W. (1988), "Is money irrelevant?", *Review*, 70, Federal Reserve Bank of St. Louis, pp. 3-17.

Dwyer, G.P. and Hafer, R.W. (1999), "Are money growth and inflation still related?", *Economic Review*, 2, Federal Reserve Bank of Atlanta, pp. 32-43.

Dwyer, G.P. and Fisher, M. (2009), "Inflation and monetary regimes", *Journal of International Money and Finance*, 28(7), pp. 1221-1241.

ECB (1999), "The stability-oriented monetary policy strategy of the Eurosystem", *Monthly Bulletin*, January, pp. 39-50.

ECB (2003), "The outcome of the ECB's evaluation of its monetary policy strategy", *Monthly Bulletin*, June, pp. 79-92.

ECB (2004), "Monetary analysis in real time", *Monthly Bulletin,* October, pp. 43-66.

Eichengreen, B. and Arteta, C. (2000), "Banking crises in emerging markets: presumptions and evidence", *Working Paper Series*, No 1007, CIDER.

Erceg, C.J. and Levin, A.T. (2003), "Imperfect credibility and inflation persistence", *Journal of Monetary Economics*, Vol. 50, pp. 915-944.

Estrella, A. and Mishkin, F.S. (1997), "Is there a role for monetary aggregates in the conduct of monetary policy?", *Journal of Monetary Economics*, 40(2), pp. 279-304.

Evans, G.W. and Honkapohja, S. (2005), "An interview with Thomas J. Sargent", *Working Paper Series*, No 1434, CESifo.

Fair, R.C. (1987), "International evidence on the demand for money", *Review of Economics and Statistics*, 69(3), pp. 473-480.

Fisher, I. (1911), *The purchasing power of money*, Macmillan, New York.

Fisher, I. (1932), *Booms and depressions. Some first principles,* Adelphi, New York.

Fisher, I. (1933), "The debt-deflation theory of great depressions", *Econometrica*, 1, pp. 337-357.

Frain, J.C. (2004), "Inflation and money growth: evidence from a multi-country data-set", *Economic and Social Review*, 35(3), pp. 251-266.

Friedman, B.M. and Kuttner, K.N. (1993), "Another look at the evidence on money-income causality", *Journal of Econometrics*, 57(1-3), pp. 189-203.

Friedman, M. (1961), "The lag in effect of monetary policy", *Journal of Political Economy*, Vol. 69, pp. 447-466.

Friedman, M. (1968), "The role of monetary policy", *American Economic Review*, 58(1), pp. 1-17.

Friedman, M. (1972), "Have monetary policies failed?", *American Economic Review*, 62(2), pp. 11-18.

Friedman, M. (1987), "The quantity theory of money", in Eatwell, J., Milgate, M. and Newman, P. (eds.), *New Palgrave Dictionary of Economics*, Macmillan, London, pp. 3-20.

Friedman, M. and Schwartz, A.J. (1963), *A monetary history of the United States, 1867-1960*, Princeton University Press.

Fuerst, T.S. (2008), "The real bills doctrine versus the quantity theory", in Durlauf, S.N. and Blume, L.E. (eds.), *New Palgrave Dictionary of Economics*, 2nd edition, Macmillan, London.

Gerdesmeier, D., Motto, R. and Pill, H. (2002), "Paradigm uncertainty and the role of monetary developments in monetary policy rules", mimeo, ECB.

Gerdesmeier, D. and Roffia, B. (2004), "Empirical estimates of reaction functions for the euro area", *Swiss Journal of Economics and Statistics*, 140(I), pp. 37-66.

Gerdesmeier, D., Roffia, B. and Reimers, H.-E. (2009), "Asset price misalignments and the role of money and credit", *Working Paper Series*, No 1068, ECB.

Gerlach, S. (2003), "The ECB's two pillars", *Discussion Paper Series*, No 3689, CEPR.

Gerlach, S. (2004), "The two pillars of the ECB", *Economic Policy*, 40, pp. 389-439.

Gerlach, S. and Svensson, L.E.O. (2003), "Money and inflation in the euro-area: a case for monetary indicators", *Journal of Monetary Economics*, Vol. 50, pp. 1649-1672.

Goldfeld, S.M. (1976), "The case of the missing money", *Brookings Papers on Economic Activity*, 3, pp. 638-730.

Goldfeld, S.M. and Sichel, D.E. (1990), "The demand for money", in Friedman, B. and Hahn, F. (eds.), *Handbook of Monetary Economics*, Elsevier, Amsterdam, pp. 299-356.

Goodhart, C. (1975), "Monetary relationships: a view from Threadneedle Street", *Papers in Monetary Economics*, No I, Reserve Bank of Australia.

Goodhart, C. (2010), "Money, credit and bank behaviour: need for a new approach", mimeo, London School of Economics.

Goodhart, C. and Hofmann, B. (2007), *House prices and the macroeconomy*, Oxford University Press.

Goodhart, C. and Hofmann, B. (2008), "House prices, money, credit and the macroeconomy", *Oxford Review of Economic Policy*, 24, pp. 180-205.

Greiber, C. und Setzer, R. (2007), "Money and housing: evidence for the euro area und the US", *Discussion Paper Series*, No 12/2007, Deutsche Bundesbank.

Hallman, J.J., Porter, R.D. and Small, D.H. (1991), "Is the price level tied to the M2 monetary aggregate in the long run", *American Economic Review*, 81(3), pp. 841-858.

Hahn, F. (1990), "Liquidity", in Friedman, B. and Hahn, F. (eds.), *Handbook of Monetary Economics*, Elsevier, Amsterdam.

Hardy, D. and Pazarbasioglu, C. (1999), "Determinants and leading indicators of banking crises: further evidence", *Staff Papers*, 46(3), IMF, pp. 247-258.

Hazzlit, H. (1947), "Our inflationary bond shortage", *Newsweek*, 22 December.

Helbling, T. and Terrones, M. (2003), "When bubbles burst", *World Economic Outlook*, Chapter 2, IMF.

Hicks, J.R. (1937), "Mr. Keynes and the 'classics': a suggested interpretation", *Econometrica*, 5(2), pp. 147-159.

Hofmann, B. (2003), "Bank lending and property prices: some international evidence", *Working Paper Series*, No 22/2003, HKIMR.

Hume, D. (1752), "Of interest", in *Political Discourses*.

Hutchison, M. and McDill, K. (1999), "Are all banking crises alike? The Japanese experience in international comparison", *Journal of the Japanese and International Economies*, 13(3), pp. 155-180.

Ireland, P.N. (2004), "Money's role in the monetary business cycle", *Journal of Money, Credit and Banking*, 36(6), pp. 969-983.

Issing, O., Gaspar, V., Angeloni, I. and Tristani, O. (2001), *Monetary policy in the euro area*, Cambridge University Press.

Jaeger, A. (2003), "The ECB's money pillar: an assessment", *Working Paper Series*, No 03/82, IMF.

Jevons, W.S. (1875), *Money and the mechanism of exchange*, D. Appleton and Co., New York.

Kaminsky, G. and Reinhart, C.M. (1999), "The twin crises: the causes of banking and balance of payments problems", *American Economic Review*, 89(3), pp. 473-500.

Kareken, J.H. and Wallace, N. (eds.) (1980), *Models of monetary economies*, Federal Reserve Bank of Minneapolis.

Kaufmann, S. and Kugler, P. (2008), "Does money matter for inflation in the euro area?", *Contemporary Economic Policy*, 26(4), pp. 590-606.

Keynes, J.M. (1936), *The general theory of employment, interest and money*, MacMillan, London.

Kilponen, J. and Leitemo, K. (2007), "Discretion and the transmission lags of monetary policy", *Discussion Paper Series*, No 8, Bank of Finland.

Kindleberger, C. (1978), "Manias, panics and crashes: a history of financial crises", in Kindleberger, C. and Laffarge, J. (eds.), *Financial crises: theory, history and policy*, Cambridge University Press.

Kiyotaki, N. and Moore, J. (2002), "Evil is the root of all money", *American Economic Review*, 92(2), pp. 62-66.

Kiyotaki, N. and Moore, J. (2008), "Liquidity, business cycles and monetary policy", mimeo, London School of Economics.

Kiyotaki, N. and Wright, R. (1989), "On money as a medium of exchange", *Journal of Political Economy*, 97(4), pp. 927-954.

Kiyotaki, N. and Wright, R. (1991), "A contribution to the pure theory of money", *Journal of Economic Theory*, Vol. 53, pp. 215-235.

Kiyotaki, N. and Wright, R. (1993), "A search-theoretic approach to monetary economics", *American Economic Review*, 83(1), pp. 63-77.

Kocherlakota, O. (1998), "Money is memory", *Journal of Economic Theory*, 81(2), pp. 232-251.

Kocherlakota, O. (2004), "Money: what's the question and why should we care about the answer?", *American Economic Review*, 92(2), pp. 58-61.

Kydland, F.E. and Prescott, E.C. (1982), "Time to build and aggregate fluctuations", *Econometrica*, 50(6), pp. 1345-1370.

Laidler, D. (1966a), "Some evidence on the demand for money", *Journal of Political Economy*, 74(1), pp. 55-68.

Laidler, D. (1966b), "The rate of interest and the demand for money: some empirical evidence", *Journal of Political Economy*, 74(6), p. 543.

Lothian, J.R. (1985), "Equilibrium relationships between money and other economic variables", *American Economic Review*, 75, pp. 828-835.

Lothian, J.R. and McCarthy, R.H. (2009), "The behavior of money and other economic variables: two natural experiments", *Journal of International Money and Finance*, 28(7), pp. 1204-1220.

Lucas, R.E. (1972), "Econometric testing of the natural rate hypothesis", in Eckstein, O. (ed.), *The econometrics of price determination*, Federal Reserve Board of Governors, Washington.

Lucas, R.E. (1976), "Econometric policy evaluation: a critique", *Carnegie Rochester Series on Public Policy*, 1, pp. 19-46.

Lucas, R.E. (1980), "Two illustrations of the quantity theory of money", *American Economic Review*, 70(5), pp. 1005-1014.

Lucas, R.E. (1988), "Money demand in the United States: a quantitative review", *Carnegie Rochester Series on Public Policy*, 29(1), pp. 137-167.

Lucas, R.E. (1996), "Nobel lecture: monetary neutrality", *Journal of Political Economy*, 104(4), pp. 661-682.

Lucas, R.E. and Stockey, N.L. (1983), "Optimal fiscal and monetary policy in an economy without capital", *Journal of Monetary Economics*, Vol. 12, pp. 55-93.

McCallum, B.T. (1976), "Rational expectations and the natural rate hypothesis: some consistent estimates", *Econometrica*, 44, pp. 43-52.

McCallum, B.T. (1984), "On low frequency estimates of long-run relationships in macroeconomics", *Journal of Monetary Economics*, 14(1), pp. 3-14.

McCallum, B.T. (1993), "Unit roots and economic time series: some critical issues", *Economic Quarterly*, 79, Federal Reserve Bank of Richmond, pp. 13-33.

McCallum, B.T. (2001), "Monetary policy analysis in models without money", *Review*, 83, Federal Reserve Bank of St. Louis, pp. 145-160.

McCallum, B.T. and Goodfriend, M.S. (1987), "Money: theoretical analysis of the demand for money", *Working Paper Series*, No 2157, NBER.

McCallum, B.T. and Nelson, E. (2010), "Money and inflation", in Friedman, B. and Woodford, M. (eds.), *Handbook of Monetary Economics*, Elsevier, forthcoming.

McCandless, G.T. and Weber, W.E. (1995), "Some monetary facts", *Quarterly Review*, 19(3), Federal Reserve Bank of Minneapolis, pp. 2-11.

Meltzer, A.H. (1963), "The demand for money: the evidence from the time series", *Journal of Political Economy*, 71(3), pp. 219-246.

Menger, K. (1892), "On the origin of money", *Economic Journal*, 2(6), pp. 239-255.

Millard, S. (2007), "The foundations of money, payments and central banking: a review", MMF Research Group Conference.

Millard, S. and Saporta, V. (2007), "Central banks and payment systems: past, present and future", in Haldane, A.G., Millard, S. and Saporta, V. (eds.), *The future of payments systems*, Routledge.

Minsky, H. (1982), "Can it happen again?", *Essays on instability and finance*, M.E. Sharpe.

Minsky, H. (1986), *Stabilizing an unstable economy*, Yale University Press, New Haven.

Minsky, H. (1992), "The financial instability hypothesis", *Working Paper Series*, No 74, Jerome Levy Economics Institute.

Mishkin, F.S. (2001), "From monetary targeting to inflation targeting: lessons from the industrialized countries", *Working Paper Series*, No 2684, World Bank.

Moutot, P. (2010), "Cash constraints and the role of money in the economy", mimeo, ECB.

Muth, J.F. (1961), "Rational expectations and the theory of price movements", *Econometrica*, 29, pp. 315-335.

Nelson, E. (2003), "The future of monetary aggregates in monetary policy analysis", *Journal of Monetary Economics*, Vol. 50, pp. 1029-1059.

Neumann, M.J.M. (2003), "The European Central Bank's first pillar reassessed", *Working Paper Series*, No 03, IIW, Bonn University.

Neumann, M.J.M. and Greiber, C. (2004), "Inflation and core money growth in the euro area", *Discussion Paper Series*, No 36/2004, Deutsche Bundesbank.

Newcomb, S. (1885), *Principles of political economy*, Harper, New York.

Orphanides, A. (2001), "Monetary policy rules based on real-time data", *American Economic Review*, 91(4), pp. 964-985.

Phelps, E.S. (1968), "Money-wage dynamics and labor market equilibrium", *Journal of Political Economy*, 76(2), pp. 678-711.

Phillips, A.W. (1958), "The relationship between unemployment and the rate of change of money wages in the United Kingdom, 1861-1957", *Economica*, 25(100), pp. 283-299.

Pigou, A.C. (1917), "The value of money", *Quarterly Journal of Economics*, 32(1), pp. 38-65.

Poole, W. (1970), "Optimal choice of monetary policy instruments in a simple stochastic macro model", *Quarterly Journal of Economics*, 84(2), pp. 197-216.

Reynard, S. (2006), "Money and the Great Disinflation", *Working Paper Series*, No 2006-7, Swiss National Bank.

Ritter, J.A. (1995), "The transition from barter to fiat money", *American Economic Review*, 85(1), pp. 134-149.

Rolnick, A.J. and Weber, W.E. (1997), "Money, inflation, and output under fiat and commodity standards", *Journal of Political Economy*, 105(6), pp. 1308-1321.

Rupert, P., Schindler, M., Shevchenko, A. and Wright, R. (2000), "The search-theoretic approach to monetary economics: a primer", *Economic Review*, 36(4), Federal Reserve Bank of Cleveland, pp. 10-28.

Samuelson, P.A. (1958), "An exact consumption-loan model of interest with or without the social contrivance of money", *Journal of Political Economy*, 66(6), pp. 467-482.

Samuelson, P.A. and Solow, R.M. (1960), "Analytical aspects of anti-inflation policy", *American Economic Review*, 50(2), pp. 177-194.

Sargent, T.J. (1971), "A note on the accelerationist controversy", *Journal of Money, Credit and Banking*, Vol. 3, pp. 721-725.

Sargent, T.J. and Surico, P. (2008), "Monetary policies and low frequency manifestations of the quantity theory", *Discussion Paper Series*, No 26, MPC Unit, Bank of England.

Schularik, M. and Taylor, A. (2009), “Credit booms gone bust: monetary policy, leverage cycles and financial crises, 1870-2008”, *Working Paper Series*, No 15512, NBER.

Smets, F., and Wouters, R. (2003), “An estimated stochastic dynamic general equilibrium model of the euro area”, *Journal of the European Economic Association*, 1(5), pp. 1123-1175.

Söderström, U. (2005), “Targeting inflation with a role for money”, *Economica*, 72 (288), pp. 577-596.

Svensson, L.E.O. (1997), “Optimal inflation targets, ‘conservative’ central banks, and linear inflation contracts”, *American Economic Review*, 87(1), pp. 98-114.

Svensson, L.E.O. (2000), “Does the P* model provide any rationale for monetary targeting?”, *German Economic Review*, 1(1), pp. 69-81.

Svensson, L.E.O. and Woodford, M. (2004), “Indicator variables for optimal policy under asymmetric information”, *Journal of Economic Dynamics and Control*, 28(4), pp. 661-690.

Taylor, J.B. (1993), “Discretion versus policy rules in practice”, *Carnegie Rochester Series on Public Policy*, 39, pp. 195-214.

Tobin, J. (1958), “Liquidity preference as behavior towards risk”, *Review of Economic Studies*, 25(1), pp. 65-86.

Vogel, R. (1974), “The dynamics of inflation in Latin America”, *American Economic Review*, 64(3), pp. 102-114.

Von Hayek, F.A. (1931), *Prices and production*, Routledge & Sons, London.

Von Mises, L. (1912), *Theorie des Geldes und der Umlaufmittel*, Duncker & Humblot, Leipzig.

Wallace, N. (1998), “A dictum for monetary theory”, *Quarterly Review*, 22(1), Federal Reserve Bank of Minneapolis, pp. 20-26.

Williamson, S. and Wright, R. (1994), “Barter and monetary exchange under private information”, *American Economic Review*, 84(1), pp. 104-123.

Williamson, S. and Wright, R. (2010a), “New monetarist economics: models”, MPRA Paper No 21030.

Williamson, S. and Wright, R. (2010b), “New monetarist economics: methods”, MPRA Paper No 21486.

Whiteman, C. (1984), “Lucas on the quantity theory: hypothesis testing without theory”, *American Economic Review*, 74(4), pp. 742-749.

Whitesell, W. (1997), “Interest rates and M2 in an error correction macro model”, *Finance and Economics Discussion Series,* No 1997-59, FRB.

Woodford, M. (1994), "Non-standard indicators for monetary policy: can their usefulness be judged from forecasting regressions?", in Mankiw, G. (ed.), *Monetary Policy*, Chicago University Press, pp. 95-115.

Woodford, M. (2003), *Interest and prices*, Princeton University Press.

Woodford, M. (2008), "Does a 'two-pillar Phillips curve' justify a two-pillar monetary policy strategy?", in Beyer, A. and Reichlin, L. (eds.), *The role of money: money and monetary policy in the twenty-first century*, ECB, pp. 56-82.

CHAPTER 2

MONETARY ANALYSIS IN THE ECB'S MONETARY POLICY PROCESS

1 INTRODUCTION[1]

The monetary policy strategy of the ECB initially announced in October 1998 and confirmed and clarified in May 2003 (ECB (1998, 2003a)) established, as a matter of principle, that the ECB's comprehensive analysis of risks to price stability in the euro area is organised around two analytical perspectives (or "pillars"): the monetary and economic analyses.

The monetary policy strategy sets out the focus and aims of each of the two pillars. It assigns monetary analysis the role of assessing medium to long-term trends in inflation, on the basis of the link between persistent trends in money and prices. Some elements of the framework to derive such an assessment were already provided in the formulation of the strategy.[2] A full description of this framework was clearly beyond the scope of this strategic formulation.

Over the years, numerous ECB and ECB staff publications have described and addressed elements of the framework used to conduct monetary analysis at the ECB.[3] From the outset, this framework has been broad and comprehensive, encompassing a wealth of techniques and tools and spanning a wide range of monetary and credit indicators. The monetary analysis has been primarily geared towards identifying risks to price stability at longer horizons. However, it has also always been designed so as to take full advantage of the insights that monetary data offer about the condition of the financial system, the portfolio behaviour of households, firms and banks, and, ultimately, the operation of the monetary policy transmission mechanism.

The central tenets of this broad framework remain valid. At the same time, the statistical data, econometric models and economic interpretations that flesh out and operationalise the framework (i.e. provide policy-relevant assessments

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2 For instance, the reference value for monetary growth as a benchmark for the assessment of monetary developments and the consideration of developments in a wide range of monetary indicators including M3, its components and counterparts, notably credit, and various measures of excess liquidity; see ECB (1998) and ECB (2003a). The derivation of the reference value and its use over time in the conduct of monetary analysis is described in Chapter 3 of this book.

3 See e.g. ECB (1999b), ECB (2000), Masuch et al. (2001), ECB (2004a) and Fischer et al. (2008).

in real time) have benefited from ongoing refinements and development. In 2007 the Governing Council of the ECB decided to formalise and provide impetus to this evolutionary process by endorsing a research programme to enhance the ECB's monetary analysis. This chapter describes the ECB's monetary analysis and explains how this analysis, enhanced by the results of this research agenda (which are discussed in more detail in subsequent chapters of this book), contributes to the assessment of risks to price stability and therefore supports monetary policy decisions.

The remainder of this chapter is organised as follows. Section 2 explains the reasons underlying the decision to pursue an agenda to enhance the monetary analysis and outlines the main themes emerging from the research carried out. Section 3 documents the paradigm for the ECB's monetary analysis, explaining how ECB staff operationalise the long-run link between money and prices to arrive at an assessment of medium to long-term risks to price stability in real time. Section 4 presents the procedural aspects of communicating the monetary analysis, both internally to the Governing Council and externally to the public and financial markets. Section 5 illustrates, by means of a number of concrete examples, the multifaceted contributions that the monetary analysis makes to the monetary policy process. Finally, Section 6 provides some brief concluding remarks.

2 THE ENHANCING MONETARY ANALYSIS RESEARCH AGENDA

The tools used to operationalise the monetary analysis have evolved continually over the first decade of Monetary Union, prompted by the availability of more and better data, the derivation and adoption of methodological advances, and the benefits of experience or "learning-by-doing" in what remains a novel environment for monetary policy. Nonetheless, during this period – in a context of continuous financial innovation and structural change – some lacunae in the analytical toolbox for monetary analysis became apparent. For example, some interpretations that had been derived on a judgemental basis needed to be codified and embodied in formal models, so as to help provide a fuller and more structural account of the economic mechanisms linking monetary developments to price dynamics.

The Governing Council recognised the importance of addressing these shortcomings in the analytical machinery of the ECB's monetary analysis. It emphasised the importance of ensuring that the monetary analysis, the assessment of risks to price stability derived from it, and the policy decisions which rest upon it, remain robust. Moreover, the Governing Council saw benefit in an explicit acknowledgement of the need to enhance the monetary analysis and a public commitment to undertake such an enhancement: this would provide impetus to the process and ensure the necessary transparency and accountability. This realisation led the Governing Council to endorse a research agenda to enhance the ECB's monetary analysis in July 2007. (Note that this decision *predated* the emergence of tensions in global financial markets, which subsequently raised interest in the role of monetary, credit and financial developments in macroeconomic dynamics at central banks, in academia and among financial market practitioners.)

The proposed research agenda aimed at enriching the toolkit available to conduct monetary analysis within the existing framework and monetary policy strategy. In this context, four main avenues for research were identified:

2.1 IMPROVING MODELS OF EURO AREA MONEY DEMAND

The episode of exceptional portfolio shifts into euro area M3 due to heightened economic and financial uncertainty in 2001-03 posed challenges for the conventional money demand specifications available at the time. Eventually, standard statistical tests indicated that these had become unstable.[4] While narrowly defined money demand stability is not a precondition for the meaningful conduct of monetary analysis, experience showed that the vintage of money demand models available at the time would benefit from refinement and extension. In particular, a need was seen to formalise and codify the judgemental interpretations of monetary developments that were made at the time,[5] which had been made off-model. This rationale gave rise to the first avenue in the research agenda to enhance monetary analysis, which envisaged modelling money demand as part of a broader portfolio choice by the private sector, taking into account the impact of uncertainty, risk and returns on a broad range of domestic and foreign financial assets.

2.2 IMPROVING MONEY-BASED INDICATORS OF RISKS TO PRICE STABILITY

To synthesise and summarise information derived from the ECB's broad-based monetary analysis and to emphasise the use of monetary analysis as a guide to policy decisions aimed at the maintenance of price stability, it has proved useful to construct money-based indicators of risks to price stability. These indicators have been used from the outset of Monetary Union (see Fischer et al. (2008)). Although providing a useful guide to the persistent component of inflation (the indicators proved to be unbiased), they had tended at times to exhibit excess volatility, making the indications they were providing difficult to interpret and communicate at the quarter-to-quarter frequency that dominates the monetary policy discourse. Against this background, it was recognised that these indicators could be enhanced, in order to better reflect the notion of persistence that is embodied in the robust longer-term relationship between money growth and inflation. The identification of these needs for improvement gave rise to a second avenue of research in the enhancing monetary analysis research agenda.

4 See the discussion in Chapter 3, especially in Annex 1 to that chapter.
5 For example, the corrections for the estimated impact of so-called "portfolio shifts" discussed in ECB (2004b).

2.3 FURTHER DEVELOPMENT OF STRUCTURAL GENERAL EQUILIBRIUM MODELS INCLUDING MONEY AND CREDIT

Estimated theoretical models with good empirical properties can provide a framework for studying the channels through which money growth transmits to pricing decisions and influences expectations. Building theoretically consistent and empirically coherent models that incorporate an active role for money and credit contributes to the shaping of a disciplined view about the risks that monetary variables pose to price stability. Research at the ECB had from a relatively early stage been at the forefront of developing such models.[6] Recognising the importance of this type of analysis and the large scope for further development, it was decided that a distinct avenue in the research agenda for the enhancement of monetary analysis would be assigned to the further improvement of an empirical framework within which various monetary aggregates interact with other variables through households' portfolio choices and banks' decisions about the provision of credit and means of payment.

2.4 EXTENDING THE FRAMEWORK FOR CROSS-CHECKING AND RISK ANALYSIS

"Cross-checking" between the macroeconomic indications released by the economic analysis and the monetary analysis, respectively, lies at the heart of the monetary policy strategy of the ECB. It is ultimately a policy-maker's activity. Nevertheless, technical work can assist the decision-making body and enforce the internal coherence of the exercise. In the context of the agenda to enhance monetary analysis, two main approaches were pursued in this direction: (a) developing empirical methods and tools linking developments in money and credit to asset price dynamics; and (b) deepening sector-based analysis of financial flows, so as to reconcile financial information with the baseline aggregate scenario implicit in real-sector projections.

The extensive work undertaken along these four avenues in the course of pursuing the enhancing monetary analysis research agenda has generated a substantial body of new analytical tools and research, which are described in greater detail in subsequent chapters of this book. Following a process of peer review (first within the Eurosystem and then with academics and other central bank researchers), these tools have been incorporated into the ECB's monetary analysis toolbox.

Taking an overview of the results of this work, several themes emerge, which illustrate how the ECB's monetary analysis has been improved through the incorporation of these enhancements. First, enhancements have allowed the codification and formalisation of institutional knowledge underlying the assessment of monetary developments in economic models. This is exemplified by the new generation of money demand equations for euro area M3. Second, the analytical work conducted under the agenda has brought about a significant

6 See e.g. Christiano et al. (2003).

degree of technical refinement to the tools used. This is evident, for instance, in the application of state-of-the-art methods to define the "historical regularities" in the monetary data and to construct money-based inflation risk indicators. Third, the models improved and developed in the context of this agenda allow 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 the eventual 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.

3 THE PARADIGM FOR THE ECB'S REAL-TIME BROAD-BASED MONETARY ANALYSIS

The theoretical and empirical underpinnings of the distinct role assigned to monetary analysis within the ECB's monetary policy strategy have been outlined in Chapter 1. Here the focus shifts to describing the paradigm underlying the broad analytical process by which ECB staff conduct monetary analysis in real time, with a view to supporting the monetary policy-making process. This characterisation should be viewed as the description of a framework, rather than as a detailed presentation of specific tools and analytical instruments (the latter is given in subsequent chapters). While the core of this framework has remained stable over time, individual aspects have evolved in the evolutionary manner discussed above. The account presented here is, therefore, inevitably a "snap-shot" of the monetary analysis process. It describes where we stand following the incorporation of results from the enhancing monetary analysis research agenda. But, by the nature of such a snap-shot, it cannot give much insight into the ongoing, continual process of further refinement and improvement upon which the success of the monetary analysis over time does and will crucially depend.

The ECB's framework for taking monetary policy decisions is broad, aiming at providing an encompassing view of economic, monetary and financial dynamics. Before delving into various elaborations and complexities, it is therefore first useful to describe the paradigm for monetary analysis in its most simplified representation, focusing on the low-frequency relationship between money and inflation. This also helps illustrate how the heuristic paradigm informs and structures the real-time, operational process of monetary analysis.

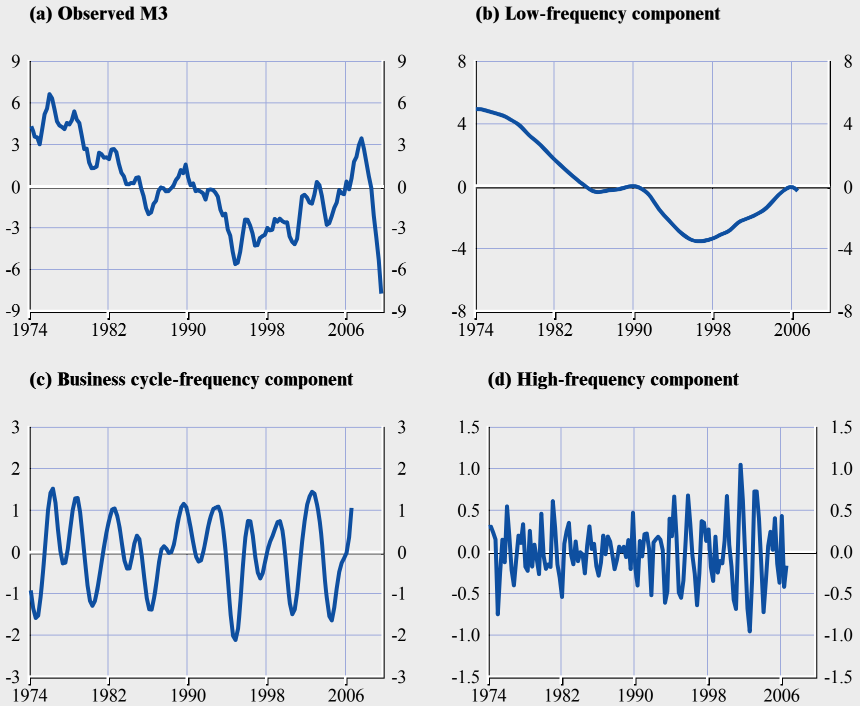
3.1 THE PARADIGM IN ITS SIMPLEST REPRESENTATION

The role assigned to the monetary analysis in the ECB's monetary policy strategy centres on the assessment of medium to long-term trends in inflation, thereby mainly serving as a means of cross-checking the short to medium-term indications stemming from the economic analysis.[7] As emphasised in Chapter 1, the role of money in the economy takes on different forms depending, inter alia, on:

7 See ECB (2003a).

Chart 1 Frequency decomposition of M3 developments

(annual percentage changes; deviations from mean)



Source: ECB calculations.

Notes: The components of M3 growth (calculated as the four-quarter log difference of M3) were derived using the symmetric version of the band-pass filter as described in Christiano and Fitzgerald (2003). The high-frequency component captures movements with a cycle length of up to two years. The business cycle-frequency component captures movements with a cycle length of more than two and up to ten years. The low-frequency component (capturing movements with a cycle length of more than ten years) was derived as a residual using the difference between the observed M3 series and the high and business cycle-frequency components.

the state of the transmission mechanism; the stage of the business cycle; the horizon considered; the nature of the financial pressures, frictions or asset price movements that it is associated with; and even the prevailing monetary policy regime. However, it is also clear that within these various elements, the most prominent and relevant to the objective of price stability is the forward-looking information contained in current monetary developments about future inflation trends.

It is this link which underlies the reference to "medium to long-term trends" in the ECB's strategy and therefore suggests that, as a starting point, it is instructive to decompose observed monetary developments (such as the growth of the broad monetary aggregate M3 (see panel a in Chart 1)) into components of varying persistence.[8] A decomposition of M3 growth in the frequency domain would for instance disentangle a low-frequency component (defined as movements

8 See Pill and Rautanen (2006).

with a periodicity of more than ten years; see panel b in Chart 1), a business cycle-frequency component (defined as movements with a periodicity of more than two and less than ten years; see panel c in Chart 1) and a higher-frequency component (defined as movements with a periodicity of less than two years; see panel d in Chart 1).

It is the low-frequency component that both theoretical and empirical considerations suggest best embodies the link with medium to long-term price developments. All components, however, carry information that can provide insights valuable for the policy assessment. For instance, movements of M3 at cyclical frequencies hold information of a conjunctural nature. Importantly, they capture the adjustments in the money-holding sectors' financial portfolios in response to changes in the yield configuration and are thus helpful in analysing the transmission of monetary policy, including the dynamics of variables important for the economic analysis. The high-frequency component, although very volatile, can provide indications of the very short-term reactions of the money-holding sectors and of the MFI sector,[9] which can be particularly valuable information on the timing of recoveries or slowdowns and in periods of financial stress.

3.2 OPERATIONALISING THE PROCESS BY FLESHING OUT THE PARADIGM

Operationalising such a stylised process is, however, by no means a trivial task. The statistical techniques employed to decompose monetary growth in the frequency domain (underlying Chart 1) can only be accurate and fully reliable from an ex post perspective. They rely on *both* past *and* future observations to calculate the frequency components at any point in time. It is obviously easier to take a view on whether a monetary innovation is persistent or not if one can use subsequent developments in the money time series to inform that assessment. But this (considerable) benefit of hindsight is obviously *not* available in the real-time environment relevant for policy-making, when analysis relies solely on information and data available at the time policy decisions are taken: by nature, one cannot incorporate the (unknown) future path of monetary variables into the analysis. This drawback in the mechanical application of (so-called symmetric) statistical filters can only partially be addressed through the use of "one-sided" (and thus asymmetric) filters, which only exploit information in available data from the past. The latter approach comes at the price of introducing potential distortions and volatility into the filtered series at the end of the sample, i.e. precisely at the point where policy-makers have to take decisions.[10] In the same way that economic analysis has its weaknesses that even the most

9 The MFI sector corresponds to that set of institutions that issue "money" according to the M3 definition, i.e. the Eurosystem, banks (strictly speaking "credit institutions") and money market mutual funds in the euro area. The money-holding sector consists (largely) of households, non-financial corporations, insurance corporations and pension funds (ICPFs) and other financial institutions (OFIs).

10 In this case, the smoothed value is calculated "off centre", with the average being determined using more data from one side of the point than the other, according to what is available. At the last observation, the outcome will be purely one-sided and thus backward-looking.

Chart 2 The monetary analysis process

Source: ECB.

up-to-date models cannot fully address, identifying the underlying rate of monetary expansion is, in practice, very challenging in real time.

The shortcomings of a purely statistical approach to the identification of the underlying trend of monetary growth have led to the adoption of a structured approach embodying judgement, which is described heuristically in Chart 2.

The starting point of this approach is a comprehensive and encompassing examination of the MFI balance sheet data, going far beyond the headline M3 aggregate. This includes the detailed monitoring of developments in components, counterparts and sectoral contributions to the monetary aggregates (Step 1). As a next step, monetary developments are explained and interpreted, primarily with a view to identifying and isolating movements in the data that are unrelated to medium to long-term price trends. This process combines a suite of econometric tools for model-based assessment with detailed institutional analysis (Step 2). The analysis conducted at this stage culminates in the development of a view on the persistence of monetary dynamics (Step 3). This view is then a first, but major input in the formulation of an assessment of the outlook for price developments. The overall assessment can however schematically be thought of as deriving from an evaluation of whether the persistent component of monetary growth has shifted (Step 4). (Of course, it should be emphasised that the view coming from the monetary analysis described here is cross-checked with the economic analysis: both are considered by the Governing Council before coming to a final monetary policy decision.)

To the extent that such a shift (e.g. a persistent increase in the growth of money holdings) has been identified, three possibilities need to be considered. First, the shift may represent a change in liquidity preference (i.e. a shift in money demand). In this case, the change in the persistent part of money growth would not be reflected in underlying monetary expansion and therefore a shift in trend inflation would not occur. But it is important in such a case to consider which other consequences may be associated with it and how they match the insights of economic analysis.[11] Second, the change in the persistent part of money growth is linked to changes in spending on goods and services, leading to a shift in underlying monetary expansion and eventually movements in trend inflation.

11 As described in Chapter 3, one example of this situation are the “portfolio shifts” into monetary assets within M3 that occurred between 2001 and 2003.

Third, the increased money holdings are mainly associated with purchases of financial and real assets. In this case, the implications for trend inflation will not be immediate. However, higher asset prices may give rise to second-round effects through, for instance, wealth or Tobin's *q* effects, thereby placing upward pressure on consumer prices.[12] Conversely, the upward movement in asset prices may eventually lead to a boom episode, invariably followed by a bust that could, in turn, harbour deflationary risks. Ultimately, monetary analysis needs to take a stand regarding the likelihood, horizons and dynamics associated with each of these three possibilities, in order to draw reliable implications for medium to long-term consumer price developments and their trends.

In practice, however, the linear process illustrated in Chart 2 is more complex and the contribution of monetary analysis to the assessment of risks to price stability is multifaceted. This contribution is firmly centred on the identification of the underlying monetary trends that are robustly linked to medium to long-term price developments. At the same time, the detailed analysis of monetary dynamics generates a wealth of information on higher-frequency developments regarding, for instance, financing conditions, the credit channels of monetary policy transmission and the condition and behaviour of banks. In addition, the analysis of monetary dynamics helps to place asset price developments into perspective and to form a view regarding the possible build-up of financial imbalances. In turn, this serves to define and calibrate monetary and financial scenarios that are used to identify risks to the baseline short to medium-term outlook stemming from the economic analysis. Finally, all of this can also feed back into the assessment of the underlying trend of monetary expansion and its impact on inflation trends. Overall, this process – which is intended to encompass in a structured way as much information as possible and to introduce it within the policy process – attempts to substitute for the absence of a single encompassing model that covers all these elements in a fully internally consistent, structured and integrated way. The remainder of this section is intended to provide more details on the various elements of this process.

3.3 THE MONITORING OF MONETARY AND CREDIT DEVELOPMENTS AND THE INSTITUTIONAL ANALYSIS

As indicated above, the starting point for the monetary analysis is the encompassing but detailed examination of the MFI balance sheet statistics. This broad approach ensures that the informational content embedded in money and credit developments is exploited to the fullest extent possible and that no relevant information goes overlooked. In practice, it has proved useful to organise information on the MFI balance sheet along two main dimensions: first, distinguishing components of M3 from its counterparts; and second, breaking down monetary and credit developments by counterpart sector. Importantly, the focus of the examination is continuously adapted, in order to tailor it to the questions at hand and the particular economic environment.

12 The link between money, credit, asset prices and consumer prices is explored in Chapter 6.

The monitoring of the individual components of M3 is primarily motivated by its ability to offer insights into the factors driving overall monetary developments, thereby assisting in the development of a view on the underlying trend of monetary expansion. For instance, the most liquid components of M3, which are included in the M1 aggregate (i.e. currency in circulation and overnight deposits), are immediately available for transactions, suggesting that the transactions motive is central to holding them. By contrast, less liquid monetary assets, such as the marketable instruments in M3, tend to be held mainly for portfolio reasons. The contribution of individual components in driving overall monetary dynamics can therefore provide useful indications regarding the relative importance of the factors underlying these dynamics. Beyond this role, some of the components are directly informative for specific questions. Perhaps the most notable such example is the ability of M1 growth to predict turning points in GDP growth.[13]

Turning to the counterparts of M3, in the euro area, M3 holdings are primarily matched on the MFI balance sheet by loans to the private sector, reflecting the predominantly bank-based financing structure of the euro area economy. Thus, while developments in the growth of these two variables may diverge in the short run, a protracted expansion of the MFI balance sheet will be reflected in both. Indeed, a close relationship between fluctuations in M3 and loans to the private sector can be discerned across all frequencies, including, importantly, the lower frequencies.[14] In this sense, monitoring current developments in lending to the private sector and forming a view on the availability of MFI loans going forward are intimately related to the process of uncovering the underlying pace of monetary expansion. At the same time, this analysis produces information relevant for addressing cyclical questions regarding, for instance, the financing conditions facing households and non-financial corporations. However, the analysis of M3 counterparts is not limited to loans to the private sector, as relevant insights can also be obtained through the monitoring of the other counterparts. For instance, the analysis of the net external asset position is helpful in monitoring international capital flows, while examining longer-term financial liabilities is important for understanding the portfolio behaviour of the money-holding sectors and the funding position of banks.

The sectoral perspective is also a very important element in the monetary analysis process. Money-holding behaviour tends to vary substantially across sectors as regards its main determinants. In this respect, whereas the money holdings of households and non-financial corporations are typically closely linked to spending decisions or plans, those of non-monetary financial intermediaries are largely driven by portfolio and liquidity considerations.[15] In addition, sectoral money holdings vary as regards their persistence, with household money holdings reacting sluggishly to changes in the economic environment and, at the opposite end of the spectrum, those of non-monetary financial intermediaries

13 See e.g. ECB (2008b).
14 This view is supported by estimates of coherence – a measure of the strength of association of two variables at various frequencies – between M3 and loans to the private sector.
15 See ECB (2006).

being very sensitive to such changes. These differences in the features of money-holding behaviour across sectors suggest that the monitoring of the sectoral contributions to overall monetary growth can be particularly helpful in recovering the underlying monetary trend, which is by definition slow-moving and conceptually only weakly related to movements in money holdings that are linked to short-term financial market developments.

Traditionally, analysis has focused on the *consolidated* MFI balance sheet, which nets out interbank positions. However, in the context of the financial crisis and associated tensions in euro money and funding markets, greater interest has been taken in the *aggregate* MFI balance sheet which reveals interbank positions. For example, analysis of the latter (in conjunction with traditional monetary indicators for the OFI sector) gives some indication of the extent to which deleveraging following the emergence of financial tensions has occurred *within* the financial sector rather than between the financial sector and the non-financial sectors. This may have important implications for whether such deleveraging has a greater impact on economic activity or asset market developments, at least in the first instance.

Developing a detailed understanding of monetary developments invariably also requires the analysis of information beyond the MFI balance sheet statistics. In this respect, the monetary analysis regularly draws on information on interest rates and other financial market prices, securities issuance statistics, financial surveys, statistics on the monetary presentation of the balance of payments, investment fund statistics as well as general economic statistics such as the national accounts. While the focus is normally on aggregate data, on occasion the analysis needs to be complemented by a disaggregated perspective. A particular source of information that has often usefully complemented the examination of the MFI balance sheet statistics has been the sectoral financial accounts. This set of accounts is especially helpful when a more encompassing perspective of the money-holding sectors' financial investment behaviour, going beyond their holdings of instruments issued by MFIs, is required in order to monitor possible portfolio shifts, in the context, for instance, of the financial market turmoil.[16] Similarly, this set of accounts is used to examine the broader financing of, for example, the non-financial corporations sector, beyond that provided by the MFI sector. For instance, again in the context of the financial market turmoil, this type of analysis was used to monitor possible substitution between bank and non-bank sources of financing and the extent of possible disintermediation effects.[17]

The part of the monetary analysis process outlined thus far relies primarily on detailed institutional analysis when assessing current monetary developments. This can be understood as comprising all activities that enable a detailed understanding and interpretation of the monetary data that goes beyond the standard macroeconomic determinants of money-holding behaviour. Institutional analysis is thus a broad and encompassing concept that draws upon a wide body

16 See ECB (2009a).
17 See ECB (2009b).

of information and a broad skill set. It includes the consideration of aspects of the microeconomics of banking and financial markets, the evaluation of the impact of financial reporting, regulatory and supervisory factors, as well as the exploitation of current market information, regarding for instance large, exceptional transactions that have an impact on aggregate developments but should not necessarily be over-interpreted. Indeed, this detailed institutional analysis has proved particularly insightful in the fast-changing environment of the financial market turmoil.[18] An important contribution of institutional analysis in the context of the ECB's monetary analysis is the identification and quantification of the impact on headline monetary dynamics of special factors, which are not related to future price developments. A prominent example of such a contribution was the derivation of a correction to M3 growth to account for the impact of extraordinary portfolio shifts in the period between 2001 and 2003.[19]

3.4 MONETARY ANALYSIS AND MONEY DEMAND MODELS

When interpreting monetary developments, the institutional analysis has, from the outset, been complemented in the ECB's monetary analysis process by model-based tools.[20] Money demand models command a central role in this respect. More specifically, money demand models help in the extraction of policy-relevant assessments from monetary developments in two broad ways.

First, money demand models can be used to explain monetary developments by allowing the quantification of the contributions of the various macroeconomic determinants to observed monetary growth. Provided that a robust relationship between money growth and a set of determinants can be established, such an analysis allows a deeper understanding of the causes of monetary growth, which is necessary for developing a view on the underlying rate of monetary expansion. For instance, an increase in money demand that can be identified as being due to heightened uncertainty – as, for instance, observed in the 2001-03 period of extraordinary geopolitical uncertainty – would not be linked with the emergence of risks to price stability and should thus be discounted when determining the pace of underlying monetary expansion. The monetary analysis conducted at the ECB relies, inter alia, on such econometric models to explain developments not only in headline M3 but also in its components (e.g. M1) and counterparts (e.g. loans to the private sector) as well as in sectoral money holdings.

Second, money demand models can be used to develop normative benchmarks of the level of money or of money growth that is consistent with price stability over the medium term. Deviations of actual money growth from such benchmarks cannot be interpreted in a mechanical manner. For instance, a persistent overshooting of money growth compared with the benchmark may suggest that upward pressure on prices so as to absorb this excess is imminent. This would be the case, for instance, if the buoyant money growth is due to money supply factors, reflecting for instance changes in banks' appreciation of risks. Alternatively, future money

18 See ECB (2009d).
19 For details on the derivation of the corrected series, see Fischer et al. (2008).
20 See Masuch et al. (2001).

growth may instead bear the brunt of the adjustment, with limited implications for future price developments. Finally, it is also conceivable that the relationship between money and its determinants may have shifted. While statistical tools can provide some guidance regarding the likelihood of each interpretation, informed judgement eventually needs to be exercised in order to draw policy conclusions.

For the ECB's conduct of the monetary analysis, improvements made in the latest vintage of money demand models [21] have restored the ability to explain monetary developments in a formal, statistically stable money demand framework. At the same time, the inclusion of additional arguments in money demand specifications has considerably complicated the extraction of the implications of monetary developments for risks to price stability. This is because, in the enhanced money demand models, the interpretation of monetary developments is dependent on an assessment regarding the sustainability of wealth and asset price developments. In addition, 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 cut across different models, the prominence of which may vary depending on the dominant forces driving monetary developments. Finally, the statistical breakdown of money demand models is not devoid of potentially policy-relevant implications. 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 attach greater importance to the behaviour of the "money-creating" sector.

The evolution of the role of money demand models in the ECB's monetary analysis has extended to the role of the reference value for monetary growth in the conduct of monetary analysis and the identification of risks to price stability. The reference value has been an important signalling device of the ECB's commitment to maintaining price stability over the medium term, recognising that this is not compatible with excessively high or low monetary growth over protracted periods of time. Particularly during the first years of the ECB, this signalling device was instrumental in ensuring that the credibility of its forerunner central banks was inherited. From the outset, however, a divergence of money growth from this reference value was not intended to be used as a mechanical signal of risks to price stability. Instead, such a deviation was intended to prompt, in the first instance, further analysis to identify and interpret the economic disturbance that caused the deviation.[22] The non-mechanical role of the reference value was illustrated, for instance, very prominently during the period of exceptional portfolio shifts into euro area M3 due to extraordinary uncertainty. During this episode, the divergence of euro area M3 growth from the reference value was not considered by the ECB's monetary analysis to carry increased risks to price stability and was, therefore, downplayed.

21 See the discussion in Chapter 3.
22 See ECB (1999a).

Experience during the first decade of Monetary Union and the results of the enhancing monetary analysis research agenda in the area of money demand have shown that the derivation of a norm for monetary growth that is compatible with price stability is particularly complex in a financial environment marked by ever-increasing sophistication and perpetual innovation and change. This has called for a more nuanced understanding of the role of the reference value, in view of the inevitable uncertainty in the assumptions necessary to derive it and the fact that, in any case, deviations from such a norm can be particularly protracted before risks to price stability materialise. In this respect, the clarification of the ECB's monetary policy strategy in May 2003 had underscored the longer-term nature of the reference value by discontinuing its annual review, previously undertaken by the Governing Council. This evolution in the role of the reference value should not, however, detract from the notion that excessive and protracted departures of monetary growth from the reference value – or benchmarks derived from money demand equations – entail large risks and are worthy of significant analysis.

3.5 THE ANALYSIS OF MONEY AND CREDIT DEVELOPMENTS USING STRUCTURAL MODELS

The interpretation of monetary developments on the basis of money demand models is essentially a partial equilibrium analysis. Moreover, interactions among the explanatory variables employed can blur the distinction of the contribution to explaining monetary developments stemming from each factor: they do not allow a more causal interpretation of developments.

Structural general equilibrium models that incorporate an active role for money and credit offer a complementary, formal and disciplined approach to explaining monetary developments that is less subject to these criticisms.[23] Historical decompositions of developments in money and credit based on a dynamic general equilibrium model with financial frictions and an explicit banking sector, which quantify the impact of shocks of different nature and source, regularly complement and indeed confirm the interpretations derived from the partial equilibrium (money and loan demand) and institutional analyses.[24] This type of analysis is therefore used to distinguish the part of monetary developments that, according to the model, has a bearing on future price developments from the part that reflects idiosyncratic movements in money. The quantification of the size of these two parts is an important contribution to the development of a view on the strength of underlying monetary dynamics. Similarly, this type of analysis is used to decompose credit developments into the contributions of various structural shocks, including shocks that are specific to the financial sector of the economy, for instance innovations in intermediation technology. This is of particular

23 Another, empirically oriented, approach that has also been used in the course of conducting the monetary analysis for the quantification of structural forces driving monetary developments is the calculation of historical decompositions on the basis of Structural Vector Auto Regression (SVAR) models.

24 See e.g. ECB (2007, 2009a) and the discussion in Chapter 5.

importance as it allows the identification of the extent to which the availability of credit to the economy is shifted by shocks emanating from the financial sector.

While such decompositions have proven to be useful exercises, this approach is not free of limitations of its own, as the necessarily highly stylised nature of such models does not always allow all the factors underpinning monetary developments to be captured. In addition, structural models may identify shocks which indicate that the capacity of the banking sector to supply money has shifted. A persistent change in the money supply, which may point to the emergence of risks to price stability over the medium to long term, cannot be identified on the basis of these models. Nevertheless, the identification of a repeated series of shocks to money supply can be informative regarding inflation trends as it points to the possibility that a potentially destabilising process is in motion.

In addition to identifying and quantifying the contribution of the various shocks driving money and credit developments, the use of structural models has enhanced the monetary analysis in a further important way. The paradigm for monetary analysis outlined at the beginning of this section attaches an important weight to the reduced-form relationship between monetary growth and prices in the medium to long run, which allows the analysis to remain agnostic on the relative importance and relevance of individual transmission channels.[25] However, this approach needs to be complemented with a complete and coherent view of the chain of events linking money growth to price developments. Clearly this is an extremely challenging aim. The efforts to further develop structural models with a meaningful role for money and credit have been heavily geared towards meeting this challenge. In the context of the real-time monetary analysis, this framework has been extensively used in order to shape a disciplined view about the risks that monetary variables pose for price stability, in the form of appropriately designed scenarios.

3.6 THE OUTLOOK FOR PRICE STABILITY AND MONEY-BASED RISK INDICATORS

The detailed examination and interpretation of monetary developments is undertaken, as already indicated, in order to form a view on the underlying monetary trends and, ultimately, to draw implications about risks to price stability. First and foremost, this process is a judgemental exercise synthesizing across models, tools, datasets and analyses. This exercise is, however, also complemented with the compilation of money-based inflation risk indicators. These are empirical tools that exploit the leading indicator properties of money for average inflation over a medium-term horizon,[26] and are therefore used to provide a summary measure of the risks to price stability over this horizon signalled by the monetary data. The results of the analytical efforts made along this avenue[27] have enhanced the tools available for constructing such

25 The advantages of such an approach in the presence of pervasive uncertainty regarding the precise workings of the monetary transmission mechanism were stressed, for instance, by Engert and Selody (1998).
26 See Nicoletti-Altimari (2001).
27 See the discussion in Chapter 4.

money-based risk indicators, mainly by introducing the notion of regime switching in the relationship between money and prices and by employing techniques that exploit large datasets, such as factor models.

Overall, money-based inflation risk indicators cannot fully capture the richness and nuanced nature of the broad monetary analysis. Moreover, they only offer a rather crude time-series approximation of the low-frequency link between money and price developments. Nevertheless, they have become an important element of the communication of the monetary analysis owing to the simplicity and intuitive appeal of their message and the fact that, being entirely mechanical exercises, they are free of subjective assessments, thereby allowing the exercise of judgement to be entirely the prerogative of the user of the indicators.

3.7 EXPLORING THE IMPLICATIONS OF DEVELOPMENTS IN MONEY AND CREDIT FOR ASSET PRICES

The ECB's monetary analysis framework recognises that monetary imbalances may in the first instance not 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 theoretical pedigree and is well documented in the empirical literature.[28] This consideration suggests that when forming a view on the underlying rate of monetary expansion, the possible implications of monetary developments for asset price dynamics need to be carefully considered. Research conducted in the context of the enhancing monetary analysis research agenda 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 has culminated in the development of early warning systems for asset price booms-busts based on the information embedded in money and credit. The integration of these systems into the monetary analysis toolbox allows the assessment of the implications of monetary developments for asset prices to be formalised.

3.8 MAKING THE OUTLOOK FOR PRICE STABILITY MORE ROBUST THROUGH THE USE OF MONETARY AND FINANCIAL SCENARIOS

The elements above should naturally lead to the regular identification of risks to price stability stemming from monetary developments. However, this identification is based on a multitude of approaches and tools, ranging from the interpretation of statistical facts, to stand-alone equations, and on to more sophisticated but never fully encompassing models. These indications may offer a consistent picture, but may also need to be reconciled to a greater or lesser extent. Reconciling them in a single quantitative indicator is likely to be difficult and may also not be warranted: it cannot do full justice to the rich set of exercises conducted in the context of a detailed monetary analysis. From this perspective, the reconciliation exercise inevitably incorporates some judgement in weighing together the individual pieces of evidence.

[28] See Chapter 6 for a review of both the theoretical interlinkages and the empirical evidence.

In all types of analysis, it is good practice to examine how robust or sensitive individual outcomes are and to what extent their message depends on the type of judgement they embody. The derivation of monetary trends which is at the heart of monetary analysis in practice runs through the identification of cyclical developments. These developments also depend on the importance given to various transformations of the monetary transmission process and other possible endogenous or exogenous shocks. However, such developments do not always follow the same pattern and can have very different timing and amplitude from one cycle to the next. The differences in cyclical phases for loans to firms and housing loans, the changing dependence of money and/or credit developments on international capital flows, or the different risks associated with a soft landing or booms-busts in asset prices are cases in point. Such differences can also result for instance from regulatory issues, bank profitability issues or general deleveraging issues.

Against this background, scenarios integrating in an explicit manner assumptions coherent with various alternative judgements help identify to what extent their consequences are in line with the information otherwise available. The consideration of these scenarios then allows the original weight given to various pieces of evidence to be reassessed, which, in turn, may have consequences both for the identification of underlying monetary trends and for the underlying dynamics of prices. Hence, such scenarios may provide indications at an early stage of a process which in the end could lead to a shift in monetary trends and potentially to a dragging of the anchoring of inflation expectations. But given that the assumptions underlying the scenarios are derived from the conjunctural understanding of monetary and financial developments, they also provide a useful means to qualify the result of economic projections of inflation such as those derived in the context of conventional macroeconomic projections.

Setting up monetary and financial scenarios depends on a number of ad hoc choices. First, their identification is dependent on the questions they are supposed to answer, which are themselves dependent on the choice of staff. Second, their conduct is usually based on a combination of techniques,[29] mixing quite often equations and models which are not necessarily derived in a mutually consistent way. However, the scenarios help in building up consistency or explaining how to reconcile different interpretations or privilege some interpretations over others. In this respect, they are the best practical possibility to include more of the information available in a meaningful way in the overall assessment of risks to price stability.

4 MONETARY ANALYSIS IN THE ECB'S MONETARY POLICY DECISION-MAKING PROCESS

Having established the paradigm of the ECB's monetary analysis, this section focuses on how the output from the ECB staff's regular monetary analysis

[29] See Chapters 5 and 7.

feeds into the monetary policy decision-making process from a procedural perspective.

The input from both the monetary and the economic analysis to the assessment of risks to price stability is channelled to the members of the Governing Council in two, overlapping cycles.[30] The first cycle has a monthly frequency defined by the dates of the key interest rate-setting meetings of the Governing Council. This cycle involves a set of regular briefing documents prepared by ECB staff for the Governing Council members. From the monetary analysis perspective, this cycle mainly entails presenting the latest monthly monetary developments to the policy-makers. In addition, some tentative interpretations of these developments are offered. This analysis is mainly based on a detailed and broad institutional analysis, as outlined in Section 3. As most of the model-based tools developed for the monetary analysis require input that is only available at a quarterly frequency, the use of such tools is rather limited during this cycle. In terms of the steps set out in Chart 2, the monthly cycle mainly focuses on Steps 1 and 2. However, a preliminary assessment of the implications of the latest data for the risks to price stability is always also undertaken, mainly in the sense of placing the latest quarterly assessment under intense scrutiny in the light of the latest available developments. Hence, the regular briefing material of the monthly cycle is typically also complemented by ad hoc analyses on topical issues relevant to monetary analysis such as whether loan growth remains in line with business cycle regularities, or whether there are specific one-off developments in the money holdings of non-bank financial intermediaries that will ultimately have no bearing on inflation.

The second cycle has a quarterly frequency and culminates in two presentations to the Governing Council members, on the eve of the March, June, September and December key interest rate-setting meetings. One presentation pertaining to the economic analysis focuses on the results of the macroeconomic projection exercise. The other presentation pertaining to the monetary analysis focuses on the different facets and results of the broad-based monetary analysis described in Section 3.

The quarterly cycle, by virtue of its frequency, provides scope for a more detailed, quantitative and conclusive analysis of economic and monetary developments. Importantly, this analysis is clearly geared towards forming a view on the outlook for inflation and deriving implications for monetary policy. Focusing on the monetary analysis, the quarterly cycle allows the full set of analytical tools at the disposal of ECB staff to be employed. This analysis is codified in a document prepared for the Governing Council, the Quarterly Monetary Assessment (QMA), which is structured so as to reflect the monetary analysis process as illustrated in Chart 2[31] and includes the traditional, quantitative illustrations of

30 For a detailed presentation of the organisation and preparation of monetary policy decisions in the Eurosystem, see Moutot et al. (2008).

31 For a description of the structure and role of the QMA, see Fischer et al. (2008).

monetary trends and money-based inflation risk indicators. As the enhancement of monetary analysis has proceeded, the QMA has gradually included in its more formal interpretations of monetary and credit developments the insights offered by the suite of new money demand models available (see Chapter 3), by a general equilibrium model with financial frictions and an explicit banking sector (see Chapter 5) and by the enhanced money-based inflation risk indicators (see Chapter 4).

The analysis included in the QMA is complemented by a series of other briefing documents prepared for the Governing Council, which tend to focus on somewhat more narrow aspects of the money, credit and financial markets sphere and become available during the quarter. These include, for instance, analysis on the results of the bank lending survey for the euro area, on the survey on the access to finance of small and medium-sized enterprises (SMEs), on developments in capital markets (including yields and financial prices of a wide spectrum of assets, and break-even inflation rates), on the financing conditions facing households and non-financial corporations, on the condition of the banking sector and on the sectoral accounts.

The analysis and interpretation of money and credit developments as reflected in the QMA and the other supporting documents, as already indicated, is also used to generate monetary and financial scenarios of risks to the baseline projection in the macroeconomic projection exercise. These scenarios are also part of the monetary analysis presentation to the Governing Council. They are devised on the basis of the analysis of developments in money, credit and sectoral balance sheets and are intended to illustrate the sensitivity of money, credit, prices and growth to alternative trajectories of various financial variables identified as relevant on the basis of the previous steps of the monetary analysis. As these scenarios are devised by adding relevant shocks to the baseline scenario, they also provide technical support to some aspects of the cross-checking that is routinely performed by the Governing Council when arriving at its final assessment of the outlook for risks to price stability.

The documentation underlying the quarterly presentation of the monetary analysis is prepared with a view to providing input to the assessment of risks to price stability and therefore supporting the policy process. At the same time, it also supports the ECB's external communication. From the outset, the ECB has been committed to maintaining a high level of transparency in its conduct of monetary policy, regarding its strategy, assessment and policy decisions.[32] This commitment has been based on the benefits of transparency for the effectiveness of monetary policy in attaining its primary objective of maintaining price stability (for instance, by facilitating the management of expectations), as well as on the greater accountability that it imparts, which is necessary for the democratic legitimacy of a central bank that has been granted independence.[33]

32 This is for instance reflected in the above-average standing of the ECB among major central banks internationally in rankings of central bank transparency that have been proposed in the literature; see e.g. Eijffinger and Geraats (2006).

33 On the effects of central bank transparency, see e.g. Geraats (2002).

At the same time, the ECB has been attentive to the need to retain clarity and effectiveness in its communication.[34]

Given the complex and at times technical nature of some of the material contained in the QMA and other documents, communication can be challenging. The analysis embodied in this material is nonetheless communicated externally through a number of channels. The regular Monthly Bulletin commentary on monetary developments – particularly in its quarterly, lengthier version – is the primary outlet for the external communication of the monetary analysis. Topical issues that help shape the assessment are regularly reported in boxes that complement the main commentary, which follows a stable structure. In addition, the Monthly Bulletin regularly hosts articles on monetary analysis. The longer and more flexible format of the articles, as well as their lower frequency, allow a somewhat longer-term perspective on monetary developments and a more analytical treatment of topical questions. While they are not meant to provide a conjunctural assessment at the time they are published and are often thematic in nature, they illustrate the type of analysis and insights that have informed monetary policy decisions over time.[35]

The tools used for the conduct of the monetary analysis are typically also communicated externally, primarily through the ECB Working Paper Series (see, for instance, the references in the remaining chapters of this book). Finally, papers and articles presented at external conferences and workshops and published by ECB staff over time have documented the framework and tools underlying the monetary analysis and are thus testament to both the continuity in the main tenets of the framework and the evolution of the tools.[36]

5 THE ROLE OF MONETARY ANALYSIS IN MONETARY POLICY DECISION-MAKING

The paradigm underpinning the ECB's conduct of the monetary analysis and its transposition into an operational process (topics described in the two preceding sections of this chapter) are geared towards ensuring monetary analysis supports monetary policy-making. This section illustrates what concrete contributions the monetary analysis makes to the ECB's monetary policy process, in terms of specific insights and perspectives, as well as more broadly defined benefits at the strategic level. A first key question that emerges in this respect is how information on normally slowly changing monetary trends can be useful for taking monetary policy decisions on a monthly basis. Second, the section discusses how the monetary analysis supports the medium-term orientation of the ECB's monetary policy. Third, the section addresses the issue of the policy stance on asset price developments in the context of a monetary policy strategy

34 See Issing (2005); this argument was also advanced in Winkler (2000).
35 Recent examples of Monthly Bulletin articles on monetary analysis include: ECB (2007, 2008a, 2009d).
36 See e.g. Masuch et al. (2001) and Fischer et al. (2008). This book itself constitutes another example.

that attaches a distinct role to monetary analysis. Fourth, the section provides some illustrations of the insights that the monetary analysis can also bring to the assessment of developments at business cycle and higher frequencies. Finally, the role of the monetary analysis as a cross-checking device is discussed.

5.1 EXTRACTING ASSESSMENTS RELEVANT FOR HIGH-FREQUENCY POLICY DECISIONS FROM SLOWLY CHANGING MONETARY INFORMATION

The analysis of the previous sections indicates that an essential contribution of the monetary analysis to the assessment of the outlook for price stability should be seen in the identification of the inflation trend and in the provision of advance indications regarding changes in this trend, rather than in the calculation of point forecasts of inflation at a given horizon. This assessment is normally slowly evolving and, for this reason, it is important to explain why monetary analysis is relevant to the monetary policy process which, by its nature, requires frequent decisions.

The monetary policy strategy of the ECB indicates that the policy horizon of the ECB is the medium term. The "length" of the medium term is, in the strategy of the Eurosystem, not specified precisely, for good reasons. Of course, the medium-term orientation reflects the inability of a central bank to influence price developments in response to unanticipated shocks at horizons shorter than the transmission lag with which monetary policy is normally expected to operate. Moreover, it recognises that such lags may vary over time and depending on the situation, potentially in ways that are hard to predict.[37]

Furthermore, the notion of medium-term rather than of a definite horizon also has for the ECB the purpose to ensure that price stability holds lastingly in the future. Hence, it is necessary for the ECB to complement the available knowledge of short to medium-term price dynamics, which is usually generated from economic analysis, with information on the medium to longer-term trend of inflation coming from monetary analysis. Moreover, it is important to have a notion of how chains of events, for instance through a longer durability or stronger autocorrelation of shocks and their impacts, affect the reading of medium-term trends, so as to link the short to medium-term dynamics to the medium-term trend as convincingly as possible.

Thus, on the one hand, the assessment of monetary trends compels the Governing Council to "look through" possibly short-term movements in inflation, which may not necessarily lead to very lasting consequences on inflation. On the other hand, the goal of monetary analysis should not only be to identify a medium-term trend at an early stage, but also to identify it with sufficient precision. This implies that one also needs to carefully check whether the way markets

[37] The length of the medium-term horizon depends, among others, on the features of the monetary policy transmission mechanism. In the euro area, the transmission lags have been estimated to be approximately 18 to 24 months for real activity, and 30 to 36 months for (annual) inflation.

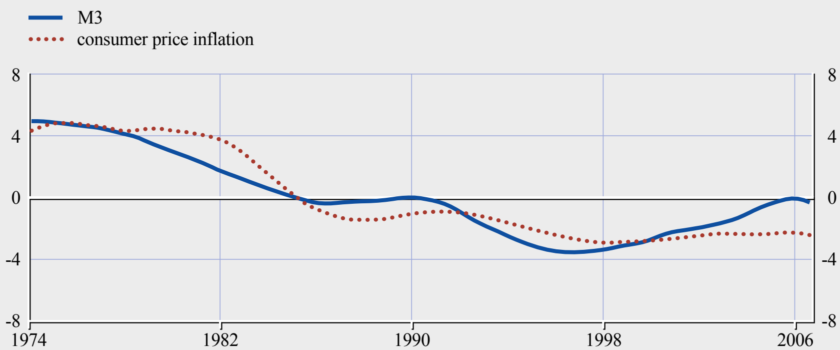
evolve in real time as well as the precise content of available statistics are consistent with the usual interpretation of money and credit growth, or whether special developments have affected them, including a host of possible factors and, inter alia, recent monetary policy measures. Alternatively, it may happen that usual interpretations of excess liquidity might be misleading. For instance, it may be the case that increases in credit are increasingly financing the rest of the world, leading to a divergence between money growth and credit growth (like in 2000) and implying asset price pressure abroad rather than domestic price pressures or that the own interest rate increases decided by the Governing Council temporarily accelerate M3 growth (like in 2008).

Hence, although smoothing inflation over very long horizons (e.g. by removing all but the low-frequency component, as in Chart 3) is useful to show the existence of advance information in money on inflation, it is important to realise that in real time it would be insufficient or misleading as the inevitable truncation of data series in real time makes such results impossible to operationalise. More importantly, the very action of the central bank is intended to affect money growth and inflation anyway. It therefore leads to ex post series that cannot reflect the actual inflation trends that the central bank had been facing and subsequently successfully combatting, in line with "Goodhart's law".[38] Related to this, Chart 3, which is based on the final realisation of money and inflation outcomes, generates the impression of a missing link between monetary trends and the low level of inflation in recent times. As explained in Chapter 1, the more successful the policy reaction in response to monetary trends is in real time, the more the signal is devalued ex post. This may contribute to explaining why inflation and money growth smoothed, ex post, give a very limited number of signals in the end.

38 See the discussion in Chapter 1 and Chapter 4 (especially Annex 1).

Chart 3 Inflation and monetary trends

(annual percentage changes; deviations from mean)



Source: ECB calculations.
Notes: Consumer price inflation is calculated as the four-quarter log difference of the HICP. Trends are the low-frequency components of the respective series, derived as described in the notes to Chart 1.

These remarks point to the challenges and strengths of the monetary analysis in the policy context. First, as illustrated in Section 3, the identification of the potential emergence of new trends must be operationalised in order to provide useful information to the Governing Council in real time.

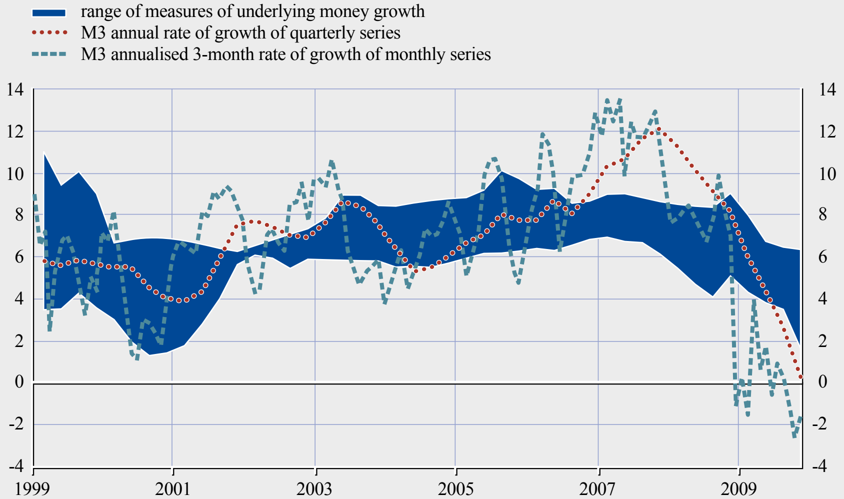
For example, Chart 4 includes a range of measures of underlying money, which are explained in detail in Chapter 4. These provide indications of the change in trend, at least as captured by a variety of measures. Given the uncertainty involved in the computation of the measures of underlying money, the approach at the ECB is to compute a range and assess signs of possible changes in the trend in monetary developments on the basis of a broad set of indicators and a suite of models.

Also, the observation that monetary policy cycles occur at a higher frequency than suggested by trend changes in inflation and money (as apparent from the comparison of Chart 5 and Chart 3) does not take into account the fact that real-time decisions affect these statistics. In practice, empirical measures of underlying monetary trends display somewhat more variation than suggested in Chart 3. As an example, looking at such measures (see Chart 4) suggests that the downward movement seen in late 2000 contributed to the decision to reduce interest rates in 2001[39] thus contributing to a reversal of monetary developments. As a result, the downward movement in the various measures of underlying money in late 2000 is eventually not reflected in trend monetary growth,

[39] The fact that the decision to lower interest rates in May 2001 was also supported by the monetary analysis was communicated at the time the decision was taken; see for instance the editorial of the May 2001 issue of the ECB's Monthly Bulletin.

Chart 4 Measures of underlying monetary expansion

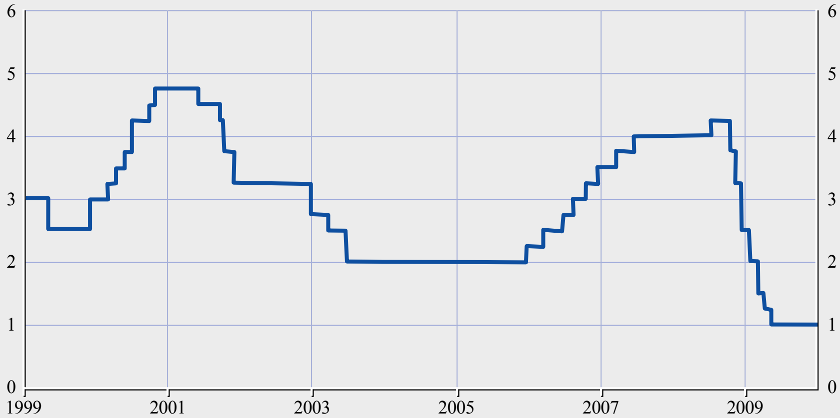
(annual percentage changes)



Sources: ECB and ECB calculations.

Chart 5 ECB monetary policy decisions – the interest rate on main refinancing operations

(fixed rate or minimum bid rate in percentages per annum)



Source: ECB.

as calculated ex post in Chart 3. In this respect, it could be argued that in some situations the reactions of the central bank, based on a plurality of indicators of monetary developments, pre-empt to some extent the possibility of destabilising processes occurring. This of course requires sound judgement, which has to balance the need to act promptly with the risk of overreacting to incoming information, as further illustrated below.

To the extent that false signals may be more frequent when inflation is relatively low, more investment needs to be made in order to recover the right signal. In this context, the enhancement of monetary analysis by insisting on the links to be made between short-term dynamics and the calculation of underlying trends matters even more. In particular, if the changes in velocity, including those changes that are caused by monetary policy itself, tend to obscure the message coming from monetary data themselves, then it is important to best understand such possible shocks to velocity which affect the inflation-risk indicators in the short term. The detailed knowledge of monetary statistics and the ability to relate them to high-frequency movements enhance that ability to evaluate underlying trends and to best interpret risk indicators (a recent example of such considerations is provided in the annex to this chapter).

5.2 THE LINK BETWEEN THE MEDIUM-TERM ORIENTATION OF THE ECB'S MONETARY POLICY AND MONETARY ANALYSIS

The ECB has always stressed the medium-term orientation of its monetary policy, which, in normal circumstances, calls for caution against changing too abruptly the level of the interest rate. A variety of reasons support such an approach. The role of model uncertainty, which also has a bearing on this principle, has already been mentioned. The desire to avoid destabilising shocks to the financial markets also supports a cautious approach. A strong reaction of the central bank to shocks may also increase the risk of serious policy mistakes which in the end risk adding to macroeconomic volatility, rather than dampening it. In addition, over-responsiveness to shocks may lead to a difficult and noisy transmission to long-term interest rates as financial markets may factor in expectations of a sharp reversal with a higher likelihood, therefore dampening the impact on long-term interest rates.

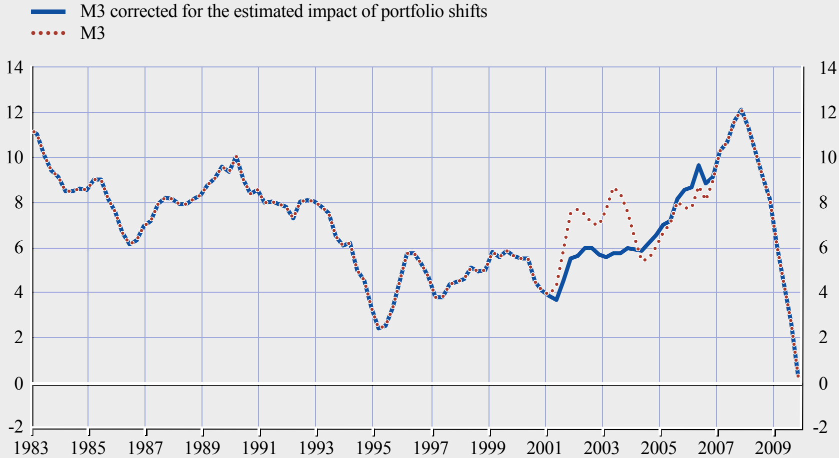
How do these considerations relate to money? As illustrated above, trends in inflation and in money are normally changing in a relatively slow fashion. Potential changes in inflation trends occur normally in a sluggish manner. Even when assessed over a host of indicators, such as those illustrated in Chart 4, before coming to a robust assessment of the possible emergence of inflationary risks, a confluence of the messages coming from various indicators should prevail for a sufficiently long period of time. A fixed rule cannot be established, as the nature and the magnitude of uncertainty differ markedly over time. Therefore, some time may need to pass before a clear new trend is spotted.

The central bank needs to exercise sound judgement regarding the amount of signals it needs to have identified before it can be convinced that a new trend has emerged. If the change in the inflation outlook is relatively rapid, which is rarely the case – especially in an environment in which the central bank has high credibility – this attitude may lead to a reaction which may appear rather slow. In general, maintaining a medium-term orientation will serve to avoid a strong overreaction in the short term. Moreover, to the extent that money contains advance information on inflation, the "advance" may somewhat compensate for the delay in the action itself. It is also worth keeping in mind that the assessment of the outlook for price stability is not confined to this long-term view of inflation developments associated with monetary analysis. The information set of the central bank contains other tools which ensure a prompt consideration of all information. As argued in Section 3, the monetary analysis itself provides a very rich set of information at various horizons which is strictly complementary to and supports the economic analysis. Overall, proper use of monetary analysis should tilt the monetary policy of the central bank in a direction favouring a smoother conduct of monetary policy.

One example of how challenging the assessment is in real time is provided by Charts 6 and 7. Towards the end of 2001, the uncertainty prevailing in financial markets was associated with significant portfolio shifts out of risky assets and into M3. This, literally taken, would have led to the detection of a rapid deceleration of the income velocity of money. Mirroring this, a measure of money not corrected for portfolio shifts would have signalled a brisk acceleration of inflation. Both indications would have probably misguided monetary policy. However, the institutional knowledge of the factors driving these developments led to an early recognition of the "false" signal. Measures of money corrected for these portfolio shifts were constructed and routinely used in the internal analysis and in the external communication, ensuring that the specifics of the situation were appropriately taken into account by policy-makers.

Chart 6 M3 and M3 corrected for the estimated impact of portfolio shifts

(annual percentage changes)



Sources: ECB and ECB calculations.

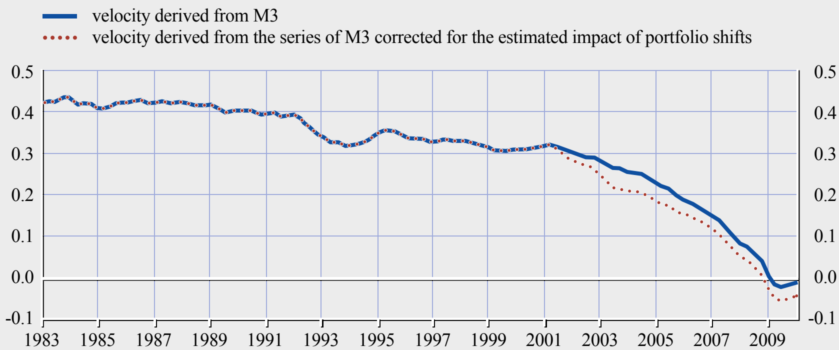
Note: Estimates of the magnitude of portfolio shifts into M3 are constructed using the general approach discussed in ECB (2004b).

Subsequently, however, the trend decline in money velocity and the trend increase in money growth, even after being corrected for the estimated impact of these portfolio shifts, led gradually to the recognition that risks to price stability were building up and led to a gradual change in the communication[40] and eventually played a significant role at the start of the tightening cycle at the end of 2005.

40 The Governing Council's assessment regarding risks to price stability emanating from the monetary analysis, as communicated in the President's Introductory Statement following the ECB's monetary policy meetings, started indicating a less benign view on risks to price stability in mid-2004; see Fischer et al. (2008).

Chart 7 Income velocity of broad money

(log levels)



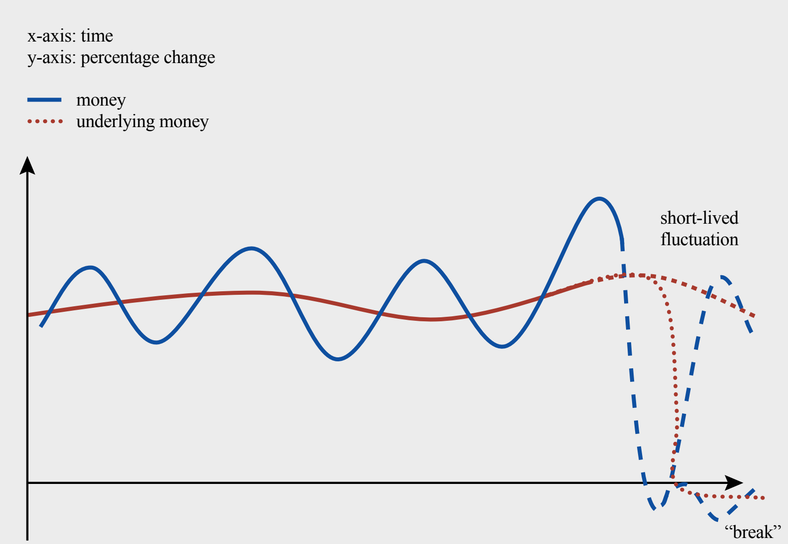
Sources: ECB and ECB calculations.

Note: Estimates of the magnitude of portfolio shifts into M3 are constructed using the general approach discussed in ECB (2004b).

The prudent approach described thus far may of course create a tension with the need for timeliness. The weight that may be given to a more cautious response of monetary policy can of course vary over time, depending on the nature of the shock and the potential risks that the central bank may face. In a time of crisis, in particular, the inflation outlook may change abruptly, in response to sizeable shocks. Clearly, in such situations, the stance of monetary policy needs to be reassessed quickly on the basis of partial information in a situation surrounded by high uncertainty. This was the situation that the central banks around the world, including the ECB, faced in the autumn of 2008, which led to a series of unprecedented policy decisions.

In such a situation of financial crisis, the possibility of a watershed in monetary dynamics arises. Monetary analysis faces the challenge to monitor and assess in real time whether the sharp movements in monetary developments signal a short-lived episode or a longer-lasting regime shift. Chart 8 illustrates this challenge at a conceptual level. While in "normal" times the underlying rate of monetary growth is slow-moving, thereby facilitating signal extraction, a pronounced boom-bust episode challenges the ability to draw inferences from past historical regularities. On the basis of available information at each point in time, monetary analysis needs to distinguish whether the unusually large movements in observed money growth constitute a "break" – reflecting an aggressive and lasting balance sheet adjustment of banks, firms and households – or an episode that due to the impact of government interventions and endogenous stabilising forces will be short-lived. In addition, monetary analysis needs to establish whether such a development is mirrored in the evolution of the underlying rate of money growth or not and thus signals inflationary or deflationary outcomes.

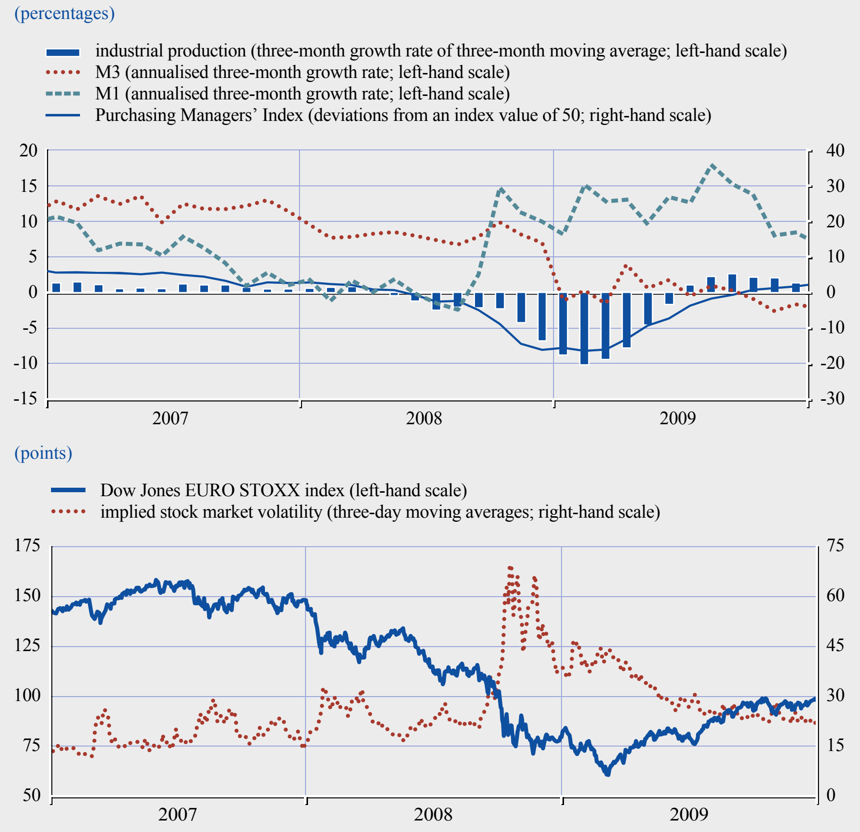
Chart 8 The monetary signal in a period of financial crisis



Source: ECB.

It is however worth stressing that, while a firm assessment of the long-term trend of money was very difficult to formulate in real time, the high-frequency indications based on money indicators tended to provide a message of concern relatively rapidly. Chart 9 indicates that the annualised three-month growth rate of M3 dropped sharply over a few months. In addition, a very pronounced movement was observed in M1 growth, which clearly signalled a change in the behaviour of the money-holding sector in the course of the crisis. Indeed, the considerable contribution of currency in circulation to the large flows into M1 in the immediate aftermath of the collapse of Lehman Brothers was a clear indication of the concerns of the money-holding sectors regarding the robustness of the banking sector. In this sense, the signal emanating from the monetary analysis promptly indicated that decisive action was required to address the

Chart 9 Evolution of economic, monetary and financial indicators



Sources: Bloomberg, ECB, ECB calculations and Eurostat.
Note: The Dow Jones EURO STOXX index has been rebased so that it equals 100 on the first trading day of 2010.

abrupt change in the macroeconomic environment. Similarly, the subsequent normalisation of the flows into currency in circulation was signalling the effectiveness of the measures introduced by central banks and governments in restoring confidence in the banking system.

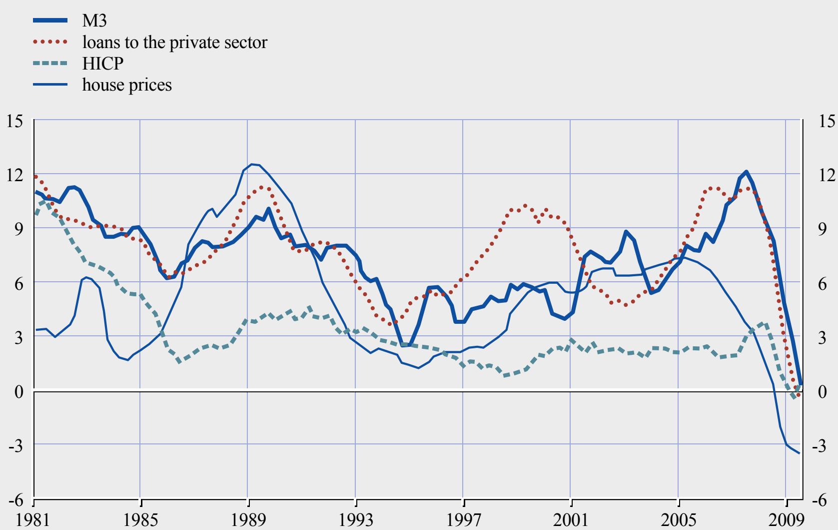
The short-term information reflected in the evolution of money aggregates was not in contrast with other sources of information, but rather reinforced the assessment. Clearly, no information could become available to the central bank as quickly as that embedded in financial market developments, as indicated for example by the immediate spike in volatility in the autumn of 2008. While in normal situations the high-frequency information derived from financial markets also deserves a cautious process of filtering, in times of abrupt changes it is virtually the only source of information available to policy-makers, who are faced with the challenge of taking monetary policy decisions based on a very limited set of information.

5.3 MONETARY ANALYSIS AND ASSET PRICES

Over the past decade increasingly robust evidence has also been provided on the link between money and credit and asset prices. Periods of very strong growth in asset prices have been typically associated with robust growth in financial aggregates. Chart 10 provides some illustrative evidence in this respect. Robust evidence can be gathered only on the basis of rigorous econometric models, such as those reviewed in Chapter 6. The literature on this issue indicates that monetary and credit aggregates not only provide information on the future evolution of asset prices, but also – perhaps more importantly – on the

Chart 10 Money, credit, consumer prices and house prices

(annual percentage changes)



Sources: ECB and Eurostat.

sustainability of such developments. It therefore appears that the analysis of monetary and credit aggregates may provide an important additional contribution to policy-makers, by identifying possible developments in asset prices which may have policy implications.

The key policy question is to which extent monetary policy should take into account the signals derived from developments in money and credit concerning asset prices. A first obvious answer is that monetary policy should take these signals into account insofar as movements in asset prices are expected to be related to inflation and in the longer term even deflation risks via, for example, the wealth channel. The information on asset prices would therefore simply help in understanding the transmission from money and credit to inflation.

A more controversial answer is linked to the view that monetary policy should react to the information content included in money and credit in order to avoid excessive developments in asset prices, which may culminate in a bust, with serious consequences for inflation. According to this view, monetary policy needs to react during the formation of a bubble to avoid facing a strong negative shock at a later stage.

This line of reasoning is fully compatible with the objective of the ECB. It may possibly require an extended interpretation of the medium-term concept, even though the evidence on the length of asset price cycles is not necessarily in contradiction with the more conventional view on the concept of medium-term. Indeed, the concept of medium-term may encompass policy actions taken to ensure the maintenance of price stability over longer horizons, and there is compelling evidence that shocks to the economy coming from asset price booms-busts may lead to lasting trends in inflation not compatible with price stability.

It has been argued that there are limitations to this line of reasoning at least on two grounds: first, the relatively high degree of uncertainty surrounding the link between developments in monetary and credit aggregates and asset prices; and second, the relatively long horizon over which risks to price stability tend to emerge. This may make it impractical for policy-makers to justify their actions in terms of their accountability in front of democratic institutions over reasonable horizons. The recent experience seems however to support and vindicate, now more than in the past, the need for a serious consideration of this role for money and credit. The build-up in stock prices and even more the phase of compression of risk premia which preceded the financial crisis had been preceded by periods of robust growth in monetary and credit aggregates. In this respect, concerns were repeatedly expressed by the ECB as the signals coming from the evolution of money and credit aggregates were confirmed by other information. In this respect, the concept of cross-checking may be applied here too.

Clearly, if other instruments (mainly in the regulatory area) could be applied to counter the possible emergence of unsustainable developments in asset prices, they would in the end facilitate the conduct of monetary policy.

In addition, this chapter has illustrated how the information content of monetary aggregates may help in identifying trends in inflation. The evidence therefore indicates that excessive growth in money and credit may lead to both consumer price inflation and increases in asset prices. At the same time, when assessing more lasting changes in inflation trends and asset prices, it is difficult to extract the signal concerning the link between monetary aggregates and inflation from the link with asset prices. In any case, the direction of the signal, for what concerns monetary policy decisions, is the same. The reaction to developments in monetary aggregates, as implied in the ECB's monetary policy strategy, contains therefore an implicit element of "leaning against the wind", which may help to take care of possible risks related to excessive growth in asset prices and, at the same time, link directly the policy action to the maintenance of price stability over the medium term.

5.4 MONETARY ANALYSIS INSIGHTS FOR THE ASSESSMENT OF CYCLICAL DEVELOPMENTS

As indicated in Section 3 of this chapter, the ECB's monetary analysis aims at identifying the underlying rate of monetary expansion that is robustly linked to inflation dynamics over the medium to longer term. At the same time, it also generates valuable insights at the business cycle and higher frequencies.

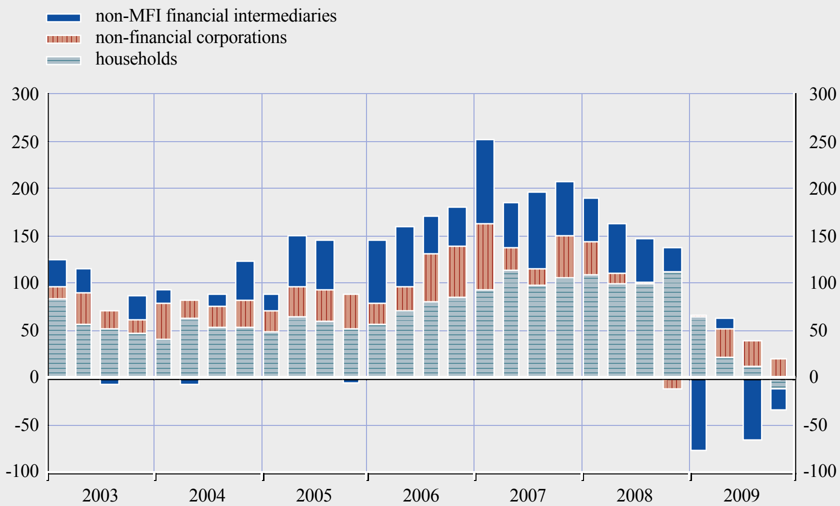
For example, the encompassing analysis of monetary and credit developments can provide valuable insights into the portfolio adjustment of households and firms as well as banks to changes in the yield configuration. In addition, the detailed analysis of bank balance sheets is critical for the assessment of the condition of the banking sector and therefore the availability of funding to the non-financial sector. Ultimately, these types of insight are particularly helpful when forming a view regarding the operation of the monetary policy transmission mechanism.

Such information is useful and relevant even when financial markets are functioning normally. But it is particularly valuable in a situation where financial markets are experiencing tensions or are in turmoil. In such a situation, it is of great importance from a monetary policy perspective to form a view on whether these tensions are impairing the availability of credit to the non-financial sectors, over and above a typical tightening of financing conditions that would have been expected due to the movement of the economy along the business and credit cycle. Such an analysis not only informs the assessment of the cyclical situation, but is also instrumental in shaping a view on the underlying trend of monetary expansion, given that a robust pace of underlying money growth is very difficult to envisage without sustained credit growth also.

For instance, in the aftermath of the intensification of the financial crisis triggered by the collapse of Lehman Brothers in September 2008, the close monitoring of developments in sectoral money holdings was helpful in assessing the response of firms' and households' holdings of monetary assets to the new yield configuration and the rapidly deteriorating economic environment in a context of heightened financial uncertainty. This was critical for assessing the funding pressures faced

Chart 11 M3 by sector

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



Sources: ECB and ECB calculations.

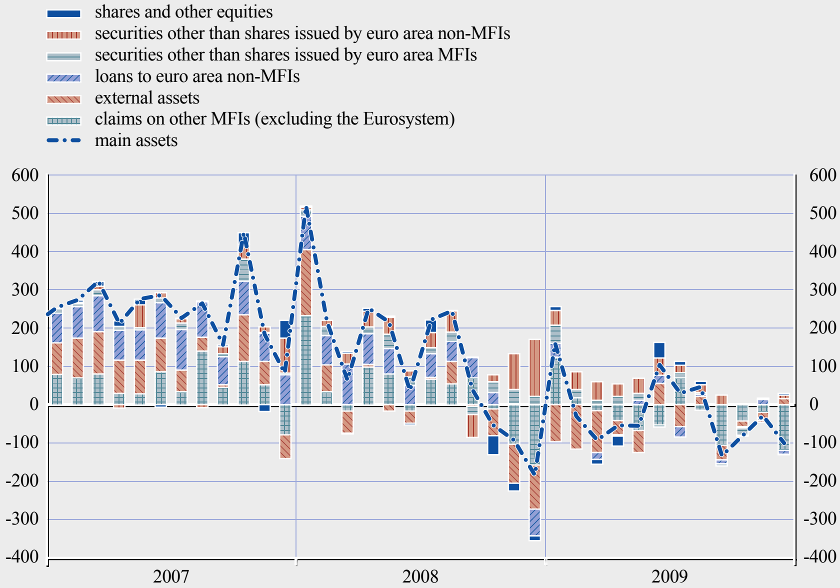
by euro area banks and the effectiveness of the policy measures introduced to address them. It was also useful as an indication of increased difficulties faced by non-banks to obtain funding from the banking system. Indeed, non-financial corporations initially reduced their holdings of monetary assets in response to the financial market turmoil (see Chart 11), following a pattern of adjustment of their liquidity buffers (in response to lower expected production levels and increased opportunity costs) that was in line with historical regularities over the business cycle.[41] At the same time, the initial downward adjustment of liquidity buffers could, to some extent, also reflect the possibility that the entities in these sectors were increasingly using these buffers to accommodate funding needs as funding through other sources may have been constrained, at least for some firms.

Non-financial corporations swiftly switched back to monetary asset accumulation in the second quarter of 2009, again following a pattern that was consistent with past business cycle regularities. On the whole, a range of indications and considerations generated from the monetary analysis were converging to the assessment that some supply-side restrictions were affecting the availability of credit to non-banks, but that the marked slowdown in bank lending to firms and households was predominantly driven by a normal reaction to the macroeconomic environment. This assessment was also formalised and corroborated by structural and semi-structural empirical analyses (recent examples of this type of analysis are also shown in the annex to this chapter).

41 See ECB (2009c).

Chart 12 Main assets of euro area MFIs

(monthly flows in EUR billions; adjusted for seasonal effects)



Sources: ECB and ECB calculations.

Notes: The reporting sector is MFIs excluding the Eurosystem. Euro area MFIs' claims on the Eurosystem are not shown.

The comprehensive analysis of the MFI balance sheet data also provided timely evidence of the adjustments taking place in the banking sector as a result of the intensification of the turmoil. For instance, the sharp and unprecedented shedding of debt securities holdings by MFIs in September 2008 across all types of issuer was the first concrete piece of evidence on the deleveraging of the MFI sector that was made available to policy-makers (see Chart 12).[42] This analysis also showed that the adjustment of bank balance sheets affected first and foremost MFIs' positions with each other and with external counterparties (mainly banks not resident in the euro area), providing a more nuanced and qualified view of the deleveraging process.

Overall, insights from the monetary analysis regarding, for instance, the extent and nature of the deleveraging process of the MFI sector, the pressures faced by credit institutions in funding their balance sheets and the dominant forces driving loan and credit aggregates during the financial turmoil were of critical importance for assessing the effect that the crisis was having on the monetary policy transmission mechanism. In this sense, the analysis of developments in money and credit was instrumental in designing and calibrating the unconventional monetary policy measures deployed to address blockages in the transmission mechanism, as well as in monitoring their effectiveness and assessing the sequencing and timing of their gradual phasing-out.

[42] See ECB (2008c).

5.5 MONETARY ANALYSIS AND CROSS-CHECKING

Monetary analysis also provides a crucial contribution to cross-checking, which is a fundamental part of the ECB's two-pillar monetary policy strategy.

Various notions of cross-checking may be conceived. According to one notion that plays a crucial role in policy-making, cross-checking can be considered as an exercise in which the information organised under each of the two pillars of the monetary policy strategy is examined and assessed carefully for its congruence or dissonance. The information on inflation from the economic analysis is compared with and assessed against the picture on inflation trends that emerges from the monetary analysis, which is, by its nature, geared towards longer horizons. As the experience since the introduction of the single monetary policy has shown,[43] monetary policy decisions have to be formulated in the face of pervasive uncertainty. This argues in favour of carefully comparing information from various models and assessing carefully the possible messages deriving from them.

While this remains an essential element of policy-making within the Eurosystem, the intention of the ECB has always been to go beyond a simple comparison of the messages from the two pillars and to allow for a deeper reconciliation of the available information. Indeed, the explicit role of the two pillars of the ECB's monetary policy strategy and the ECB's commitment to announcing and explaining in detail, and in real time, its decisions to the public forces policy-makers at the ECB not only to review thoroughly the information coming from different information sets, but also to propose interpretations of any diverging signals coming from the two pillars.

The latter approach to cross-checking makes it desirable to support judgement with detailed and, if possible, model-based arguments. In the absence of a fully encompassing model, this supports the use of various modelling techniques across time. While the idea of separate models was emphasised in the early stages of EMU, the complementarity of the two perspectives has since become more prominent.[44] More specifically, the information from the economic analysis may support a better understanding and interpretation of the monetary analysis and vice versa. Moreover, the use of scenarios to express judgement in a more structured and formal manner has been developed extensively. This approach ensures that the legitimacy of the hypotheses made to define the scenarios considered has to be supported quantitatively. In addition, the model or suite of models used to conduct the scenarios needs to be clearly set out.

The importance of scenarios has thus gradually increased and the techniques used to conduct them have progressed. This has been supported by complementing the analysis of the MFI balance sheet with the flow-of-funds analysis to identify new issues which have a bearing on monetary aggregates and credit trends. In addition, a variety of models have been applied to identify shocks to monetary

43 See ECB (2000).
44 See ECB (2003b).

and credit aggregates, which may have an impact on inflation at various horizons. In some cases the results of this exercise may be presented in relation to a baseline and, if it is deemed useful, are illustrated by showing the impact of the shocks via a representation of the flow of funds involved in the exercise.

This type of cross-checking is primarily conducted at the technical level. This can be viewed as assessing how monetary and real variables and shocks interact in a scenario analysis. In this respect, general equilibrium models including monetary and credit aggregates have proved to be an essential tool supporting policy-making during the financial crisis. The interaction between the real and financial parts of economic models has normally been a weak spot of many macro-models supporting policy decisions. To compensate for this, one of the ways of enhancing the monetary analysis has been to include money and credit in general equilibrium models. Within this framework, it has been possible to assess the possible consequences of financial shocks which propagated through the banking sector for real economic activity and inflation. While possibly less visible in the external communication than other tools, the application of these models contributed to the preparation of projections at the time of the crisis over short to medium-term horizons. These models have helped to identify persistent shocks which may make inflation risks trend away from price stability in a more lasting way, and have also helped to deepen the monetary analysis. In any case, this analysis has improved policy-makers' understanding of the way in which financial shocks propagate through the economy and thus feed into the policy process.

Examples of applications include the assessment of the potential impact on inflation trends of shocks to monetary and credit aggregates stemming from changes in regulation, such as those which may result from the application of the proposed Basel Committee capital and liquidity reform package (i.e. Basel III). Another example is the examination of scenarios regarding the correction of past movements in asset prices, which may also generate or reflect shocks to monetary and credit aggregates and, ultimately, impact on inflation.

Over time the relative importance of the information content at various horizons related to monetary and credit aggregates in shaping monetary policy decisions may vary. At times of steady economic growth, it is important to assess whether the accumulation of assets by the money-holding sector may generate risks to price stability or, conversely, whether a gradual contraction in financial flows may be a sign of a significant deceleration of the nominal dynamics in the economy. In other situations, the provision of information shedding light on the interaction between the real and the financial sectors improves significantly the understanding of the short to medium-term effects of shocks. In such a situation, an assessment of the risks of a more lasting deviation from developments in line with price stability may, in all likelihood, emerge only over time.

All in all, significant efforts have been devoted over the past few years to giving serious consideration to the impact of shocks to monetary and credit aggregates and to assessing the ways in which they may interact with the real economy and ultimately provide a view of the impact on inflation at various horizons.

This approach ensures full consistency with the monetary policy strategy of the ECB. It also allows the information from the monetary pillar to interact in a flexible way with that stemming from the economic pillar. This rather unique feature of the ECB's monetary framework, reflecting its two-pillar strategy, has necessitated the development of new techniques in addition to the continuous updating of tools.

6 CONCLUDING REMARKS

This chapter has described the ECB's monetary analysis and explained how it contributes to the real-time assessment of risks to price stability in the euro area from a medium to long-term perspective. In this manner, the monetary analysis supports monetary policy-making at the ECB.

The chapter has described the ECB's monetary analysis, emphasising the broad but detailed analytical process structuring the analysis, founded on the robust link between money and inflation at low frequencies. At the same time, monetary analysis also goes beyond this link to also provide insights relevant for the analysis of business cycle as well as higher-frequency developments, which have proven to be particularly valuable in periods of financial stress.

In short, the ECB's monetary analysis framework is encompassing and flexible, using all relevant information and a multitude of models and techniques as required. It does not rely on a single "workhorse" model and cannot be reduced to mechanical characterisations focusing on comparing headline money growth with a unique benchmark. In addition to the main role of enabling the identification of underlying monetary trends, the insights from the analysis of monetary and credit developments are also distilled into scenarios of risks to the baseline projections and assessments.

The central tenets of the paradigm have remained firmly unchanged, underscoring the continuity demonstrated in the conduct of monetary analysis since the introduction of the euro. The research agenda pursued to enhance the monetary analysis has not interrupted this continuity. Rather it has confirmed the main elements of the analytical process and, at the same time, enriched the set of tools and techniques available to implement that process.

Importantly, the experience of pursuing the enhancing monetary analysis research agenda has highlighted the complementary relationship between *deepening* the analysis (i.e. developing greater insight into the association between persistent trends in monetary growth and inflation) and *broadening* the monetary analysis (to encompass the effect of money at higher frequencies on a broader set of macroeconomic variables). Genuine enhancement requires *both* of these.

The concrete contributions that the monetary analysis makes to the monetary policy process of the ECB are multifaceted. By virtue of its longer-term nature, the monetary analysis supports the necessarily medium-term orientation of monetary policy. While nominal trends are by nature slowly changing, the monetary analysis must evaluate *all* incoming information continuously, so as to ensure that the existing assessment of these trends is not challenged and to alert policy-makers to any indications that they may become unhinged. This is relevant at all times, but it is particularly important in periods of financial tension, when changes in monetary trends may even threaten to be abrupt. Under such circumstances, shorter-term indications from monetary analysis are particularly useful and more than usual emphasis is placed on short-term dynamics.

The financial crisis has proven to be a powerful reminder that policy-makers need to be attentive to the build-up of imbalances in the nominal sphere of the economy. Monetary analysis endows the ECB's monetary policy strategy with a framework to always be attentive to the build-up of financial imbalances, which ultimately bear risks to price stability. Finally, the monetary analysis in the context of the two-pillar strategy ensures that no perspective and no information set is overlooked in the decision-making process. This notion of cross-checking has many dimensions, including the consideration of the long-term perspective in addition to the shorter-term one and the assessment of financial as well as real developments.

Overall, this chapter has documented the richness of the contributions that the monetary analysis can and systematically does make to the monetary policy decision-making process of the ECB. At the same time, it has shown that the monetary analysis remains clearly focused on the identification of risks to price stability over the medium to long term. The chapter has illustrated the complexity and nuanced nature of some of the contributions provided by the monetary analysis, related to the perpetual emergence of new challenges to be investigated and addressed. Notwithstanding the efforts made in this chapter, communicating the role of the monetary analysis in the ECB's monetary policy process remains a considerable challenge.

REFERENCES

Christiano, L.J. and Fitzgerald, T.J. (2003), "The band pass filter", *International Economic Review,* 44(2), pp. 435-465.

Christiano, L.J., Motto, R. and Rostagno, M. (2003), "The Great Depression and the Friedman-Schwartz hypothesis", *Journal of Money, Credit and Banking,* 35(6), pp. 1119-1197.

ECB (1998), *A stability-oriented monetary policy strategy for the ESCB,* press release, 13 October.

ECB (1999a), "The stability-oriented monetary policy strategy of the Eurosystem", *Monthly Bulletin*, January, pp. 39-50.

ECB (1999b), "Euro area monetary aggregates and their role in the Eurosystem's monetary policy strategy", *Monthly Bulletin*, February, pp. 29-46.

ECB (2000), "The two pillars of the ECB's monetary policy strategy", *Monthly Bulletin*, November, pp. 37-48.

ECB (2003a), *The ECB's monetary policy strategy,* press release, 8 May.

ECB (2003b), "The outcome of the ECB's evaluation of its monetary policy strategy", *Monthly Bulletin*, June, pp. 79-92.

ECB (2004a), *The monetary policy of the ECB*, ECB, Frankfurt.

ECB (2004b), "Monetary analysis in real time", *Monthly Bulletin*, October, pp. 43-66.

ECB (2006), "Sectoral money holding: determinants and recent developments", *Monthly Bulletin*, August, pp. 59-72.

ECB (2007), "Interpreting monetary developments since 2004", *Monthly Bulletin*, July, pp. 51-74.

ECB (2008a), "The external dimension of monetary analysis", *Monthly Bulletin*, August, pp. 71-84.

ECB (2008b), "The informational content of real M1 growth for real GDP growth in the euro area", *Monthly Bulletin*, October, pp. 16-18.

ECB (2008c), "Recent developments in the balance sheets of euro area credit institutions", *Monthly Bulletin*, December, pp. 25-28.

ECB (2009a), "Tracking extraordinary portfolio shifts into money during the period of financial turmoil", *Monthly Bulletin*, January, pp. 17-20.

ECB (2009b), "The external financing of households and non-financial corporations: a comparison of the euro area and the United States", *Monthly Bulletin*, April, pp. 69-84.

ECB (2009c), "Some considerations regarding the driving forces behind non-financial corporations' M3 deposit holdings", *Monthly Bulletin*, July, pp. 16-19.

ECB (2009d), "Monetary analysis in an environment of financial turmoil", *Monthly Bulletin*, November, pp. 81-96.

Eijffinger, S. and Geraats, P. (2006), "How transparent are central banks?", *European Journal of Political Economy*, 22(1), pp.1-21.

Engert, W. and Selody, J. (1998), "Uncertainty and multiple paradigms of the transmission mechanism", *Working Paper Series*, No 98-7, Bank of Canada.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008), "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, pp. 102-175.

Geraats, P. (2002), “Central bank transparency”, *Economic Journal*, 112(483), pp. F532-F565.

Issing, O. (2005), “Communication, transparency, accountability: monetary policy in the 21st century”, *Review*, Vol. 87(2), Federal Reserve Bank of St. Louis, pp. 65-83.

Masuch, K., Pill, H. and Willeke, C. (2001), “Framework and tools of monetary analysis”, in Klöckers, H-J. and Willeke, C. (eds.), *Monetary analysis: tools and applications*, ECB, Frankfurt, pp. 117-144.

Moutot, P., Jung, A. and Mongelli, F.P. (2008), “The workings of the Eurosystem: monetary policy preparations and decision-making – Selected issues”, *Occasional Paper Series*, No 79, ECB.

Nicoletti-Altimari, S. (2001), “Does money lead inflation in the euro area?”, *Working Paper Series*, No 63, ECB.

Pill, H. and Rautanen, T. (2006), “Monetary analysis: the ECB experience”, presented at *The ECB and its watchers VII* conference, Centre for Financial Studies, Frankfurt (available at: www.ifk-cfs.de/papers/20060505ecb_pill_document.pdf).

Winkler, B. (2000), “Which kind of transparency? On the need for clarity in monetary policy-making”, *Working Paper Series*, No 26, ECB.

ANNEX

AN ILLUSTRATION OF THE ENHANCED MONETARY ANALYSIS IN PRACTICE

INTRODUCTION [45]

The importance of monetary analysis for policy-makers is reflected in the material which is regularly prepared for and presented to the Governing Council. Section 4 in the main text of this chapter reviewed the process in detail.

In this annex, we present an example of how the information is structured and presented to the Governing Council. In order to provide a concrete case, the example is based on the information which was available at the beginning of March 2010 (and is therefore aligned with the information included in the March 2010 ECB projections, which were also presented to the Governing Council). A more detailed analysis of the various tools and models that contribute to the preparation of this presentation is contained in the subsequent chapters of this book.

The presentation discusses three of the main issues that emerged from the detailed quarterly monetary assessment undertaken in the first quarter of 2010 and concludes with scenarios that may help to explain how inflation trends will develop in the future.

ISSUE 1: THE STRENGTH OF UNDERLYING MONETARY GROWTH RELATIVE TO M3

Annual M3 growth turned negative at the end of 2009. The magnitude of the decline was small, but it was the first since the start of the euro area series (based on synthetic euro area data prior to the introduction of the euro in 1999) in 1980. How should this deceleration of annual M3 growth into negative territory be interpreted, and how does weak headline money growth compare with underlying monetary trends?

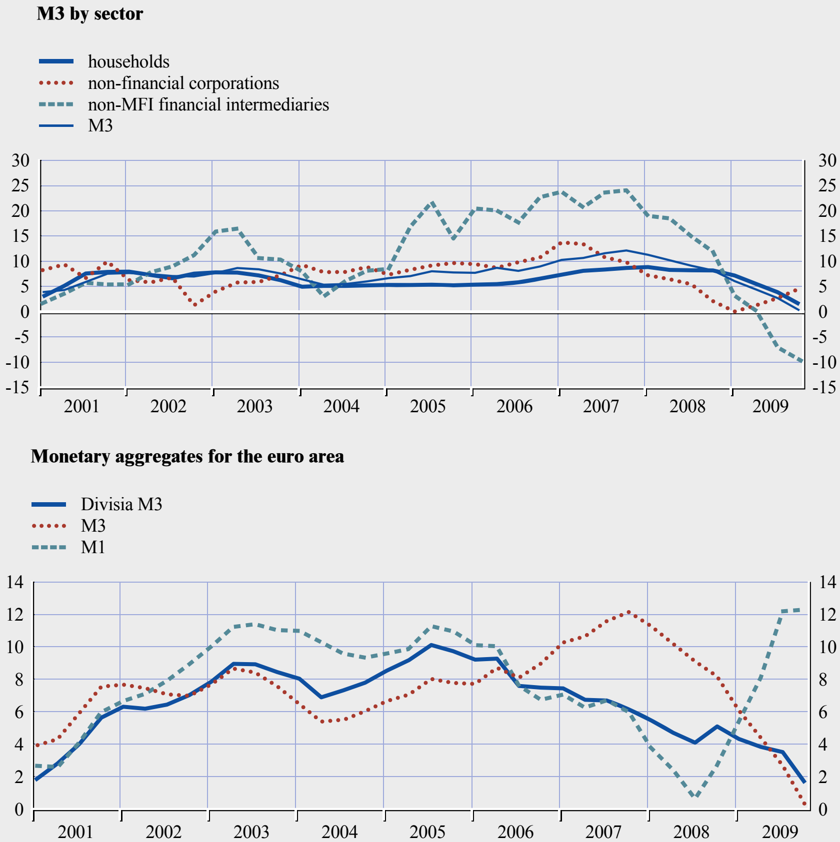
More precisely, as illustrated in Chart 4 (in the main text) and in Chart A1 (below), the annual growth in headline M3 in 2009 and 2010 has continued to decelerate faster than the pace of underlying monetary expansion.[46] It is the latter that provides the signal relevant for the assessment of risks to price stability in the medium term.

45 This annex was prepared by Francesco Drudi, Philippe Moutot and Thomas Vlassopoulos.

46 For an insight into the concept of "underlying money", see the extensive discussion in Chapter 4.

Chart A1 Monetary developments

(annual percentage changes)



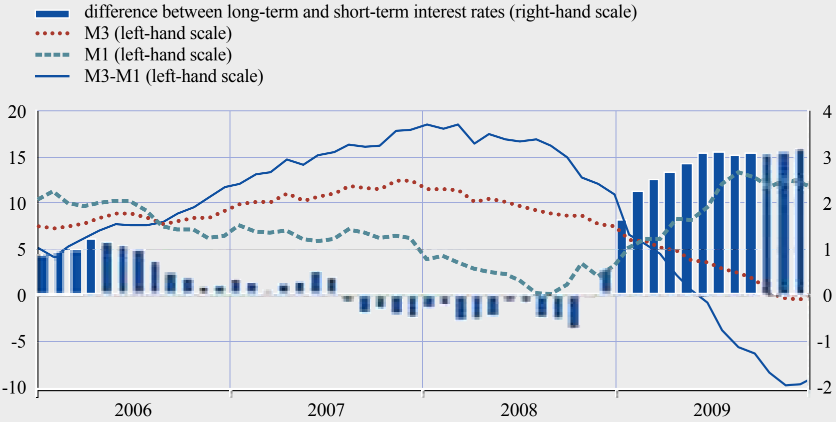
Sources: ECB and ECB calculations.

For example, one measure of underlying money is provided by holdings of the household sector (on the basis that household holdings have the closest relationship with inflation over the medium term and thus lend themselves to being an indicator of underlying monetary growth). The annual growth of household M3 declined in the preceding quarters, but on balance less strongly than that of headline M3; it remained positive at the end of 2009. The growth of M3 holdings by non-financial corporations, which typically provides better indications for economic growth than for inflation (at least immediately), also strengthened over preceding quarters. By contrast, the holdings of non-monetary financial intermediaries were affected more strongly, probably reflecting the effects of the perturbation in financial markets.

The stronger decline in headline M3 growth than in underlying monetary growth is largely explained by the exceptionally steep slope of the yield curve (see Chart A2). Between end-September and end-December 2009 the yield curve increased marginally further and continued to provide strong incentives to shift funds out of M3 into instruments such as equity and debt securities. Part of these

Chart A2 M3 and the shape of the yield curve

(annual percentage changes; percentage points)

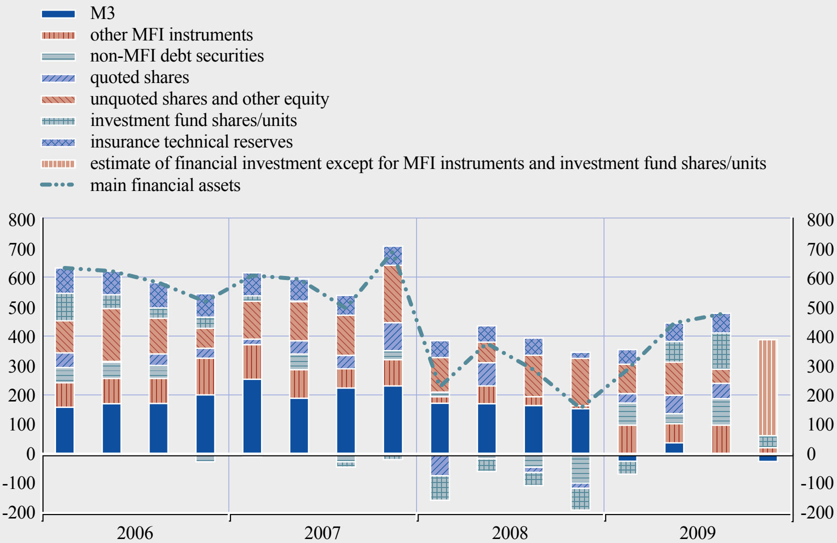


Source: ECB.

shifts went into longer-term bank instruments, but, overall, the funding that banks received from the money-holding sector has declined. Integrated accounts data point indeed to the fact that the aggregates contained in M3 were particularly affected, as, in light of the constellation of remuneration, there was a preference to invest in other financial products, for which the decline in the annual rate of growth was significantly less pronounced (see Chart A3).

Chart A3 Financial investment of the money-holding sectors

(quarterly flows in EUR billions)

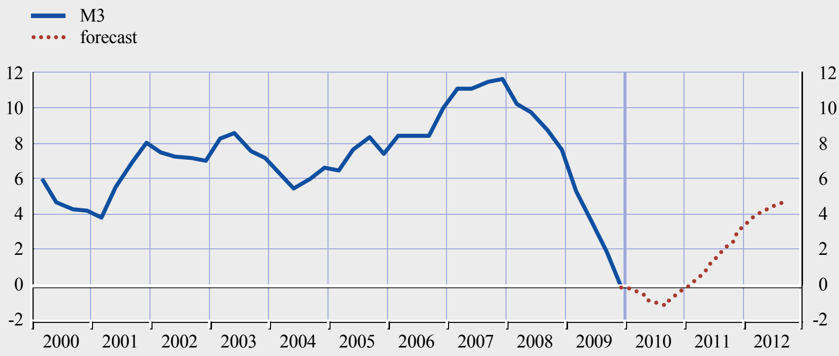


Sources: ECB and ECB estimates.

Notes: Integrated euro area accounts data go up to Q3 2009, while MFI data include Q4 2009. Investment in investment fund shares/units in Q4 2009 only includes October and November 2009.

Chart A4 M3 and model-based forecast of M3

(annual percentage changes)

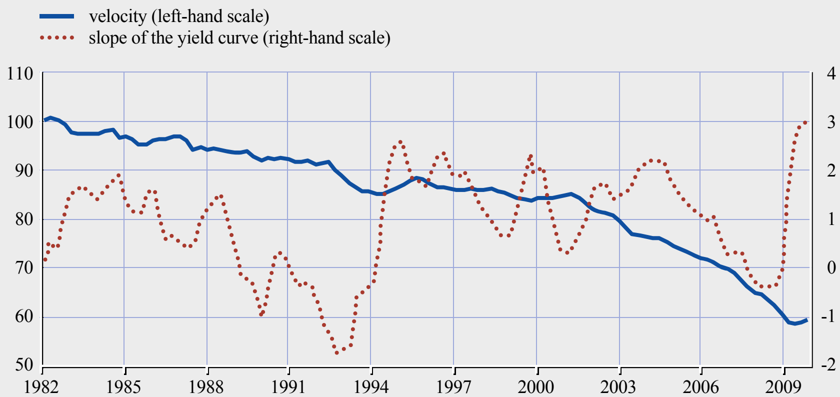


Sources: ECB and ECB estimates.
Notes: The forecast is produced using the model presented in De Santis et al. (2008), which is discussed in Annex 2 to Chapter 3. The forecast is conditional on the preliminary assumptions and projections from the March 2010 ECB macroeconomic projection exercise.

Looking forward, forecasts based on a money demand model with asset prices (De Santis et al. (2008); see Chart A4) suggest that annual M3 growth may remain slightly negative for a few quarters and then turn positive again in mid-2011. Such a short spell of negative annual M3 growth would be in line with historical experience. Qualitatively, the current episode has the same "ingredients" to negative money growth as earlier episodes in individual euro area countries in the mid-1990s, namely a steep yield curve, a preceding economic recession, and preceding excess growth of money (e.g. captured in velocity developments; see Chart A5). However, quantitatively, this time round, these factors are partly much more pronounced and thus caution against relying too much on historical experience.

Chart A5 Velocity and yield curve constellation in the euro area

(index: Q2 1981 = 100; percentage points)



Sources: ECB, ECB calculations and Eurostat.
Note: The slope of the yield curve is calculated as the difference between a synthetic euro area long-term (ten-year) government bond yield and a short-term (three-month) interest rate.

ISSUE 2: WILL THE GROWTH OF LOANS TO THE PRIVATE SECTOR RECOVER?

A rebound in underlying monetary growth is inconceivable, at least over the longer term, without a recovery in loan growth. The pattern observed in Q4 2009 – strengthening household loan growth and a continued contraction in loans to non-financial corporations – remains consistent with business cycle regularities. What are the driving factors behind this pattern and are they more on the demand or the supply side of borrowing/lending?

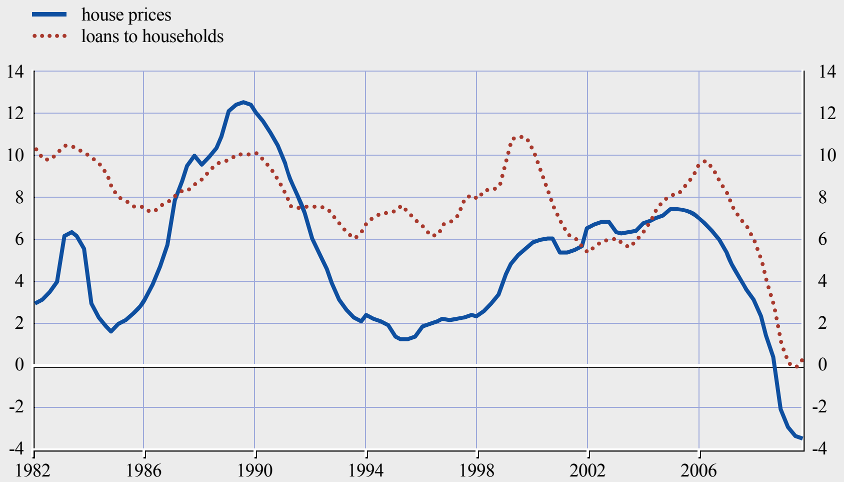
The Q4 2009 data provide further evidence of a turning point in the annual growth of loans to households towards the end of 2009 (see Chart A6). Such a turning point early in the economic cycle is consistent with historical regularities, possibly reflecting in part that with a still uncertain economic outlook banks may have a preference for granting typically better collateralised mortgage loans.

By contrast with the experience of households, the volume of loans to non-financial corporations (NFCs) (see Chart A7) contracted further. Increasingly negative annual loan growth is a common feature across most euro area countries, but this does not imply that the turnaround expected towards mid-2010 – as would be in line with business cycle regularities for the euro area – will hold for each country. Here, the reasons for negative NFC loan growth are likely to differ, depending for instance on the nature of the mostly affected sectors (e.g. structural drags in real estate versus conjunctural drags in manufacturing) or the size of the affected firms (e.g. dependence on banks versus access to markets).

Continued substitution with financing through securities issuance throughout 2009 can explain part of the lower growth in bank loans to NFCs. This does not explain

Chart A6 Loans to households and house prices

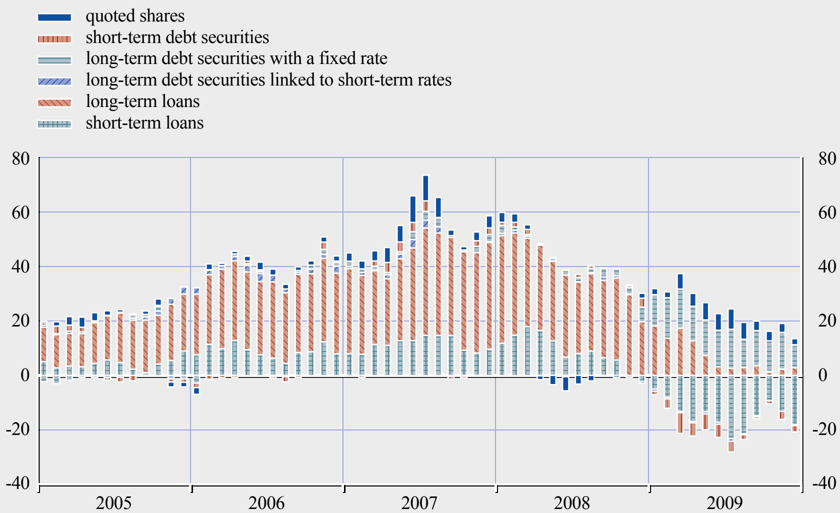
(annual percentage changes)



Sources: ECB and ECB estimates.

Chart A7 Borrowing from MFIs, net debt securities issuance and net equity issuance by non-financial corporations

(three-month non-centred average flows in EUR billions; adjusted for seasonal effects)

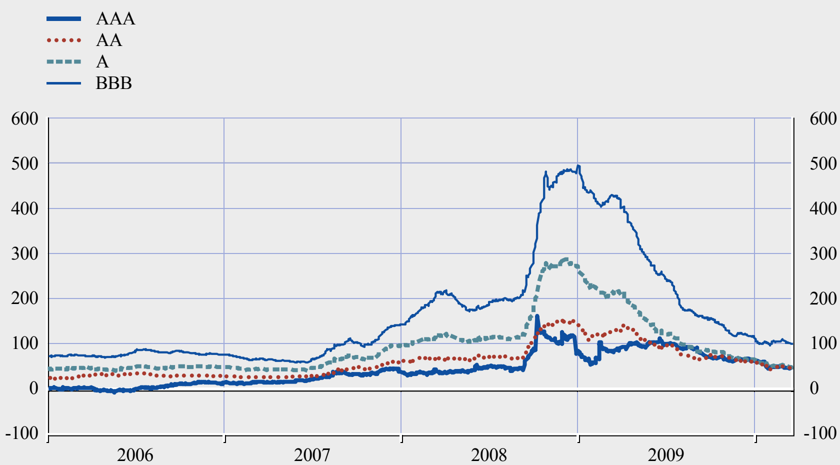


Sources: ECB and ECB estimates.

whether firms found it more attractive in terms of cost to raise their financing directly in the market or whether they were "forced" to do so by difficulties experienced in obtaining bank credit. Corporate bond spreads have continued to decline over Q4 2009 and are currently not much higher than before the onset of the financial turmoil (see Chart A8). The cost of market-based debt has also declined much faster than bank lending rates and at the end of 2009 it was only marginally

Chart A8 Euro area corporate bond spreads (non-financials)

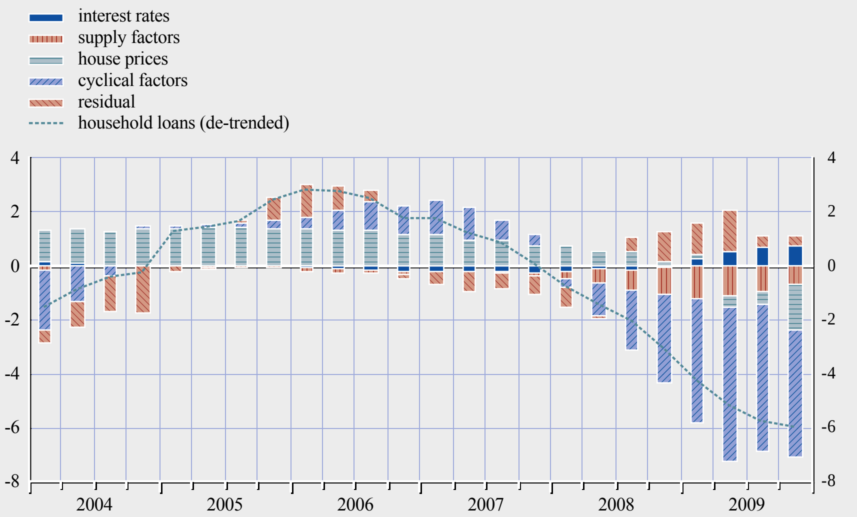
(basis points)



Source: Thompson Financial Datastream.
Note: The benchmark for the calculation of the spreads is the EMU AAA government bond index calculated by Merrill Lynch.

Chart A9 Model-based decomposition of growth in loans to households

(percentage changes; percentage point contributions)



Sources: ECB and ECB estimates.

Notes: Expressed as deviations from trend household loan growth. The results are derived from a panel data regression in which supply factors are proxied by "cost of funds and balance sheet constraints" from the bank lending survey conducted by the Eurosystem; cyclical factors include real GDP developments and "expectations regarding general economic activity" from the bank lending survey.

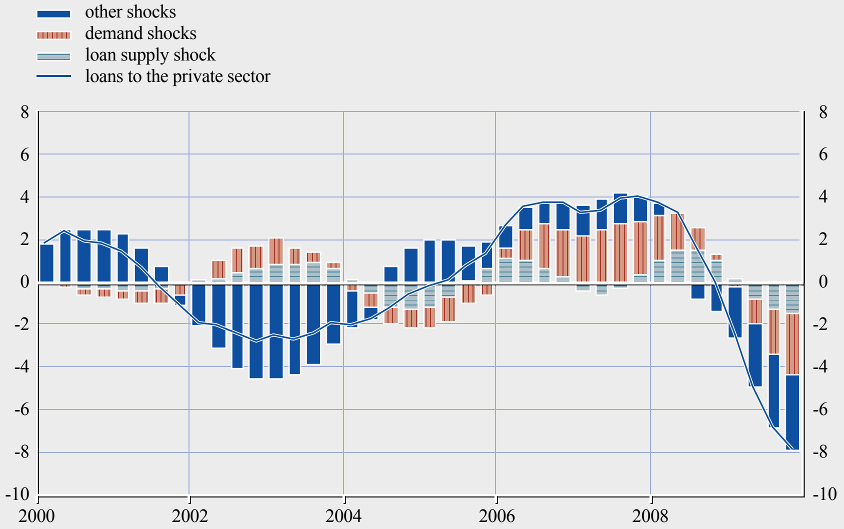
higher. This suggests that the availability of bank loans cannot be seen by itself as the decisive limiting factor for the economic outlook and that the appropriate perspective also needs to take into account financing besides MFI loans.

Distinguishing demand and supply influences on bank loan developments in quantitative terms is inherently difficult. One way of exploring this issue further is to use the results of the bank lending survey and split changes in bank credit standards into the contribution from macroeconomic risk factors that are driven by banks' assessment of the credit risk emerging from the economic cycle and balance sheet factors that are driven by banks' own funding and capital positions. Applying this distinction in a model for household loans suggests that the "purely" bank-related supply-side factors only explain a small and in Q4 2009 quickly diminishing downward impact on annual loan growth (see Chart A9). This is consistent with evidence from a structural VAR model for total loans to the private sector (which also includes NFC loans where the supply constraints may be more prevalent; see Chart A10): loan supply shocks continue to exert downward pressure on loan growth in Q4 2009, but less than loan demand shocks, and they are dwarfed by the sum of all other negative shocks currently impacting on loan growth.

The expected pick-up in the demand for bank loans from the private sector as the economic recovery proceeds will depend both on the willingness and the ability of banks to provide such loans. As regards banks' funding situation, the divergence between positive flows in longer-term funding sources and negative flows in shorter-term sources has been reduced further over the course

Chart A10 Model-based decomposition of private sector loan growth

(percentage changes; percentage point contributions)



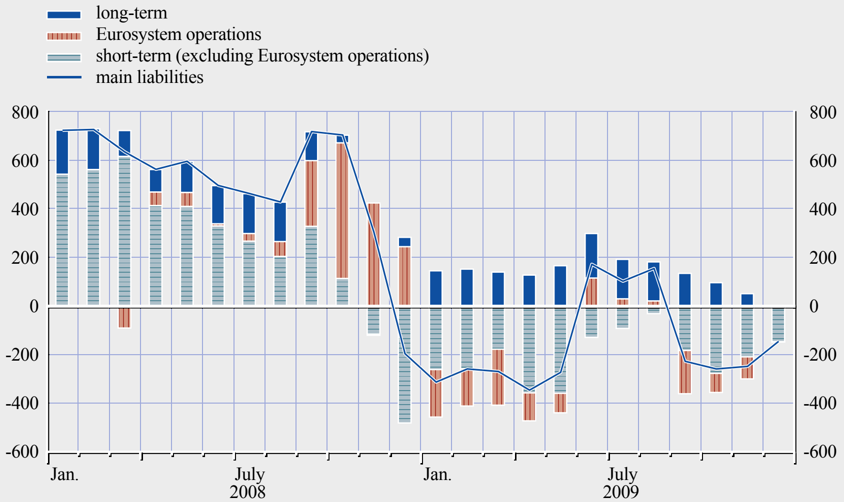
Sources: ECB and ECB estimates.

Notes: Expressed as deviations from the trend of private sector loan growth. "Other shocks" include aggregate supply and other unidentified shocks.

of Q4 2009 (see Chart A11). Most of the remaining longer-term funding reflects household deposits, which have the advantage of typically being a relatively stable funding source. However, the size of the balance sheet of the euro area MFI sector has continued to shrink and the negative flows in bank funding are

Chart A11 MFI main liabilities

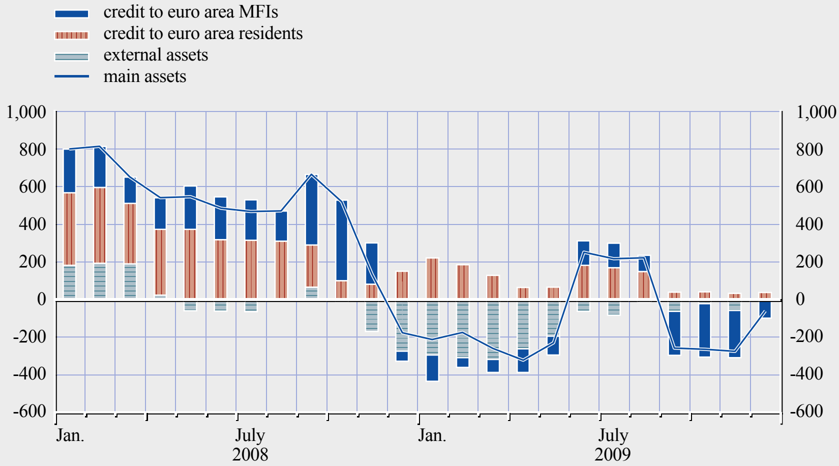
(three-month flows in EUR billions; adjusted for seasonal effects)



Sources: ECB and ECB estimates.

Chart A12 MFI main assets

(three-month flows in EUR billions; adjusted for seasonal effects)



Sources: ECB and ECB estimates.

mirrored in negative flows of bank assets (see Chart A12). The contraction on the assets side still mainly reflects the shedding of assets held vis-à-vis other euro area banks (including the redemption of central bank liquidity raised earlier in Eurosystem refinancing operations).

Overall, it appears that the weak nominal dynamics of banks' balance sheets were largely determined by the extremely unfavourable cyclical situation. At the same time, balance sheet effects have contributed to weak loan growth, although they probably were not the main factor so far restricting the provision of credit.

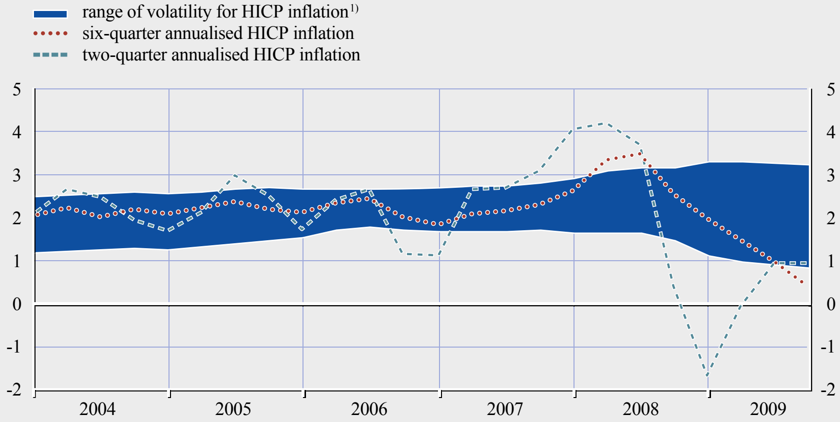
ISSUE 3: OUTLOOK FOR PRICE DEVELOPMENTS ON THE BASIS OF MONETARY DEVELOPMENTS

Taking into account the aforementioned uncertainties, it is extremely challenging to formulate an assessment of the risks to the inflation outlook based on monetary data currently in light of the uncertainty as regards the pace of underlying money growth and the possible correction of accumulated money balances. Low levels of underlying money growth may reflect a return to long-run equilibrium and therefore not necessarily indicate very weak nominal dynamics in the economy.

In addition, assessing the risks to trend consumer price inflation derived from bivariate money-based models, which combine information from monetary aggregates with the autoregressive components of consumer price inflation, has remained challenging (see Chapter 4 for a more detailed analysis). This challenge stems from the influence that lagged actual inflation, which is routinely used as an explanatory variable in these models and has been subject to strong volatility in recent quarters, currently has on the forecasts (see Chart A13). Given the models' lag structure (typically one autoregressive term with one

Chart A13 Volatility of annualised two-quarter HICP inflation

(annualised growth rates in percentages)



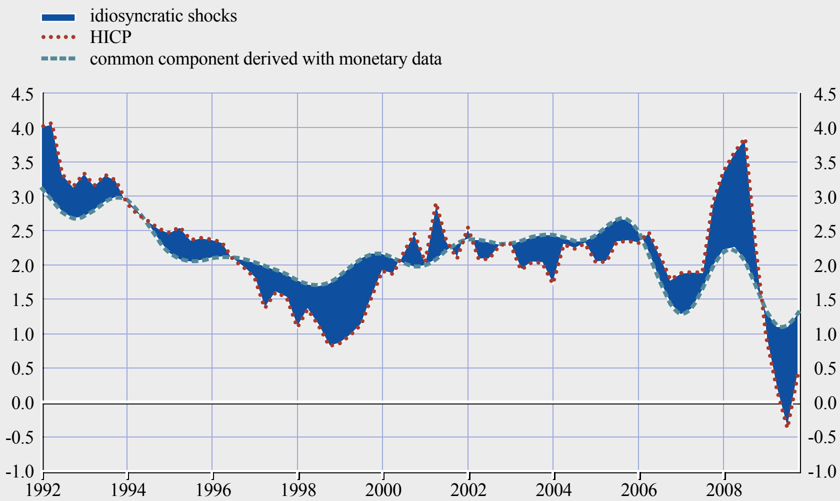
Sources: Eurostat and ECB calculations.

1) Calculated as average annualised two-quarter HICP inflation plus/minus one standard deviation.

quarter lag), the rebound in actual inflation over 2009 currently implies upward pressure on the forecasts for average inflation in the period ahead and blurs the downward pressure from the continued deceleration visible in most monetary variables. This problem is also prevalent in a more sophisticated empirical model that derives inflation risks from the common factors that a large set of different monetary variables has with inflation (see Chart A14). The model cannot avoid

Chart A14 Decomposition of inflation based on a factor model

(annual growth rates in percentages)



Sources: Eurostat and ECB estimates.

Note: Based on the model presented in Nobili (2009).

allocating part of the strong past movements in actual inflation to the common factors and thus to the trend of inflation rather than to idiosyncratic shocks.

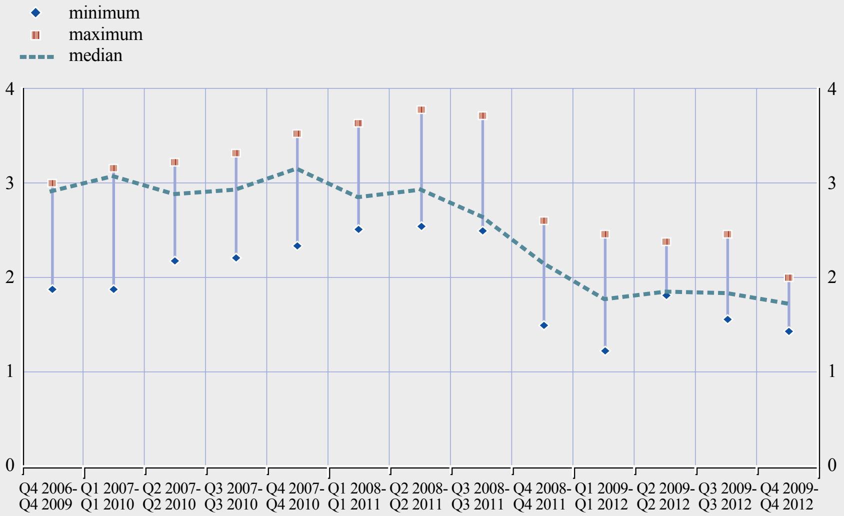
Bearing these caveats in mind, the various specifications of models, using actual growth rates of different monetary variables and measures of underlying trends, point to average HICP inflation over the next 6 to 12 quarters from Q4 2009 onwards (see Chart A15 and Charts 7 and 8 in Chapter 4) of between 1½% and 2%. Looking across the forecast exercises of the past couple of quarters shows that there has been a clear downward shift in inflation risks compared with the pre-Lehman period, when risk indicators moved on balance clearly above the 2% mark. This picture also emerges from a non-linear Markov-switching model (Amisano and Fagan (2010); see Chart A16 and Chart A1.3 in Annex 1 to Chapter 4) where developments in monetary growth determine the probability of inflation shifting between a low and a high inflation regime. Given the past deceleration in M3 growth, the model in Q4 2009 shows a high and increasing probability of staying in a low inflation regime (identified as inflation at 1.6%) over the course of the next three years.

Comparing this with the inflation outlook embodied in financial market prices shows a high degree of conformity. Long-term break-even inflation rates have remained relatively volatile in the fourth quarter, but on balance remained broadly unchanged compared with the average levels in the third quarter (see Chart A17). The same picture emerges from inflation expectations derived from surveys amongst market analysts and professional forecasters.

Overall, the assessment of the inflation outlook based on the monetary analysis does not seem to point to the emergence of upside risks to price stability so far.

Chart A15 Range of money-based inflation risk indicators over the next 12 quarters derived from underlying money measures

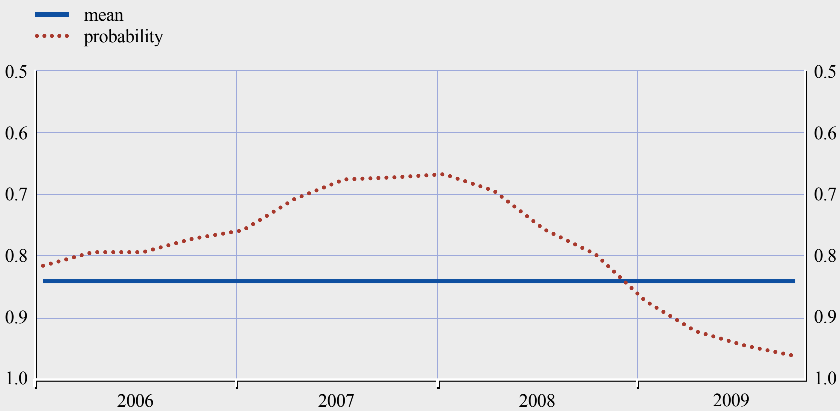
(annualised growth rates in percentages)



Source: ECB estimates.

Chart A16 Money-based inflation risk indicator based on the conditional probability of staying in a low-inflation regime

(probabilities; inverted scale)



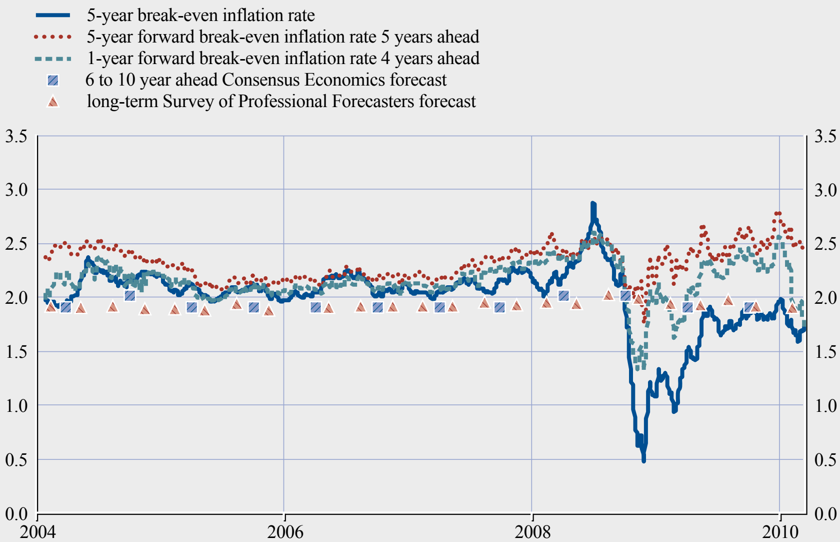
Source: ECB estimates.

Notes: The probabilities are conditional on monetary growth and have been estimated on the basis of the model presented in Amisano and Fagan (2010), which is discussed in Annex 1 to Chapter 4. The state-conditional means of inflation in the low and high inflation states are estimated, respectively, at 1.6% and 3.8%. Owing to the lag structure of the model, the value reported for Q4 2009 is a prediction for early 2012. The "mean" denotes the probability of staying in a low-inflation regime evaluated at the sample mean of the monetary growth variable.

At the same time, the various elements of the analysis do not point to the risk of a further weakening in the inflation process and support the assessment that inflationary pressures remain moderate for the time being.

Chart A17 Market and survey-based measures of inflation expectations in the euro area

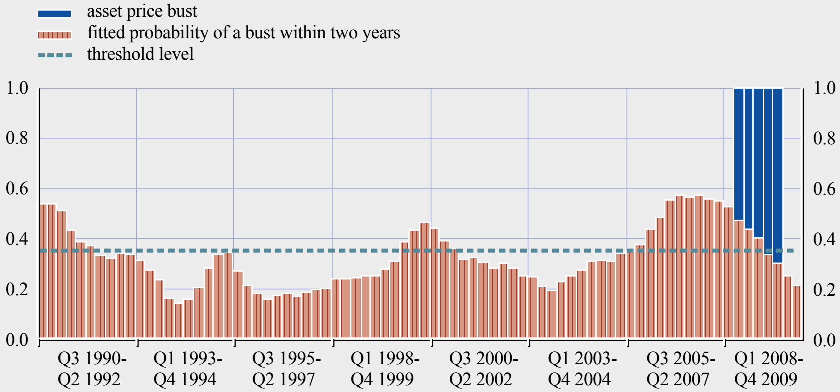
(percentages per annum)



Sources: ECB, Consensus Economics and Reuters.

Chart A18 Probability of an asset price bust in the next two years based on a probit model

(probabilities)



Source: ECB estimates.

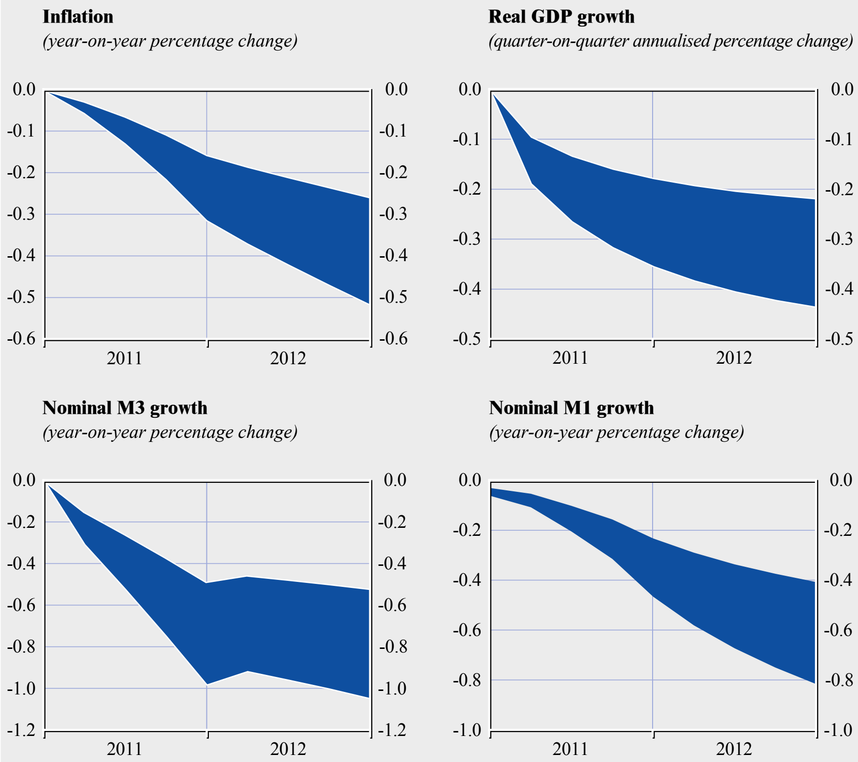
Notes: The fitted probabilities have been estimated on the basis of the probit model (specification B) presented in Gerdesmeier et al. (2009), which is discussed in Annex 3 to Chapter 6. The blue bars represent the detection of a bust on the basis of the methodology presented in Gerdesmeier et al. (2009). The threshold level is set at 0.35 (i.e. 35%).

Well-anchored expectations with regard to consumer price inflation may however imply a risk that nominal pressures unwind instead in the form of asset price imbalances. A composite asset price indicator for the assessment of asset price booms-busts (see Annex 3 to Chapter 6 for a description of the indicator) showed signs of a strong recovery in Q3 2009 (latest available data), but this recovery is currently lacking both the strength and the persistence of the boom observed between 2003 and 2006. A panel probit model (Gerdesmeier et al. (2009); see Chart A18) that links credit gaps and other variables to future developments in this composite asset price indicator currently suggests a low and declining probability of a bust and thus implicitly also a preceding boom. It is true, however, that such indications do not yet cover all types of assets, and in particular do not cover government bonds.

Scenarios

Looking forward, some factors may affect the path of monetary and credit aggregates, leading to a change in the longer-term inflation outlook. Risks could emanate from an active management of capital ratios by banks. It is possible that banks may try to further improve their capital position for multiple reasons. First, several banks have reported that they are currently targeting a 1-2 percentage point rise in their capital ratios. Second, banks may want to frontload some of the regulatory changes currently under discussion aimed at improving the stability of the banking sector and to be implemented in the future. Rising capital ratios may become a source of downside risk for loans to non-financial corporations and households at a time when the economic recovery seems in progress. In addition to the increase in capital ratios, an amplification effect may emanate from the pro-cyclical nature of Basel II and may constitute a further source of downside risk.

Chart A19 Model-based simulations of a downside scenario of adjustment in bank capital



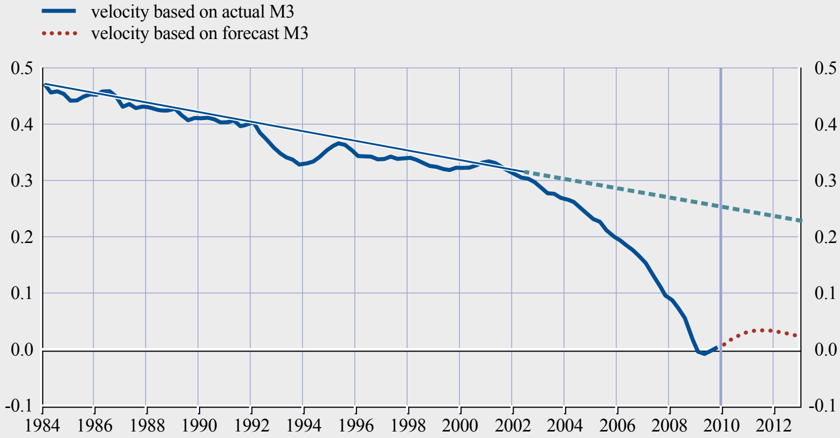
Source: ECB estimates.
Notes: The shaded areas represent the difference between simulations based on the model presented in Christiano et al. (2007 and 2010) and the benchmark. The Christiano et al. (2007 and 2010) model is discussed in Chapter 5.

Model-based analysis (see Chart A19) suggests that the macroeconomic impact of such developments in banks would be non-negligible, but there are at this point no indications that they may turn out to be strongly destabilising. The downward impact on inflation is expected to be in the order of 20 basis points. These results are consistent with the, admittedly, scant economic literature addressing this issue. An important caveat is that the results are based on an aggregate perspective and predicated on the assumption that existing differences across individual banks and countries will not act as a trigger for sizeable spillover effects that could threaten financial sector stability.

In assessing future money developments, various scenarios for the evolution of monetary aggregates may lead to different implications for the evolution of inflationary pressures. This holds in particular for the degree of excess liquidity and the possibility that its unwinding keeps M3 growth negative or subdued at a time when other factors such as economic activity or opportunity costs are already working towards a rebound in money growth. Given possible structural changes in money-holding behaviour, indicators of excess liquidity, such as money gaps or deviations from velocity trends,

Chart A20 M3 income velocity

(log levels)

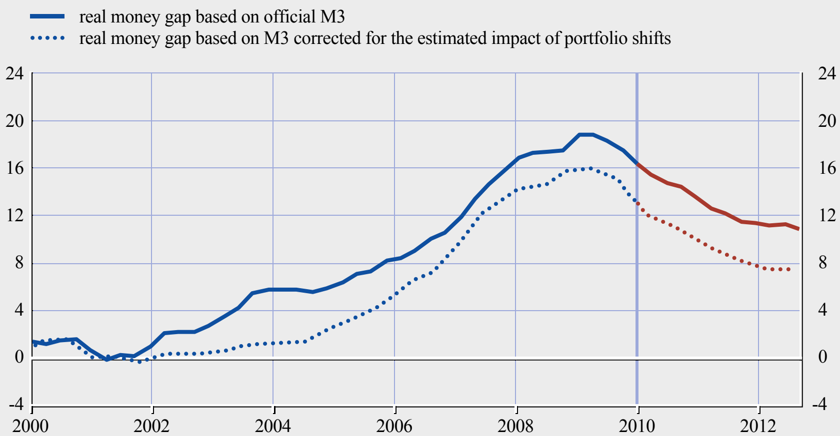


Sources: ECB, ECB estimates and Eurostat.
Note: See notes to Chart A4.

are surrounded by considerable uncertainty in terms of their precise quantity. But they suggest that even with the subdued M3 growth projected for the next two years, not all of the previously accumulated liquidity may yet have unwound (see Charts A20 and A21). This of course cautions against interpreting weak money growth developments literally.

Chart A21 Range of real money gaps

(as a percentage of the stock of M3; adjusted for seasonal and calendar effects; December 1998 = 0)



Sources: ECB and ECB estimates.
Notes: The real money gap is defined as the difference between the actual level of M3 deflated by the HICP and the deflated level of M3 that would have resulted from constant nominal M3 growth at its reference value of 4½% and HICP inflation in line with the ECB's definition of price stability, taking December 1998 as the base period. Estimates of the magnitude of portfolio shifts into M3 are constructed using the general approach discussed in ECB (2004). The red lines denote estimates of the real money gaps calculated on the basis of forecast M3, which was derived as described in the notes to Chart A4.

REFERENCES

Amisano, G. and Fagan, G. (2010), "Money growth and inflation: a regime switching approach", *Working Paper Series*, No 1207, ECB.

Christiano, L.J., Motto, R. and Rostagno, M. (2007), "Shocks, Structures or Policies? The Euro Area and the US After 2001", *Journal of Economic Dynamics and Control*, 32(8), pp. 2476-2506.

Christiano, L.J., Motto, R. and Rostagno, M. (2010), "Financial factors in economic fluctuations", *Working Paper Series*, No 1192, ECB.

De Santis, R., Favero, C.A. and Roffia, B. (2008), "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability", *Working Paper Series*, No 926, ECB.

ECB (2004), "Monetary analysis in real time", *Monthly Bulletin*, October, pp. 43-66.

Gerdesmeier, D., Reimers, H.-E. and Roffia, B. (2009), "Asset price misalignments and the role of money and credit", *Working Paper Series*, No 1068, ECB.

Nobili, A. (2009), "Composite indicators for monetary analysis", *Discussion Paper Series*, No 713, Banca d'Italia.

II SPECIFIC AVENUES FOR RESEARCH

CHAPTER 3

IMPROVING MODELS OF EURO AREA MONEY DEMAND

1 INTRODUCTION[1]

Money demand models are the workhorses of monetary analysis, playing an unglamorous but crucial role in any comprehensive framework for the assessment of monetary conditions. Traditionally, money demand equations have served two purposes. First, from a positive perspective, they offer a framework within which to explain monetary developments on the basis of the evolution of other macroeconomic variables, notably the price level, economic activity and interest rates. Second, from a normative or policy point of view, they constitute a mechanism for determining the stock of money holdings or rate of monetary growth that is consistent with price stability over the medium term. In turn, such benchmarks can be a starting point for constructing indicators relevant for taking monetary policy decisions.

As described by Masuch et al. (2001), money demand equations have been central to the ECB's conduct of monetary analysis from the very outset. Nevertheless, over the decade since the introduction of the euro in 1999, experience of using money demand models to underpin the real-time analysis of monetary developments has been far from straightforward.

As is well-documented,[2] during the period of heightened economic and financial uncertainty between 2001 and 2003, exceptional portfolio shifts into euro area M3 rendered conventional specifications of broad money demand unstable (at least on the basis of standard statistical tests).[3] For the purposes of real-time policy preparation, ECB staff froze the parameters of the existing models and introduced judgmental adjustments to the M3 series so as to account for the portfolio shifts that the conventional models failed to capture.[4] Such an approach

1 This chapter was prepared by Björn Fischer and Huw Pill. Thanks are due to the contributors of the annexes (Andreas Beyer, Barbara Roffia, Thomas Vlassopoulos and Julian von Landesberger), to Samuel Reynard and James Proudman (who acted as discussants at an ECB colloquium on "Enhancing the monetary analysis" in April 2010) and to Alessandro Calza, Laurent Clerc, Francesco Drudi, Stefan Gerlach, Charles Goodhart, David Laidler, Jesper Lindé, Philippe Moutot, John Muellbauer, Lucrezia Reichlin, João Sousa, Volker Wieland and Mika Tujula for their many helpful comments and suggestions. The views expressed are those of the authors and not necessarily those of the ECB or the Eurosystem.

2 See, for example, ECB (2004).

3 Notable examples of specifications that illustrate this experience include Calza et al. (2001), Coenen and Vega (2001), and Brand and Cassola (2004). For a discussion of the definition of stability and the analysis underpinning this conclusion, see Annex 1 to this chapter.

4 See Fischer et al. (2008, 2009).

helped to structure the real-time assessment of monetary developments during this challenging period. Arguably, it helped avoid potential monetary policy mistakes, by guarding against the danger that the surge in broad money growth between 2001 and 2003 was erroneously interpreted as an indicator of inflationary pressures.[5] The somewhat ad hoc nature of the judgmental adjustments, however, was obviously inadequate for use as a long-term solution.[6]

Against this background, the natural starting point for enhancing euro area money demand models was clear. Experience suggested that models should be refined so as to better allow for portfolio shifts into and out of monetary assets. To account for such behaviour, additional arguments needed to be incorporated into the conventional money demand specification. Examples of what needed to be included are: a broader range of opportunity cost variables (including the returns on foreign assets); wealth variables; asset prices; and measures of financial market volatility and economic uncertainty. Much of the remainder of this chapter (and particularly the annexes) reports on the experience of extending money demand models in this way.

Adopting such an approach proved fortunate, given the significant fluctuations in asset prices, yields and wealth holdings seen over the past decade. All would agree that the defining macroeconomic event of this period has been the financial crisis surrounding the collapse of Lehman Brothers in September 2008. This crisis was preceded by a sustained increase in asset prices (particularly in the housing market), which most accounts associate with structural changes in the financial system and their consequences for monetary and credit growth.[7] Similarly, the crisis itself triggered balance sheet adjustments in both the banking and the non-bank sectors, raising questions about the reliability of the loan supply and the portfolio choices of households and firms. The financial crisis thus reinforced the importance of enhancing monetary analysis and, in particular, of deepening our understanding of the nexus linking monetary and credit developments, asset price dynamics, financial innovation and monetary policy. Such considerations were central to the extension of money demand models that was being pursued in any event.

Foreshadowing somewhat the results presented in the remainder of this chapter, two main conclusions emerge from the "improving money demand models" avenue of the agenda for enhancing monetary analysis.

5 At the same time, the continued strength of underlying monetary dynamics was also interpreted as a signal that deflationary pressures were weaker than some argued at that juncture.

6 While the judgmental adjustments were, by nature, ad hoc, they were nonetheless firmly rooted in a comprehensive technical analysis developed using a suite of underlying statistical and economic models and a thorough evaluation of the impact of institutional and structural factors (see Fischer et al. (2008)).

7 Gorton (2008).

On the one hand, considerable progress has been made in explaining recent monetary developments within the money demand framework. By including additional arguments in money demand equations, stability – in the narrow, technical sense – has been restored. Extended money demand specifications are better able to account for portfolio shifts than their conventional predecessors. Moreover, they provide insight into the interrelationships between monetary developments, asset prices and financial structures that have been central to recent experience. For example, the strong growth of euro area broad money between 2004 and 2007 can be explained by the rapid increase in asset prices and household wealth over that period.

On the other hand, having better explanations of monetary developments has not necessarily rendered the interpretation of their implications for monetary policy and the outlook for price stability more straightforward. To the extent that money and credit growth are associated with asset price developments, extracting policy-relevant signals from monetary developments relies, at least in part, on coming to a judgement on the sustainability of asset price dynamics. Such conjecture is fraught with difficulty. Moreover, recent research – some of which is reviewed in Chapter 6 of this volume – points to a bi-directional causality between asset prices and monetary developments. Such simultaneity requires policy-relevant assessments to entertain the interactions between a set of key variables, rather than an evaluation of monetary indicators in isolation. In the light of these results, traditional monetary indicators – such as broad money growth or estimates of the "monetary overhang" – need to be employed with caution. A more sophisticated and encompassing interpretation than in the past may be required.

In short, over recent years, improvements in modelling euro area money demand have yielded significant advances in positive analysis, but need to be interpreted carefully in a normative context. This outcome reflects the overall message of this volume: the richer understanding of monetary developments obtained by enhancing the analysis has reconfirmed the importance of monetary developments, but has also, at the same time, revealed the complex challenges faced in extracting policy-relevant messages from the monetary data.

2 CONVENTIONAL MONETARY POLICY ANALYSIS USING MONEY DEMAND MODELS

Ultimately, inflation is a monetary phenomenon. Without a monetary unit to define the general price level, the macroeconomic concept of inflation would simply not exist.[8]

Moreover, the statistical correlation between monetary growth and inflation is one of the most robust in macroeconomics.[9] The overwhelming weight of empirical evidence induced Robert E. Lucas to conclude (in his Nobel lecture)

8 King (2002).

9 See, for example, McCandless and Weber (1995) and Benati (2009).

that the relationship between monetary growth and inflation "needs to be a central feature of any monetary or macroeconomic theory that claims empirical seriousness".[10]

While these assertions are largely uncontroversial in the academic literature, their relevance to the practical conduct of monetary policy has been the subject of an intense, lengthy and ongoing debate. From the outset, the ECB has argued that "giving money an important role in the Eurosystem's [monetary policy] strategy was important".[11] For a central bank with the primary objective of price stability, the insight into the outlook for underlying price developments offered by monetary trends constitutes a potentially important input into policy decisions.

2.1 THE ROLE OF MONEY DEMAND STABILITY

Clearly, when being exploited to underpin monetary policy decisions, the stability of the relationship between money and prices is crucial. Once a robust and stable relationship has been established, it can be used to derive a "norm" for monetary developments, which is consistent with the objective of price stability.

As discussed in Chapter 2, should monetary developments deviate from this norm, three explanations are possible. First, the norm may have shifted, due to instabilities – possibly temporary – in the relationship between money and prices. Second, monetary developments may correct themselves, implying that their deviation from the norm was itself temporary.[12] Third, a departure from price stability will eventually be observed, so as to validate the deviation of monetary developments from the norm.

In the event of the latter being relevant, there is an immediate case for a monetary policy response. But motivating a policy action to contain the implied risk to price stability will rest crucially on policy-makers' ability to distinguish the persistent "signal" component in monetary developments from the "noise" created by instabilities and short-term dynamics.

In outlining its monetary policy strategy in January 1999, the ECB acknowledged the central character of the stability of the money/price relationship in the analytical framework for monetary analysis. Furthermore, it recognised that "the stability of this relationship is typically assessed in the context of a money demand function, where a specific monetary aggregate is related to the price level and other macroeconomic variables, such as real income and interest rates".[13]

10 Lucas (1996).
11 ECB (1999), p. 47.
12 What constitutes a "temporary" deviation in this context is open to interpretation. The available empirical evidence suggests that the money/price relationship is most robust for the low-frequency (or trend-like) components of monetary and price developments (see, for example, Greiber and Neumann (2004), Bruggeman et al. (2005), Pill and Rautanen (2006) and Benati (2009)). Since such underlying trends are, by nature, very persistent, it is possible for temporary deviations to be quite long-lived, lasting for several quarters or even years.
13 ECB (1999), p. 47.

Since the introduction of the euro, money demand has therefore been a key component of the ECB's monetary analysis.

Any empirical assessment of the stability of the money/price relationship that is based on a money demand equation entails the need to make a number of practical (and inter-related) choices. What sample period should be used? What frequency of data should be employed (monthly, quarterly, annual)? Which interest rates and measures of economic activity should be included as arguments? What functional form should the relationship take? Which monetary aggregate should be chosen (M3, M1, base money, a weighted aggregate)? Naturally, the results obtained can be sensitive to the respective choices made.

In practice (and as reflected in the annexes to this chapter), the ECB's analysis of money demand has focused on quarterly semi-log linear models for euro area M3.[14] This is unsurprising, given the identification of M3 as the key aggregate used to define the ECB's reference value for monetary growth. Indeed, the choice of M3 for this role was based on the view that the demand for M3 was stable, which in turn derived from an analysis using synthetic euro area data for the sample 1980-98.[15]

However, experience of money demand instability (particularly, but not exclusively, in the Anglo-Saxon world) in the 1980s[16] led to healthy caution with respect to relying on a single monetary indicator, whatever attractions such an approach may have in terms of the simplicity of presentation. In setting out its strategy in 1999, the ECB already argued that an analysis of M3 alone was insufficient: "developments in other monetary aggregates, in the various components of M3 and in the counterparts of all these aggregates in the consolidated MFI balance sheet will also be thorough assessed on an ongoing basis".[17]

More generally, over time and with the benefit of the experience gained in monitoring euro area monetary developments, a broad set of complementary instruments and tools for monetary analysis has been developed at the ECB. Model-based analysis is supplemented by expert judgement, informed by a thorough assessment of structural developments in the financial system and wider economy. On this basis, a broad-based assessment of the monetary data has been developed, which is both more comprehensive and more robust. This volume describes some elements of this overall framework.

14 Euro area M3 is defined as currency in circulation plus overnight deposits, deposits with an agreed maturity of up to two years, deposits redeemable at a period of notice of up to three months, repurchase agreements, money market fund (MMF) shares/units and debt securities with a maturity of up to two years issued by the monetary financial institutions (MFIs) sector and held by households, non-financial corporations, non-monetary financial institutions and general government other than central government resident in the euro area.

15 Furthermore, the details of the definition of euro area M3 – i.e. the choice as to which bank liabilities to include in the aggregate – were partly motivated by an assessment of the stability of demand for the resulting aggregate.

16 Goodhart (1989).

17 ECB (1999), p. 49.

Money demand stability remains a central component of this broad-based analysis. But it is understood in a deeper and more fundamental sense than the statistical stability of a certain specification of demand for one monetary aggregate on the basis of a standard set of econometric tests (see Annex 1). In particular, greater emphasis is now placed on analysing and understanding the reasons why money stocks may deviate from the equilibrium level defined by the money demand equation. Explanations are sought of why such deviations emerge. In particular, attempts are made to distinguish shifts in the demand for money – which are generally seen as a passive response to the evolution of other (possibly unobservable) variables, such as uncertainty or interest rate spreads – from shifts in the money supply (which might be associated with structural change in the banking sector, for example the adoption of new business models, such as the "originate-to-distribute" model based on securitisation). Prima facie, the former are seen as rather benign in terms of the outlook for price stability, whereas the latter are viewed with more caution.

Therefore, and as reflected in the remainder of this chapter, analysing the stability of various money demand specifications remains a key component of the ECB's approach. But rather than being interpreted as an indictment of the role played by monetary analysis in the ECB's overall strategy, the emergence of instability in one specification of money demand is seen as both a trigger for, and a guide to, subsequent attempts to deepen and improve this analysis. Recent efforts to improve money demand models should be seen in this light. Such an evolutionary approach helps to deepen our understanding of monetary developments and, thereby, to reveal the underlying relationship between money and prices on which the overall monetary analysis rests.

2.2 TOOLS TO SUPPORT MONETARY POLICY DECISIONS DERIVING FROM MONEY DEMAND MODELS

Having established the importance of money demand stability for monetary analysis, it is useful to briefly recall two practical tools that have traditionally been used to transform money demand analysis into monetary policy advice. Both of these tools fit within the general framework outlined above, whereby a stable relationship between money and prices yields a norm for monetary developments that is consistent with price stability.

2.2.1 A REFERENCE VALUE FOR MONETARY GROWTH

From a standard log-linear money demand model:[18]

$$\ln\left(\frac{M_t}{P_t}\right) = \alpha + \beta \ln(y_t) - \gamma \tilde{i}_t$$

[18] Such a specification is standard in the literature, where the arguments are intended to proxy, for the transactions, precautionary and speculative motives that underpin the microeconomic theory of money demand. The notation used here is conventional: M is the money stock, P is the price level, y is a measure of economic activity (in real terms) and $\tilde{i}$ is a vector of opportunity costs (interest rates). In what follows, $\dot{a}$ is the growth rate of a, π is the inflation rate ($=\dot{P}$) and v is the income velocity of circulation of money.

one can establish the following relationship between monetary growth and inflation:

$$\dot{M}_t = \pi_t + \beta \dot{y}_t - \gamma \Delta \tilde{i}_t$$

or, equivalently, expressed in terms of the velocity of circulation:

$$\dot{M}_t = \pi_t + \dot{y}_t - \dot{v}_t \text{ where } \dot{v}_t = (1-\beta)\dot{y}_t + \gamma \Delta \tilde{i}_t$$

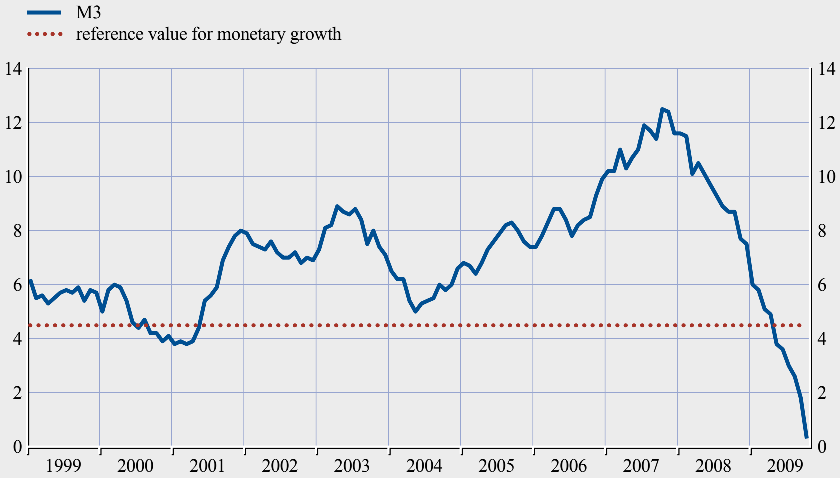
By substituting the inflation objective in this expression (and assuming (i) that the underlying money demand relationship is stable, (ii) specific values for trend developments in real economic activity and income velocity of circulation, and (iii) that the trend dynamics of velocity and real income are independent of the trend dynamics of money), one can establish a norm for monetary growth that is consistent with price stability over the medium term. Applied to the annual growth rates of euro area M3, it is precisely this approach that underpinned the derivation of the ECB's reference value for monetary growth that was announced in December 1998.[19]

Chart 1 illustrates the evolution of euro area M3 relative to the ECB's reference value since the introduction of the euro in 1999.

[19] ECB (1998).

Chart 1 Annual M3 growth and the reference value

(annual growth rate; percentages)



Source: ECB.

2.2.2 THE MONETARY OVERHANG AND THE P-STAR MODEL

Focusing on growth rates may underplay the importance of slow, but sustained, accumulations of monetary imbalances. However, such developments may be among the most crucial for monetary policy-makers, since it is the persistent trends in money – rather than its shorter-term dynamics – that are most robustly associated with price developments over the medium term. This perspective points to the need to develop an analysis based on the stock of money holdings, rather than on its growth rate – an approach that is formalised in the so-called P-star model.[20]

Again, this framework starts from a stable money demand equation, which is used to define a level of real money holdings (m^*) that is consistent with the prevailing configuration of yields and the level of real economic activity.

$$m_t^* = \ln\left(\frac{M_t}{P_t}\right)^* = \alpha + \beta \ln(y_t) - \gamma \tilde{i}_t$$

Within a vector error-correction model (VECM) context,[21] any excess of real money holdings over the equilibrium level defined by the money demand equation will be eroded over time. Under certain conditions, at least part of this erosion comes via inflation at rates above those consistent with price stability.[22] In such circumstances, a relationship between inflation and the so-called monetary overhang, $(m_t - m_t^*)$ emerges.[23]

$$\pi_t = \rho\, \pi_{t-1} + \theta\,(m_{t-1} - m_{t-1}^*)$$

Projecting forward, this framework can be used to develop a money-based risk indicator for future inflation. For a central bank with the objective of maintaining price stability, the monetary overhang may therefore be an important information variable.

Chart 2 shows the evolution of the monetary overhang for the euro area M3 model estimated by Calza et al. (2001) (hereafter referred to as the "CGL model").[24] This model was the workhorse for the ECB staff's internal analysis in the early years of Economic and Monetary Union.

20 Hallman et al. (1991); for an application to the euro area, see Gerlach and Svensson (2003).

21 Engle and Granger (1987).

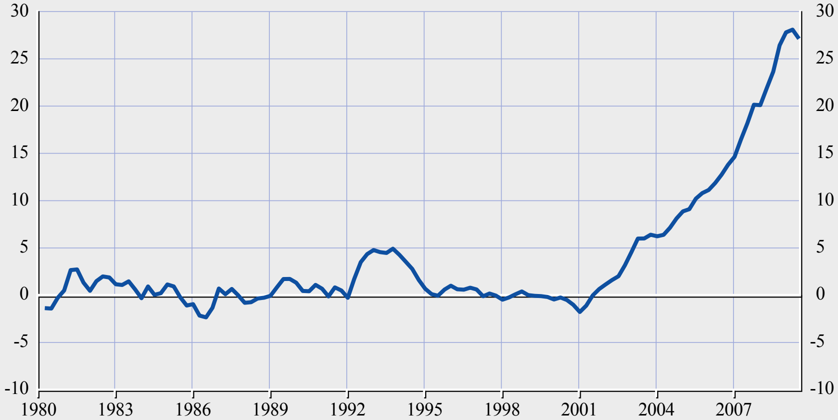
22 And vice versa, when actual money holdings fall short of their equilibrium level. Technically, prices must not be weakly exogenous to the VECM system, the long-run behaviour of which is defined by the money demand equation.

23 Concepts such as the money gap are also used in this context. The difference between the monetary overhang and the money gap relates to whether actual or potential levels of real activity are used to define the equilibrium level of money. For a detailed discussion of various measures of monetary disequilibrium derived from money demand models, see Masuch et al. (2001), pp. 134-139. Strictly speaking, the real money gap consists of both the monetary overhang and a measure of the so-called output gap. In this chapter, the presentation focuses on the former.

24 As already mentioned in the introduction, the parameters of this model were frozen on the basis of estimates over the sample period from the first quarter of 1980 to the second quarter of 2001.

Chart 2 Monetary overhang according to the CGL model

(percentage of the money stock, corrected for the estimation sample mean; parameters estimated over sample 1980-2001)



Source: ECB calculations, based on Calza et al. (2001).

2.3 INTERPRETING MONEY-BASED INDICATORS

Having reviewed how a variety of standard money-based indicators are constructed, the question of their interpretation arises. In the interests of brevity and simplicity, the focus here is on the monetary overhang. The assessment draws on the general framework developed above.

First, the accumulation of a large monetary overhang after 2001 could be seen as an indicator of future inflation. This would be the implication of the P-star model.

Second, the emergence of the monetary overhang may be seen as a temporary phenomenon. In other words, the overhang will dissipate, over time, through a future contraction in money holdings, rather than a bout of higher inflation, so as to restore monetary equilibrium over the medium term. Indeed, as has been discussed extensively elsewhere,[25] ECB staff saw the monetary overhang accumulated between 2001 and 2003 as benign, in that it was a temporary phenomenon associated with portfolio shifts into monetary assets that were likely to be reversed in the future as financial market conditions normalised.

Third, the money demand equation capturing the (conditional) relationship between the money stock and the price level may have shown signs of instability, resulting in a permanent upward drift of the monetary overhang. Reflecting the definition of the overhang in the previous section, this implies that the observed stock of money has departed permanently from the equilibrium level defined by its prior relationship to prices and other key macroeconomic variables.

[25] And is, therefore, not repeated here. For details, see, for example, ECB (2004) and Fischer et al. (2008).

In other words, the "residuals" of the long-term money demand equation – those monetary developments that the model fails to explain – have grown over time.

It should be noted that a standard test of the stability of a money demand equation is whether it constitutes a cointegrating vector.[26] In essence, this requires that the monetary overhang is stationary (in the statistical sense), i.e. that it tends to revert to a constant mean (normalised to zero in Chart 2 for the period 1980-2001) over time.

By implication, at the moment when the emergence of a large and persistent monetary overhang points to significant risks to price stability, questions will arise, by construction, regarding the stability of the equation used to define the overhang. The same model and data are open to two contrasting interpretations. Of course, statistical tests can offer guidance as to which interpretation is correct. But – as with any such test – both "type 1" and "type 2" errors are possible. Weighing which type of error is more costly requires policy judgment to be exercised.

The money demand equation itself cannot determine which of the interpretations is most relevant for the conduct of monetary policy. Rather, it provides a framework within which policy-makers can formulate, analyse and discuss various competing views of the established facts (such as, in this case, the strong growth of euro area broad money between 2001 and 2007). And, in so doing, analysis based on the original model can provide guidance regarding the potential direction of further work.

In short, any "instability" (in the technical, statistical sense) of one money demand model demonstrates the need for a richer explanation of monetary developments that is both relevant for the real-time policy assessment and, over time, serves as the starting point for developing new models. The enhancement of euro area money demand models discussed in the following section has followed this approach.

3 NEW DEVELOPMENTS IN MODELLING EURO AREA MONEY DEMAND

As indicated earlier, conventional specifications of money demand proved unable to account for the rapid pace of broad money growth in the euro area between 2001 and 2007. In its real-time analysis, the ECB split this period into two phases.[27] Until mid-2004, the view that M3 growth could largely be explained by temporary portfolio shifts into monetary assets led to a benign interpretation of the strong pace of monetary expansion. From early 2005 onwards, by contrast, the growth of broad money was seen as more fundamentally driven and associated with growing risks to price and macroeconomic instability.[28]

26 See Engle and Granger (1987) and Johansen (1995).
27 ECB (2006a).
28 ECB (2007).

Such real-time interpretations relied on judgmental explanations of monetary developments, which, in turn, drew on a comprehensive assessment of a broad set of monetary and financial data. Over time, much of this analysis has been codified in money demand models. The remainder of this section reports on the enhancements made to money demand in this manner. Details of individual models developed by ECB staff are described in the annexes.

3.1 MODELLING MONEY DEMAND AS A PORTFOLIO CHOICE

Both the experience of exceptional portfolio shifts (in the period from 2001 to 2003) and the correlation between the money stock, the level of asset prices and thus wealth (observed between 2004 and 2009) point to a need to model money demand as part of a broader portfolio choice decision. A number of initiatives have been taken in this direction.

3.1.1 MONEY DEMAND AND UNCERTAINTY

Portfolio shifts into broad money between 2001 and 2003 were associated with the then prevailing state of heightened economic and financial uncertainty (stemming from, inter alia, the collapse of the "dot-com" bubble in the US stock market and the start of the wars in Iraq and Afghanistan). Two main explanations were identified for such flows: first, heightened uncertainty led to an increase in the precautionary demand for money, as abundant liquid assets represented a "buffer" to cushion firms and households in the face of large income and demand shocks, and second, the poor returns and high volatility observed in equity and bond markets led to a stronger speculative demand for money, as investors sought a "safe haven" from capital market turbulence in certain monetary assets. As these remarks demonstrate, the relationship between money demand and uncertainty thus has a strong theoretical basis, dating back at least to Keynes.

The empirical application of these ideas within a money demand framework initially involved including various proxies for uncertainty as additional arguments in conventional money demand specifications. Prominent examples in the euro area literature include Carstensen (2003, 2006) who included a measure of equity market volatility, De Bondt (2009) who added unemployment to capture household precautionary motives for holding money, and Greiber and Lemke (2005) who used a synthetic indicator of uncertainty constructed by extracting a common factor from a broad set of volatility and survey measures. A survey of these approaches is offered by ECB (2005). Broadly speaking, such approaches were able to account for the portfolio shifts seen between 2001 and 2003 and, thereby, to re-establish money demand stability for this period. Indeed, such exercises were seen as providing an ex post confirmation of the ECB's real-time analysis of portfolio shifts derived using more judgmental and ad hoc empirical techniques.

However, these extended money demand equations suffered from two significant drawbacks.

At the empirical level, they failed to account for more recent monetary developments. Between 2004 and 2007, financial market conditions were generally viewed (at least at the time) as remarkably benign, with volatility at historically low levels. However, despite the apparent dissipation of heightened financial and economic uncertainty, strong monetary growth continued – and even accelerated – throughout the middle of the decade. By implication, the positive relationship between money demand and the uncertainty observed during the episode of portfolio shifts broke down. And, as a result, statistical instability emerged in those extended money demand equations that had relied on this relationship to account for monetary developments in the period of portfolio shifts.

Moreover, these extended models suffered from a conceptual weakness. The "safe haven" motivation for holding money embedded in them lacked the necessary general equilibrium perspective. More specifically, if one investor shifts from holding risky equity to safer monetary assets, another investor must be taking the opposite position. To the extent that both investors are members of the money-holding sector, such behaviour will merely lead to a reshuffling in the distribution of money holdings, not an increase in aggregate money holdings.

Only if the counterpart to the safe-haven transaction is part of the money-creating sector (i.e. a bank) or the money-neutral sector (e.g. central government, non-residents) will aggregate money holdings rise. Such models therefore implicitly assumed differential attitudes towards uncertainty on the part of money-holding and other sectors, without explaining them.

3.1.2 MONEY DEMAND AND INTERNATIONAL CAPITAL FLOWS

Recognising this weakness (and building on the real-time analysis conducted by ECB staff),[29] De Santis et al. (2008) set out to explicitly model the extra-euro area flows underlying portfolio shifts (see Annex 2). Their starting point was the observation that the main counterpart (in the consolidated euro area bank balance sheet) to strong money growth between 2001 and 2003 was net external assets. This suggested that the (aggregate) safe-haven flows into monetary assets seen over this period involved the sale of non-monetary securities (notably equities) to non-residents, a view supported by other evidence (derived from, for example, the financial accounts, the balance of payment statistics and surveys of investor behaviour).[30]

Consideration of such behaviour in the standard money demand framework entailed a number of extensions to the conventional specifications. Notably, a broader set of opportunity cost variables had to be included: to explain portfolio shifts between money and securities holdings, stock and bond returns were incorporated, as well as interest rates. Moreover, to capture the incentives for extra-euro area transactions, returns on US assets were added to models of euro area money demand.

The resulting model (hereafter referred to as the "DFR model") yielded a stable money demand relationship over the 1980-2007 sample, for which it was originally estimated. In other words, such a model could account for both the

29 ECB (2008).
30 See ECB (2004); Fischer et al. (2008).

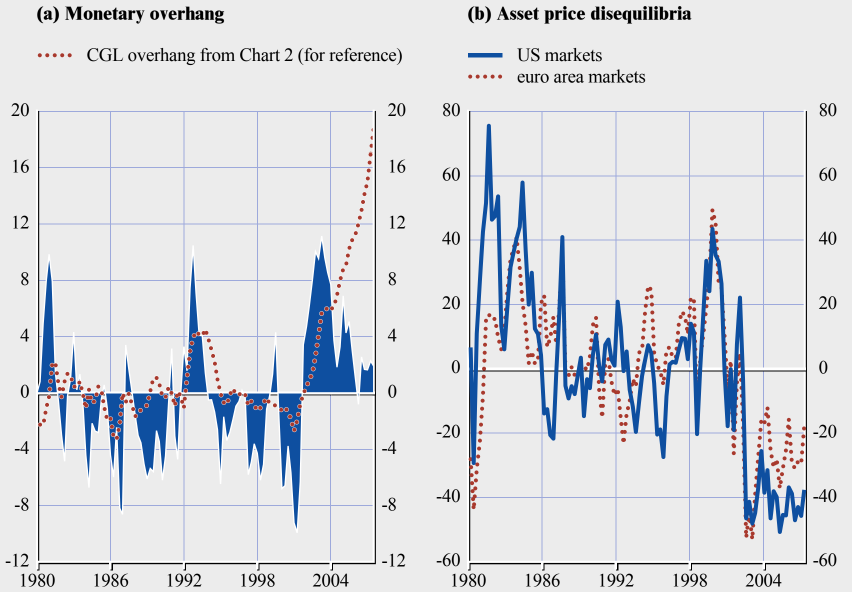
portfolio shifts episode and the continued strength of broad money growth in the euro area after 2004. Chart 3a shows the monetary overhang derived from this money demand equation (with the overhang of the CGL model included as a benchmark for illustrative purposes). This model remains stable on the basis of the standard cointegration tests until the end of 2009.

Against the background of the overall success of the DFR model in explaining recent monetary developments, a number of additional and interrelated points should be made.

First, it is crucial to bear in mind that the model is estimated – and needs to be understood and interpreted – as a system. A number of long-run relationships exist between the variables included in the model, not just the money demand equation. (This should not come as a surprise, as one would anticipate at least a weak form of arbitrage to exist among the yields on equities, bonds and money across countries, which implies a long-run relationship involving these returns.) Moreover, monetary developments are driven by the system as a whole, not just by the monetary overhang. And not only do asset prices influence money holdings, but the converse is also true (see also Chapter 6). Against this background, a more sophisticated interpretation of the monetary overhang and its implications is required – one that allows for the simultaneity between asset price and monetary developments.

Chart 3 Model developed by De Santis, Favero and Roffia (DFR model)

(percentage of the money stock) (basis point deviations from equilibrium)



Source: ECB calculations, based on De Santis et al. (2008).

Second (and related), the model does not yield a P-star indicator for inflation. While some exercises suggest that inflation risk indicators can be derived from the DFR model, the monetary overhang itself is not a leading indicator of future price developments. This follows from the different interpretation of the monetary overhang in this system context.

Third, the model explains recent monetary developments on the basis of the evolution of a broad set of asset returns. As a result, the model assesses the sustainability of monetary dynamics (and, by implication, their consistency with policy objectives) conditional on the behaviour of asset prices. Chart 3b illustrates the asset market disequilibria identified by the model in the given sample. While the statistical stability of the model as a whole implies that these asset market disequilibria are not incompatible with the longer-run behaviour of asset prices observed in the past, it is apparent that the DFR system has shifted part of the "monetary disequilibrium" identified by Calza et al. (2001) to the "asset price disequilibria" shown in Chart 3b. The monetary overhang is therefore diminished relative to the original benchmark model (as shown in Chart 3a). But the overall outlook for macroeconomic and price stability has not necessarily improved. In other words, the extended money demand system can explain money growth over the past decade in a consistent manner. But it does so on the basis of developments in asset prices that may themselves not be sustainable. In this context, one should be wary of drawing comfort from a smaller monetary overhang, when the forces explaining monetary dynamics may also be undermining macroeconomic stability. Arguably, the experience of the financial crisis since mid-2007 bears these concerns out.

Fourth, looking at the evolution of the monetary overhang in Chart 3a, it is apparent that the DFR long-run money demand equation explains monetary developments prior to 2001 less well than the conventional CGL specification: the overhang ("residuals") fluctuates with greater amplitude and persistence. If one were simply seeking to explain monetary developments, it would be preferable to use the CGL model up to 2001 and the DFR model subsequently, pointing in the direction of a structural break in the behaviour of money holders. Structural changes in the financial system – notably the increased globalisation of financial markets – would be consistent with such an interpretation. The possibility of such structural breaks reinforces the need for a continuous monitoring of monetary developments and for the parallel development and renewal of money demand frameworks to account for changes in financial structures and money-holding behaviour.

Finally (and again drawing on the observation that fluctuations in the DFR overhang exhibit a greater amplitude and more persistence than those of the conventional CGL specification prior to 2001), the analysis has demonstrated that including asset returns as arguments in money demand equations leads to a deterioration of fit, at least in the shorter run. This is unsurprising: asset prices can exhibit high volatility, so that using them to explain slower moving stock variables is likely to lead to a poor short-run fit. If asset prices do have an important influence on monetary developments – as evidence deriving from the DFR model suggests – then this reconfirms the importance of analysing the more persistent (or lower-frequency) component of monetary dynamics, so as to "look through" the impact of shorter-term asset price volatility. As reflected in Chart 3a, the DFR model suggests that relatively large monetary disequilibria can accumulate and persist for several years, even if the underlying money demand relationship remains stable.

All in all, the DFR model has deepened understanding of the behaviour of euro area broad money over the past decade. However, the insight it provides into monetary developments needs to be interpreted carefully. Monetary growth needs to be analysed in association with broader asset price developments before drawing conclusions relevant for monetary policy.

3.1.3 MONEY DEMAND AND WEALTH

Similar results emerge from parallel attempts to explain euro area monetary developments on the basis of the evolution of wealth. Once money demand is placed in the context of a broader portfolio choice by the money-holding sector, it is natural to include wealth as an additional scaling variable. Hall et al. (2008) propose such an approach, building on earlier work undertaken at national central banks.[31]

Unfortunately, progress in this area has been hampered by the lack of reliable data for euro area wealth. Initial efforts to model money and wealth were forced to rely on proxies, such as real estate or equity prices, to capture the dynamics of wealth holdings.[32] Such analysis was not open to straightforward interpretation, since rises in non-monetary asset yields can lead to both substitution out of money to exploit the high returns available, and flows into money to re-establish a portfolio balance.

Thanks to the efforts reported in ECB (2006c), this bottleneck has been overcome by the construction of euro area time series for housing and financial wealth (even if an element of judgment was required to do so). Including such measures in conventional money demand specifications has also served to re-establish stability over the extended sample up to 2009. In other words, the strong growth of euro area broad money from 2004 to 2007 (and its subsequent decline after the onset of financial crisis) can be satisfactorily explained (at least in the statistical sense) on the basis of a positive relationship between money and wealth.

One example of such work is the model proposed by Beyer (2009) (hereafter referred to as the "MWM model", i.e. the money/wealth model) (see Annex 3). By including a measure of housing wealth in the money demand system, a stable

31 Gerdesmeier (1996), Fase and Winder (1998) and Hall et al. (1989).
32 Greiber and Setzer (2007).

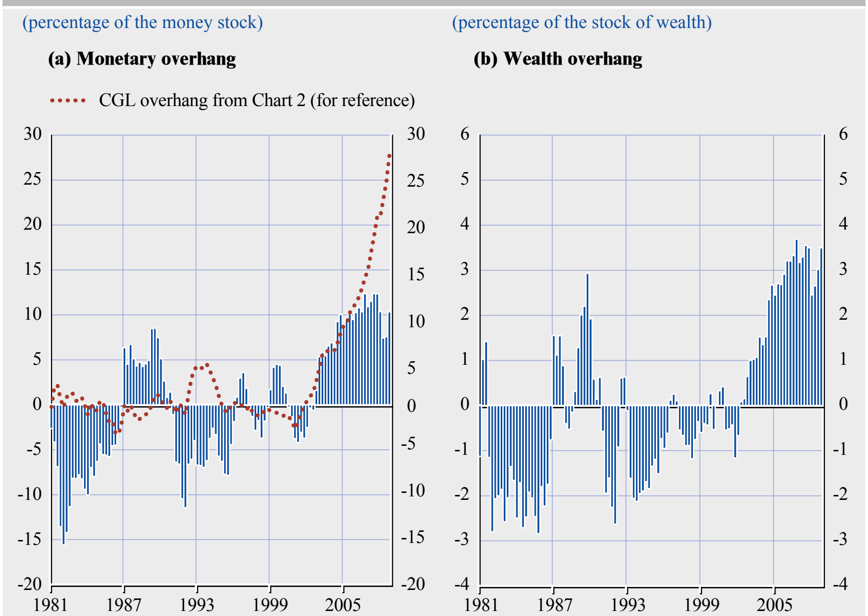
money demand equation is recovered.[33] Chart 4a shows the monetary overhang derived from the MWM model, illustrating its mean-reverting properties.[34]

Many of the issues identified above in the context of the DFR model reappear here. In the interests of brevity, they are not repeated at length. It suffices to say that, as shown in Chart 4b, part of the disequilibrium in money holdings identified by conventional models (such as the CGL model) has been shifted into a wealth disequilibrium. Interpretation of the MWM monetary overhang thus needs to be made in a system context. Caution is required in interpreting monetary developments on the basis of this model, at least to the extent that the smaller monetary overhang (and implied stability of money demand) has to be understood as conditional on underlying developments in euro area wealth, which may themselves not be sustainable and/or compatible with macroeconomic and price stability over the medium term.

33 Admittedly, as regards economic plausibility, the use of housing wealth alone is open to question. From a portfolio perspective, a measure of total wealth, or of financial wealth, would appear a more natural variable to explain money demand, at least prima facie. At the individual household level, the scope for replacing housing wealth with money holdings is limited. At the aggregate level, however, one can imagine that a rise in housing prices that is perceived as permanent by households would imply greater total household mortgage borrowing and, for the sellers of houses that have paid off their mortgages, a release of cash that will partly be held in the form of broad money.

34 As in Chart 3, the monetary overhang derived from the conventional CGL model specification is also shown as a benchmark for illustrative purposes in Chart 4.

Chart 4 Model proposed by Beyer (MWM model)



Source: ECB calculations, based on Beyer (2009).

3.2 DIVISIA INDICES FOR MONEY

The preceding section described how money demand models have been extended to capture portfolio allocation decisions by money holders. As we have seen, such an approach has pros and cons.

An alternative avenue to addressing the instability of conventional money demand models created by portfolio shifts is to redefine the monetary aggregate being modelled, such that it more closely captures the transaction balances held to make payments. By construction, such an aggregate will – at least in principle – not be influenced by precautionary or speculative motives for holding monetary assets, but will rather capture only money held for transaction purposes.

The simplest form of this approach would be to focus on more narrowly defined monetary aggregates, such as M1 or currency in circulation.[35] However, modelling each aggregate has its own specific challenges. In the case of currency, for example, methods are required to deal with the impact of the euro cash changeover at the end of 2001.

A more sophisticated approach is to weight the different components of a broad monetary aggregate according to the extent to which they perform "transaction services". The classical approach has been to construct a Divisia index for money, where the "user cost" of the transaction service provided by each component is constructed from the spread between the remuneration on that component and a benchmark asset that cannot be used to make payments.[36] An early empirical application of this approach to the euro area is reported in Stracca (2004).

Applying such an approach in the euro area raises additional (and somewhat unique) aggregation questions. Should Divisia indices first be constructed at the national level and then be aggregated to a euro area-wide measure? Or should components first be aggregated, with a Divisia index then being constructed at the euro area-wide level? Barnett (2007) makes a proposal to address such questions. Unfortunately, constructing the time series required to implement this proposal over a sufficiently long sample for meaningful empirical analysis has proved very challenging in some euro area countries, because the necessary series for various monetary components were not collected prior to Economic and Monetary Union. Vlassopoulos (2010) makes a first attempt (see Annex 4), which yields some promising results.

Certainly, Divisia indices for money represent a conceptually interesting and intellectually challenging framework for understanding the policy relevance of various components of broad money. However, in line with experience gained at other central banks,[37] such indices have not attained high prominence in the

35 See Stracca (2003) and Fischer et al. (2004) respectively.

36 The original proposal was made in Barnett (1980). Alternative approaches, which focus on stocks rather than growth rates, have also been considered (see, for example, Rotemberg et al. (1995)).

37 Pill and Pradhan (1994).

ECB's monetary analysis, at least not yet. In general, it has been deemed more useful to analyse the components themselves – as part of a comprehensive and all-encompassing assessment of the MFI balance sheet – rather than to aggregate them in innovative ways, however appealing such approaches may be in theory.

3.3 SECTORAL MONEY DEMAND

Divisia indices represent an analysis of M3 components defined by instrument. Other breakdowns of the aggregate are also available, notably that by sector.[38] Indeed, the money-holding sector underlying the definition of euro area broad money consists of several sub-sectors, which – at least prima facie – are quite diverse in nature: households, non-financial corporations (NFCs) and non-monetary financial institutions (comprising insurance corporations and pensions funds (ICPFs) and what are known as "OFIs"[39]). Analyses of sectoral money represent an important part of the ECB's analytical framework.[40]

Against this background, so-called "aggregation bias" represents a potential explanation of the observed statistical instability of conventional euro area money demand models. To the extent that the aggregate measure of M3 encompasses the deposits of sectors with different motivations for holding money, instability at the aggregate level may result (a) from cross-sectoral variation in the response to common shocks and/or (b) from changes in the relative importance of various sectoral contributions to the overall stock of M3. In other words, aggregate instability is potentially compatible with statistically well-behaved demand for money at the sectoral level.

Von Landesberger (2007) investigates this phenomenon by estimating sectoral money demand equations with a common set of conventional determinants (see Annex 5). Unfortunately, the available time series for euro area sectoral deposits only start in the early 1990s; therefore, making a conclusive assessment of aggregation bias has proved impossible. Nonetheless, the results obtained in the empirical exercise point to cross-sectoral variations in money demand behaviour.

To summarise briefly, household money demand follows conventional patterns established in the literature most closely (with an income elasticity close to one, for instance). Moreover, its dynamic response to shocks is rather sluggish: developments in household deposits thus represent one measure of the underlying monetary dynamics that are most robustly correlated with inflation trends over the medium term. NFCs' demand for deposits, by contrast, is relatively more cyclical than that of households. Firms appear to accumulate money holdings

38 Constructing sectoral monetary aggregates requires some estimation, in particular concerning sectoral holdings of currency, money market fund shares/units and short-term MFI debt securities.

39 The abbreviation is based on the label "other financial intermediaries", meaning non-MFI financial institutions other than insurance corporations and pension funds, bearing in mind that MFIs are the money-creating sector. Some public institutions are also part of the money-holding sector, but these are of negligible consequence.

40 See ECB (2006b).

in periods of buoyant economic activity, both owing to a build-up of internal funds and in anticipation of investment in productive and working capital. And OFIs' money demand shows higher interest rate sensitivity than that of the other sectors, reflecting that many funds in this sector are managed by professional investors who continuously seek to optimise their returns.

As regards the stability of these sectoral money demand equations, it appears that the demand for M3 deposits by NFCs and OFIs remained relatively stable from the early 1990s to the late 2000s. By contrast, conventional specifications of household demand for M3 demonstrate some signs of statistical instability over this period. This is not surprising, given that household holdings represent the bulk of the M3 aggregate, and therefore mimic its behaviour.

Against this background, a series of subsequent papers have attempted to deepen understanding of sectoral money demand by allowing different arguments in each sectoral demand equation.[41] For the corporate sector, the sectoral analysis was complemented by an evaluation of firm-level survey data.[42]

Given the role played by special investment vehicles during the initial phases of the financial turmoil in 2007, analysis of the OFI sector is of particular relevance. This sector encompasses a broad set of heterogeneous institutions, including a number of off-balance-sheet vehicles central to the securitisation process. On occasion,[43] the integrity of the euro area monetary data has been called into question, given the magnitude of off-balance-sheet activity conducted through such vehicles. As explained in ECB (2009), the Eurosystem's statistical framework has fortunately proved robust to these challenges. This is one example of where an in-depth analysis of the sectoral components of M3 has helped to deepen the ECB staff's appreciation of the financial behaviour driving monetary and macroeconomic developments.

4 POLICY IMPLICATIONS OF NEW EURO AREA MONEY DEMAND MODELS

A rich body of money demand analysis has been developed at the ECB in recent years. What implications has this work had for the framework of monetary analysis and, ultimately, for monetary policy decisions?

The (statistical) stability of euro area broad money demand has been re-established. This is an important achievement. It demonstrates that the real-time assessment of monetary developments by ECB staff over the past challenging decade can

41 See Seitz and Von Landesberger (2010) for the household sector, Martinez-Carrascal and Von Landesberger (2010) for the NFC sector and Moutot et al. (2007) for the OFI sector.

42 In the context of the Eurosystem's research network on household finances and consumption, a survey is currently being undertaken which promises to allow such a micro study to be conducted also for the household sector. Unfortunately, the first euro area-wide wave of household survey data will only become available in 2011.

43 And, in particular, in those jurisdictions where disintermediation of financial services has proceeded further than in the euro area.

be embodied in money demand models in a manner that meets the standards imposed by the conventional battery of econometric tests. Moreover, these results represent an important – but, by necessity, ex post – validation both of the conduct of monetary analysis since the introduction of the euro and, by implication, of the monetary policy decisions that were based – at least in part – thereon.

But codifying the past behaviour of money demand does not imply that the new, extended money demand models will remain stable into the indefinite future. Indeed, signs of a re-emergence of instability are already apparent, even though they have yet to lead to model failure in a formal statistical sense. Experience suggests that such instabilities may be inevitable in an environment of perpetual structural change in an innovative financial system. Moreover, the repercussions of the financial crisis – in regulatory and behavioural terms – for financial institutions and money-holders are unlikely to leave the new money demand equations unscathed.

From the positive perspective of developing a better understanding of monetary developments, such failures are far from catastrophic. On the contrary, the manner and timing of such failures represent important triggers and guides for new analysis. As documented by Fischer et al. (2008), the ECB's conduct of monetary analysis proceeds in precisely this way. And the resulting understanding of monetary developments has been enriched through this evolutionary approach.

However, the ECB has always viewed monetary analysis as instrumental: its purpose is not simply to explain (still less to control) monetary dynamics, but rather to extract information from monetary developments that can provide guidance for monetary policy decisions that serve the maintenance of price stability over the medium term. Do recent improvements in money demand models support this objective?

There is a danger that improvements in money demand models represent a Pyrrhic victory: the considerable (and ultimately successful) efforts made to re-establish stability have led to the development of models that offer less immediate or straightforward guidance for policy decisions. As illustrated in the previous section, extended money demand models do not yield the simple indicators of risks to price stability (expressed in terms of money growth or monetary overhangs) that their conventional predecessors purported to do.

Yet the distinction between analysis that is difficult and analysis that is important needs to be kept in mind. There can be little doubt that (inter alia) the changing structure of the financial system has rendered the real-time analysis of monetary developments more difficult. The need to extend and refine money demand models in the ways described above is proof of this fact. However, experience – not least that of the financial crisis – also suggests that monetary developments and bank behaviour have become, if anything, more important in recent years as guides to the outlook for the economy and price developments. The simple fact that analysis has become more complex does not mean that it should be discontinued. On the contrary, to the extent that the importance of monetary analysis has been confirmed, greater efforts are required to meet the challenges posed by the increasing complexity of the financial and monetary system, and its interactions with the rest of the economy.

The development of money demand models should be seen in this light. A number of general messages shine through. The robust relationship between trend developments in money and prices has not been challenged. But it is apparent that deviations of monetary developments from their long-term "norm" consistent with price stability can be significant and protracted. Understanding the reasons for these deviations serves to better identify the underlying monetary trends that may pose longer-term risks to price stability. And the deviations themselves may contain key information – about investor attitudes regarding risk, about bank funding and the loan supply, and about the risks to asset price developments – that is important in its own right.

By their nature, stable money demand models explain monetary developments, and thus serve the required decomposition of observed monetary dynamics into the relevant trend and cyclical components. It is through this mechanism that the enhanced money demand models developed in recent research contribute to a richer monetary analysis, and thus to better monetary policy decisions.

5 CONCLUDING REMARKS

In the introduction, money demand models were said to be an unglamorous, yet crucial, component of monetary analysis. Recent research undertaken as part of the ECB's agenda for enhancing monetary analysis has confirmed this view.

In the course of pursuing this research, progress has been made. Money demand stability has been re-established and understanding of monetary developments has been codified and enriched. All this represents a considerable achievement.

However, the new money demand models developed in recent years also raise questions about many of the simple monetary indicators constructed on the basis of an earlier generation of conventional money demand equations. A more nuanced interpretation of such indicators is required. Monetary analysis has become more complex, and thus potentially more difficult to communicate.

But this does not mean that money demand is any less important. On the contrary, the financial crisis suggests that understanding monetary developments is a crucial part of a robust framework for monetary policy deliberations. And money demand models have a key role to play in developing and refining that understanding, even if recent research demonstrates that it is overly optimistic to believe that such models offer a short cut to normative monetary policy conclusions.

REFERENCES

Barnett, W.A. (1980), "Economic monetary aggregates: an application of aggregation and index number theory", *Journal of Econometrics*, Vol. 14(1), pp. 11-48.

Barnett, W.A. (2007), "Multilateral aggregation-theoretic monetary aggregation over heterogeneous countries", *Journal of Econometrics*, Vol. 136(2), pp. 457-482.

Benati, L. (2009), "Long run evidence on money growth and inflation", *Working Paper Series*, No 1027, ECB.

Beyer, A. (2009), "A stable model for euro area money demand: revisiting the role of wealth", *Working Paper Series*, No 1111, ECB.

Brand, C. and Cassola, N. (2004), "A money demand system for euro area M3", *Applied Economics*, Vol. 36, pp. 817-838.

Bruggeman, A., Camba-Méndez, G., Fischer, B. and Sousa, J. (2005), "Structural filters for monetary analysis: the inflationary movements of money in the euro area", *Working Paper Series*, No 470, ECB.

Calza, A., Gerdesmeier, D. and Levy, J. (2001), "Euro area money demand: measuring the opportunity costs appropriately", *Working Paper Series*, No 01/179, IMF.

Carstensen, K. (2003), "Is European money demand still stable?", *Kiel Working Paper Seri*es, No 1179, Kiel Institute for the World Economy.

Carstensen, K. (2006), "Stock market downswing and the stability of European Monetary Union money demand", *Journal of Business and Economic Statistics*, Vol. 25, pp. 395-402.

Coenen, G. and Vega, J.-L. (2001), "The demand for M3 in the euro area", *Journal of Applied Econometrics*, Vol. 16(6) pp. 727-748.

De Bondt, G. (2009). "Euro area money demand: empirical evidence on the role of equity and labour markets", *Working Paper Series*, No 1086, ECB.

De Santis, R., Favero, C.A. and Roffia, B. (2008), "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability", *Working Paper Series*, No 926, ECB.

ECB (1998), "The quantitative reference value for monetary growth", press release, 1 December.

ECB (1999), "The stability-oriented monetary policy strategy of the Eurosystem", *Monthly Bulletin*, January, pp. 39-50.

ECB (2004), "Monetary analysis in real time", *Monthly Bulletin*, October, pp. 43-66.

ECB (2005), "Money demand and uncertainty", *Monthly Bulletin*, October, pp. 57-73.

ECB (2006a), “The changing nature of strong monetary dynamics in recent years”, *Annual Report*, pp. 28-31.

ECB (2006b), “Sectoral money holding: determinants and recent developments”, *Monthly Bulletin*, August, pp. 59-72.

ECB (2006c), “Estimates of housing wealth for households in the euro area”, *Monthly Bulletin*, December, pp. 47-49.

ECB (2007), “Interpreting monetary developments since mid-2004”, *Monthly Bulletin,* July, pp. 51-74.

ECB (2008), “The external dimension of monetary analysis”, *Monthly Bulletin*, August, pp. 71-84.

ECB (2009), “Monetary analysis in an environment of financial turmoil”, *Monthly Bulletin*, November, pp. 81-96.

Engle, R. and Granger, C. (1987), “Cointegration and error correction: representation, estimation and testing”, *Econometrica*, Vol. 55, pp. 251-276.

Fase, M.G. and Winder, C.A. (1998), “Wealth and the demand for money in the European Union”, *Empirical Economics*, Vol. 23(3), pp. 113-156.

Fischer, B., Koehler, P. and Seitz, F. (2004), “The demand for euro area currencies: past, present and future”, *Working Paper Series*, No 330, ECB.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008), “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, pp. 102-175.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2009), “Monetary analysis and monetary policy in the euro area”, *Journal of International Money and Finance*, Vol. 28(7), pp. 1138-1164.

Gerdesmeier, D. (1996), “The role of wealth in money demand”, *Discussion Paper Series*, No 5/1996, Deutsche Bundesbank.

Gerlach, S. and Svensson, L.E.O. (2003), “Money and inflation in the euro area: a case for monetary indicators?”, *Journal of Monetary Economics*, Vol. 50(8), pp. 1649-1672.

Goodhart, C.A.E. (1989), “The conduct of monetary policy”, *Economic Journal*, Vol. 99(2), pp. 293-346.

Gorton, G.B. (2008), “The Panic of 2007”, in Federal Reserve Bank of Kansas City, *Maintaining stability in a changing financial system*, Kansas City.

Greiber, C. and Lemke, W. (2005), “Money demand and macroeconomic uncertainty”, *Discussion Paper Series*, No 05/2005, Deutsche Bundesbank.

Greiber, C. and Neumann, M. (2004), “Inflation and core money growth in the euro area”, *Discussion Paper Series*, No 26/2004, Deutsche Bundesbank.

Greiber, C. and Setzer, R. (2004), "Money and housing: evidence for the euro area and the US", *Discussion Paper Series*, No 12/2007, Deutsche Bundesbank.

Hall, S.G., Hondroyiannis, G., Swamy, P.A.V.B. and Tavlas, G. (2008), "A portfolio balance approach to euro area money demand in a time varying environment", Bank of Greece.

Hall, S.G., Henry, S.G.B. and Wilcox, J.B. (1989), "The long-run determination of the UK monetary aggregates", *Discussion Paper Series*, No 41, Bank of England.

Hallman, A., Porter, R. and Small, A. (1991), "Is the price level tied to the M2 monetary aggregate in the long run?", *American Economic Review*, Vol. 81(3), pp. 841-857.

Hendry, D. (1995), *Dynamic econometrics*, Oxford University Press, p. 32.

Johansen, S. (1995), "Identifying restrictions of linear equations – with applications to simultaneous equations and cointegration", *Journal of Econometrics*, Vol. 69, pp. 111-132.

King, M.A. (2002), "No money, no inflation", *Quarterly Bulletin*, Bank of England, pp. 162-177.

Lucas, R.E. (1996), "Monetary neutrality", *Journal of Political Economy*, 104(3), pp. 661-682.

Martinez-Carrascal, C. and von Landesberger, J. (2010), "Explaining the money demand of non-financial corporations in the euro area: a macro and a micro view", *Working Paper Series*, ECB, forthcoming.

Masuch, K., Pill, H. and Willeke, C. (2001), "Framework and tools of monetary analysis", in Klöckers, H.-J. and Willeke, C. (eds.), *Monetary analysis: tools and applications*, ECB, pp. 117-144.

McCandless, G.T. and Weber, W.E. (1995), "Some monetary facts", *Quarterly Review*, Vol. 19, Federal Reserve Bank of Minneapolis, pp. 529-538.

Moutot, P., Gerdesmeier, D., Lojschová, A. and Von Landesberger, J. (2007), "The role of other financial intermediaries in monetary and credit developments in the euro area", *Occasional Paper Series*, No 75, ECB.

Pill, H. and Rautanen, T. (2006), "Monetary analysis: the ECB experience", *The ECB and its watchers VII*, Centre for Financial Studies, www.ifk-cfs.de/papers/20060505ecb_pill_document.pdf.

Pill, H. and Pradhan, M. (1994), "Monetary aggregation: a reconciliation of theory and central bank practice", *Working Paper Series*, No 94-118, IMF.

Rotemberg, J.J., Driscoll, J.C. and Poterba, J.M. (1995), "Money, output, and prices: Evidence from a new monetary aggregate", *Journal of Business and Economic Statistics*, Vol. 13(1), pp. 67-83.

Seitz, F. and von Landesberger, J. (2010), "Household money holdings in the euro area: an explorative investigation", *Working Paper Series*, ECB, forthcoming.

Stracca, L. (2004), "Does liquidity matter? Properties of a Divisia monetary aggregate in the euro area," *Oxford Bulletin of Economics and Statistics*, Vol. 66(3), pp. 309-331.

Stracca, L. (2003), "The functional form of the demand for euro area M1", *Manchester School*, Vol. 71(2), pp. 172-204.

Vlassopoulos, T. (2010), "New Divisia monetary aggregates for the euro area: construction and empirical properties", mimeo, ECB.

Von Landesberger, J. (2007), "Sectoral money demand models for the euro area based on a common set of determinants", *Working Paper Series*, No 741, ECB.

ANNEX I

MONEY DEMAND STABILITY AND THE ROLE OF MONEY IN MONETARY POLICY-MAKING

1 INTRODUCTION[44]

After 2001, evidence emerged of statistical instability in conventional specifications of the demand for euro area M3 (originally estimated using quarterly data for the period 1980-99), at least on the basis of standard econometric tests. This annex explores the implications of such evidence for the role of money in the ECB's monetary policy strategy and the conduct of the ECB's monetary analysis.

2 DEFINITIONS OF STABILITY

In the context of money demand, the term stability has a spectrum of meanings that range from a broad interpretation of the relationship between money and prices, on the one hand, to a narrow, more technical definition related to the application of a standard battery of statistical tests to a particular specification of money demand, on the other.

The broader interpretation of stability focuses on the possibility of identifying a stable long-run relationship between money growth and inflation. It is associated with the view that the underlying link between monetary developments and their main macroeconomic determinants (prices, aggregate demand and interest rates) is systematic. Satisfaction of the requirements of this broad definition of stability is a maintained hypothesis for the conduct of monetary analysis: it is the existence of some underlying systematic relationship between money and prices that makes understanding and interpreting monetary developments meaningful input to monetary policy decisions aimed at maintaining price stability.

The narrow definition of stability refers to the constancy, over time, of parameters in a particular money demand specification for a specific monetary aggregate.[45] The rejection of parameter constancy only has meaning in the context of the specific empirical model (i.e. a chosen functional form, choice of variables, estimation period and method). Only such a narrow definition is open to formal empirical testing. And it naturally forms an important basis for assessing the value of specific tools used to conduct monetary analysis, rather than the value of conducting monetary analysis itself.

44 This annex was prepared by Andreas Beyer, Björn Fischer and Julian von Landesberger.
45 Hendry (1995).

Given that the latter, narrow definition is statistically verifiable in available data using standard econometric techniques, it has been at the forefront of the analysis of money demand stability in the discussion of the ECB's monetary analysis.

3 EMPIRICAL APPLICATION: PARAMETER STABILITY IN COINTEGRATION MODELS

As discussed briefly in the main text, money demand models are typically estimated using cointegration techniques. Cointegration allows the evolution of economic variables to be modelled as so-called "error correction mechanisms" (and even implies that this is possible), in which variables adjust to their long-run equilibrium over time (typically specified in levels).

In the academic literature, it is now widely acknowledged that there are potential drawbacks of this empirical strategy. They do not provide a fully structural, micro-founded interpretation of behaviour, and thus do not distinguish between (or identify) money demand and money supply. Empirical relationships that have remained empirically stable over a certain time horizon may suffer from parameter non-constancy, owing (inter alia) to shifts in the policy regime (an application of the Lucas critique), structural changes in the financial sector and changes in agents' behaviour and portfolio choices. More practical issues concern whether the specific time series chosen for modelling purposes represent a suitable operationalisation of the underlying economic concept. For example (and as discussed in the main text), it remains open to question whether the monetary aggregate M3 – a statistical construct – meaningfully captures the economic concept of money.

Nonetheless, room remains for a continued estimation and use of empirical money demand models based on cointegration methods. For such models, the objective may not be to provide the best representation of theoretical priors, but rather to capture parsimoniously the driving forces and co-movements of money and prices evident in the data.

The empirical framework generally used to investigate money demand is the cointegrated vector autoregression (VAR), which specifies both the long-run relationships between the variables and their short-run behaviour. An important parameter of this model is the number of long-run relationships present in the model (i.e. the so-called cointegration rank), which should be constant over time. The results obtained from stability tests are conditional on the correct choice of the number of long-run relationships. Moreover, a failure to detect a long-run relationship may be considered evidence that the statistical long-run relationship to which the variables should converge is not stable. Within the framework of parameter constancy, the cointegration rank parameter plays an important role.

When investigating parameter constancy, three different sets of parameters need to be examined, namely the cointegration rank, the parameters entering the long-run money demand equation and the parameters forming the short-run dynamics of the estimated system (which are typically given little behavioural interpretation).

In practice, these three elements are assessed in a sequential manner. First, the long-run properties of the system need to be investigated and assessed with respect to the number of long-run relationships. This is a precondition for the application of stability tests to the other parameters. Second, the stability

Table A1.1 Overview of studies of stability of demand for euro area M3

Paper	*Method*	*Sample*	*CI rank*	*y*
Coenen and Vega (2001) specification				
Coenen and Vega (2001)	VAR	Q4 1980 - Q2 1997	3	1.14
Early models				
Golinelli and Pastorello (2002)	VAR	Q1 1980 - Q4 1997	3	1.37
	Pool			1.47
Funke (2001)	FMOLS	Q1 1980 - Q4 1998	1	1.21
Gerlach and Svensson (2003)	SEECM	Q1 1981 - Q4 1998	1	1.06
Dedola et al. (2001)	VAR	Q1 1982 - Q4 1999	2	1.26
	Pool			1.16
Brand and Cassola (2004) specification				
Brand and Cassola (2004)	VAR	Q1 1980 - Q3 1999	3	1.33
Kontolemis (2002)	VAR	Q1 1980 - Q4 2000	-	1.35
				1.04
Second vintage specification				
Kontolemis (2002)	VAR	Q1 1980 - Q3 2001	2	1.00
Cassola and Morana (2004)	SVAR	Q1 1980 - Q4 2000	3	1.10
Beyer and Artis (2004)	VAR	Q1 1980 - Q4 2000	3	1.00
Calza et al. (2001) specification				
Calza et al. (2001)	VAR	Q1 1980 - Q4 2001	1	1.33
Carstensen (2006)	VAR	Q1 1980 - Q4 2004	1	1.25
Greiber and Lemke (2005)	VAR	Q1 1980 - Q4 2004	1	1.26
Bruggemann et al. (2003) specification				
Bruggeman et al. (2003)	VAR	Q2 1980 - Q4 2001	2	1.38
Further specifications				
Beyer (2009)	VAR	Q1 1980 - Q4 2007	2	1.70
Boone et al. (2005)	VAR	Q1 1970 - Q4 2003	2	1.00
Dreger and Wolters (2006)	VAR	Q1 1983 - Q4 2004	1	1.24
Avouyi-Dovi et al. (2006)	VAR	Q1 1987 - Q4 2004	2	1.00
De Santis et al. (2008)	VAR	Q1 1980 - Q3 2007	3	1.84

Note: y = real GDP; s = short-term interest rate; l = long-term interest rate; s_{OWN} = own rate of return on M3; r_{eq} = return on equity; σ = measure of uncertainty; *whh* = nominal housing wealth; π = inflation; $(q - e)$ = price/earnings ratio.

of the long-run parameters is investigated, taking the stability of the short-run parameters as given. Any instability of the long-run relationships would pose significant problems for using the model to conduct monetary analysis, since the benchmark constituted by the model against which monetary developments are

s	*l*	S_{own}	*Other*	*Evidence presented against stability of model*	*Test applied*
Coenen and Vega (2001) specification					
0.82	-0.82		π.-1.46		
Early models					
	-0.67				
	0.07				
-0.003					
1.005	-1.005		*t*: 0.285		
0.41	-3.36	3.36			
-1.27	-4.12	4.12			
Brand and Cassola (2004) specification					
	-1.61				
	-0.6		*t*: -0.002		
0.06	-0.5				
Second vintage specification					
-1.70			r_{eq}:-0.08	Instability in Brand/Cassola	
			r_{eq}:0.06		
	-6.15				
Calza et al. (2001) specification					
-0.72		0.72			
-1.87		1.87	r_{eq}:0.14 σ: 0.04	Instability in CGL	Andrews-Kim test Nyblom test
-1.20		1.20	σ: 0.71		
Bruggemann et al. (2003) specification					
-0.81		1.31			
Further specifications					
			(Δ whh-π): -4.1	Instability in CGL	Hansen-Johansen test Ploberger et al. test Nyblom test Recursive Chow Standard misspecification tests
-0.01	-0.004		*W*: 0.27 π. -5.12		
-0.01	-0.04	0.01	r_{eq}:0.05	Instability in Avouyi-Dovi	
	l^{EA}: 1.37, l^{US}: -1.37		$(q^{EA} – e^{EA})$: 0.38 $(q^{UA} – e^{US})$: -0.38	Instability in CGL	Nyblom test Chow forecast test Recursive analysis Standard misspecification tests

evaluated would then lack economic meaning. Third, assuming the stability of the long-run parameters, the complementary hypothesis regarding the stability of the short-run parameters is analysed.

The main advantage of assuming the stability of a subset of parameters is that when all parameters are allowed to vary simultaneously, distinguishing between sources of instability becomes very difficult. However, the results of the standard stability tests are conditional on the assumed stability of the remaining parameters. They thus need to be interpreted carefully: statements that "money demand is stable (or unstable)" need to be evaluated carefully.

By implication, empirical evidence for parameter non-constancy can, in principle, take three forms: (i) a long-run relationship between money and its determinants cannot be found; (ii) the long-run parameters are not constant; or (iii) the short-run parameters are not constant. However, given the estimation procedure for cointegrated VAR models, any instability of either of the two latter forms invariably affects the power of cointegration tests, and thus the ability to find a long-run relationship.

Table A1.1 presents an overview of available evidence on empirical models for the demand for euro area M3 published since 1999. The majority of the models were estimated for M3 using the cointegrated VAR methodology discussed above. At the outset of Stage Three of Economic and Monetary Union, these studies found a stable relationship between a set of determinants and real money holdings. (The table also reports on three panel studies, which imply significant heterogeneity in the long-run money demand behaviour at the country level, even after the introduction of the euro.)

Most studies using cointegrated VARs report a cointegration rank of more than one, with the notable exception of Calza et al. (2001). The existence of more than one long-run relationship in the model typically reflects a term structure relationship (between the level of short-term and long-term interest rates) or the Fisher equation (between the level of nominal interest rates and the inflation rate). In the presence of multiple cointegration relationships, the rejection of parameter constancy in the long-run relationship may affect any or all of the parameters.

4 POLICY-RELEVANT IMPLICATIONS OF INSTABILITY IN MONEY DEMAND MODELS

As already discussed in the main text, empirical evidence (summarised in Table A1.1) points to an instability – at least in the narrow technical sense associated with standard statistical tests – of conventional demand for money specifications for euro area M3. What are the implications for the analysis of monetary developments for monetary policy purposes?

First, it must be recognised that this concept of instability relates to a specific empirical model. Moreover, such instability may come from various sources (measurement problems; omitted variables; shifting parameters). Either way, evidence of parameter non-constancies in empirical models of money demand may simply reflect deficiencies in those specific models. Evidence that specific models are unstable does not necessarily imply that money demand in the broader definition is unstable, still less that information of relevance for the conduct of monetary policy and the assessment of risks to price stability cannot be extracted from monetary developments.

Second, it is possible that the instability of empirical money demand models reflects the omission of important determinants of money demand. In such cases, the evolution of monetary developments will be informative about the evolution of the missing variable. Since such missing variables may be latent and may not have good direct empirical proxies, such a situation rationalises the close monitoring of monetary developments (as argued by Nelson (2003) in the case of interest rate spreads) even if money demand is unstable. When observing parameter non-constancy for a certain model specification, one cannot distinguish between model residuals that signal an "instability of the model" and those that signal an "accumulation of excess liquidity". It should also be noted that any judgment on parameter non-constancy that is based on empirical tests is to some extent arbitrary as it is always the user who decides on the critical value and the significance level, for which there are conventions, but not objective choices.

Third, since monetary analysis has to be conducted in real time, one does not have the luxury of waiting until the statistical tests are giving sufficiently strong signals before coming to an interpretation of recent monetary developments. Instead, monetary analysis needs to be based on a broad set of indicators and has to continuously examine a broad set of data, information and functional forms to identify possible factors that shift money demand in order to be able to extract the signals from money. In principle, such analysis can help to identify whether instabilities found in a money demand equation do indeed reflect structural factors, so that the resulting evolution of money does not necessarily imply risks to price stability, or whether the observed money growth does indeed constitute a warning signal. Still, a prolonged observation of parameter non-constancy leaves the analyst with great uncertainty regarding the "correct" interpretation of those instabilities.

Such considerations inform the discussion presented in the main text. The estimation of augmented money demand systems that demonstrate stability through the first decade of the 21st century involve the inclusion of wealth and asset price variables that were omitted from the conventional specifications reported in Table A1.1, while the real-time analysis reported in Fischer et al. (2008) discusses how the (in)stability of conventional models was addressed for policy purposes.

REFERENCES

Avouyi-Dovi, S., Brun, M., Dreyfus, A., Drumetz, F., Oung, V. and Sahuc, J.-G. (2006), "La fonction de demande de monnaie pour la zone euro: un réexamen", Working Paper, No 142, Banque de France.

Beyer, A. and Artis, M. (2004), "Issues on money demand: the case of Europe", *Journal of Common Market Studies*, Vol. 42, pp. 717-736.

Beyer, A. (2009), "A stable model for euro area money demand: revisiting the role of wealth", *Working Paper Series*, No 1111, ECB.

Boone, L., Mikol, F. and Van den Noord, P. (2005), "Wealth effects on money demand in EMU: econometric evidence", *Working Paper Series*, No 411, OECD.

Brand, C. and Cassola, N. (2004), "A money demand system for euro area M3", *Applied Economics*, Vol. 36, pp. 817-838.

Bruggeman, A., Donati, P. and Warne, A. (2003), "Is the demand for euro area M3 stable?", *Working Paper Series*, No 255, ECB.

Calza, A., Gerdesmeier, D. and Levy, J. (2001), "Euro area money demand: measuring the opportunity cost appropriately", *Working Paper Series*, No 179/01, IMF.

Carstensen, K. (2006), "Stock market downswing and the stability of European Monetary Union money demand", *Journal of Business and Economic Statistics*, Vol. 25, pp. 395-402.

Cassola, N. and Morana, C. (2004), "Monetary policy and the stock market in the euro area", *Journal of Policy Modelling*, Vol. 16(6), pp. 387-399.

Coenen, G. and Vega, J.-L. (2001), "The demand for M3 in the euro area", *Journal of Applied Econometrics*, No 16(6), pp 727-748.

De Santis, R., Favero, C.A. and Roffia, B. (2008), "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability", *Working Paper Series*, No 926, ECB.

Dedola, L., Gaiotti, E. and Silipo, L. (2001), "Money demand in the euro area: do national differences matter?", *Banca d'Italia temi di discussione*, No 405, Banca d'Italia.

Dreger, L. and Wolters, R. (2006), "Investigating M3 money demand in the euro area: new evidence based on standard models", *DIW Discussion Paper Series*, No 561, German Institute for Economic Research.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008), "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, pp. 102-175.

Funke, R. (2001), "Money demand in Euroland", *Journal of International Money and Finance*, Vol. 20, pp. 701-713.

Gerlach, S. and Svensson, L. (2003), "Money and inflation in the euro area: a case for monetary indicators?", *Journal of Monetary Economics*, Vol. 50, pp. 1649-1672.

Golinelli, L. and Pastorello, M. (2002), "Modelling the demand for M3 in the euro area", *European Journal of Finance*, Vol. 8, pp. 371-401.

Greiber, C. and Lemke, W. (2005), "Money demand and macroeconomic uncertainty," *Discussion Paper Series*, No 26/2005, Deutsche Bundesbank.

Hendry, D. (1995), *Dynamic Econometrics*, Oxford University Press.

Kontolemis, Z.G. (2002), "Money demand in the euro area: where do we stand (today)?", *Working Paper Series*, No 02/185, IMF.

Nelson, E. (2003), "The future of monetary aggregates in monetary policy analysis", *Journal of Monetary Economics*, Vol. 50, pp. 1029–1059.

ANNEX 2

MONEY DEMAND MODEL FOR THE EURO AREA: AN INTERNATIONAL PORTFOLIO ALLOCATION APPROACH

1 INTRODUCTION[46]

While many studies have shown that monetary developments in the euro area could be explained on the basis of the evolution of prices, economic activity and interest rates in samples of data up to 2001, evidence of parameter instability (at least on the basis of the standard statistical tests) in such specifications has been pervasive in samples extending beyond 2004.[47]

De Santis et al. (2008) address this instability with a model (hereafter referred to as the "DFR model") augmenting conventional money demand specifications with additional explanatory variables associated with cross-border capital flows. Recent evidence suggests that cross-border portfolio investment transactions have played an important role in driving aggregate monetary dynamics in the euro area over the past decade.[48] The DFR model, therefore, sets out to incorporate the impact of international portfolio allocation on euro area money demand, so as to re-establish stability.

2 MONEY DEMAND AND INTERNATIONAL PORTFOLIO ALLOCATION: A THEORETICAL APPROACH

To model the link between euro area M3 and international portfolio flows, De Santis et al. (2008) develop a simple Tobin portfolio framework to analyse asset choice in a two-country, open economy setting.[49] A key element is the structure of asset markets. Five assets are considered: domestic equities and bonds; foreign equities and bonds; and (domestic) money.

The representative consumer in the domestic economy maximises utility subject to an intertemporal budget constraint. Given the opportunity cost of holding money, consumers' money holdings are those required to finance their consumption plans in the current period. With a constant consumption/wealth

46 This annex was prepared by Barbara Roffia.

47 See, inter alia, Coenen and Vega (2001), Brand and Cassola (2004), Calza et al. (2001), Kontolemis (2002), Bruggemann et al. (2003), Gerlach and Svensson (2003), Greiber and Lemke (2005), Avouyi-Dovi et al. (2006), Carstensen (2006), and Dreger and Wolters (2006).

48 See ECB (2005a, 2005b, 2007, 2008).

49 For details of the model, see De Santis et al. (2008).

ratio (b_h),[50] the allocation of the portfolio of each representative agent turns out to be proportional to the Sharpe ratios, and the resulting money demand of the domestic agent ($M_{h,t}$) has the following form:

$$
\begin{aligned}
M_{h,t} &= (1 - b_h)\, W_{h,t} && \text{=>wealth effect} \\
&\times (1 + e[\phi\, (\Phi_{t-1}^{*} - \Phi_{t-1})]\,/2\delta) && \text{=>portfolio allocation effect} \\
&- \Pi_t / 2 && \text{=>firms' valuation effect}
\end{aligned}
\qquad (1)
$$

where $W_{h,t}$ represents domestic wealth, e is a row of ones, ϕ is disposable wealth of the foreign agent relative to disposable wealth of the domestic agent, $\Phi_{t-1} = E_t\, r_{t+1} - i_{h,t} + \sigma^2_{t+1}$ is a vector of the excess returns in local currency expected by the domestic agent, $\Phi_{t-1}^* = E_t^*\, r_{t+1} - i_{h,t} + \sigma^{*2}_{t+1}$ is a vector of the excess returns in local currency expected by the foreign agent, δ represents the coefficient of relative risk aversion and Π_t is the aggregate asset value of domestic and foreign firms. Wealth-owners hold a diversified portfolio consisting of money, as well as risky domestic and foreign assets (stocks and bonds).[51] In the long run, money balances are a positive function both of the relative disposable wealth and of the differentials between the Sharpe ratios expected by foreign and domestic agents, whereas they are a negative function of half of the firms' aggregate asset value.

On the basis of this stylised model, in the long run money balances are a positive function of the following:

1. Domestic real disposable wealth, since money is held as part of a wealth portfolio (in the empirical analysis, income is used as an (imperfect) proxy for wealth).

2. The ratio of foreign residents' wealth to that of domestic residents (i.e. a "size effect"): if the attractiveness of non-monetary assets increases, foreign demand for these assets will crowd out domestic demand simply because domestic wealth is smaller than foreign wealth. The resulting purchases of assets from domestic residents by non-residents imply a rise in domestic money holdings.

3. The differential between risk-adjusted excess returns expected by non-resident and domestic agents on the same asset (i.e. a "portfolio allocation effect"). In a closed economy, any attempt to shift out of money into non-monetary assets (for instance, when the risk-adjusted excess returns on assets rise) will simply transfer money from the purchaser to the seller of the asset, leaving the aggregate stock of money unchanged.[52] In an open economy, transactions between money holders and non-residents (which are not part of the money-holding sector) can result in changes in aggregate M3 holdings.

50 This hypothesis is supported by a recent work by Skudelny (2009), who finds a long-run cointegrating relationship between euro area consumption and wealth.

51 For details, see De Santis et al. (2008).

52 In a closed economy, the substitution effect would still arise if the transaction occurs between the money-holding sector and the MFI sector.

Indeed, a rise in expected excess returns, for example, does not necessarily imply a lower demand for money. In fact, if risk-adjusted excess returns on domestic and/or foreign assets rise, non-resident investors are also willing to buy domestic and/or foreign assets from domestic agents. Therefore, the portfolio model does not yield unambiguous predictions about the effect of an increase in risk-adjusted excess returns on the demand for money.

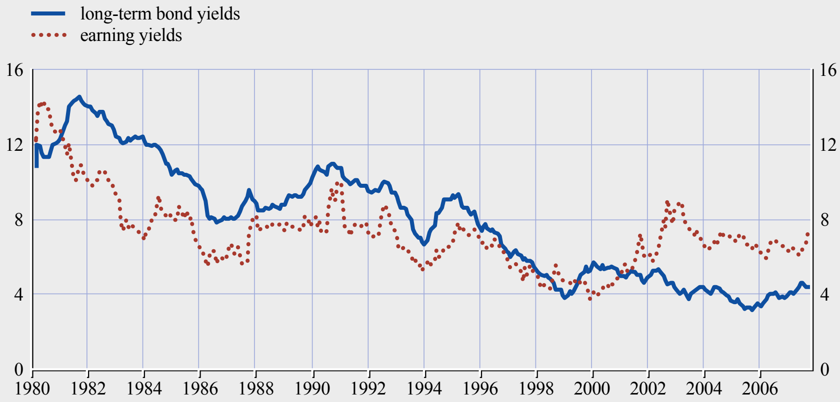
All in all, the model characterises money demand as part of a broader portfolio allocation problem, where the returns on domestic and foreign assets, as well as the own return on M3, influence domestic money holdings. This portfolio approach thus relates monetary developments to asset price dynamics in an international context.

3 A NEW SPECIFICATION OF THE EURO AREA MONEY DEMAND

The theoretical model suggests that the relative portfolio allocation among risky assets depends on asset returns expected by domestic and non-resident agents on domestic and foreign assets, relative to the own rate of return on money. These return differentials are modelled in the money demand system by applying an extended version of the so-called FED model (Lander et al. (1997) and Koivu et al. (2005)). The FED model associates declines in excess returns on stocks with the deviation of the price/earnings ratio from the long-term (ten-year government) bond yield. By implication, investors reallocate assets in response to expected falls in returns, causing stock and bond prices to move in a manner that restores equilibrium in the asset markets. The application of this model to the euro area and the United States demonstrates the strong link between the price/earnings ratios and bond yields observed in both economies (as shown in Charts A2.1 and A2.2).

Chart A2.1 Earning yields and long-term (ten-year) bond yields in the euro area

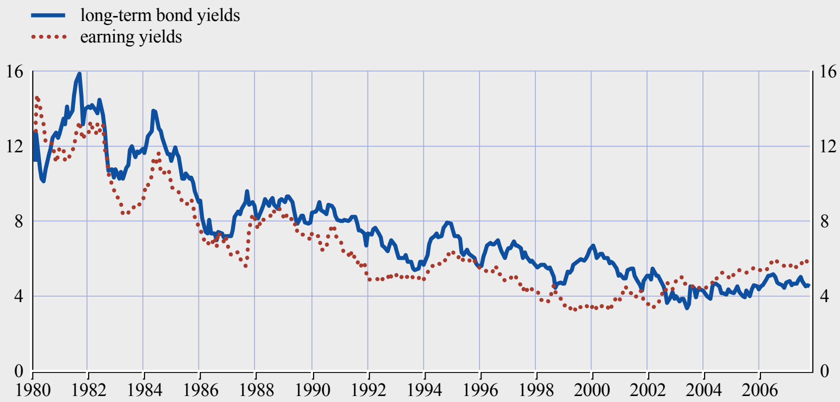
(percentages per annum)



Sources: Bank for International Settlements, ECB calculations and Datastream.

Chart A2.2 Earning yields and long-term (ten-year) bond yields in the United States

(percentages per annum)



Sources: Bank for International Settlements, ECB calculations and Datastream.

On the basis of this finding, the theoretical specification of the long-run money demand function will depend not only on the usual scale variable (which, in our case, will be income), but also on the long-run returns on risky assets:

$$X_t = A(L)X_{t-1} + \upsilon_t$$
$$X_t' = [(m_t - p_t)\, y_t\, i_t^{OWN} (q_t^{EA} - e_t^{EA})\, R_t^{EA} (q_t^{US} - e_t^{US})\, R_t^{US}] \qquad (2)$$

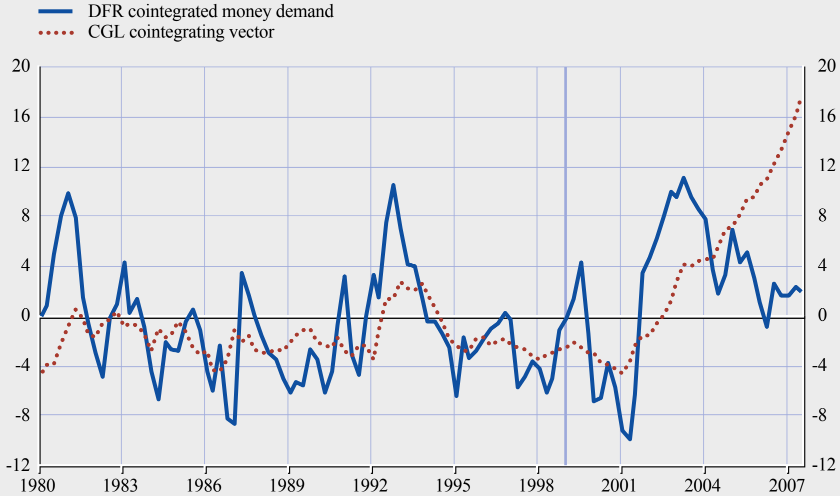
where m_t denotes M3, p_t is the GDP deflator and y_t is real GDP, with all these variables being measured in logarithms.[53] i_t^{OWN} is the OWN rate of return on M3, while $(q_t - e_t)$ represents the price/earnings ratio and R_t the long-term interest rate for the euro area (EA) and the United States (US) respectively.[54] This model is estimated over the sample covering the period from the first quarter of 1980 to the third quarter of 2007. The application of the Johansen test points to the existence of three cointegrating vectors. Applying a series of restrictions, a long-run money demand for the euro area and a FED model for both the euro area and the United States are found, with the following parameter estimates:[55]

$$m_t - p_t = \beta_{10} + \underset{(0.046)}{1.84}\, y_t + \underset{(0.035)}{0.38}\, (q_t^{EA} - e_t^{EA}) - \underset{(0.035)}{0.38}\, (q_t^{US} - e_t^{US}) + \underset{(0.42)}{1.37} R_t^{EA} - \underset{(0.42)}{1.37} R_t^{US}$$
$$(q_t^{EA} - e_t^{EA}) = \beta_{20} + \underset{(2.92)}{14.11}\, i_t^{OWN} - \underset{(2.24)}{15.83} R_t^{EA} \qquad (3)$$
$$(q_t^{US} - e_t^{US}) = \beta_{30} - \underset{(2.41)}{18.46}\, R_t^{US}$$

53 For more detail on the sources and compilation of the series, see De Santis et al. (2008).
54 The choice of the United States is based on the role that US assets play in global financial transactions.
55 Standard errors are reported in parenthesis.

Chart A2.3 The CGL and DFR money demand models for the euro area

(cointegrating money demand models)



Sources: Based on the Calza et al. (CGL) and the De Santis et al. (DFR) money demand models for the euro area.

All parameters of the three cointegrating vectors are significant, and the model (hereinafter referred to as the DFR model) is stable.[56]

Two main observations are worth noting. First, given that asset prices are relatively volatile series, some volatility is introduced into the residuals of the money demand relationship. At the same time, the series exhibits a fast reversion to the mean. Second, there are linkages between money and asset price developments that run in both directions: disequilibria in any of the three markets encompassed in the model trigger corrective responses in the other markets, as well as in the market in which disequilibrium existed. Turning to the short-run dynamics, analysis of the coefficients suggests that the impact of the three disequilibria is rather pervasive in the system, as many variables react to some or all the disequilibria, thereby emphasising interlinkages between money and asset prices.

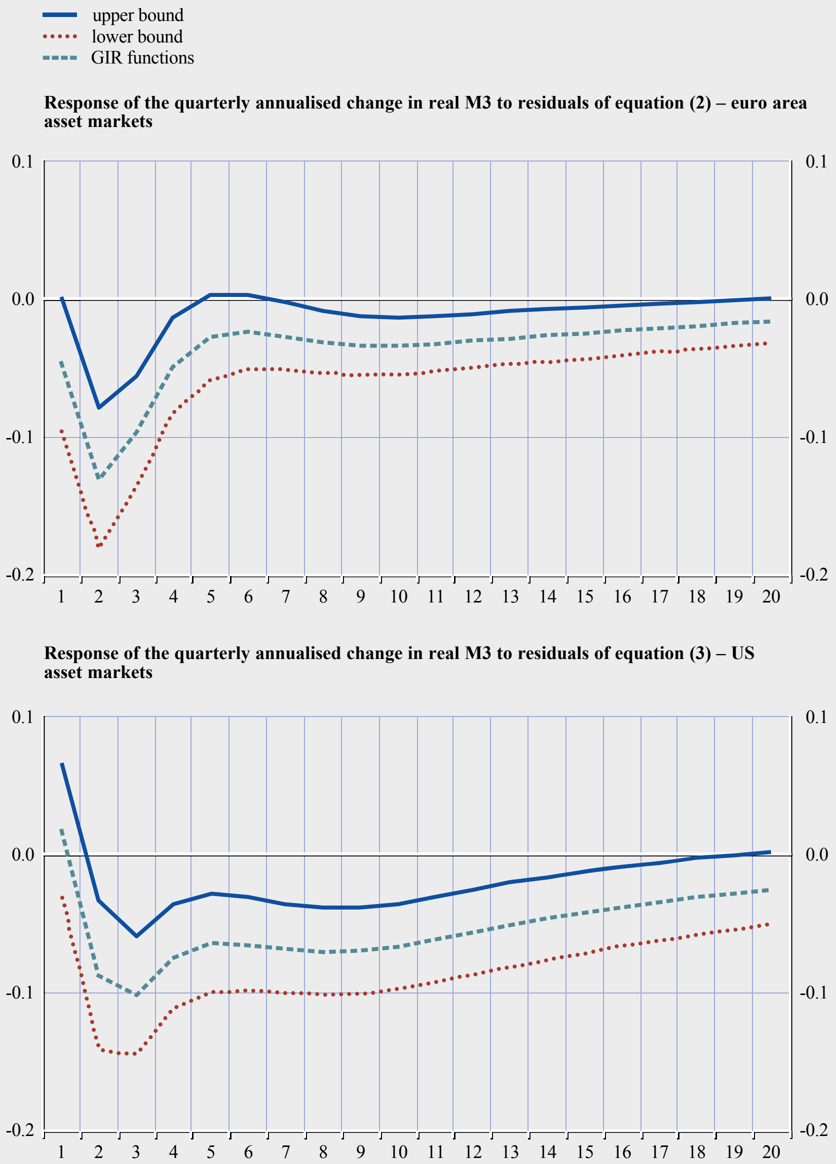
4 THE IMPACT OF ASSET PRICE SHOCKS ON M3 GROWTH

To illustrate the properties of the DFR model, one can investigate the impact of asset price shocks on M3 growth by studying the impulse response to financial markets shocks identified by the model. As a first experiment, the generalised impulse responses (GIRs) of real M3 growth to shocks to disequilibria in the euro area and the US asset markets are reported (see Chart A2.4).

56 Both the structural stability tests and the recursive analysis of the long-run coefficients of the model from 1999 onwards, as well as the Chow forecast test for the short-run parameters, show that all the coefficients are stable and that the identified restrictions are valid for all possible sample splits (see Figures 8A, 8B and 8C in De Santis et al. (2008)).

Chart A2.4 Generalised impulse responses of euro area real M3 growth to disequilibria in the euro area and US financial markets

(one standard deviation innovation; ±1 standard error)

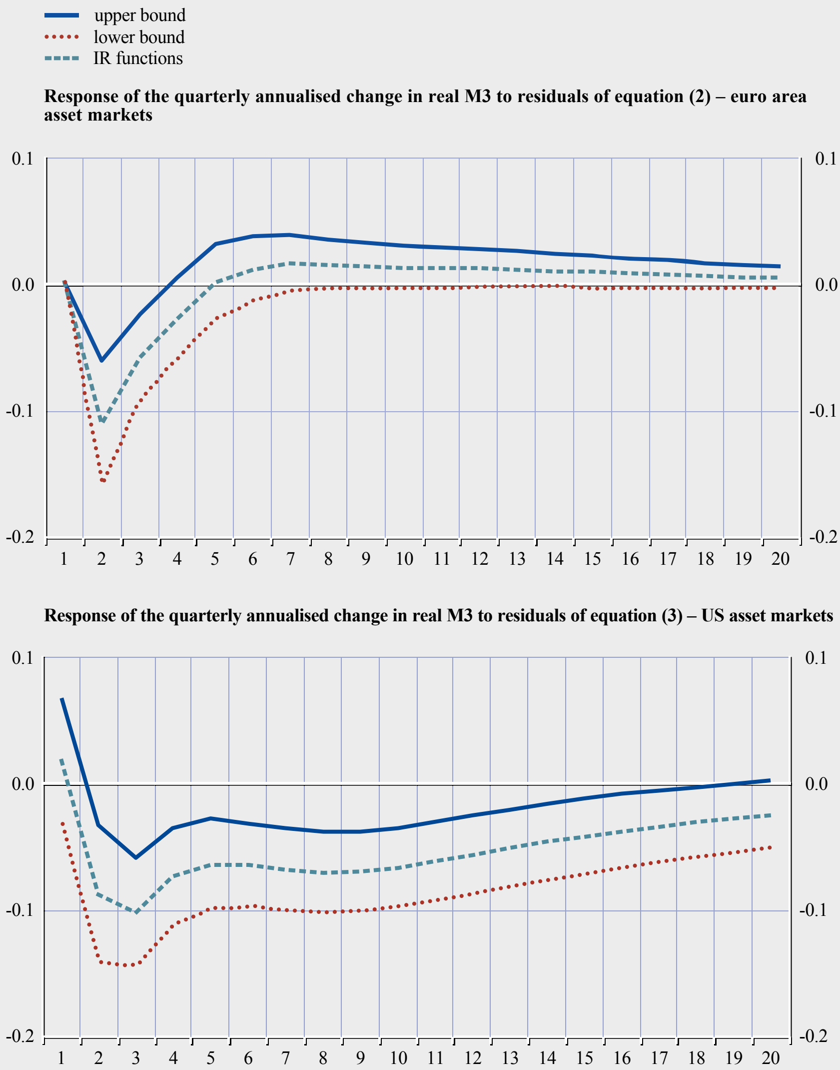


Source: De Santis et al. (2008).

This exercise demonstrates that, if the euro area price/earnings ratio exceeds euro bond yields, the expected decline on euro area equities results in a decline in euro area M3 growth as (in aggregate) non-residents sell euro area assets to domestic residents who pay for them by drawing down their deposit holdings. Such results can be augmented by the identification of shocks based on Cholesky decomposition in a structural VAR context. Assuming euro area asset markets

Chart A2.5 Impulse responses of euro area real M3 growth to structural shocks in the euro area and US financial markets

(one standard deviation innovation; ±1 standard error)



Source: De Santis et al. (2008).

Note: Based on the assumption that US asset markets do not respond to shocks in the euro area markets; while euro area asset markets respond to shocks in US markets.

respond to US markets, and not vice-versa, a natural Cholesky order emerges. The impulse response (IR) of money growth in this setting is very similar to those obtained via GIR analysis (see Chart A2.5).

5 CONCLUDING REMARKS

Since 2001, conventional specifications of euro area money demand have not been able to explain observed monetary dynamics. Given the relationship between M3 developments and cross-border portfolio investment flows identified in the real-time analysis, De Santis et al. (2008) propose a money demand model within which wealth owners hold a diversified portfolio that includes interest-bearing monetary assets and both domestic and foreign assets. The estimated three cointegrating vector system – identifying money demand and asset pricing relationships – is stable over the sample period from the first quarter of 1980 to the third quarter of 2007, illustrating the importance that portfolio shifts related to international capital flows have had for the evolution of monetary developments in the euro area over the past decade.

REFERENCES

Avouyi-Dovi, S., Brun, M., Dreyfus, A., Drumetz, F., Oung, V. and Sahuc, .J-G. (2006), "La fonction de demande de monnaie pour la zone euro: un réexamen", *Working Paper Series*, No 142, Banque de France.

Brand, C. and Cassola, N. (2004), "A money demand system for euro area M3", *Applied Economics*, Vol. 36, pp. 817-838.

Bruggeman, A., Donati, P. and Warne, A. (2003), "Is the demand for euro area M3 stable?", *Working Paper Series*, No 255, ECB.

Calza, A., Gerdesmeier, D. and Levy, J. (2001), "Euro area money demand: measuring the opportunity costs appropriately", *Working Paper Series*, No 179, IMF.

Carstensen, K. (2006), "Stock market downswing and the stability of European Monetary Union money demand", *Journal of Business and Economic Statistics*, Vol. 25, pp. 395-402.

Coenen, G. and Vega, J.L. (2001), "The demand for M3 in the euro area", *Journal of Applied Econometrics*, Vol. 16, pp. 727-748.

De Santis, R., Favero, C.A. and Roffia, B. (2008), "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability", *Working Paper Series,* No 926, ECB.

Dreger, C. and Wolters, J. (2006), "Investigating M3 money demand in the euro area: new evidence based on standard models", *DIW Discussion Paper Series*, No 561, German Institute for Economic Research.

ECB (2005a), "External capital flows and domestic monetary dynamics in the euro area", *Monthly Bulletin*, February.

ECB (2005b), "Recent developments in MFI net external assets", *Monthly Bulletin*, May.

ECB (2007), “Developments in MFIs’ gross external assets and liabilities”, *Monthly Bulletin*, June.

ECB (2008), “The external dimension of monetary analysis”, *Monthly Bulletin*, August.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008), “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, pp. 102-175.

Gerlach, S. and Svensson, L. (2003), “Money and inflation in the euro area: a case for monetary indicators?”, *Journal of Monetary Economics*, Vol. 50, pp. 1649-1672.

Greiber, C. and Lemke, W. (2005), “Money demand and macroeconomic uncertainty”, *Discussion Paper Series*, No 26, Deutsche Bundesbank.

Johansen, S. (1995), “Identifying restrictions of linear equations – with applications to simultaneous equations and cointegration”, *Journal of Econometrics*, Vol. 69, pp. 111-132.

Koivu, M., Pennanen, T. and Ziemba, W.T. (2005), “Cointegration analysis of the FED model”, *Finance Research Letters*, Vol. 2, pp. 248-259.

Kontolemis, Z.G. (2002), “Money demand in the euro area: where do we stand (today)?”, *Working Paper Series*, No 185, IMF.

Lander, J., Orphanides, A. and Douvogiannis, M. (1997), “Earnings, forecasts and the predictability of stock returns: evidence from trading the S&P”, *Journal of Portfolio Management*, Vol. 23, pp. 24-35.

Skudelny, F. (2009), “Euro area private consumption: is there a role for housing wealth effects?”, *Working Paper Series*, No 1057, ECB.

ANNEX 3

MODEL OF MONEY AND WEALTH FOR THE EURO AREA

I INTRODUCTION[57]

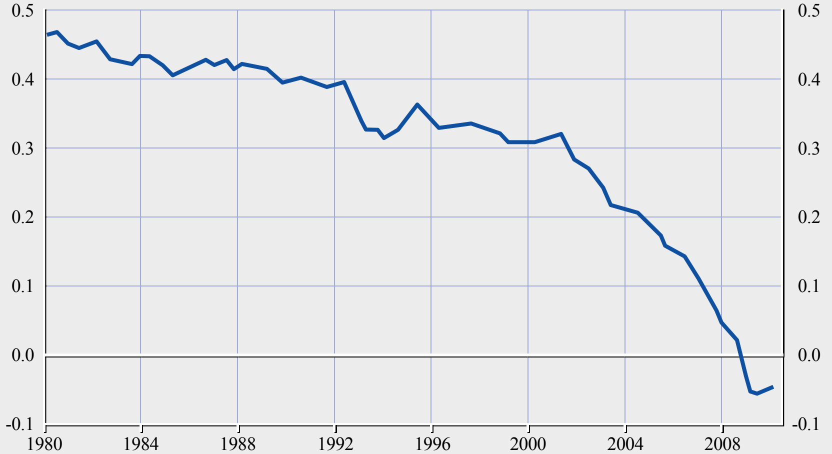
The period since 2002 has proved particularly challenging for euro area money demand models. The income velocity of circulation for the key monetary aggregate M3 demonstrates a break in its long-run downward trend at the start of that period. For example, the emergence of instability (at least on the basis of the standard statistical tests) in the ECB's workhorse money demand model of Calza et al. (2001) (hereafter referred to as the "CGL model") is closely related to the break in trend-velocity (see Chart A3.1).

In a recent paper, Beyer (2009) presents a stable money demand model for the euro area containing a stable long-run money demand relationship. Housing wealth plays an important role in capturing the behaviour of trend-velocity in the first decade of this century. This annex describes the main features of this new model (hereafter referred to as the "MWM model", i.e. the money and wealth model) in a non-technical manner.

57 This annex was prepared by Andreas Beyer.

Chart A3.1 The break of trend income velocity of M3

(difference between the logarithm of nominal GDP and the logarithm of M3)



Source: ECB.

2 THE MWM MODEL

The data set that has been used to estimate the MWM model contains variables for money, output, prices, wealth and interest rates in the euro area. The series are: the real money stock M3 ($m - p$); real GDP (y); the growth in nominal housing wealth (Δwhh); the inflation rate of the GDP deflator (Δp); a short-term three-month money market interest rate (RS); and the own rate of M3 (RO). Apart from housing wealth, these are the same variables as those used in the CGL model.

2.1 MODELLING LONG-RUN MONEY DEMAND FOR THE EURO AREA

The baseline MWM model is estimated for quarterly data from the first quarter of 1980 to the fourth quarter of 2007, and also up to the fourth quarter of 2008, although the 2008 observations for GDP and wealth were still preliminary at the time when the model was estimated. The MWM model hosts two cointegrating relationships. The first is identified as a long-run money demand equilibrium:

$$(m-p)^{*} = \alpha_1 + 1.7y - 4.11\,(\Delta whh - \Delta p) \qquad (1)$$

where the income elasticity is 1.7, significantly larger than unity. This is a rather common finding in the empirical literature on euro area money demand (compare with 1.3 in the CGL model and as much as 1.8 in the DFR model).[58] The second cointegrating relationship represents a long-run wealth growth equilibrium path:

$$(\Delta whh - \Delta p)^{*} = \alpha_2 + 0.84\,(y - 0.006\,trend) - 1.37\,(RS - RO) \qquad (2)$$

Real wealth growth is positively related to trend real GDP and negatively related to the interest rate spread. Chart A3.2 shows the recursive estimates of the long-run coefficients, together with their ±2 standard error bands and the recursive test statistic for the validity of the imposed restrictions in order to identify these long-run relationships.

[58] See Annex 2 to this chapter.

Chart A3.2 Recursive coefficients of cointegrating vectors

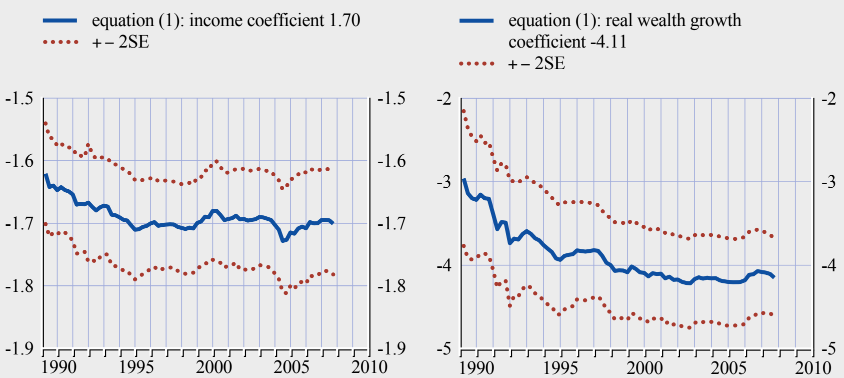
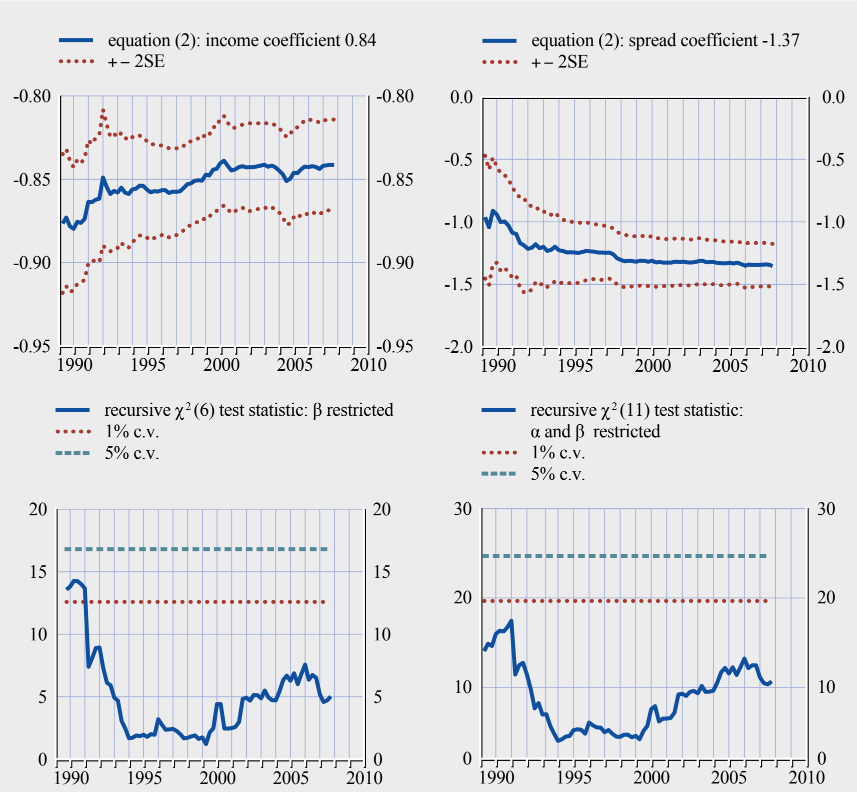


Chart A3.2 Recursive coefficients of cointegrating vectors (cont'd)



Source: Beyer (2009).

The coefficients are stable over time and there are no signs of structural breaks. No dummy variable for outlier correction has been used for the estimation of the model.

2.2 A MONEY DEMAND SYSTEM: ESTIMATING A VECM

Over and beyond establishing stable cointegrated long-run relationships, the MWM model also offers a framework for policy analysis within a small-scale macro-model for the euro area. Each of the variables in the system is modelled in a so-called vector error-correction model (VECM). In its equations, the model is reduced to a parsimonious system, and the way in which the long-run equilibria enter or do not enter the equations gives room for economic interpretation. The most important equation of the MWM model is its error-correction model for money demand itself:[59]

$$\Delta(m-p)_t = 0.017\ (0.002) + 0.43\ (0.09)\ \Delta(m-p)_{t-1} + 0.2\ (0.08)\ \Delta y_{t-2} - 0.34\ (0.09)\ \Delta RS_{t-2}$$

$$-0.05\ (0.01)\ \{(m-p) - (m-p)^*\}_{t-1} + 0.31\ (0.06)\ (\Delta whh - \Delta whh^*)_{t-1} \qquad (3)$$

[59] Standard errors are shown in brackets.

What is shown for the other equations is just whether and, if so, in which direction the two long-run equilibria enter. Short-run dynamics are represented by (•).

$$\Delta y_t = f_y [\{(m-p) - (m-p)^*\}_{t-1}, (\Delta whh - \Delta whh^*)_{t-1}, (\bullet)] \quad (4)$$
$$\qquad (+) \qquad\qquad (-)$$

$$\Delta\Delta whh_t = f_{whh} [(\bullet)] \quad (5)$$

$$\Delta\Delta p_t = f_p [\{(m-p) - (m-p)^*\}_{t-1}, (\bullet)] \quad (6)$$
$$(+)$$

$$\Delta RO_t = f_{RO} [\{(m-p) - (m-p)^*\}_{t-1}, (\bullet)] \quad (7)$$
$$(+)$$

$$\Delta RS_t = f_{RS} [\{(m-p) - (m-p)^*\}_{t-1}, (\Delta whh - \Delta whh^*)_{t-1}, (\bullet)] \quad (8)$$
$$\qquad (+) \qquad\qquad (-)$$

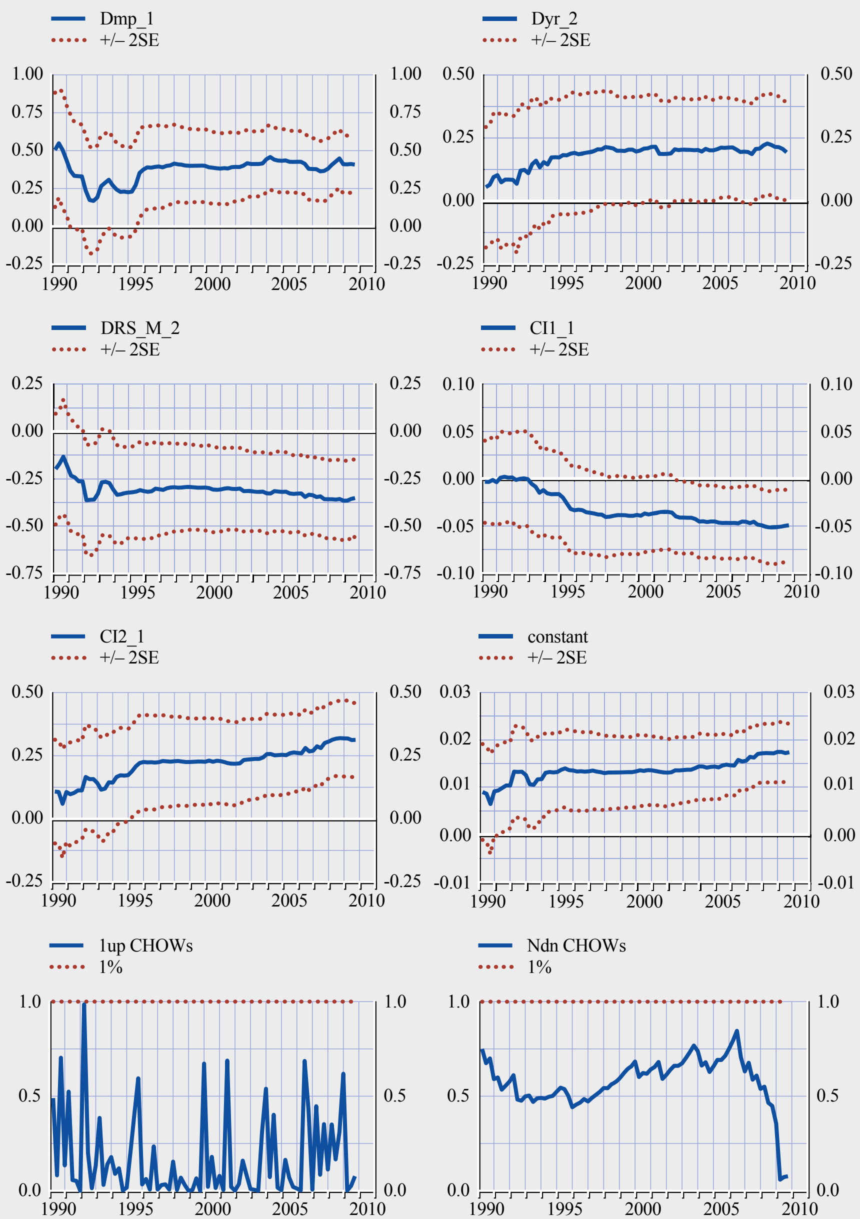
2.3 ECONOMIC INTERPRETATION

In the money demand equation (3), real balances error-correct 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 money stock equilibrium relationship (1) itself. There, real wealth is negatively related to the level of real money balances. The interpretation of the GDP and wealth equations (4) and (5) is rather straightforward. Whereas housing wealth is just an autonomous exogenous process, real GDP is positively related to excess real money balances and is error-correcting to excess long-run growth of real wealth. In addition, the inflation equation allows a conventional interpretation: lagged excess real balances enter with a positive sign. This supports the view that excess long-run money demand precedes an acceleration of inflation. Finally, excess real money balances enter both interest rate equations (7) and (8), whereas excess real wealth growth enters the short rate equation, but not the own rate equation. Equation (8) might be interpreted as a type of empirical policy rule. One result is noteworthy: no other variable enters the wealth equation, but, conversely, wealth enters, inter alia, money demand. This constitutes evidence against the empirical relevance of both an "asset-inflation channel" and a "credit channel", where the latter predicts that the degree of more or less restrictive monetary policy would affect movements in housing wealth.

3 USING THE STABLE MWM MODEL FOR POLICY ANALYSIS: MEASURES OF (EXCESS) LIQUIDITY

The economic recession in the euro area that ensued from the financial crisis saw the sharpest decline in real GDP after World War II. Whereas real GDP growth was still positive in the first quarter of 2008, it was estimated to have shrunk at an annual rate of 5%, or even more, in the fourth quarter. Moreover, the decline in wealth, measured by various indicators, was expected to be dramatic. However, the stability of the MWM model did not suffer, despite the exceptionally marked outliers in some of its explanatory variables. Chart A3.3 shows the recursive estimates of the coefficients of the money demand equation (3). The coefficients remain stable over the entire sample and, as is also evident from the Chow tests in the two bottom panels, there are no signs of structural breaks, neither at times when the CGL and other models broke down, nor during the episode of the current financial crisis.

Chart A3.3 Recursive estimates of the money demand equation

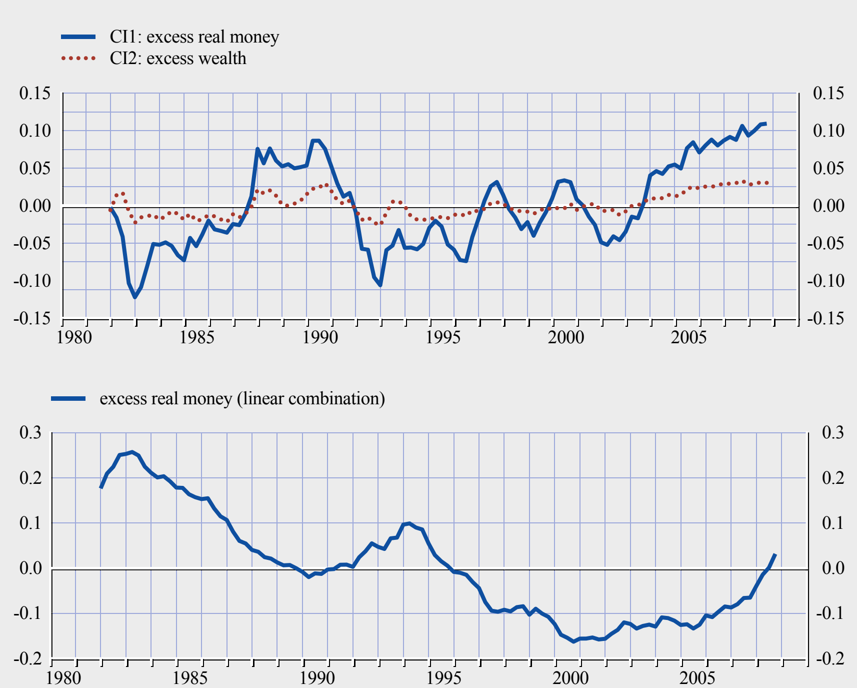


Source: Beyer (2009).

For policy-makers who base decisions on, inter alia, predictions that stem from money demand models, a key challenge consists of judging in real time whether a residual (or "shock") to a model is a "regular" shock or whether it is caused by a structural break in behaviour. The MWM model is able rather well to explain the drop in real money balances that was observed at the beginning of 2008 – precisely when its explanatory variables (GDP and wealth) faced huge and unprecedented negative shocks. This suggests that the MWM model is indeed stable and robust to exogenous shocks over time. Therefore, the model might be suited to provide meaningful benchmarks for measures of excess money.

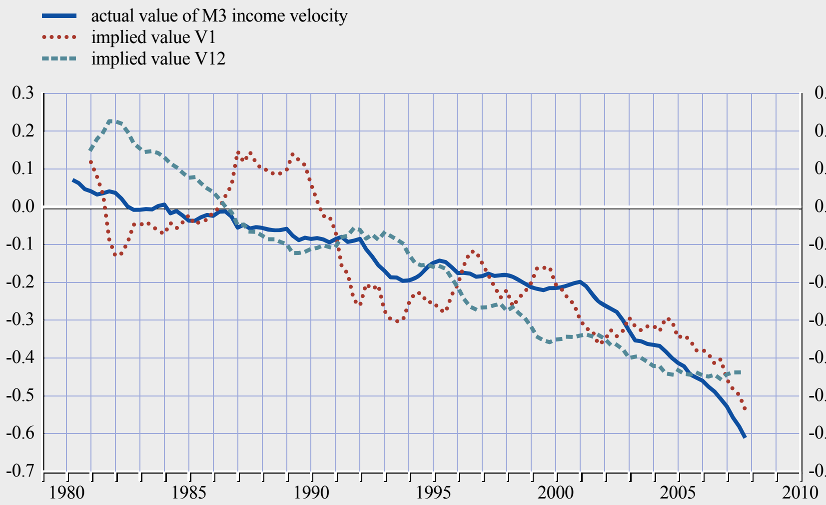
Two alternative versions are presented in Chart A3.4. First, excess money is derived from a partial equilibrium, i.e. the money demand relationship in isolation. Together with the second cointegrating vector, which represents a measure for excess real wealth, this is shown in the upper panel. The lower panel shows the implied linear combination of both cointegrating vectors, which is a more persistent measure of excess liquidity. If a model contains more than one long-run relationship, economic identification of any particular equilibrium relationships is to a large extent arbitrary. In a cointegrating system, basically any linear relationship of cointegrating vectors could potentially yield another valid cointegrating relationship. One possible criterion for an informal plausibility check is to examine what velocity function would be implied by the system of cointegrating vectors that have been estimated in (1) and (2) and how these velocity functions can explain a standard "quantity theory" version for velocity,

Chart A3.4 Mesures for "excess money"



Source: Beyer (2009).

Chart A3.5 M3 velocity – theoretical and implied



Source: Beyer (2009).
Notes: Velocity = – (*m* – *p* – *y*).
V1 = – 0.7014*y* + 4.1146Δ (*whh* – *p*).
V12 = – 1.144 (*RS* – *RO*) + 3.2818Δ (*whh* – *p*) – 0.0043trend.

i.e. [-(*m-p-y*)]. Chart A3.5 presents two empirical measures of velocity. "V1" is just the right-hand side of (1) when CI1 is "solved" for [-(*m-p-y*)]. "V12" is velocity implied by the linear combination of both cointegrating vectors. Given that both empirical velocity measures track the quantity theory measure well, the derived excess liquidity measures in Chart A3.4 appear to be plausible tools for an analytical framework for policy analysis.

4 CONCLUSIONS

The MWM model is an empirically stable money demand model for the euro area. Adding housing wealth to a set of cointegrated variables that contain M3, GDP, prices and interest rates, serves to re-establish a remarkably stable long-run money demand model. Empirically stable long-run equilibrium relationships for excess real balances and wealth disequilibria feed into the equations of a small-scale macro-model. Within that model, portfolio and wealth effects determine the growth of real money balances in opposite directions. Excess money holdings feed into the inflation equation with positive sign. Housing wealth is not explained either by excess money holdings or by any other variable within the system. That is evidence against a direct and even indirect channel from monetary policy to movements in housing wealth, i.e. against so-called asset-inflation and credit channels. The model is able to trace the latest movements in the data for money remarkably well, and thus offers a benchmark for (excess) liquidity, based on its empirically stable long-run equilibrium relationships.

REFERENCES

Beyer, A. (2009), "A stable model for euro area money demand: revisiting the role of wealth", *Working Paper Series*, No 1111, ECB.

Calza, A., Gerdesmeier, D. and Levy, J. (2001), "Euro area money demand: measuring the opportunity cost appropriately", *Working Paper Series*, No 179/01, IMF.

De Santis, R., Favero, C.A. and Roffia, B. (2008), "Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability", *Working Paper Series*, No 926, ECB.

ANNEX 4

ALTERNATIVE APPROACHES TO THE MEASUREMENT OF MONEY: A DIVISIA MONETARY INDEX FOR THE EURO AREA

1 INTRODUCTION[60]

Conventional monetary aggregates are defined as simple sums of the quantities of those assets deemed to offer monetary services. Such an approach is the norm in central banking practice, with the official euro area M3 series as a prominent example. The popularity of this approach is arguably due to its intuitive appeal and the availability of data for such calculations, which only require stock measures of the quantities of financial assets.

However, this approach can be viewed as a special case of a more general one, in which assets are assigned a weight in the calculation of the aggregate, according to their degree of "moneyness". The standard, simple-sum monetary aggregates implicitly impose a binary weighting scheme, whereby assets are assigned a weight of unity if they are deemed to be a part of the aggregate, and zero otherwise. By imposing an equal weight on monetary assets, standard monetary aggregates essentially assume that holders view them as perfect substitutes. Such an assumption, however, seems to be at odds with the observation that most economic agents hold a portfolio of different monetary assets with varying opportunity costs, rather than a single asset with the lowest cost, as should be the case if they viewed individual monetary assets as perfect substitutes.

A number of authors have argued that the difficulties in establishing stability of money demand functions that rely on simple-sum measurements of money are linked – at least in part – to the implausible assumption of perfect substitutability of monetary assets implied by such aggregates (an argument dubbed the "Barnett Critique" by Chrystal and MacDonald (1994)). In this respect, a research agenda to establish a stable money demand function would usefully be complemented by efforts to relax this assumption, in other words to derive meaningful weighting schemes for monetary aggregation.

A number of approaches that fall into two broad categories have been proposed in the literature.

60 This annex was prepared by Thomas Vlassopoulos. The underlying analytical and statistical work was undertaken over a period of several years by a number of ECB staff, including Alessandro Calza, Björn Fischer and Gwenaël Le Breton.

One approach is grounded in theory. The most prominent example of this approach, combining economic aggregation theory with statistical index number theory, is the Divisia monetary index proposed by Barnett (1980), within which monetary assets are weighted according to the value of the monetary services they provide, measured as the opportunity cost of holding them. A closely related approach to the Divisia monetary index is the currency-equivalent (CE) aggregate proposed by Rotemberg et al. (1995), which defines the stock of currency that would yield the same transactions services as the complete set of monetary assets. Another approach falling into this broad category, albeit motivated by quantity-theoretic considerations, is the MQ aggregate advocated by Spindt (1985), which weights assets used in transactions according to their turnover in paying for final output.

On the other side of the spectrum of proposed weighting approaches lie those that are based on empirical considerations. The weighting schemes that fall into this category assign weights to monetary assets in such a way that the resulting aggregate has a stable, useful relationship with a key macroeconomic variable. Notable examples of this approach include that of Feldstein and Stock (1996), which focuses on the ability of the monetary aggregate to forecast nominal GDP, and that of Drake and Mills (2005), which is based on the existence of a stable long-run (cointegrating) relationship between the monetary assets and nominal GDP, with the coefficients on the individual assets being the respective weights.

While research at the ECB has been conducted on a number of these approaches, the Divisia analysis is most long-standing. Further to a number of earlier attempts to construct Divisia monetary indices for subsets of the group of countries that would eventually form the euro area,[61] Stracca (2004) presented such an index covering all euro area Member States at that time.[62] In the absence of full theoretical underpinnings and necessary data to extend the single-country case to a currency union setting, this index essentially treated the euro area as a single country. Barnett (2007) subsequently provided the necessary theoretical extensions. The purpose of this annex is to present more recent work on a Divisia monetary index for the euro area, constructed on the basis of the approach suggested by Barnett (2007).

2 THE DIVISIA APPROACH TO MONETARY AGGREGATION IN A CURRENCY UNION SETUP

The Divisia approach to monetary aggregation, as proposed by Barnett (1980), is founded on economic aggregation theory as it is based on a consumer utility

61 See, inter alia, Fase (1996), Drake et al. (1997) and Wesche (1997). In addition, Divisia monetary indices have been constructed for various individual euro area countries (cf. Issing et al. (1993) and Herrmann et al. (2000) for Germany; Ayuso and Vega (1993) for Spain; Gaiotti (1996) for Italy; Janssen and Kool (2000) for the Netherlands; and Lecarpentier (1996) for a survey of Divisia indices for France).

62 A number of studies have subsequently presented and assessed Divisia monetary aggregates for the euro area (see, for example, Reimers (2002), Binner et al. (2005, 2009) and Mäki-Fränti (2007)).

optimisation problem.[63] To track the – unknown – aggregator function that is implied by this optimisation problem, Barnett uses a statistical index number, shown by Diewert (1976) to provide a second-order approximation to a class of flexible functional forms in discrete time. The use of a statistical index number allows the calculation of an index of monetary quantities, without the need to make (strong) assumptions regarding the functional form of the aggregator function and to estimate its parameters.[64] This statistical index number, which Barnett advocates as a measure of the real flow of monetary services, is the Törnqvist-Theil discrete-time approximation to the continuous-time Divisia index (hereafter referred to as the "Divisia index"), defined as:

$$\log M_t - \log M_{t-1} = \sum_i \bar{s}_{i,t} \left(\log m_{i,t} - \log m_{i,t-1}\right), \text{ with } \bar{s}_{i,t} = \frac{(s_{i,t} + s_{i,t-1})}{2} \text{ and } s_{it} = \frac{\pi_{i,t} m_{i,t}}{y_t}$$

M_t is the level of the real Divisia index at time t; $m_{i,t}$ is the real stock of monetary asset i at time t; $s_{i,t}$ is the expenditure share of monetary asset i at time t; $\pi_{i,t}$ is the nominal user cost of monetary asset i at time t; and y_t is the total expenditure on monetary assets at time t, i.e. $y_t = \sum_i \pi_{i,t} m_{i,t}$. Therefore, the growth rate of the Divisia index is a weighted sum of the rates of change of the individual component assets, with each component's share in total expenditure on monetary services used as the weight. This share depends not only on the quantity of each component held, but also on the user cost of the monetary services associated with holding the asset. The user cost has been derived in Barnett (1978) from a consumer optimisation problem, where money is treated as a durable good. It is given by the expression:

$$\pi_{i,t} = P_t \frac{R_t - r_{i,t}}{1 + R_t} \, ,$$

where P_t is the price index at time t, $r_{i,t}$ is the nominal holding period yield on monetary asset i at time t and R_t is the nominal holding period yield on the benchmark asset at time t. The benchmark asset is an (imaginary) risk-free asset that provides no monetary services and is held purely for an intertemporal transfer of wealth. The user cost is thus the opportunity cost of holding a unit of a monetary asset for a single period, discounted to reflect the (assumed) receipt of interest at the end of the period. Importantly, this assumes that all the liquidity characteristics of an asset are fully reflected in its yield.

The extension of this framework to a currency union setting, such as that of the euro area, raises one important question: how to aggregate across countries. In principle, two broad approaches are conceivable. The "direct" approach

63 Barnett (1987) has shown that this can equivalently be formulated as a problem of firm demand for monetary assets derived from a firm optimisation problem. In both cases, Barnett (1987) argues that the "deeper"' reasons why real money balances enter the utility or production functions are irrelevant from a monetary aggregation perspective, as the fact that monetary assets have a positive value in equilibrium, i.e. agents hold money in equilibrium, suffices to indicate that such functions exist.

64 The trade-off from a practical perspective is that the calculation of the quantity index also requires data on prices.

entails, as a first step, the calculation of euro area stocks of the individual monetary assets through simple-sum aggregation across countries. In a second step, Divisia aggregation of the resulting euro area stocks of monetary assets is undertaken, using weighted average rates of return to calculate the component weights. This essentially amounts to treating the euro area as one country and is the approach that was used in the construction of euro area Divisia aggregates thus far. The "indirect" approach also involves two steps, the first being the calculation of a Divisia index for each country in the euro area. In the second step, the country indices are aggregated to derive a euro area Divisia index. In this case, the question of the appropriate weighting scheme for aggregation across countries arises.

The issue of Divisia aggregation for the euro area has been addressed theoretically in Barnett (2007). This paper shows that the "direct" method of aggregation presumes the existence of a representative agent across all euro area countries. This, in turn, requires implausibly strong assumptions as it implies that the consumer's country of residence is irrelevant for his/her consumption decisions. In the presence of considerable cultural diversity and demographic heterogeneity across euro area Member States, such an assumption seems rather unrealistic. Instead, Barnett (2007) advocates a heterogeneous-agents approach to aggregation across countries, which only requires the existence of a representative agent in each country, i.e. the assumption also made in the single-country case, and which is also implicit in simple-sum aggregation. Under this approach, the euro area's real monetary services flow (in discrete time) is given by:[65]

$$\log M_t^{EA} - \log M_{t-1}^{EA} = \sum_k \overline{W}_{k,t} \left[\log(\rho_{k,t} M_{k,t}) - \log(\rho_{k,t-1} M_{k,t-1})\right],$$

where M_t^{EA} is the level of the euro area real Divisia index at time t, $\rho_{k,t}$ is the share of country k in the euro area population at time t, $M_{k,t}$ is the level of the real Divisia index of country k at time t as derived from the Divisia aggregation procedure within each country and $\overline{W}_{k,t} = \frac{(W_{k,t} + W_{k,t-1})}{2}$. $W_{k,t,}$ in turn, is the expenditure share of country k at time t, defined as:

$$W_{k,t} = \frac{M_{k,t} \Pi_{k,t} P_{k,t} e_{k,t} \rho_{k,t}}{\sum_k M_{k,t} \Pi_{k,t} P_{k,t} e_{k,t} \rho_{k,t}},$$

where $\Pi_{k,t}$ is the monetary real user-cost price aggregate of country k at time t, i.e. the dual price index of the Divisia monetary services flow index for country k at time t, $P_{k,t}$ is the price index of country k at time t and $e_{k,t}$ is the exchange rate of country k at time t relative to a weighted currency basket like the ECU.

Under the heterogeneous-agents approach, the benchmark asset's rate of return is different from country to country, and is thus a fairly general case that does not impose strong assumptions regarding the degree of convergence among euro area economies. As such, it is appropriate for monetary aggregation across euro area countries even prior to the start of Stage Three of EMU. Under more restrictive assumptions, the heterogeneous-agents approach nests the following cases:

65 Barnett (2007) defines the Divisia monetary services flow index in per capita terms.

(i) the multilateral representative-agent approach, whereby tastes are allowed to differ across countries, but there is a common benchmark asset, and (ii) the unilateral representative-agent approach, whereby countries are no longer distinguished, which essentially amounts to the "direct" approach.

3 APPLICATION OF THE HETEROGENEOUS-AGENTS APPROACH TO THE EURO AREA

The application of the heterogeneous-agents approach to the euro area raises a multitude of practical issues. The first question that needs to be addressed is the choice of assets to be included in the calculation of the index. Formally, this choice should be the outcome of weak separability tests.[66] In the interests of preserving comparability with the official, simple-sum monetary aggregates, it was decided to include in the Divisia indices the components included in the respective official aggregates. In any case, Binner et al. (2009) have found, on the basis of non-parametric weak separability tests, that the assets included in the official euro area M2 and M3 aggregates satisfy this condition, and are thus admissible groupings of assets for monetary aggregation. Table A4.1 shows the assets included in the euro area Divisia monetary indices, by level of aggregation.

A second important issue relates to the calculation of the return on the benchmark asset. Given that this asset should provide no liquidity or other services beyond its yield, it cannot be traded in a market. At the same time, rates of return on illiquid assets are very seldom available.

66 Weak separability tests determine whether the decision-making problem regarding the holdings of a specific set of assets can be treated separately from the more general optimisation problem over all assets and consumption goods, in which case aggregation over these assets is admissible. More formally, weak separability implies that the marginal rates of substitution among the variables in the weakly separable group are independent of the quantities of the decision variables outside the group (see Anderson et al. (1997a)).

Table A4.1 Monetary assets included in the euro area Divisia monetary indices, by level of aggregation

	1980-1998	1999 to the present
Divisia M1	• Currency in circulation • Overnight deposits	• Currency in circulation • Overnight deposits
Divisia M2	• Deposits with an agreed maturity of up to two years • Deposits redeemable at notice of up to three months	• Deposits with an agreed maturity of up to two years • Deposits redeemable at notice of up to three months
Divisia M3	• Marketable instruments (sum of repurchase agreements, MFI debt securities with a maturity of up to two years and money market fund shares/units)	• Repurchase agreements • MFI debt securities with a maturity of up to two years • Money market fund shares/units

Source: ECB.

The standard approach in the literature is, therefore, to calculate a proxy for the rate of return on the benchmark asset. In line with standard practice in the literature, the upper envelope of the rates of return on all monetary assets has been used here. To arrive at the rate of return on the benchmark asset from the upper envelope, it is necessary to add a premium that would represent the compensation for giving up the liquidity services of the assets included in the envelope. Barnett (2007) advocates the use of a spread between a corporate bond rate of moderate quality and the Treasury security rate of the same maturity. He also suggests that this premium can be common among countries, even before Stage Three of EMU. The spread between the yield to maturity corresponding to the Merrill Lynch EMU non-financial corporate bond index and that corresponding to the Merrill Lynch EMU Government Bond Index has thus been used for all countries.[67] Clearly this does not imply that the rate of return on the benchmark asset is common across countries, as the upper envelope varies.

The data availability requirements imposed by the heterogeneous-agent approach are quite daunting, particularly for the period prior to Stage Three of EMU, given the lack of a harmonised statistical reporting framework in the euro area Member States at the time. This is particularly relevant in the case of the series on rates of return, where the respective data had at the time not been collected in a number of cases. In such cases, the missing data have been estimated on the basis of the relationship of the rate of return (during the period when it is available) with other rates that are also available for the period when data for the series in question were not collected. The partially estimated nature of some rates of return series data and the possible cross-country heterogeneity in statistical definitions need, therefore, to be taken into consideration when assessing the resulting Divisia monetary indices for the period prior to 1999.

The euro area Divisia monetary indices have been constructed on a "changing composition" basis for the period since 1980, i.e. countries are included in the aggregation from the date when they join the euro area, as is also the case for the official simple-sum aggregates. For the period before 1999, the euro area Divisia monetary indices aggregate across the initial 11 members of the euro area. In line with the approach adopted for the calculation of the historical series of the official euro area monetary aggregates, the irrevocable exchange rates are applied during this period to convert monetary stocks from the legacy national currencies to euro values. As regards the treatment of the enlargement of the euro area, when a new country joins the euro area, the actual growth rate of its monetary assets during the entry period is used. This approach ensures that discrete jumps in the indices are avoided.[68] An issue similar in character arises when a new monetary

67 During the period for which the Merrill Lynch indices were not available, the premium is calculated as the difference between the average yield on French corporate bonds (taux mensuel obligataire) and the average yield on long-term French government bonds (taux mensuel de rendement des emprunts d'Etat). The choice of French rates of return is motivated by the fact that in the 1980s the corporate bond market in France was the most developed among the countries that subsequently formed the euro area.

68 In addition, to avoid jumps in the series in the period when a country joins, population shares used for the calculation of the period-to-period growth rates are adjusted so as to include the new member from the previous period.

asset is introduced, as in the period of introduction the Divisia index is not well defined. This is relevant, for instance, in the case of the introduction of money market fund shares/units in a few countries. In such cases, in line with standard practice, the Fisher ideal index is applied to calculate the growth rate in the period of introduction of the new asset.[69]

A final important issue relates to a particular aspect of the approach adopted by the statistical framework of the ECB for the compilation of monetary statistics, which requires national statistics to be reported primarily as contributions to the euro area total. The implication of this is that monetary assets reported by MFIs in any euro area country relate to holdings of all euro area residents and not only to those of residents of that particular country. This can occasionally be particularly important as some euro area countries tend to host MFIs that are geared towards servicing residents of other euro area countries. For the calculation of the simple-sum aggregates and, indeed, for the application of the direct approach to euro area Divisia aggregation, this is not problematic. However, the heterogeneous-agents approach requires the use of series on monetary asset stocks that are compiled from a purely national perspective, i.e. that reflect the holdings of the money-holding sector of solely the respective country. For the period for which the required data are available, adjustments are made in order to reallocate as appropriate monetary assets reported by MFIs in one country but held by residents in other euro area countries.

4 DESCRIPTIVE ANALYSIS OF THE NEW DIVISIA MONETARY AGGREGATE FOR THE EURO AREA

The annual growth rate of the euro area nominal Divisia M3 index of monetary service flows is shown in Chart A4.1. The dynamics of this aggregate can at times differ quite markedly from those of the simple-sum euro area M3 series, in terms of both the profile and the level of the growth rate. Prominent episodes of such divergence are those from 1989 to 1994 and from mid-2006 to 2009. At the same time, for most of the period since 1981, the Divisia M3 index exhibits a very high degree of co-movement with the simple-sum M1 series, with the two series having a correlation coefficient of 70% (see Table A4.2). Interestingly, the close relationship with M1 has broken down since early 2008 and indeed the two series have moved in opposite directions, a reflection of the strong influence of the shape of the yield curve in driving M1 dynamics over this period,

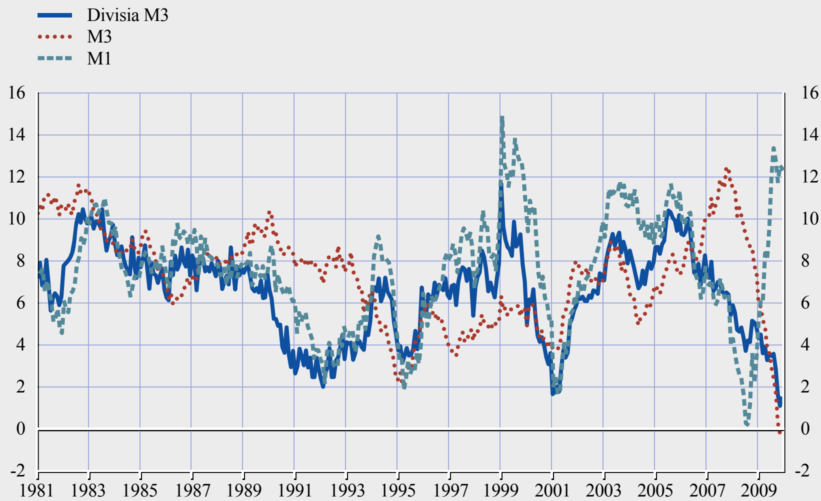
69 The Fisher ideal index also provides second-order approximations to unknown economic aggregator functions, and is thus also superlative in the sense of Diewert (1976), although the Törnqvist-Theil discrete time approximation to the Divisia index has been shown to be superior. Therefore the Fisher ideal index:

$$M_t^F = M_{t-1}^F \sqrt{\frac{\sum_k \pi_{k,t} m_{k,t}}{\sum_k \pi_{k,t-1} m_{k,t}} \cdot \frac{\sum_k \pi_{k,t} m_{k,t-1}}{\sum_k \pi_{k,t-1} m_{k,t-1}}}$$

is only used in periods when new monetary assets are introduced, and therefore the Divisia index is not well-defined. On the procedure for the introduction of new monetary assets, see Anderson et al. (1997b).

Chart A4.1 Euro area Divisia M3 and simple-sum euro area monetary aggregates in nominal terms

(annual percentage changes)



Sources: ECB and ECB calculations.

from which the Divisia aggregate was shielded. Overall, during the period since 1981, Divisia M3 exhibits a lower average growth rate, as well as somewhat less volatility, than the simple-sum euro area aggregates M3 and M1.

The close relationship of Divisia M3 with the simple-sum aggregate M1 – which only contains assets typically associated with the transactions motive of holding money – is unsurprising given the nature of the Divisia aggregate as a measure of the flow of liquidity services from the monetary assets held by agents. Indeed, the weight assigned in the calculation of the Divisia M3 index to monetary instruments beyond M1 is markedly lower – and considerably more volatile – than their share in the stock of the simple-sum M3 aggregate, as shown in Chart A4.2. Similarly, the weight assigned to individual euro area Member States in the calculation of the Divisia M3 index differs considerably from that of the simple-sum M3 aggregate.

It is also interesting to examine the behaviour of the euro area Divisia M3 index in comparison with that of monetary aggregates beyond the official simple sum series. Chart A4.3 shows the evolution of the annual growth rate of the euro area

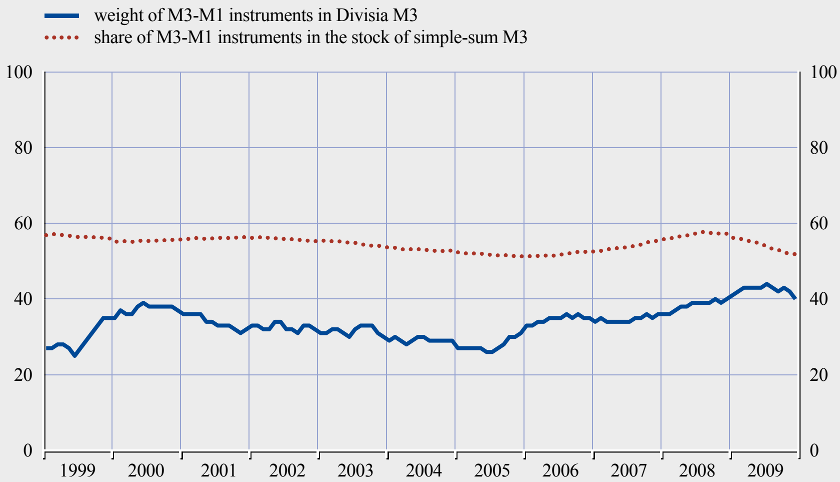
Table A4.2 Descriptive statistics for the euro area M1, M3 and Divisia M3 annual growth rates

	M1	M3	Divisia M3
Mean	7.49	7.28	6.52
Standard deviation	2.64	2.33	2.12
Correlation coefficient with Divisia M3	0.70	0.37	

Source: ECB calculations.

Chart A4.2 Weight of instruments included in M3-M1 in the calculation of Divisia M3 and share of these instruments in the stock of simple-sum M3

(percentages)

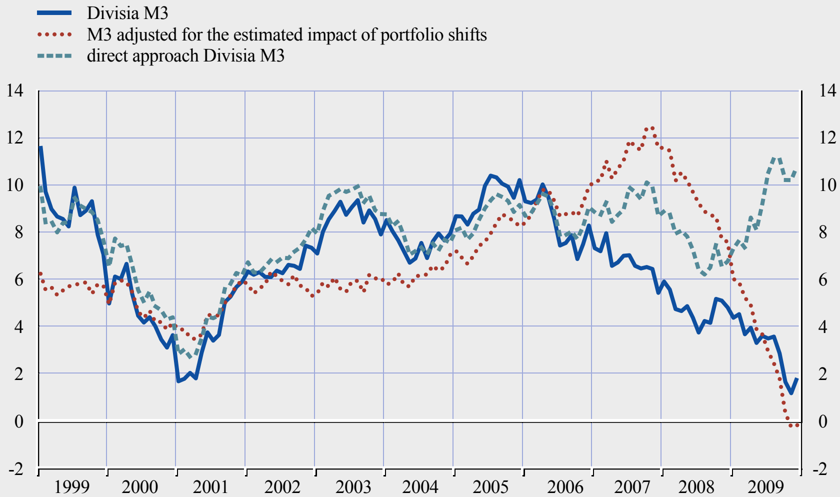


Sources: ECB and ECB calculations.

Divisia M3 index against that of M3 adjusted for the estimated impact of portfolio shifts due to extraordinary uncertainty between 2001 and 2003 (see ECB (2004)) and a Divisia M3 series calculated under the "direct", or unilateral representative-agent approach, as in Stracca (2004). As regards the relationship between Divisia M3 and M3 adjusted for the estimated impact of portfolio shifts, as expected, there are considerable differences in the dynamics of the two series, similar to

Chart A4.3 Euro area Divisia M3 and other alternative monetary aggregates

(annual percentage changes)



Sources: ECB and ECB calculations.

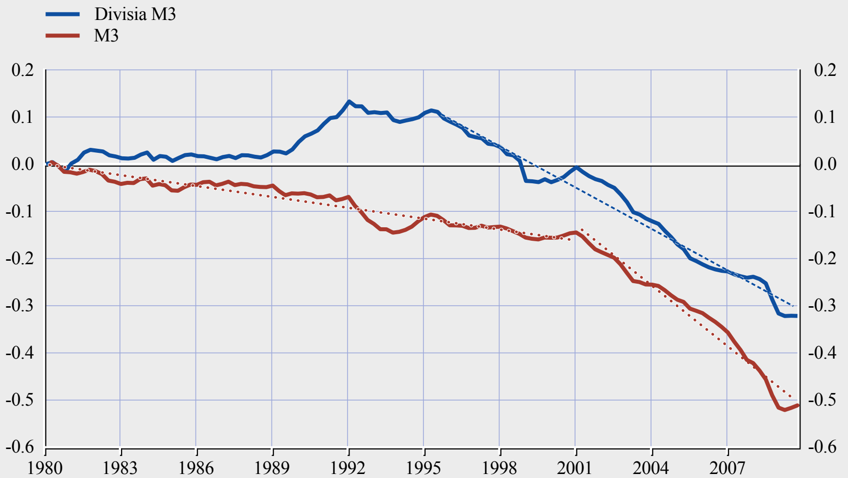
those observed in the case of the official M3 aggregate. Interestingly, however, the level and profile of the two series are very similar during most of the portfolio shift period, in particular during 2001 and 2002, although the two series diverge in 2003. Turning to the comparison with a Divisia M3 series constructed using the "direct" approach to aggregation across countries, the two series move very closely together until the end of 2006, after which their dynamics differ markedly. It should be noted, in this respect, that in addition to the methodological differences in the cross-country aggregation, the calculation of the two series differs in that, for the Divisia aggregate proposed in Stracca (2004), a fixed (60 basis point) liquidity premium was used in the derivation of the rate of return on the benchmark asset. While this assumption did not have a major impact on the calculation for most of the period, with the eruption of financial turmoil in 2007, which increased liquidity premia to unprecedented levels, it contributed to the divergence in the two series.

From a money-demand perspective, what ultimately matters is the empirical relationship of the monetary aggregate under consideration with the determinants of money-holding behaviour. A simple way to graphically illustrate the relationship between Divisia M3 and income, one of the standard determinants of money demand, is to plot the income velocity of circulation. Chart A4.4 shows that the downward trend in Divisia M3 velocity that is discernible since 1995 has not been disrupted by the break that appears to have affected simple-sum M3 velocity in 2001.[70] While this is an encouraging result, formal modelling and

[70] This is confirmed by the results of Quandt-Andrews breakpoint tests.

Chart A4.4 Income velocity of Divisia M3 and simple-sum M3

(log levels)



Sources: ECB, ECB calculations and Eurostat.
Note: Velocity has been normalised to zero in the first quarter of 1980.

testing of the stability of the demand for euro area Divisia M3 is warranted before any conclusive statement can be made with respect to the empirical relationship of this monetary aggregate with its determinants.

5 CONCLUDING REMARKS

This annex has presented work on the construction of monetary aggregates for the euro area that are based on the Divisia approach, as extended for a currency union setup by Barnett (2007). By relaxing the implausible assumption of perfect substitutability between monetary assets implied by simple-sum aggregation, the construction of such weighted aggregates contributes to the efforts to establish a stable money demand function for the euro area. While the Divisia approach to monetary aggregation has clear theoretical advantages over simple-sum aggregation, it should also be recognised that it is not altogether free of shortcomings.[71] Moreover, the Divisia approach focuses on the role of money as a medium for transactions. However, the link between money and nominal spending – and ultimately prices – which is crucial from a monetary policy perspective, cannot be viewed as stemming exclusively from its role in settling transactions. Indeed, even literature in the monetarist tradition stresses the importance of portfolio rebalancing in response to an increase in the money stock as a trigger of increased spending.[72] Finally, as this annex has shown, the compilation of Divisia monetary aggregates is a challenging endeavour. In this respect, the work presented should be considered as ongoing, in view of the further challenges that remain to be addressed, relating, for instance, to the consideration of risk and the compilation of aggregates at the sectoral level.

REFERENCES

Anderson, R.G., Jones, B.E. and Nesmith, T.D. (1997a), “Monetary aggregation and statistical index numbers”, *Review*, Vol. 79(1), Federal Reserve Bank of St. Louis, pp. 31-51.

Anderson, R.G., Jones, B.E. and Nesmith, T.D. (1997b), “Building new monetary services indexes: concepts, data and methods”, *Review*, Vol. 79(1), Federal Reserve Bank of St. Louis, pp. 53-82.

Ayuso J. and Vega, J.L. (1993), “Weighted monetary aggregates: the Spanish case”, *Working Paper Series*, No 9303, Banco de España.

Barnett, W.A. (1978), “The user cost of money”, *Economics Letters*, Vol. 1(2), pp. 145-149.

71 For a discussion of shortcomings of the Divisia approach, see, for example, Cuthbertson (1997) and Barnett (1997).
72 See, for example, Meltzer (1995).

Barnett, W.A. (1980), "Economic monetary aggregates: an application of index number and aggregation theory", *Journal of Econometrics*, Vol. 14(1), pp. 11-48.

Barnett, W.A. (1987), "The microeconomic theory of monetary aggregation", in Barnett, W.A. and Singleton, K. (eds.), *New approaches to monetary economics*, Cambridge University Press, pp. 115-168.

Barnett, W.A. (1997), "Which road leads to a stable money demand?", *Economic Journal*, Vol. 107(443), pp. 1171-1185.

Barnett, W.A. (2007), "Multilateral aggregation-theoretic monetary aggregation over heterogeneous countries", *Journal of Econometrics*, Vol. 136(2), pp. 457-482.

Binner, J.M., Bissoondeeal, R.K., Elger, C.T., Gazely, A. and Mullineux, A. (2005), "A comparison of linear forecasting models and neural networks: an application to euro inflation and euro Divisia", *Applied Economics*, Vol. 37(6), pp. 665-680.

Binner, J.M., Bissoondeeal, R.K., Elger, C.T., Jones, B. and Mullineux, A. (2009), "Admissible monetary aggregates for the euro area", *Journal of International Money and Finance*, Vol. 28(1), pp. 99-114.

Chrystal, K.A. and MacDonald, R. (1994), "Empirical evidence on the recent behaviour and usefulness of simple-sum and weighted measures of the money stock", *Review*, Vol. 76(2), Federal Reserve Bank of St. Louis, pp. 73-109.

Cuthbertson, K. (1997), "Microfoundations and the demand for money", *Economic Journal*, Vol. 107(443), pp. 1186-1201.

Diewert, W.E. (1976), "Exact and superlative index numbers", *Journal of Econometrics*, Vol. 4(2), pp. 115-145.

Drake, L. and Mills, T.C. (2005), "A new empirically weighted monetary aggregate for the United States", *Economic Inquiry*, Vol. 43(1), pp. 138-157.

Drake, L., Mullineux, A. and Agung, J. (1997), "One Divisia money for Europe?", *Applied Economics*, Vol. 29(6), pp.775-786.

ECB (2004), "Monetary analysis in real time", *Monthly Bulletin*, October, pp. 43-66.

Fase, M.M.G. (1996), "Divisia aggregates and the demand for money in core EMU", *DNB Staff Reports*, No 5, De Nederlandsche Bank.

Feldstein, M. and Stock, J.H. (1996), "Measuring money growth when financial markets are changing", *Journal of Monetary Economics*, Vol. 37(1), pp. 3-27.

Gaiotti, E. (1996), "Measuring money with a Divisia index: an application to Italy", in Mullineux, A. (ed.), *Financial innovation, banking and monetary aggregates*, Edward Elgar, pp. 39-65.

Herrmann, H., Reimers, H.-E. and Toedter, K.-H. (2000), "Weighted monetary aggregates for Germany", in Belongia, M.T. and Binner, J.M. (eds.), *Divisia monetary aggregates: theory and practice*, Palgrave, pp. 79-101.

Issing, O., Toedter, K.-H., Herrmann, H. and Reimers, H.-E. (1993), "Zinsgewichtete Geldmengenaggregate und M3 – ein Vergleich", *Kredit und Kapital*, Vol. 26(1), pp. 1-21.

Janssen, N.G.J. and Kool, C.J.M. (2000), "Weighted Dutch and German monetary aggregates: how do they perform as monetary indicators for the Netherlands?", in Belongia, M.T. and Binner, J.M. (eds.), *Divisia monetary aggregates: theory and practice*, Palgrave, pp. 120-137.

Lecarpentier, S. (1996), "Divisia monetary aggregates: a survey in the case of France", in Mullineux, A. (ed.), *Financial innovation, banking and monetary aggregates*, Edward Elgar, pp. 187-198.

Mäki-Fränti, P. (2007), "The information content of the Divisia monetary aggregates in forecasting inflation in the euro area", *Empirical Economics*, Vol. 33(1), pp. 151-176.

Meltzer, A. (1995), "Monetary, credit and (other) transmission processes: a monetarist perspective", *Journal of Economic Perspectives*, Vol. 9(4), pp. 49-72.

Reimers, H.-E. (2002), "Analysing Divisia aggregates for the euro area", *Discussion Paper Series*, No 13/02, Deutsche Bundesbank.

Rotemberg, J.J., Driscoll, J.C. and Poterba, J.M. (1995), "Money, output, and prices: Evidence from a new monetary aggregate", *Journal of Business and Economic Statistics*, Vol. 13(1), pp. 67-83.

Spindt, P.A. (1985), "Money is what money does: monetary aggregation and the equation of exchange", *Journal of Political Economy*, Vol. 93(1), pp. 175-204.

Stracca, L. (2004), "Does liquidity matter? Properties of a Divisia monetary aggregate in the euro area", *Oxford Bulletin of Economics and Statistics*, Vol. 66(3), pp. 309-331.

Wesche, K. (1997), "The demand for Divisia money in a core monetary union", *Review*, Vol. 79(5), Federal Reserve Bank of St. Louis, pp. 51-60.

ANNEX 5

SECTORAL MONEY DEMAND IN THE EURO AREA

1 INTRODUCTION[73]

A detailed monetary analysis may benefit from looking at the demand for money at the level of the individual money-holding sector. Such an approach may offer a more consistent and richer explanation of the forces driving monetary developments. Indeed, the demand for money is likely to vary across sectors, as the relative importance of the motives for holding money balances – e.g. their use as a medium of exchange or as a store of value – differ according to the holder.[74] Of course, heterogeneity in money-holding behaviour goes beyond the sectoral level to the individual. But, at present, data suitable for analysis are only available by sector.[75] By improving our understanding of the individual components, sectoral analysis of money demand can contribute to a better understanding of the covariation of the aggregate money stock with its determinants.

Conventional aggregate money demand functions that do not distinguish between sectors may suffer from biases since the aggregate parameter values are weighted averages of the sectoral values, rather than fundamental values in themselves. Two different biases can afflict aggregate estimates in this context: aggregation bias, when the sectoral relationships depend on sector-specific determinants (implying a lack of microeconomic homogeneity), and composition bias, when the sectoral composition of the aggregate changes (implying a lack of compositional stability). In the first case, the sector-specific forces are only incompletely captured at the aggregate level by the macro-determinants. The aggregate demand parameters may thus change, reflecting the different sectoral behaviour, although the behavioural relations and the composition of the aggregate have remained unchanged at the micro-level. In the second case, the composition of sectors in the economy changes over time, causing the aggregate parameters to vary, even if the sectoral behaviour remains unchanged, but is structurally different across sectors.

Two different modelling strategies can be considered to shed light on this issue in the context of sectoral money demand: first, modelling money demand using on a common set of macroeconomic determinants, which permits a comparison of the money-holding behaviour across sectors, and, second, finding a refined

73 This annex was prepared by Julian von Landesberger.
74 See also ECB (2006a).
75 Efforts are currently being made to construct a panel data set on households' financial behaviour in the euro area.

specification for each sector, thus trying to identify the determinants best capable of explaining sectoral holdings of money.

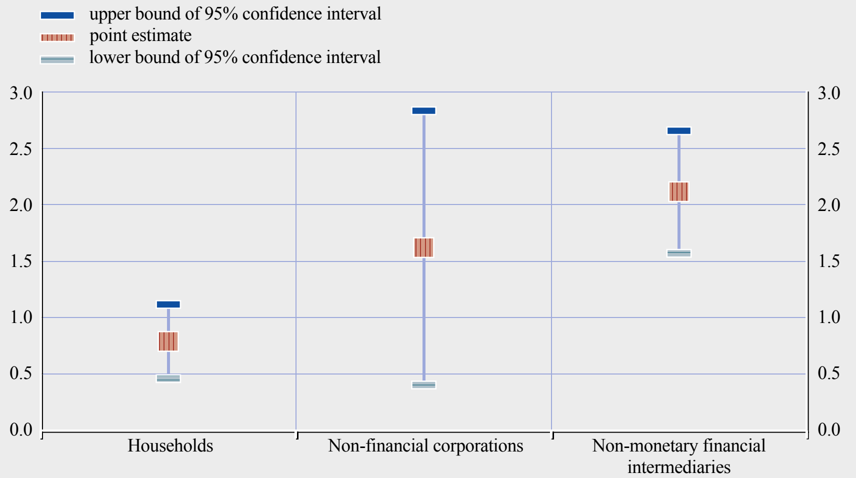
2 SECTORAL HOLDINGS OF MONEY EXPLAINED BY USING A COMMON SET OF DETERMINANTS

Conventional models for aggregate money demand explain real money holdings on the basis of developments in income (proxied by real GDP) and in the opportunity cost of money holdings, typically captured by a limited number of interest rate terms. In order to determine whether money-holding behaviour differs at a sectoral level, a natural starting point is to regress sectoral M3 estimates on the same variables.

Results from the application of such a standardised approach across money-holding sectors for the euro area over the sample from 1991 to 2005 suggest that households, non-financial corporations and non-monetary intermediaries display significantly different money demand behaviour with respect to real GDP, the long-term government bond yield and the dividend yield of the euro area equity market.[76] The relative importance of the main motives for holding money varies across sectors, leading to different income and interest rate elasticities across sectoral money holdings. For example, the long-run income elasticity of households is found to be well below that of both financial and non-financial firms (see Chart A5.1). This could reflect differences in the need to execute

76 For details of the econometric analysis, see Von Landesberger (2007).

Chart A5.1 Estimates for sectoral income elasticity



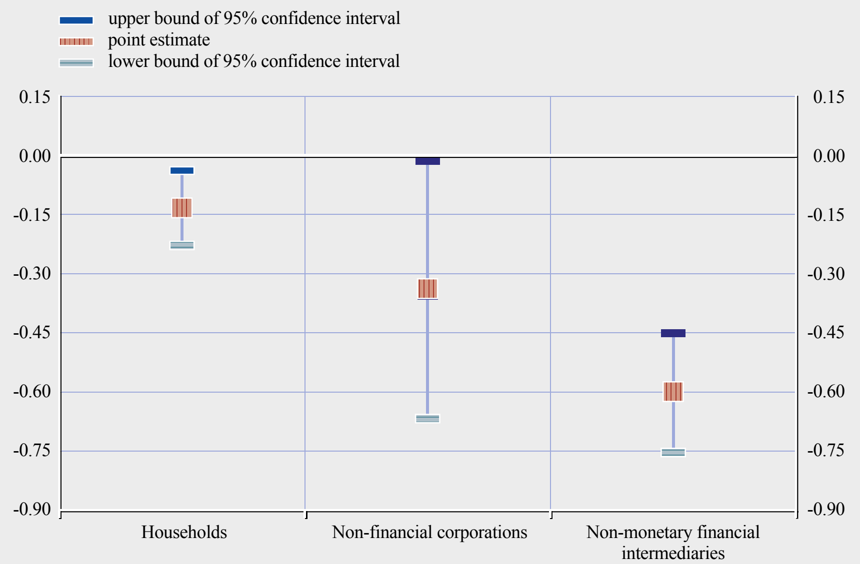
Source: Von Landesberger (2007).
Notes: The data shown in the chart are updates of the original estimates for the period from the first quarter of 1991 to the fourth quarter of 2005. Confidence intervals are based on the normal distribution.

transactions across economic sectors, leading to differing income elasticities of money demand. At the same time, the long-run elasticity of money holdings with respect to government bond yields is significantly higher for non-monetary financial intermediaries than for the non-financial sectors (see Chart A5.2). Finally, the dividend yield seems to affect households money demand behaviour, while more surprisingly, it does not seem to influence firms M3 holdings. Overall, these results are in line with the findings presented for US data.[77]

It is evident that using such a standardised modelling framework for all three sectoral monetary aggregates falls short of taking into account important sectoral specificities. Against this background, caution is necessary when interpreting the results of such estimations, as they should not be seen as a comprehensive explanation of the sectoral money demand behaviour. In particular, estimated elasticities may be affected by an "omitted variable" bias. At the same time, a standardised modelling approach allows the different money demand behaviours of households and firms to be synthesised into a small number of parameter estimates, thus facilitating comparison across sectors.

77 See Jain and Moon (1994) and Butkiewicz and McConnell (1995). For a comparable study of sectoral money demand in the United Kingdom, see Brigden et al. (2000).

Chart A5.2 Estimates for sectoral interest rate elasticity



Source: Von Landesberger (2007).

Notes: The data shown in the chart are updates of the original estimates for the period from the first quarter of 1991 to the fourth quarter of 2005. Confidence intervals are based on the normal distribution.

3 SECTORAL MONEY HOLDINGS EXPLAINED BY USING SECTOR-SPECIFIC DETERMINANTS

In order to gain a better understanding of the forces driving sectoral monetary growth, a refined modelling approach can be implemented, which attempts to provide a more elaborate explanation by including sector-specific determinants among the explanatory variables. In the following, the approaches for households and non-financial corporations are presented.

3.1 HOUSEHOLDS

Households are the largest money-holding sector, accounting for approximately two-thirds of euro area M3.[78] Moreover, households' money holdings are interesting from an economic perspective as well: households usually hold a large proportion of their money holdings as transaction balances, using these balances mainly as a buffer, while slowly adjusting their portfolio composition. Households' financial decisions are likely to have a significant impact on real macroeconomic activity, rendering the interaction between households' money balances and consumption important. Finally, the dynamics of households' M3 holdings are also found to be informative for price developments in the euro area, giving their explanation particular relevance for monetary analysis.[79]

The model explains households' nominal M3 holdings using the private consumption deflator *pc* as a measure of the price level and two scale variables, the first of which is a flow (real private consumption expenditure *rc*) and the second a stock (a measure of the trend in housing wealth deflated with the private consumption deflator *rthw*).[80] Analysis for aggregate M3 by Boone et al. (2008), Greiber and Setzer (2007), Beyer (2009) and De Bondt (2009) found a significant role for wealth in euro area money demand, with the latter three studies emphasising the role of housing wealth. The spread between the bank lending rate for house purchases *blr* and the own rate on households' M3 holdings *own* enters the money demand model as the measure of opportunity costs. The possession of housing exacerbates the need for a monetary buffer stock, which will, however, be calibrated by the households via the financing conditions they face. In order to model precautionary motives in the demand for money, the uncertainty measure developed in Greiber and Lemke (2005), *GL1* related to capital market forces, enters the model as a measure of uncertainty. Finally, expectations with regard to unemployment over the next 12 months, UN^e from the survey of the EU Commission, are included in the VAR system but not in the long-run relationship. Variables written in lower case denote logarithms.

78 For the comprehensive analysis, see Seitz and Von Landesberger (2010).

79 See ECB (2006b).

80 The measure of longer-term housing wealth is based on the trend in house prices, instead of actual house prices. The reason underlying such a calculation is that households may not perceive themselves to be more or less wealthy on the basis of high-frequency movements in the prices of their asset holdings, but rather take a medium-term-view of asset prices. The trend in house prices is derived using an approach common to the analysis of the link between money and asset prices (see Detken and Smets (2004) and Adalid and Detken (2007)). The trend is estimated using a very slow-adjusting HP filter (λ = 100,000).

In the long run, money holdings should theoretically be linear homogenous in the price level, thus suggesting that a parameter restriction of -1 be imposed on the long-run parameter for the price level. At the same time, the consumption expenditure deflator used in the empirical analysis might be a restrictive proxy for the notion of the price level actually entering into households' money-holding decisions. In this case, parameter estimates different from one might also be justified. However, the data do not reject the restriction of long-run neutrality ($F(1,59)= 0.31$, p-value = 0.58). The long-run relationship is:

$$\begin{bmatrix} \Delta m_t \\ \Delta pc_t \\ \Delta rc_t \\ \Delta rthw_t \\ \Delta(blr_t - own_t) \\ \Delta GL1_t \end{bmatrix} = \begin{bmatrix} \underset{0.009}{-0.051} \\ - \\ \underset{0.009}{0.039} \\ - \\ - \\ - \end{bmatrix} \begin{bmatrix} m_{t-1} - pc_{t-1} - \underset{0.04}{0.67} rc_{t-1} - \underset{0.04}{0.67} rthw_{t-1} \\ + \underset{0.09}{0.70} (blr - own)_{t-1} - \underset{0.28}{1.23} GL1_{t-1} \end{bmatrix} + \ldots \qquad (1)$$

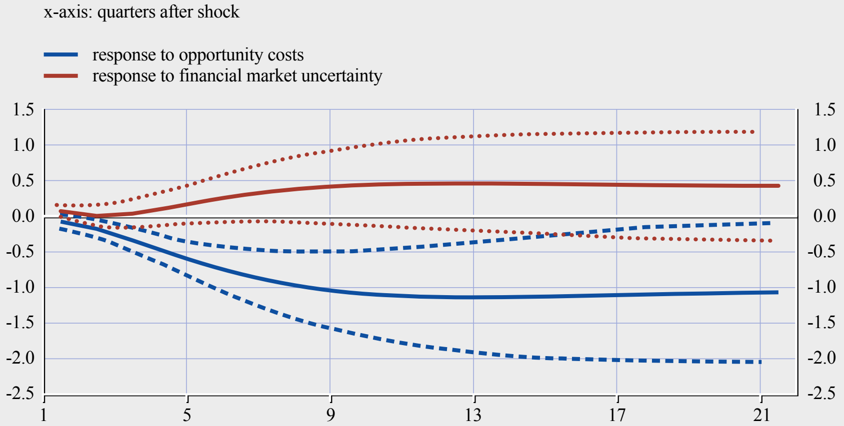
with standard errors shown below the coefficients. The parameters for consumption, trend housing wealth, the opportunity costs and the uncertainty measure all have the expected sign and are significantly different from zero (at the 5% level). A second over-identifying restriction is introduced by postulating that real consumption and trend housing wealth are equally important for the demand for money, an assumption similar to that in Thomas (1997a). The opportunity costs for households to hold M3 balances is modelled by the spread between bank lending for house purchases and the own rate on households' M3 balances (in logs).[81] As expected, a widening of this spread has a significant and negative effect on the level of real M3 holdings by households. In the face of higher borrowing costs, households have an incentive to reduce their holdings of lower-yielding monetary assets. The complete impact has unfolded after around ten quarters (see Chart A5.3) and remains negative on the level of money thereafter. An increase in the level of financial market uncertainty, proxied by the uncertainty measure proposed by Greiber and Lembke, implies higher money holdings (also see Chart A5.3). Here, too, the impact takes around ten quarters, suggesting a fairly gradual reaction of money holdings. In terms of magnitude, the impact of the interest rate seems to dominate uncertainty effects.

As an exogenous regressor in the system's short-term dynamics, the model includes households' unemployment expectations in the coming 12 months

81 Interest rates can enter the money demand relationship in two functional forms: the semi-log specification (see, for example, Ericsson (1998), which implies the same response of money holdings to each percentage point reduction in nominal interest rates, and the double log form (proposed by, inter alia, Lucas (2000)), which entails that a percentage point reduction in nominal interest rates has a proportionally greater impact on money holdings, the lower the level of interest rates (i.e. semi-elasticities vary with the level of interest rates). For higher levels of interest rates, the two functional forms lead to very similar results. The non-linear impact at low levels of interest rates can be motivated with a prevalence of fixed costs for alternative investment opportunities and with the fact that households that hold only cash do not incur these costs. A logarithmic money demand function may also be rationalised within a stylised general equilibrium model with money (see Chadha et al. (1998) and Stracca (2001)).

Chart A5.3 Generalised impulse response of household money holdings

(deviation from baseline in percentages)



Source: Seitz and Von Landesberger (2010).

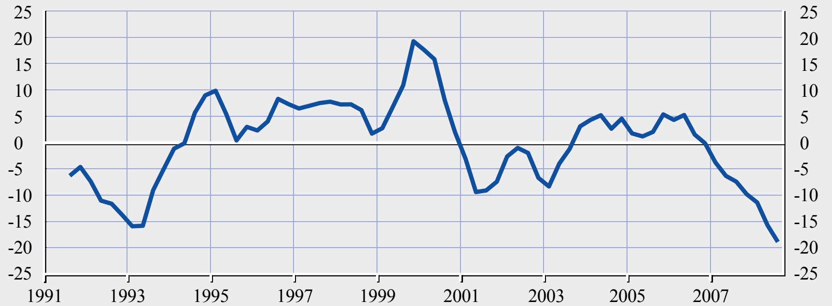
Note: Dotted lines denote 95% confidence interval around the respective impulse response.

as a proxy for consumer sentiment. At first sight surprisingly, the point estimate is negative. A similar result for broad money in Canada is reported by Atta-Mensah (2004). It should be noted that the parameter estimate is not significant at the 5% confidence level, possibly reflecting the fact that two countervailing effects may periodically have been relevant over the sample. The two effects are, on the one hand, the fact that a deteriorating employment situation may induce precautionary money holdings to meet unforeseen expenditures and, on the other, the fact that an expected deterioration in the economic environment reduces the propensity to accumulate money balances.

The cointegration relationship as shown in equation (1) is illustrated in Chart A5.4 and displays persistent deviations from the embodied "equilibrium" (average) level, suggesting that the differences between the level of money holdings and its

Chart A5.4 Cointegration relationship

(percentage of household M3)



Source: Seitz and Von Landesberger (2010).

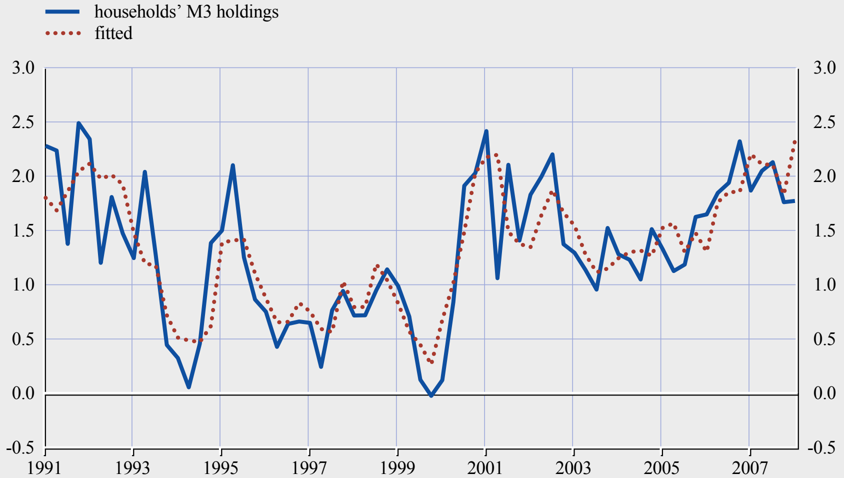
determinants can last for significant periods of time before correcting. Downside deviations from the average level are observed for periods in which the pace of economic activity in the euro area was slowing (1992-1994, 2001-2003 and since the first quarter of 2007), while upside deviations are observed particularly for the period around 1995, 1999-2000 before the bursting of the dot-com bubble and, to a lesser extent, between 2004 and 2006.

Tests for weak exogeneity of the variables indicate that the load factors on the change in the price deflator, the change in wealth, the interest rate spread and the uncertainty measure can be restricted to zero. Implementing these restrictions leaves two variables to adjust to disequilibria, *m* and *rc*. The parameters for the two load factors are highly significant, with nominal money and real consumption helping to reduce the disequilibrium in the long-run relationship. This notwithstanding, the speed of adjustment observed for both variables is rather low, as commonly found in studies of the household sector's money demand. This renders the short-run dynamics more important. Recursive estimation of the load factors indicates that the parameter estimate remained broadly unchanged between the fourth quarter of 2002 and the third quarter of 2008. A joint test for the exclusion restrictions placed on the alpha vector cannot be rejected at conventional significance levels [F(4,58) = 1.52, *p*-value = 0.21].

The cointegrated VAR model seems to explain changes in households' holdings of money quite well (adjusted $R^2 = 0.69$). The goodness-of-fit of the equation is also illustrated by Chart A5.5, which compares actual and fitted data. In order to assess the statistical properties of the model, several standard misspecification tests on the residuals of the VAR were carried out: normality and the absence of an autocorrelation of residuals cannot be rejected. The Nyblom tests conditional on the full-sample estimates for the constant and the lagged endogenous parameters

Chart A5.5 Households' actual and fitted M3 holdings

(quarterly percentage changes)



Source: Seitz and Von Landesberger (2010).

do not point to any instability of the long-run parameters for the sample under consideration. Finally, the LM tests against the alternative of non-linearity in the deterministic variables or the cointegration parameters do not suggest parameter non-constancy either.

3.2 NON-FINANCIAL CORPORATIONS

Non-financial corporations hold around one-fifth of the broad money stock M3. Over the past two decades, deposits of non-financial corporations have grown more quickly and fluctuated more widely than those of households, implying an increasing role in aggregate monetary dynamics.[82]

Non-financial firms devote important resources to managing their financial situation, and this degree of sophistication leads to a different interaction between money, opportunity costs and income than in the case of households. Non-financial corporations' money demand is determined by a wider range of relevant scale variables, such as investment, output or the wage bill, than is the case for households, and by a larger spectrum of alternative investment opportunities.

At a theoretical level, non-financial corporations are generally also thought to be free of money illusion and, therefore, related to price level in the long-run. This notion suggests imposing a parameter restriction of -1 on the long-run parameter for the price level. The implied price deflator for real gross value added may, however, be an imperfect measure of firms' price considerations. Deviations from strict parity could thus result from a measurement error. However, the neutrality restriction is not rejected at the 5% significance level (p-value = 0.08), with small deviations from neutrality proving to be less constraining for the model. Furthermore, the parameters on output and the capital stock are fairly similar, with point estimates of 1.27 and 1.39, thereby making it possible to restrict the values to being identical (p-value = 0.19). Introducing only the restriction on the parameters of output and capital stock would lead to a point estimate of 0.98 on the price level, very close to unity. Together the two restrictions are clearly not rejected by the appropriate F test (p-value = 0.21). The long-run relationship found is:

$$\begin{bmatrix} \Delta(m3)_t \\ \Delta p_t \\ \Delta y_t \\ \Delta blr_t \\ \Delta OWN_t \end{bmatrix} = \begin{bmatrix} \underset{0.068}{-0.28} \\ \underset{0.016}{0.042} \\ \underset{0.016}{0.074} \\ 0 \\ 0 \end{bmatrix} \begin{bmatrix} m3_{t-1} - p_{t-1} - \underset{0.048}{1.370} y_{t-1} + \underset{0.010}{0.065} BRL_{t-1} \\ -\underset{0.010}{0.116}(OWN)_{t-1} - \underset{0.048}{1.370} cap_{t-1} \end{bmatrix} + \ldots \qquad (2)$$

with standard errors shown below the parameter estimates. A joint F test for the restrictions placed on the alpha and beta vectors in equation 2 is not rejected at conventional significance levels (p-value = 0.13).

82 For the comprehensive analysis, see Martinez-Carrascal and Von Landesberger (2010).

The long-run relationship explains non-financial corporations' demand for money as positively dependent on the level of prices. Furthermore, a higher level of economic activity induces a larger demand for money, reflecting the need for working capital, with the increase more than proportionate, given that the elasticity is greater than one. Constraining the parameter estimate on output to one is not rejected by the data (p-value = 0.14), but leads to a rise in the parameter estimate on the capital stock, to 1.69, without a marked deterioration in the precision of the estimate.[83] Similarly, assuming that real money holdings move in parallel to the capital stock of the corporate sector, an assumption not rejected by the data, leads to a slightly stronger increase in the output elasticity, to 1.79.

As expected, a negative relationship between bank interest rates and money holdings is found, in line with the results reported for UK data in Brigden and Mizen (1999): an increase in the long-term interest rate on bank borrowing induces firms to reduce their money holdings in order to save financing costs. An increase in the bank lending rate by 100 basis points reduces the level of money holdings by 6.5%, while an increase in the own rate of return on money holdings will cause firms to hold more liquid assets, to the order of 11.6%. An equality restriction on both interest rate parameters (spread restriction) cannot be imposed, as such a restriction leads to a breakdown of the model.

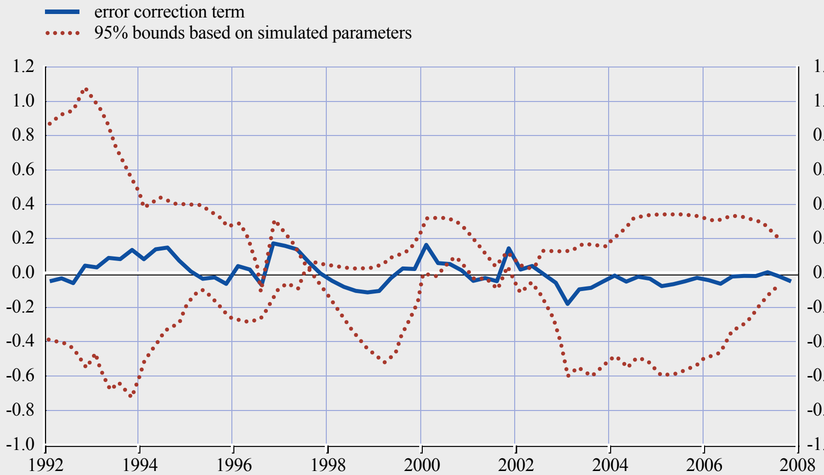
The speed of adjustment as indicated by the point estimate -0.285 seems to be quite high, suggesting that non-financial corporations adjust their money holdings relatively quickly to approach their optimal level. The estimated parameters indicate that, when money holdings depart from their long-run level, the return to the equilibrium is achieved not only through an adjustment in this variable, but also through changes in prices and gross value added. More specifically, these two variables adjust upwards when M3 is above its long-run level. In line with the quick adjustment implied by the model, the cointegration relationship, shown in Chart A5.6, stood at very low levels over the sample period, indicating that money holdings were broadly in line with the value implied by their fundamentals during this period. In order to gauge whether the deviations from the equilibrium are meaningful, bounds are constructed on the basis of a grid-search simulation exercise for all unrestricted beta parameters.[84] The bounds suggest that recent developments in money holdings are essentially in line with their long-run determinants, although considerable uncertainty is present in evaluating the error-correction term.

83 A similar restriction on the income and wealth parameter is imposed by Thomas (1997b). In this estimation, it is not rejected at the 5% significance level. At the same time, linear homogeneity with real money may be imposed on the parameter for income, with the restriction not being rejected at this significance level either. A larger parameter estimate for the capital stock is then observed.

84 The grid-search begins with fixing the parameter on output at -2.37, one point above the estimated parameter. The other model parameters are re-estimated and the resulting log-likelihood value is compared with the log-likelihood value of the main model in an LR test. The parameter values used to construct the bounds refer to the 95% value at which the new parameters do not differ from the parameter values shown in equation 2. The search continues in increments of 0.01. The exercise is repeated for all unrestricted parameters. The values obtained are similar to the bootstrapped parameter estimates presented below.

Chart A5.6 Cointegration relationship

(percentage of non-financial corporations' M3)

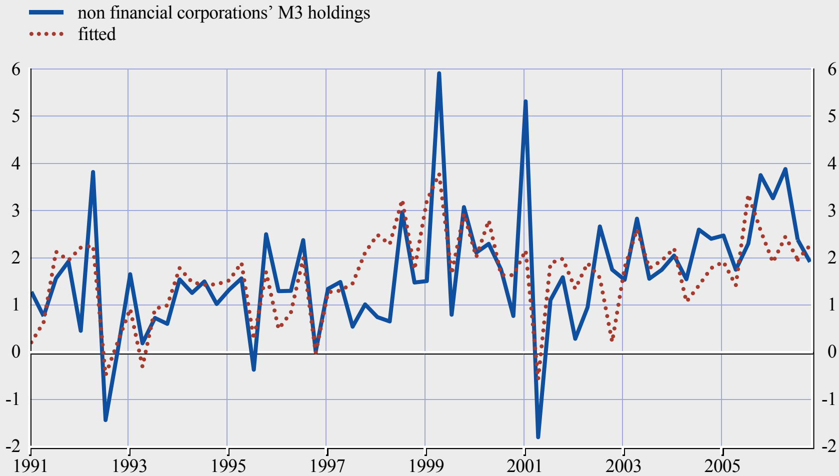


Source: Martinez-Carrascal and Von Landesberger (2010).

The dynamic model seems to explain changes in non-financial corporations' level of activity and holdings of money quite well. Chart A5.6 illustrates the developments in M3 holdings of non-financial corporations as well as those that would be derived from the cointegrated VAR model. The adjusted R^2 is lower than for economic activity, at 0.48. Overall, the main fluctuations are captured by the equation.

Chart A5.7 Non-financial corporations' actual & fitted M3 holdings

(quarterly percentage changes)



Source: Martinez-Carrascal and Von Landesberger (2010).

In order to assess the statistical properties of the model, standard misspecification tests on the residuals of the cointegrated VAR model were conducted. LM tests did not point to the presence of autocorrelation or ARCH. The Nyblom tests conditional on the full-sample estimates for the constant and the lagged endogenous parameter values do not point to any instability of the long-run parameters for the estimation sample under consideration.

4 CONCLUDING REMARKS

The euro area household, non-financial corporations and non-monetary intermediaries sectors display different long-run money-holding behaviour patterns in terms of a common set of determinants. In this respect, the long-run income elasticity seems to differentiate between households and firms, both financial and non-financial, while higher interest rate elasticity of money holdings distinguishes non-monetary financial intermediaries from the non-financial sector. Precautionary considerations seem to play a particularly strong role for household holdings. A refined modelling of the money-holding determinants provides additional insights: first, households' and non-financial corporations' money holdings do not reject long-run neutrality with the price level and, second, measures of economic activity (real disposable income or real consumption in the case of households, real gross value added in the case of non-financial corporations) are affected by the monetary disequilibria between money and its determinants, and also adjust. Third, in explaining the scale of households' broad money balances, wealth and, in particular, housing wealth are found to play an important role, which is mirrored by the real capital stock in the case of non-financial corporations. Lastly, non-financial corporations' money holdings tend to be strongly determined by the economic cycle, while households' money holdings tend to adapt in a rather gradual manner.

REFERENCES

Adalid, R. and Detken, C. (2007), "Liquidity shocks and asset price boom/bust cycles", *Working Paper Series*, No 732, ECB.

Atta-Mensah, J. (2004), "Money demand and economic uncertainty", *Working Paper Series*, No 2004-25, Bank of Canada.

Beyer, A. (2009), "A stable model for euro area money demand: revisiting the role of wealth", *Working Paper Series*, No 1111, ECB.

Boone, L. and Van den Noord, P. (2008), "Wealth effects on money demand in the euro area", *Empirical Economics*, Vol. 34, pp. 525-536.

Brigden, A. and Mizen, P. (1999), "Money, credit and investment in the UK corporate sector", *Working Paper Series*, No 100, Bank of England.

Brigden, A., Chrystal, A. and Mizen, P. (2000), "Money, lending and spending: a study of the UK non-financial corporate sector and households", *Quarterly Bulletin*, Vol. 40(2), Bank of England, pp. 159-167.

Butkiewicz, J. and McConnell, M.M. (1995), "The stability of the demand for money and M1 velocity: Evidence from the sectoral data", *Quarterly Review of Economics and Finance*, Vol. 35(3), pp. 233-243.

Chadha, J., Haldane, A. and Janssen, N. (1998), "Shoe leather costs reconsidered", *Economic Journal*, Vol. 108, pp. 363-382.

Chrystal, A. and Mizen, P. (2001), "Consumption, money and lending: a joint model for the UK household sector", *Working Paper Series*, No 134, Bank of England.

De Bondt, G.J. (2009), "Euro area money demand: empirical evidence on the role of equity and labour markets", *Working Paper Series*, No 1068, ECB.

Detken, C. and Smets, F. (2004), "Asset price booms and monetary policy", *Working Paper Series*, No 364, ECB.

Ericsson, N.R. (1998), "Empirical modelling of money demand", *Empirical Economics*, Vol. 23(3), pp. 295-315.

ECB (2006a), "Sectoral money holdings: determinants and recent developments", *Monthly Bulletin*, August, pp. 59-72.

ECB (2006b), "Sectoral money holdings and the information content of money with respect to inflation", *Monthly Bulletin*, September, pp. 18-20.

Greiber, C. and Lemke, W. (2005), "Money demand and macroeconomic uncertainty", *Discussion Paper Series*, No 26-2005, Deutsche Bundesbank.

Greiber, C. and Setzer, R. (2007), "Money and housing: evidence for the euro area and the US", *Discussion Paper Series*, No 12-2007, Deutsche Bundesbank.

Jain, P. and Moon, C.-G. (1994), "Sectoral money demand: a cointegration approach", *Review of Economics and Statistics*, Vol. 76(1), pp. 196-202.

Juselius, K. (2006), *The cointegrated VAR model: methodology and applications*, Oxford University Press.

Lucas, R.E. (2000), "Inflation and welfare", *Econometrica*, Vol. 68(2), pp. 247-274.

Martinez-Carrascal, C. and Von Landesberger, J. (2010), "Explaining the money demand of non-financial corporations in the euro area: a macro and a micro view", *Working Paper Series*, ECB, forthcoming.

Seitz, F. and Von Landesberger, J. (2010), "Household money holdings in the euro area: an explorative investigation", *Working Paper Series*, No 1238, ECB.

Stracca, L. (2001), "The functional form of the demand for euro area M1", *Manchester School*, Vol. 71, pp. 172-204.

Thomas, R. (1997a), "The demand for M4: a sectoral analysis Part 1 – The personal sector", *Working Paper Series*, No 61, Bank of England.

Thomas, R. (1997b), “The demand for M4: a sectoral analysis Part 2 – The corporate sector”, *Working Paper Series*, No 62, Bank of England.

Von Landesberger, J. (2007), “Sectoral money demand models for the euro area based on a common set of determinants”, *Working Paper Series*, No 741, ECB.

Warne, A. (2008), *Structural VAR, version 0.50*.

CHAPTER 4

MONEY-BASED INFLATION RISK INDICATORS: PRINCIPLES AND APPROACHES

1 INTRODUCTION[1]

Money-based inflation risk indicators operationalise the long-run link between monetary growth and consumer price inflation. A large amount of empirical evidence across various economies and monetary regimes demonstrates this link.[2] Regular consideration of this relationship supports the medium-term orientation of monetary policy by pointing the attention of central banks towards longer-term developments in nominal variables – ultimately, the price level – over which they can exert control and for which, given the mandate to maintain price stability, they should be held accountable.

In developing money-based inflation risk indicators that can support monetary policy decisions on a month-on-month or quarter-on-quarter basis, this longer-term relationship is used in the form of a "maintained hypothesis". Indicators are not intended to prove the existence of the long-run link between money and prices – which is seen as a feature of any plausible economic model – but to make the relationship accessible and useful for monetary policy purposes.

The information in money of relevance to the assessment of risks to price stability is embedded in the persistent or lower frequency movements of the monetary developments. The practical challenge for the monetary analysis is to identify these persistent movements or – in the terminology used by the European Central Bank (ECB) in its official communication – the pace of "underlying monetary growth". In practice, this amounts to using different tools and techniques to "smooth" the raw monetary data. (The more smoothing is applied, the less relevant the issue of forecast horizon becomes, as the phase shifts between variables are likely to diminish.) Once the detailed monetary analysis has generated a view on the pace of underlying monetary growth, the one-to-one long-run link between money and inflation should more or less automatically generate a view on the persistent trends in inflation prevailing at a certain point in time and – without shocks to these trends – also in the period ahead.

1 This chapter was prepared by Julian von Landesberger and Thomas Westermann. The authors would like to thank the contributors of the annexes (Gianni Amisano, Gabriel Fagan, Domenico Giannone, Michele Lenza and Lucrezia Reichlin), Huw Pill and the commentators at the ECB colloquium on "Enhancing the monetary analysis" held in April 2010 for their many helpful comments and suggestions. The views expressed are those of the authors and not necessarily those of the ECB or Eurosystem.

2 For a recent study, see Benati (2009).

Mapping monetary variables into quantitative indicators of risks to price stability has been a central element of the ECB's monetary analysis from the outset.[3,4] Within the ECB's monetary policy strategy, such indicators are primarily seen as heuristic or illustrative tools, which are useful for the purposes of presentation and comparison. In particular, money-based inflation risk indicators emphasise the instrumental nature of the monetary analysis: money is analysed to support the formulation of a monetary policy that maintains price stability over the medium term, rather than to achieve any specific normative growth rate of M3 in and of itself. Moreover, such indicators are – at least in principle – a convenient way to summarise and synthesise the information in the detailed monetary analysis, thus permitting comparison with the outcome of conventional macroeconomic forecasting exercises, such as the Eurosystem's macroeconomic projections.

With regard to the practical implementation of such indicator tools, one point should be emphasised from the outset. While judgement is used in the regular conduct of the ECB's monetary analysis to derive a quantitative view of the pace of underlying monetary growth,[5] the mapping of this into a view of inflation risks is implemented in an entirely mechanical manner using the available tools. In contrast to the Eurosystem macroeconomic projections, the money-based inflation risk indicators are judgement-free in that they reflect pure model output derived from the assessment of underlying monetary dynamics. The monetary analysis thus foresees the possibility of judgment being applied to the input to indicator models, but does not influence the generation of their output.

This approach has two implications. First, forecasting tools should be robust enough over time to survive without judgmental interference. Experience suggests that it is often the simpler tools that provide this robustness. Second, it is unlikely that there is a single robust indicator that outperforms others at all times. In this respect, robustness can be interpreted as being able to cut across a set of different tools and indicators in gauging inflation risks. Indeed, widening this set has been one of the main motivations behind the agenda to enhance money-based inflation risk indicators. In so doing, a number of tools already employed in other types of analysis – such as in assessing developments in economic activity – have been adapted for use in the monetary analysis.

In general terms, in devising money-based inflation risk indicators that are relevant and useful for monetary policy-making, two main challenges need to be overcome. First, the underlying tools need to be applicable in real time,

3 See Masuch et al. (2001) and ECB (2004).

4 This reflected to some extent the "peer pressure" related to the inflation targeting framework adopted at other central banks and strongly favoured by an influential body of academic opinion. In an inflation targeting context, a variable is deemed relevant for monetary policy-making only insofar as it improves inflation forecasts at the so-called policy horizon.

5 For example, in the form of the construction of estimates of exceptional "portfolio shifts" into monetary assets between 2001 and 2003, as discussed in Chapter 3 and reported in detail in Fischer et al. (2008).

i.e. use only data and information that is available at the time of the analysis and which could thus serve as input in a policy discussion. Second, such tools need to embed the notion that it is the persistent component of monetary developments that provides the relevant signal for risks to price stability over the medium term. These two challenges are intimately related, as it is precisely the derivation of the unobservable persistent trends that is the challenge in real time, rather than, for instance, the application of models that map monetary trends into inflation or the somewhat different timeliness of data inputs to such models.

The remainder of this chapter is organised as follows. Section 2 recalls that the link between money and inflation that can be exploited for policy purposes stems from the relationship between the trend components of the two variables. Section 3 presents a flexible empirical framework to link monetary trends to a medium-term inflation outlook, while Section 4 elaborates on extensions of models built under this unifying framework and efforts to increase their robustness. Section 5 concludes with the view that attempts to condense information from the money-based inflation indicators into a single summary indicator should be treated with caution as the advantages in terms of simplicity are more than outweighed by the dangers of over-simplification.

2 THE ADVANTAGES OF USING MONETARY DEVELOPMENTS TO ASSESS INFLATION RISKS

When discussing the benefits of using money to gauge risks to price stability, it is important to first set the scene and manage expectations. Even advocates of monetary analysis would not claim that money is adequate to forecast inflation or conduct monetary policy,[6] but they would argue that it is a necessary component. Money-based inflation risk indicators should therefore be seen as one guide among many that support monetary policy decisions, which have to be understood in the context of a broader set of analyses of both money and, of course, other economic variables.

Against this background, a number of important observations should be made. First, since the early 1990s inflation has generally become harder to forecast, both at the global level and in the euro area. The empirical evidence available in this respect covers the period until the outbreak of the financial tensions in 2007, but is likely to hold with even greater force during the financial crisis.[7] This "secular" decline in the predictability of inflation rests on two developments: (a) over the past twenty years the volatility of inflation – in line with other

6 Indeed, the ECB's two pillar strategy – consisting of both monetary and economic analyses – explicitly recognises that money alone is insufficient for the conduct of a successful monetary policy aimed at maintaining price stability.

7 Several papers (Atkeson and Ohanian (2001), Stock and Watson (2005), Ang et al. (2007)) using a diverse set of methods document that the performance of models in forecasting US inflation has significantly diminished since the mid-1980s. Benati and Mumtaz (2005) complement this literature with an analysis for the United Kingdom.

macroeconomic variables – has declined;[8] and (b) the persistent component of inflation has come to be deemed as less important in explaining the overall dynamics of consumer price inflation.[9]

From a central bank's perspective, both features of the data are symbols of success: they reflect the achievement of the mandate to maintain price stability over the medium term. For example, over the past twenty years there have not been any persistent deviations of inflation from levels consistent with price stability, such as those seen during the Great Inflation of the 1970s. However, from a forecasting perspective, these features of the data create problems. Taken together, they have increased the relative predictive power of "naive" forecasting techniques (such as the random walk benchmark), implying that it has become more difficult for any inflation forecasting framework to provide value-added beyond a simple univariate time series model. However, it should be emphasised that this diminishing (relative) predictability is not confined to money-based inflation indicators, but seems to be common to all inflation forecasting models.

In other words, the loss in predictability of inflation comes together with (and is a consequence of) a gain in the credibility of monetary policy.[10] This calls for an interpretation along the lines of Goodhart's law, namely that the more successful a central bank is in keeping inflation expectations anchored, the more it upsets the statistical regularities that govern the reduced form relationship between indicator variables on the one side and inflation outcomes on the other.

Yet the decline in the predictability of inflation cannot be a reason for monetary policy-makers to forego economic underpinnings and confine their attention to univariate inflation forecasting models. An approach based only on the time series of inflation will not warn of any loosening in the anchoring of longer-term private inflation expectations. By contrast, underlying monetary trends provide (at least potentially, given the regularities observed in very long time series) important information about the medium-term outlook for inflation that is not contained in the history of inflation itself.

Second, it is trivial to observe that forecasting inflation becomes harder as the forecast horizon is extended. This can easily be demonstrated with the confidence bands around the out-of-sample forecasts generated with a univariate autoregressive (AR(1)) approach (see Chart 1). For a stationary process, this can be illustrated by calculating the respective contribution of the constant and the observation in period 0 of the forecast to the forecast value. When the contribution of the constant determines the forecast, predictability is lost – in Chart 2 this is around eight quarters out. The bound of predictability is not changed by temporal aggregation (from monthly data to quarterly),

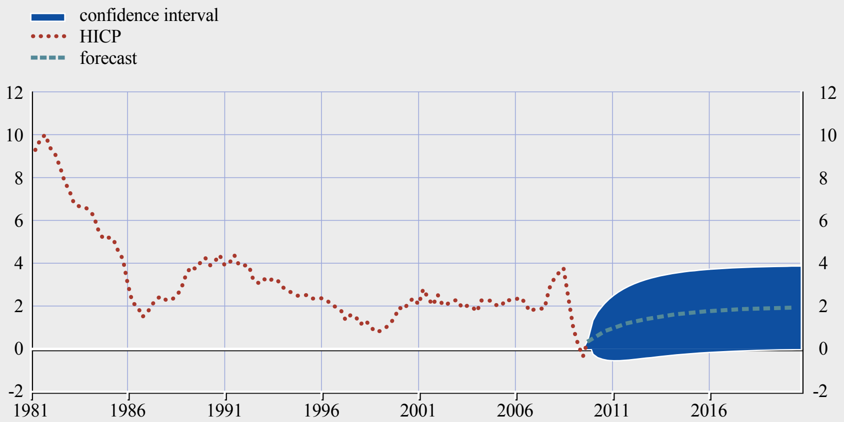
8 See Kim and Nelson (1999) for an introduction; see Cogley and Sargent (2005) and D'Agostino et al. (2006) for detailed investigations.

9 See Stock and Watson (2005) for the United States and Benati (2008) for a number of euro area countries.

10 See Benati (2008).

Chart 1 Out-of-sample forecast of HICP inflation using an AR(1) model

(annual percentage changes)



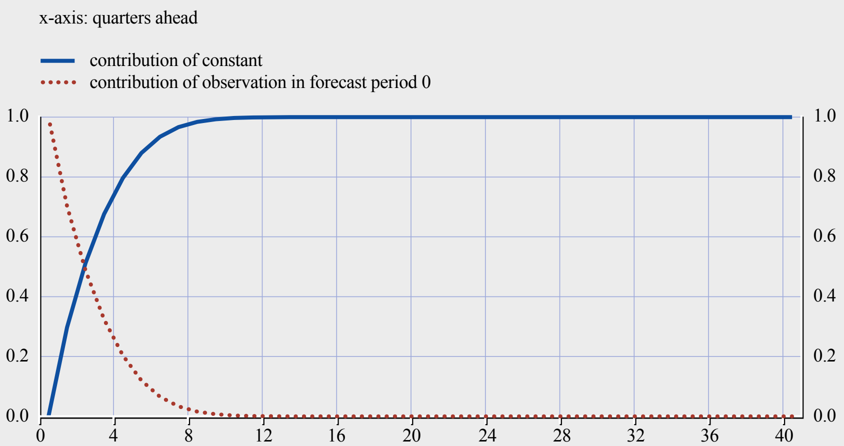
Sources: Eurostat and ECB estimates.

but is affected by temporal transformation (moving averages), owing to the change in the persistence of the series that the transformation induces.

Of course, money-based inflation risk indicators also face precisely this issue: the further away the forecast horizon, the more uncertainty surrounds the forecast. At the same time, it is necessary to distinguish between, on the one hand, the ability to forecast actual inflation rates several years ahead and, on the other, the ability of monetary developments to inform on inflation trends at longer horizons.

Chart 2 Stylised representation of inflation predictability at longer horizons in an estimated AR(1) model

(share)



Source: ECB estimates.

The possibility of gauging the size and timing of idiosyncratic and conjunctural shocks to inflation in the future obviously diminishes with the length of the forecast horizon. Any prediction of the inflation rate in a particular quarter may thus be far off the eventual rate, as it has very little anchor in the information available at the point in time the forecast is made. However, monetary developments today can offer an insight into the more persistent parts of the inflation process that have a "long memory" and typically do not change in a sudden way. It is precisely because these components are persistent, that they will also exert an influence at longer horizons.

Money therefore comes into the play by helping to assess the evolution of these underlying inflation trends that are prevalent at all points in time, not because it provides information on inflation at a specific point in time. Any money-based prediction for the trend rate of inflation is unlikely to correspond to the inflation rate that actually materialises at a specific point in the future – unless all shocks away from trend cancel each other out by chance. However, this does not mean that the monetary information is unimportant. On the contrary, it gives an insight into developments in the medium-term outlook for price developments, which are central to the monetary policy process.

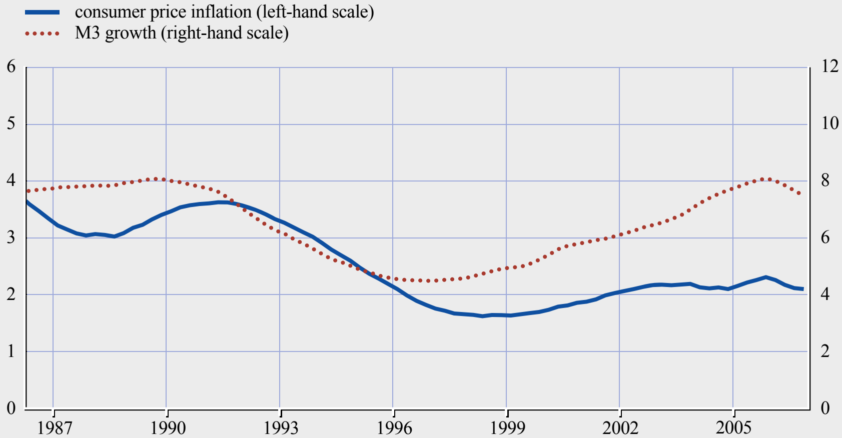
A useful approach to exemplifying and communicating the information content of money for inflation is to decompose monetary developments into their components at different frequencies.[11] Each component can be compared with the respective component of consumer price inflation. In this respect, the frequency domain is simply a different type of representation of decompositions into trend and cycle commonly performed in the time domain. For the euro area, such a decomposition and comparison in the frequency domain demonstrates that there is a robust relationship between the low frequency or persistent components of M3 growth and inflation, consisting of only those developments which prevail beyond the length of a typical business cycle (see Chart 3). At the same time, the relationship is much less apparent or noisier at business cycle frequencies and higher. It is important to note the following three points.

First, the close empirical relationship at low frequencies emphasises the common trends in nominal variables (particularly money and prices). This implies the strong role played by central banks and money in controlling or anchoring the evolution of the general price level that is implicit in the quantity theory. A number of empirical studies have made explicit use of this long-run one-to-one relationship in explaining inflation dynamics.[12] The modelling set-up is often referred to as a "two-pillar Phillips curve" that – in addition to conventional inflation determinants such as output gaps and commodity prices – includes a measure of "core" or underlying monetary growth. This measure is derived as the low frequency component of a broad monetary aggregate and replaces the longer-term inflation expectations that typically function as an anchor in Phillips-type equations.

11 See Pill and Rautanen (2006).
12 See Greiber and Neumann (2004), Assenmacher-Wesche and Gerlach (2006) and Carstensen (2007).

Chart 3 Low frequency components of M3 growth and CPI inflation

(annualised percentage changes)



Source: ECB estimate.

Note: The low frequency components of M3 growth and consumer price inflation have been calculated as the difference between the observed series and the filtered series for all cycle lengths below ten years, which were derived using the symmetric version of the Christiano-Fitzgerald bandpass filter.

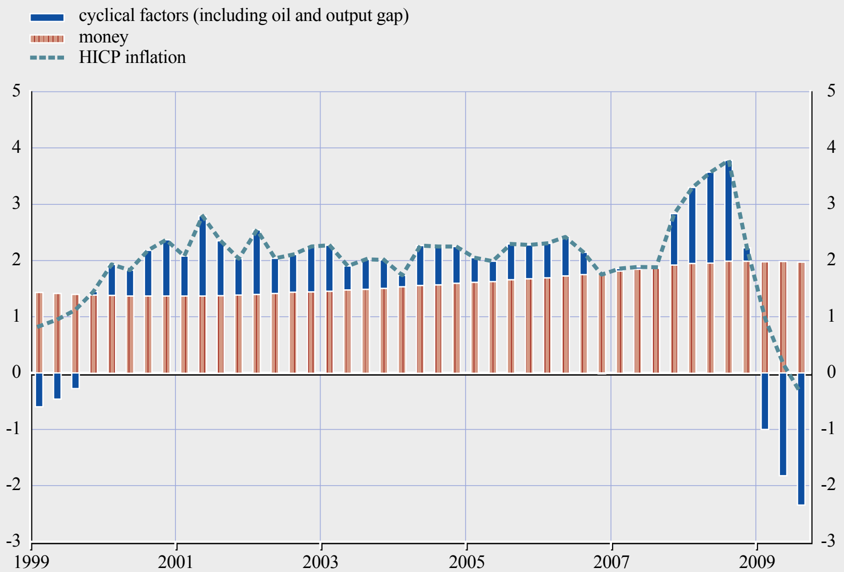
All studies confirm that the different inflation determinants have comparative advantages at different frequency bands. Underlying monetary growth plays a causal role in inflation trends, while at business cycle frequencies and higher, non-monetary indicators such as the output gap or commodity prices increasingly come into play as correlates and forward-looking indicators of inflation. Chart 4 exemplifies the relative importance of different factors in gauging and explaining inflationary pressures.[13] In the specification, underlying monetary growth essentially takes on the combined role of the regression constant and inflation expectations.[14] The decomposition illustrates the role of money in explaining the gradual upward creep in inflation trends after 2003, as well as their moderation after 2008.

13 A money-augmented Phillips curve, including lagged inflation, M3 growth, output gap and oil prices, is estimated over the horizon from 1980 to 2009, using a general to specific approach to determine the relevant lags. The automatically chosen lags of money growth and output gap are in line with empirical stylised facts in that they embed a considerably longer lead time for money growth than for the output gap. By recursively substituting out the lagged inflation terms on the right side of the equation, it is possible to decompose current inflation into contributions from lagged money growth, the lagged output gap, current and lagged oil prices, and further exogenous shocks.

14 In such representations, money refers to a trend measure of monetary growth and not to actual monetary growth (unless the inclusion of lagged values implies sufficient smoothing). At the same time, the decomposition suffers from the caveat that it assumes orthogonality (linear independence) of money, output gap and exogenous supply factors, which is neither in line with the theory of the transmission mechanism nor with empirical evidence. A technically cleaner way to decompose a series is based on the derivation of appropriate orthogonal shocks, as for instance in Bruggeman et al. (2005). However, the orthogonal shocks are not observed, difficult to interpret and depend heavily on the identification scheme imposed by the decomposition, so that the practical value of identifying those shocks remains unclear.

Chart 4 Decomposition of inflation using a money-augmented Phillips curve

(annual percentage changes; contributions in percentage points)



Sources: ECB and ECB estimates.

Second, developments in the low frequency component of M3 growth lead equivalent developments in inflation by around one and a half years. This broadly corresponds to the normal length of the monetary policy transmission mechanism. This is simply an empirical feature of the euro area data: in principle, the relationship could be coincident or lagging, if all it does is capture the idea that, in the long run, changes in money will ultimately be reflected in changes in prices (see Box 1).[15] However, the lead of money over inflation developments at low frequency supports the usefulness of the monetary analysis for the (necessarily forward-looking) conduct of monetary policy.

More generally, the observation that there is a link between money and inflation at frequencies beyond that of a business cycle should not be confused with the length of any lead of trend monetary developments over trend inflation developments. The lead of around one and a half years shows that trend inflation reacts relatively quickly to changes in trend money growth. However, as long as it is possible to derive a reliable notion of underlying or trend money growth, the lead is long enough for the central bank to use this signal to avoid underlying inflationary pressures in a sufficiently pre-emptive manner before they materialise in actual inflation data.

15 See Woodford (2008).

Box 1 The co-movement between money growth and inflation, and the prominent role for money

The strong co-movement between the low frequency components of broad money growth and inflation depicted in Chart 3 is a necessary, but not sufficient, condition for money to play a prominent role in assessing inflation risks.

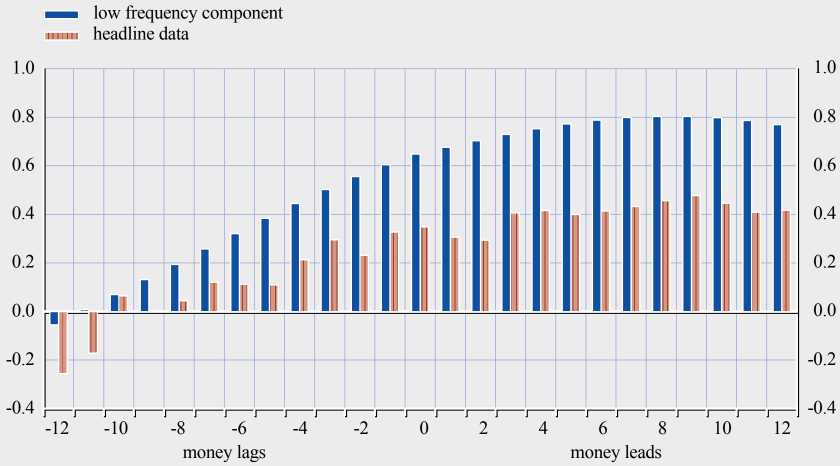
It is important to emphasise the role of the lead that exists empirically between monetary growth and inflation. Chart A illustrates two aspects: (i) the correlation of M3 growth and Harmonised Index of Consumer Prices (HICP) inflation is considerably higher for the low frequency components than for the raw (headline) data; and (ii) the maximum correlations are reached for a lead of money growth over inflation of between six and eleven quarters. Chart B shows that this maximum correlation and the lead at which it occurs changes with the sample size and that over the past decade there has in fact been some decline in the correlation, but also a lengthening of the lead time.

Overall, both high correlation and lead appear to be robust facts, which can be exploited in the sense that a notion of trend money growth today provides policy-makers with indications for inflation tomorrow that are sufficiently early to allow a reaction to the signal (see also Assenmacher-Wesche/Gerlach (2006) and Marquez/Pina (2002)).

Woodford (2008) simulates a numerical version of a simple New Keynesian model to generate a similar empirical lead of the low frequency component of money relative to that of inflation – even in the absence of an active role for money in price level determination. He uses this finding to argue against a "prominent" role for money in monetary policy discussions.

Chart A Correlation of low frequency and raw data on M3 growth and inflation

(correlation coefficient)



Source: ECB calculations.

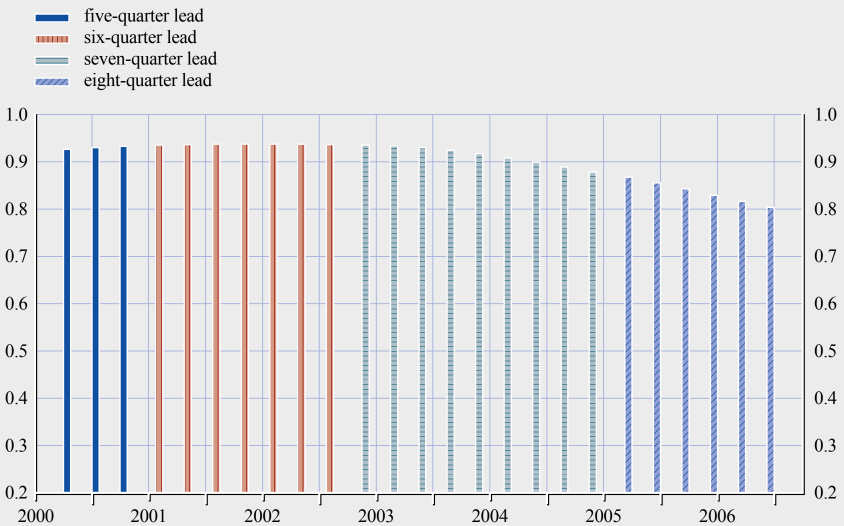
Box 1 The co-movement between money growth and inflation, and the prominent role for money (cont'd)

In order to accommodate the empirical persistence of the inflation process characteristic of the data, the inflation target in this simple New Keynesian framework is assumed to follow a random walk, around which the actual inflation rate fluctuates. This stochastic trend suggests that central banks modify their inflation target every quarter, which contrasts with reality. Moreover, it does not necessarily provide very helpful guidance to policy-makers: the advice that central banks should maintain a stable and constant inflation objective so as to avoid persistent deviations of inflation from price stability is well-taken, but arguably not very useful from an operational perspective.

While it is empirically undisputed that inflation as such has a stochastic trend, it does not necessarily result from fluctuations in the inflation objective, but could also be embedded in the money supply process, i.e. how the banking system provides financing to the economy. Indeed, as noted by Goodhart (2007) "The bulk of money is in the form of commercial bank liabilities, and banks can behave very differently over time. The form of their liabilities, their capital base, their confidence, their risk appetite can and does alter over time, both cyclically and more permanently." Expected deviations of the central bank's future equilibrium interest rate from the unobservable natural rate of interest will create money and credit in the economy, induce higher asset valuations (in the spirit of Tobin's q) and prompt firms to invest, as described by Wicksell (1898).

Chart B Maximum correlation of low frequency component of M3 growth and inflation for growing sample sizes

(correlation coefficient)



Source: ECB calculations.

Note: The chart shows the maximum correlation coefficient and indicates the respective lead of a filtered broad money series with respect to a filtered inflation series. The x-axis denotes the last period of the filtered series considered in the computation of the correlation. The methodology applied to filter the series is described in the note to Chart 3 in the main text. Owing to the symmetry of the filter, the observation for the fourth quarter of 2006 is based on input data from as recent as the fourth quarter of 2009.

Box 1 The co-movement between money growth and inflation, and the prominent role for money (cont'd)

While short-lived deviations (stationary) may not have a strong impact on aggregate demand and inflation, in the context of Woodford's model, longer-lasting misperceptions could also impart the inflation process with a stochastic trend. Wicksell (1898, p. 101) emphasised this argument stating that the elasticity of the monetary system was crucial for the unfolding of his cumulative process.

Not only may this alternative explanation of the stochastic trends in inflation be more plausible, it may also offer more meaningful guidance to policy-makers. Recognising that stronger than expected money and credit growth may be symptomatic of misperceptions of the natural real interest rate points to the need for central banks to analyse monetary developments. As a minimum, such analysis may prompt a re-evaluation of interest rate levels. More ambitiously, responding to monetary developments may help to stabilise the economy by eliminating such stochastic nominal trends.

Woodford also assumes that the stochastic trend in inflation is readily observable. However, without identifying assumptions for the nature of the trend, an infinite number of trend-cycle decompositions of the inflation process can empirically be undertaken. In fact, analysing the low frequency components in money growth and inflation can be one form of identifying the stochastic trend as the trend needs to be common to money and inflation, while not present in the output gap or the interest rate. In addition, the co-movement of money and inflation in the long run suggests that deviations in this long-run relationship must correct. Money demand shocks will by their nature engender adjustments in money holding behaviour without affecting future price developments, while money supply shocks will influence future price developments. In this respect, the observation in actual euro area data that money leads inflation is a building block for the monetary analysis.

Third, the charts and discussion above illustrate that any operationalisation of the link between underlying monetary growth and underlying inflation depends on appropriate measures of monetary trends being derived in real time. Convincing as the link in Chart 3 appears ex post, its exploitation in real time will be complicated by the "end-point problem". Statistical filters (of which forecasting models are simply one variant in this context) essentially smooth time series by taking a moving average of past and future observations. As analysis moves towards the end of the sample, such filters have no future observations to rely on and thus tend to lend too much weight to the latest observations.[16] This will affect the reliability of estimated trends in real time and may be particularly misleading given that these latest developments are exceptional. The financial crisis of 2008-09 illustrates this point: the steep decline in monetary growth implies that any filtered measure of monetary trends declines strongly, even though with the benefit of hindsight – and recognising the subsequent stabilisation and

16 In principle, it is possible to alleviate the problem of asymmetry in the filter by including forecast data, but to some extent this implies a trade-off between uncertainty in the filter and uncertainty in the forecasts.

eventual recovery of monetary growth – the long-term trend that will be derived ex post in ten years time might look radically different.

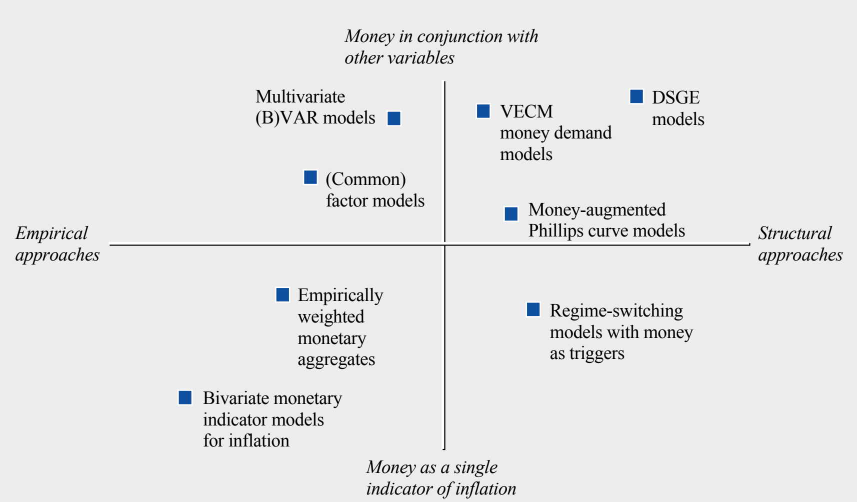
In practice, the derivation of underlying monetary trends in the context of the ECB's monetary analysis places considerable emphasis on "institutional analysis". This can be seen as an attempt to address the end-point issues. The identification of underlying monetary trends may start from raw statistical data such as "headline" M3, but by taking into account data on the components, counterparts and sectors of M3, on financial flows and prices more generally, and on indicators of the real economy and financial markets, a much richer and more comprehensive assessment is developed than would emerge from the mechanical application of a simple statistical filter to M3. The construction of an M3 series corrected for the estimated impact of portfolio shifts described in Chapter 3 is an example of this approach. This can be seen as embedding – albeit in a large part judgmentally – structural and off-model information in the derivation of underlying monetary growth.[17] More generally, the ECB's practice has been to complement statistical approaches with a broad variety of other methods and tools to produce a comprehensive assessment of the latest trends that provide the relevant signal for inflation.

The main goal of the efforts to enhance the monetary analysis by means of the money-based inflation risk indicators was to broaden the set of methods and tools used. In particular, a promising approach was to develop tools that had been successfully employed in other fields, such as in the analysis of developments in economic activity. Three broad categories of tools were investigated to identify monetary trends: (a) tools which smooth the monetary time series through time; (b) tools that have a smoothing effect by exploiting cross-sectional information across various sub-components of the monetary data or across a variety of indicators and models (e.g. forecast combination); and (c) explicit, more structural modelling of monetary developments. The latter can, in turn, take many different forms, such as general equilibrium models or partial equilibrium approaches, such as money demand equations and (augmented) Phillips curves.

Chart 5 offers a typology of these tools along two dimensions, helping to illustrate the caveats and trade-offs that are associated with the various approaches. The first dimension spans the spectrum from empirically-motivated tools (which better fit the data) to theoretically-based tools (with a richer, micro-founded economic structure), a distinction which is common in the academic literature. In developing tools, it is important to take a stance on the extent to which theoretical priors should shape the analysis of monetary developments and thus condition the empirical assessment of the available data. The second dimension of the typology spans the spectrum from tools that focus on the information in money (amounting in essence to bivariate analysis of money and inflation) to tools that use money in conjunction with other variables to explain inflation. The latter allow for a richer description of the channels of transmission, but also imply increased complexity and thus the risk

17 See Fischer et al. (2008).

Chart 5 Typology of models for monetary analysis



Source: ECB.

that mis-specification of the relationship between inflation and non-monetary determinants disrupts the relationship between inflation and money.

Regardless of the varying degrees of empirical or theoretical sophistication, ultimately all tools rely on moving averages of monetary data (potentially in conjunction with other data) to estimate the underlying pace of monetary expansion. There is no "magic" transformation of headline series for monetary growth into a notion of underlying monetary growth or directly into inflation risks and thus no model acts as a "silver bullet" in offering a comprehensive indication of the policy-relevant information in monetary developments.

Moreover, the rich set of tools shown in Chart 5 is not exhaustive, but hints at the idea that there is no single best money-based inflation risk indicator. Each tool or indicator has its specific pros and cons: by looking across the set of models, the overall analysis aims at minimising the disadvantages and maximising the advantages of the models. At the same time, it is unlikely that it is possible to cut across the information from the different models in order to arrive at a single synthetic quantitative summary indicator, given that the forecast output can come in very different representations, such as average inflation numbers, actual inflation numbers or probabilities of inflation outcomes.

The remainder of this chapter discusses the practical implementation of money-based inflation risk indicators. It starts with a description of a simple, but flexible tool and goes on to discuss how other tools, such as those identified in Chart 5, can be used to increase the depth and robustness of the overall information generated.

3 OPERATIONALISING THE MONEY-INFLATION LINK IN A SIMPLE SET-UP

3.1 THE TECHNICAL SET-UP OF THE MODEL

A straightforward way of mapping the detailed monetary analysis into an outlook for inflation is to employ a reduced-form inflation forecast equation in the spirit of Stock and Watson (1999). Such models have been used consistently in the ECB's monetary analysis over the past ten years, as described and assessed in Fischer et al (2008).[18] Before discussing how these models smooth the raw data so as to construct trend estimates that identify the information content of money, it is useful to recall briefly the main features of the framework.

In essence, the model augments an autoregressive equation for forecasting consumer price inflation π at time $t+h$ with the information embodied in monetary indicators x at point t:

$$\pi^{k}_{t+h} = c + \alpha(L)\,\pi_t + \beta(L)\,x_t + \varepsilon_{t+h}$$

In its application to the euro area monetary data, their specification exploits quarterly data and embodies several smoothing elements that can help to capture the idea that the policy-relevant link between money and inflation concerns the lower frequency components of the two variables. In particular, the lag polynomial $\beta(L)$ implies that a (weighted) average of monetary developments over several periods is the key explanatory variable, rather than simply the most recent observation. Moreover, the parameter k denotes the number of quarters over which the inflation term is calculated in annualised terms $\pi^{k}_{t} = (4/k) \cdot \ln(P_t/P_{t-k})$. For instance, $k=4$ represents the annual growth rate of the price level P (i.e. inflation over the past four quarters). A specification with $k=4$ would thus generate point forecasts for annual HICP inflation at any specific horizon chosen for h. By contrast, a value of $k>4$ represents annualised inflation over a period longer than one year, which can be seen as a measure that smoothes (by taking an (equally) weighted moving average of quarterly inflation developments.

These smoothing elements can be combined in a flexible way – possibly restricted by some priors – and it is ultimately an empirical question regarding which specification delivers the most policy-relevant information. The money-based inflation risk indicators derived using this framework (and presented in official ECB publications, for example ECB (2004, 2005, 2006)) use a specification where the number of lags in the polynomials $\alpha(L)$ and $\beta(L)$ are selected using the Schwartz information criterion (with a maximum of 3) and $h=k$ at values of either 6 or 12.

The selection of the lags in a purely data dependent manner implies that the precise specification of a model can change from one forecast to the next. This makes it more difficult to assess the factors behind changes in the forecast

18 This largely follows the methodology outlined in Stock and Watson (1999). Empirical applications to euro area data include Nicoletti-Altimari (2001) and Hofmann (2008).

results, but this may be a small price to pay for the considerable reduction in the complexity of the modelling task. Moreover, experience with the rolling re-estimations of the models over the past years shows that the number of lags typically remains rather stable, with mostly only one lag being selected by the data.

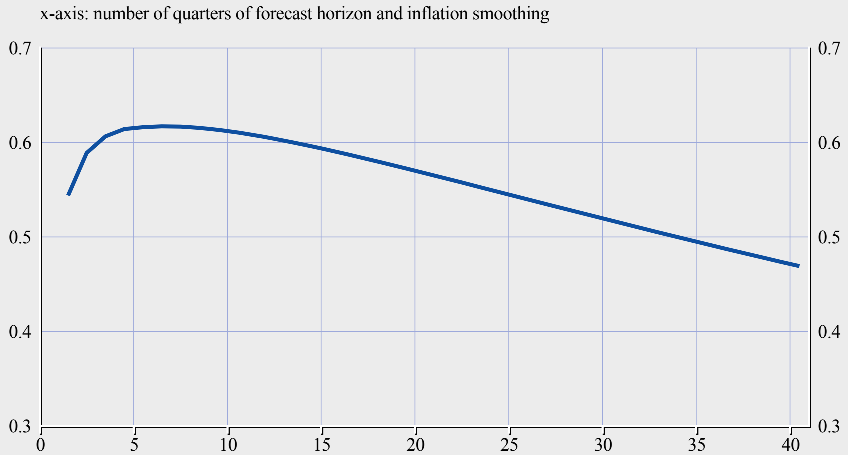
3.2 CONCEPTUAL ISSUES IN THE OPERATION OF THE MODEL

In order to bring out the conceptual issues in this model's set-up, it is useful to review the convention to set the forecast horizon equal to the smoothing of the dependent variable ($h=k$). Reichlin and Lenza (2007) have shown that this assumption can be underpinned by a statistical exercise run for the monetary indicator M3. Taking the relative predictability of the bivariate model compared with the autoregressive model as a statistical criterion, this exercise demonstrates that for a given degree of smoothing k, the relative predictability remains broadly stable for forecast horizons h up to three years, but then deteriorates continuously. At the same time, for a given forecast horizon h, the predictability increases for degrees of smoothing k up to four years before flattening off. When setting $h=k$, the highest and broadly stable relative predictability is found for values between six and twelve quarters, while for both lower and higher values the performance is declining (see Chart 6).

Overall, the analysis by Reichlin and Lenza (2007) suggests that forecast horizons of only six or twelve quarters produce indicators that are most informative about the medium-term trends in inflation that will influence developments at horizons well beyond 12 quarters ahead. In other words, it is horizons of this length that best manage the trade-off between longer horizons (which inevitably lead to a deterioration in information content for the reasons discussed in Section 1) and

Chart 6 Granger causality at different horizons and different degrees of smoothing

(causality measure of money to inflation)



Sources: Reichlin and Lenza (2007).

more smoothing (which improves information content since it increases the focus on the relevant persistent trend-like developments in money and inflation). Barring clear breaks in the inflation trends – which can occur in the aftermath of financial crises – these trends will also still carry information beyond three years. If money today informs us on future trends in inflation it thus covers periods that correspond well to a medium-term perspective.

The information content of money for future inflation is best revealed by smoothing the raw data to focus on its persistent components. There are a number of other ways to introduce smoothing into the bivariate set-up that go beyond the introduction of averages and lags of the variables featuring in a particular specification. For example, the bivariate indicator models can be run for a broad set of monetary indicators, including both raw statistical series (such as M3, M2, M1 and loans to the private sector) and derived series (such as M3 corrected for outliers and portfolio shifts or measures of excess money growth calculated relative to money demand models) – see ECB (2005, 2006). Integrating all this information using forecast combination techniques also imparts smoothness to the raw data.

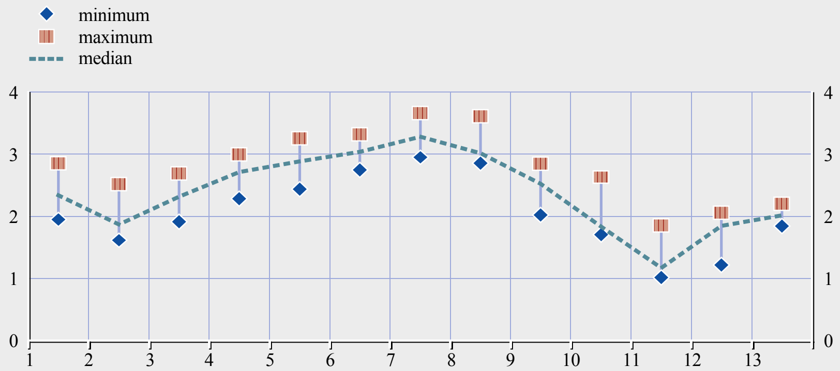
Cutting across the forecasts generated with these different models is performed using simple-to-exploit cross-sectional information, given that none of the indicators may be suitable individually to represent the more persistent or underlying trends of money. The implicit assumption is that idiosyncratic shocks typically move the individual indicators away from a common underlying pace of monetary expansion in possibly different directions, and that cutting across the model outcomes would help to cancel out these shocks and focus on the underlying common trend. For instance, a yield curve that is particularly flat at the short end, but particularly steep at the long end will at the same time dampen M3 growth through the high opportunity costs of not investing in longer-term assets and foster M1 growth through the low opportunity costs of keeping all monetary liquidity in cash or overnight deposits. In such circumstances, the more lasting, underlying pace of monetary expansion most likely lies somewhere between the growth rates of M3 and M1.

Against this background, the indicators generated using different monetary series may be best summarised in a box-plot type of representation, showing the minimum, maximum and median across the models (see Charts 7 and 8). Showing the median rather than mean outcome reflects the assumption that there is no normal distribution in the way the different indicators may be affected by specific shocks. Having for instance, a surfeit of indicators based on M3 (headline, corrected and excess measures) may tilt the mean outcome in an unwarranted way. A simple forecast averaging, which is sometimes used as a tool for increasing the robustness and average forecast performance in inflation predictions, is not therefore appropriate, especially when there is no prior information about different weights that might be applied in this averaging process.

The developments in the range and the median of the outcomes are assessed along two dimensions. First, the movement in the range and median from one forecast

Chart 7 Range of annualised inflation forecasts over the next six quarters

(annualised percentage changes; real-time results of the various vintages)



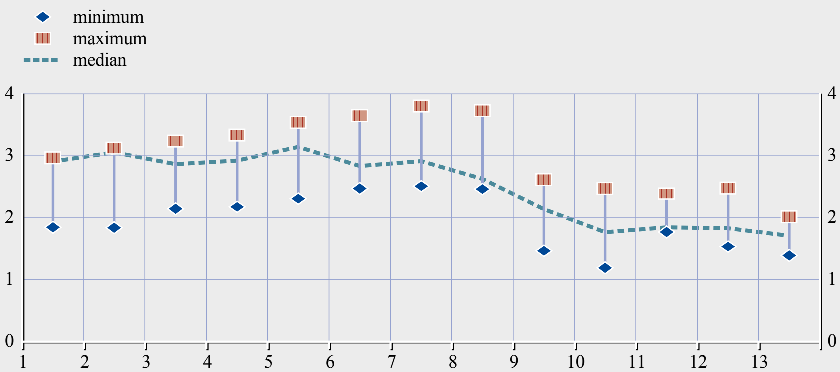
1 Q4 2006-Q2 2008
2 Q1 2007-Q3 2008
3 Q2 2009-Q4 2008
4 Q3 2007-Q1 2009
5 Q4 2009-Q2 2009
6 Q1 2008-Q3 2009
7 Q2 2008-Q4 2009
8 Q3 2008-Q1 2010
9 Q4 2008-Q2 2010
10 Q1 2009-Q3 2010
11 Q2 2009-Q4 2010
12 Q3 2009-Q1 2011
13 Q4 2009-Q2 2011

Source: ECB estimates.

to the next provide the signals for possible changes in the risks to price stability in the medium term. Second, the width of the range gives indications about the consistency of the signal coming from the monetary data, with a smaller range pointing to the possibility for greater assertiveness in the message to be conveyed to policy-makers from the exercise.

Chart 8 Range of annualised inflation forecasts over the next twelve quarters

(annualised percentage changes; real-time results of the various vintages)



1 Q4 2006-Q4 2009
2 Q1 2007-Q1 2010
3 Q2 2007-Q2 2010
4 Q3 2007-Q4 2010
5 Q4 2007-Q4 2010
6 Q1 2008-Q1 2011
7 Q2 2008-Q2 2011
8 Q3 2008-Q3 2011
9 Q4 2008-Q4 2011
10 Q1 2009-Q1 2012
11 Q2 2009-Q2 2012
12 Q3 2009-Q3 2012
13 Q4 2009-Q4 2012

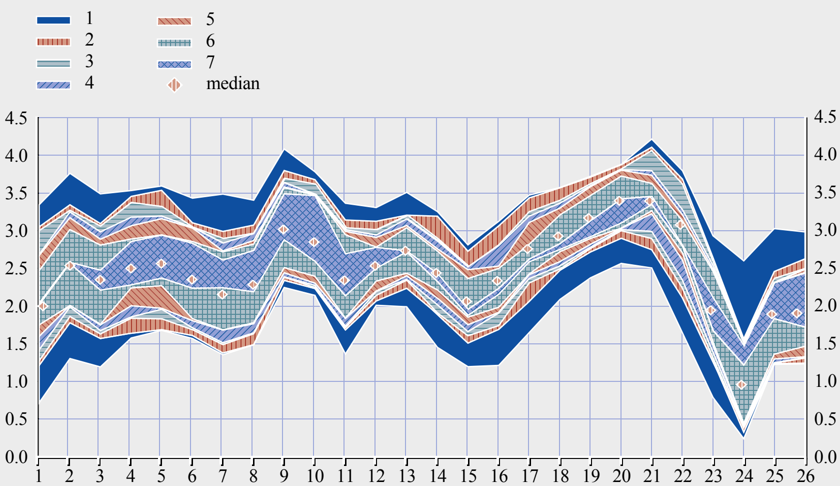
Source: ECB estimates.

Comparing the median of the six-quarter-ahead forecasts with that of the twelve-quarter-ahead forecasts shows that the latter display less variability from one quarter to the next. At the same time, the range of indications across the different models is typically larger for the twelve-quarter horizon. Given that the best predictability is found for values between six and twelve quarters, it is useful to assess the forecasts for the two horizons in conjunction. The broad picture emerging from such an assessment is that, between the end of 2006 and the end of 2008, the outlook for inflation pointed towards upside risks to medium-term price stability, while from the end of 2008 forecasts were between 1% and 2% and thus pointed neither to upside nor to downside risks.

When interpreting the output of bivariate leading indicator models, it is fair to acknowledge that the uncertainty surrounding each model is relatively large. Confidence intervals of one standard deviation easily amount to a band of 1 percentage point around the respective forecast values. This type of uncertainty is overlaying the uncertainty implied by the range of the individual model forecasts depicted in Charts 7 and 8. However, the representation of this second layer of uncertainty can also enhance the assessment of the consistency of the risk indicators. For instance, Chart 9 shows the confidence bands surrounding the individual six-quarter-ahead indicators, which overlap significantly: in the chart, the different colours denote the degrees of overlap. Based on the exercises

Chart 9 Overlapping confidence bands of the inflation forecasts from different indicator models at the six-quarter horizon

(annualised percentage changes; real-time results of the various vintages)



1 Q3 2003-Q1 2005
2 Q4 2003-Q2 2005
3 Q1 2004-Q3 2005
4 Q2 2004-Q4 2005
5 Q3 2004-Q1 2006
6 Q4 2004-Q2 2006
7 Q1 2005-Q3 2006
8 Q2 2005-Q4 2006
9 Q3 2005-Q1 2007
10 Q4 2005-Q2 2007
11 Q1 2006-Q3 2007
12 Q2 2006-Q4 2007
13 Q3 2006-Q1 2008
14 Q4 2006-Q2 2008
15 Q1 2007-Q3 2008
16 Q2 2007-Q4 2008
17 Q3 2007-Q1 2009
18 Q4 2007-Q2 2009
19 Q1 2008-Q3 2009
20 Q2 2008-Q4 2009
21 Q3 2008-Q1 2010
22 Q4 2008-Q2 2010
23 Q1 2009-Q3 2010
24 Q2 2009-Q4 2010
25 Q3 2009-Q1 2011
26 Q4 2009-Q2 2011

Source: ECB estimates.

Note: The number and colour denote the degree of overlap of the different model outcomes. For instance, the number "4" in the legend means that the confidence interval of four models overlaps.

conducted over the past years, the median forecast mostly lies in the darkest area, meaning that it is included in the set of statistically indiscriminate outcomes of all different models. This implies that it embeds a fair degree of robustness in the signal that it provides for risks to price stability.

4 ENHANCEMENTS TO THE INFLATION RISK INDICATOR FRAMEWORK

4.1 ENHANCEMENTS TO AND PERMUTATIONS OF THE BIVARIATE MONETARY INDICATOR MODEL

The conventional operation of the bivariate indicator described above can be enhanced with additional or alternative smoothing elements in order to reflect the notion of persistence that is inherent in the link between money growth and inflation. Effectively, such smoothing can be applied to both the right-hand side and the left-hand side of the model equation. Table 1 provides an overview of the possible permutations.

One approach that is used in practice is to augment the set of empirical measures for underlying monetary growth $\tilde{x}$ that enter the bivariate model framework to include derived measures of underlying monetary growth.

$$\pi^k_{t+h} = c + \alpha(L)\pi_t + \beta\tilde{x}_t + \varepsilon_{t+h}$$

In this set-up, no lags of the monetary indicators are foreseen given that an underlying measure $\beta\tilde{x}$ should effectively encompass the smoothing implicit in using $\beta(L)x$ in the original specification. Three types of measure for $\tilde{x}$ are used in the bivariate set-up: (a) exclusion measures, which take out specific, especially volatile components of M3; (b) measures derived by applying statistical filtering techniques to M3; and (c) measures derived from structural models (see ECB (2007) for a presentation of these measures).

One exclusion measure is the annual growth rate of household money holdings (M2 plus repurchase agreements), given that these holdings tend to be the ones that are most closely linked to future expenditure and thus ultimately inflation (see Annex 5 to Chapter 3). The statistical filtering techniques include a univariate (band-pass) filter that extracts movements in M3 growth with a pre-determined cycle length of more than eight years and a multivariate filter that extracts the movements in M3 that show statistically the closest link to those parts of inflation not already explained by output growth (for details, see Bruggeman et al. (2005)).

Table 1 Overview of the permutations of the bivariate set-up

		Monetary variables	
		Annual growth rates	*Underlying measures*
Inflation variable	*Average growth rates*	Standard set-up in use	Enhancement in use
	Underlying measures	Enhancement not pursued	Enhancement in use through common factor model

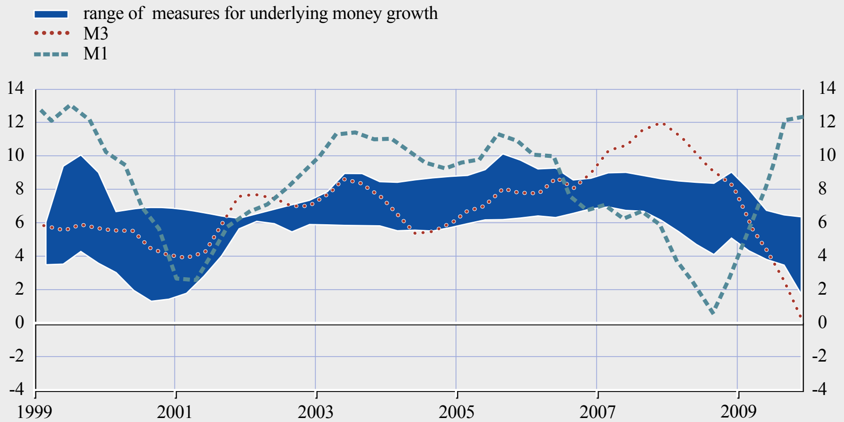
The potential shortcomings of such explicit filtering tools have already been discussed above with regard to the "end-point problem".

The advantage of constructing measures of underlying money growth is that it forces the concept to be quantified in real time, imposing discipline and the need for consistency on the process. Moreover, it allows information from the complex overall analysis of money and credit data to be incorporated in the underlying measure. As a result, in an environment characterised by sharp changes in monetary dynamics, measures of underlying monetary growth are less susceptible to distortions by idiosyncratic developments, for instance in individual components, than the headline monetary indicators. At the same time, the measures of underlying money growth depend on specific methods that may more or less well cope with idiosyncratic developments. The backward-looking nature of most available methods may cloud the view as far as shifts in the underlying dynamics are concerned and suggest a degree of safety in the assessment of trend developments that is not warranted.

The set of statistically-motivated measures for underlying monetary growth also includes a dynamic factor model that derives the common factors of a large set of monetary series (33 in total, including M1, M2 and M3, M3 deposits by sector of money holder, short-term debt securities, money market fund shares/units, loans to the private sector, loans to households (broken down by purpose) and loans to non-financial corporations (broken down by maturity)). The indicators are decomposed into a common factor and idiosyncratic factors, whereby the common factor is driven by shocks affecting all individual monetary series (see Cristadoro et al. (2005) for a description of the methodology). In this approach, the measure of underlying monetary growth is effectively derived

Chart 10 Measures of underlying monetary growth and actual monetary growth

(annual percentage changes; quarterly data)



Source: ECB estimates.

Note: The range of underlying monetary growth spans the minimum and maximum of the different measures (see text).

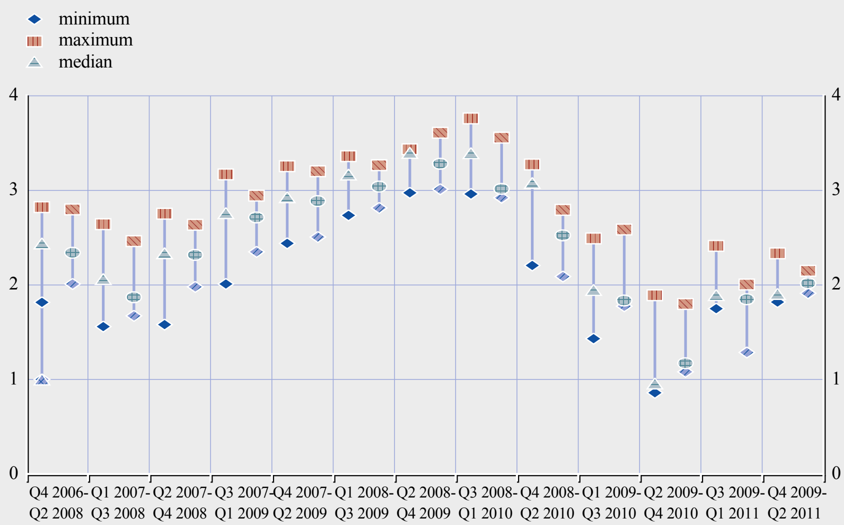
by weighing down series with large idiosyncratic variances and drawing on the covariances of the lower frequency movements in the series.

Chart 10 shows the range of these different measures of underlying monetary growth together with annual M3 and M1 growth to appreciate the smoother developments than in the actual growth of key monetary series. The measures thus look, for instance, beyond the periods where actual M3 growth was first affected upwards by a particularly steep yield curve and subsequently affected downward by an exceptionally steep yield curve. As expected, running the underlying measures through the bivariate set-up produces median forecasts of inflation that have somewhat less variability than the median forecasts generated with the models that are based on the annual growth rates of different monetary variables (see Chart 11). Moreover, the range across the different forecasts is smaller than that produced by the models based on annual growth rates, confirming the notion that applying a stronger degree of smoothing reduces the uncertainty regarding the signal that money gives regarding risks to price stability.

Taken together, however, the uncertainties surrounding the forecasts produced with the bivariate indicator models suggest that the outcomes should be monitored in their broad trends rather than in their quarter-on-quarter evolution. This will be an important point of reference with regard to the development of regime-switching models of inflation discussed below.

Chart 11 Comparison of six-quarter-ahead forecasts based on annual growth rates of different monetary aggregates and measures of underlying monetary growth

(annualised percentage changes; real-time results of the various vintages)



Source: ECB estimates.

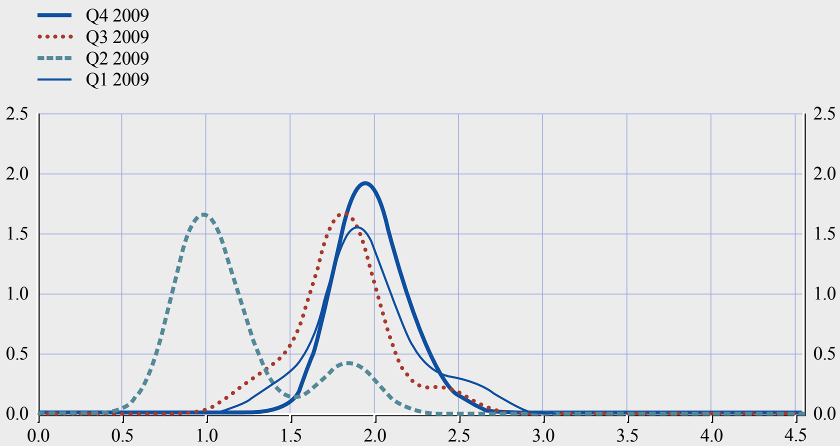
Note: The first set of markers in a vintage refers to forecasts based on annual growth rates of different monetary aggregates, while the second set of markers refers to forecasts based on measures of underlying money growth.

An alternative to employing a box-plot representation to summarise compactly the information from the various bivariate indicator models and gauge the uncertainty surrounding the median outcome is to estimate the "distribution" of the outcomes. Chart 12 shows the evolution of the kernel density estimate over the four quarters of 2009. While the distribution was relatively wide and strongly skewed in the first half of the year, it was much narrower and assumed a more normal shape in the second half. This type of change typically implies a clearer signal from monetary indicators. However, given that the period of financial turmoil has been associated with a general deterioration in model performance, the narrow shape of the distribution may simply reflect this unifying low performance, which implies a strong role for the mean reversion element (constant) in the models. Information on the distribution or ranges of the different model outcomes thus has to be assessed in conjunction with the uncertainties of the models such as the one shown in Chart 9.

A number of other monetary indicators can conceivably enhance the bivariate set-up if they capture the notion of "smooth" or "average" monetary developments. For instance, a Divisia M3 aggregate as described in Annex 4 to Chapter 3 weighs the individual components of M3 according to their opportunity costs relative to a benchmark asset. The developments in this Divisia aggregate thus often move between those in the narrow aggregate M1 and those in the broad monetary aggregate M3 – just as is typically the case for the empirical measures of underlying monetary growth in Chart 10. Not surprisingly, therefore, in out-of-sample forecast exercises, the Divisia measure of M3 performs better at the six-quarter horizon than M1 and M3 individually. However, there are also limits to this performance given that Divisia aggregates are typically affected by some of the same shocks as the headline monetary aggregates. Like other

Chart 12 Dispersion of money-based inflation risk indicators with a horizon of six quarters

(probability densities)



Source: ECB estimates.

Note: A normal kernel estimator is used in the construction of the dispersion measures. The date denotes the end of the data vintage used to derive the indicators.

smoothed measures of monetary growth, Divisia indices cannot be taken as a stand-alone measure of underlying monetary growth, but need to be analysed and assessed as just one in a broad set of such measures.

Enhancements have also been made by creating monetary indicators as input to the bivariate set-up that – by construction – already embed some relationship with inflation. One approach is to weigh the individual M3 components in a way that the resulting aggregate has the best predictive power for the smoothed inflation π^k_{t+h}. The unobserved weights of this "empirically-weighted M3" aggregate are estimated with the help of the Kalman filter, such that their variation over time follows some smooth transition and avoids abrupt changes (see Feldstein and Stock (1996) for the methodology). For the out-of-sample forecasts to be constructed in real time, it is assumed that the weights estimated for the end of the sample remain unchanged when going forward. This approach therefore develops two ideas simultaneously: first, that the robustness of inflation predictions is increased when cutting across the information in different monetary series; and second, that the information content of an individual monetary series for inflation can vary over time. However, it faces the usual practical end-point problem with regard to the weights.

Another approach is to include inflation directly in a dynamic factor model for a broad set of monetary indicators. The model then derives those shocks that are common to the chosen set of monetary indicators on the one hand and inflation on the other. The model proposed by Nobili (2009) combines 47 different monetary series (including the main monetary aggregates M1, M2 and M3, as well as the individual components of M3 and their respective sectoral breakdowns) with HICP inflation. The common factors explain a large part of the variance in the money holdings of households and thus confirm the usefulness of using these holdings as approximations of underlying monetary growth – as in the exclusion measure introduced above. By contrast, the procedure downplays the much more volatile money holdings of financial intermediaries. The methodology allows for common shocks at both low and higher frequencies and thus generates underlying measures that embed more variation than those depicted in Chart 3.

The common factors are then used to forecast inflation at the six-quarter horizon. In contrast to the standard bivariate model, the forecast is for annual HICP inflation in six quarters rather than annualised inflation over the next six quarters. This reflects the fact that inflation in this model is by construction – through the extraction of only the common factors – already a reasonable approximation of the more persistent part of inflation. Viewed in this way, additional smoothing of inflation variables to provide consistency with those investigated in the standard bivariate set-up would be excessive; indeed, in the Nobili (2009) model, such an approach worsens forecast performance.

4.2 ROBUSTNESS OF THE BIVARIATE INDICATOR MODEL

The reduced form approach implicit in the bivariate indicator model has proven to be relatively robust in a period where existing money demand models based on M3 have increasingly suffered from statistical instability, and the monetary overhangs derived from those models were, as a consequence, surrounded by considerable uncertainty. The bivariate models circumvent this issue in two ways.

First, these models are based on a set of indicators rather than headline M3 only. Cutting across indicators – and, in particular, weighting the available monetary indicators in the form of empirically-weighted aggregates or factor models – de-emphasises issues of money demand instability that are specific to a simple sum aggregate of M3 (such as during the period of "portfolio shifts" in 2001-03). The underlying idea is that monetary overhangs may still be stationary and the income velocity of money may still be stable if the individual components of M3 have time-varying weights in the aggregation in order to account for innovation in financial markets and changes in the relationship between individual monetary assets and inflation.

Second, the bivariate models are based on growth rates rather than levels. This implicitly treats developments in the level of money as bygones for the inflation process. If there are permanent but benign shocks to the money stock, such a feature serves to improve model performance. However, it also implies that an important measure of the persistent component in monetary developments – which provides the relevant signal for risks to price stability – may be lost from the analysis. This may be particularly relevant in situations such as the one seen in 2008-09, when M3 growth decelerated for a protracted period (even turning negative), even though the stock of money holdings remained in excess of many measures of its equilibrium level. The growth perspective may then already point to low inflationary pressures when the level perspective would still suggest the contrary (see Chart 13).

Chart 13 Broad money growth and M3 income velocity over the course of time

(annual percentage changes; nominal GDP to M3)

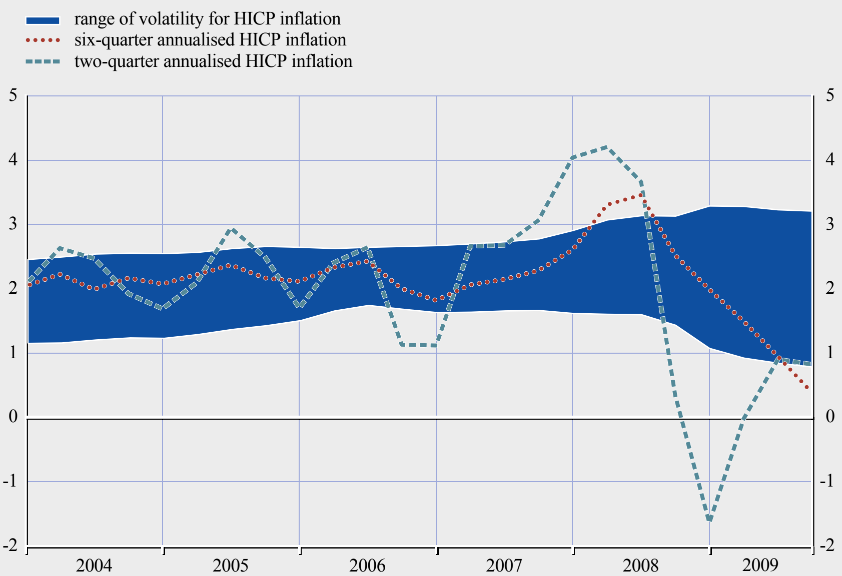
Source: ECB estimates.

Note: M3 income velocity is calculated as the difference between the logarithm of nominal GDP and the logarithm of M3.

A different issue of robustness in the bivariate indicator models emerged over the period of financial turmoil regarding the impact of lagged inflation terms $\alpha(L)\pi_t$. These terms have a beneficial effect on the estimation results given that they can absorb the impact of temporary shocks that would otherwise distort the coefficients $\beta(L)x_t$. In times of "normal" volatility of inflation, the lagged inflation terms – mostly only one lag is selected by the data – do not give rise to distorted parameter estimates and forecasts (see Chart 14). However, in "crisis" times where inflation changes strongly and quickly, the lagged inflation terms may pull the forecasts in a direction that is opposite to that suggested by the monetary dynamics $\beta(L)x_t$ (see Box 2 for an evaluation of forecast performance in recent periods). In such situations, robustness exercises to assess the information that comes specifically from money usefully examine the forecasts that would emerge: (a) when freezing the parameters before the onset of the period of high volatility; and (b) when closing down the impact of lagged inflation.

Chart 14 Volatility of annualised HICP inflation

(annualised percentage changes)



Source: ECB.

Note: The range of volatility for HICP inflation is calculated over a seven-year window as average two-quarter annualised HICP inflation plus/minus 1 standard deviation.

Box 2 Evaluation of the forecasting of bivariate indicator models over a different time period

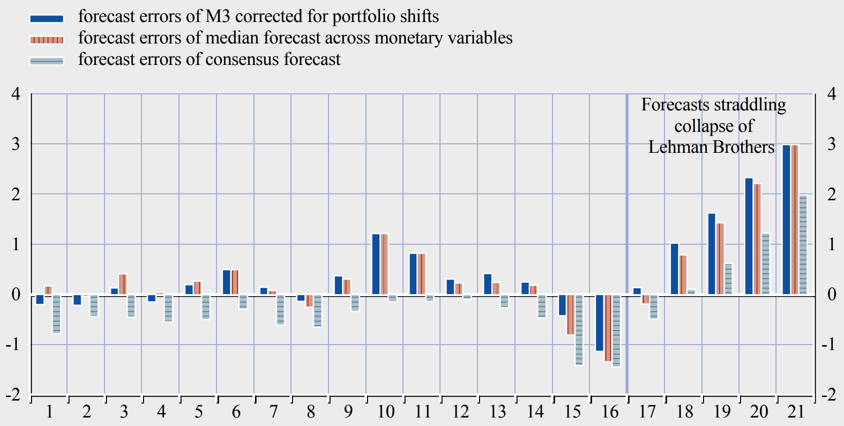
The financial turmoil has affected not only the inflation forecast performance of money-based models, but also that of traditional macroeconomic projection frameworks. The chart below shows the errors of the six-quarter-ahead forecast compared with the actual HICP inflation outcomes for three approaches: (a) the forecasts produced using the M3 series corrected for portfolio shifts; (b) the median of the inflation forecasts derived from the set of seven indicators described in Chart 7; and (c) the forecasts of market analysts as compiled by Consensus Economics.

Evaluating these forecasts and projections shows that the relative forecast performance of the three approaches has changed over time. In the period up to mid-2005 (denoting the start of the out-of-sample forecast horizon) the errors of the forecast based on M3 corrected and of the median forecast from the various indicator models were relatively small and unbiased compared with the larger and downward biased errors of the forecast by Consensus Economics. This difference was a prominent part of the results presented in Fischer et al. (2008).

The relatively large errors in the money-based forecasts from mid-2005 until the beginning of the period of financial turmoil reflect the impact of strong oil price increases on inflation, which in the money-based models implies upward pressure through the lagged inflation terms.

Forecast errors of real-time money-based inflation risk indicators and macroeconomic projections

(percentage point difference from actual HICP inflation)



1 Q2 2003-Q4 2004
2 Q3 2003-Q1 2005
3 Q4 2003-Q2 2005
4 Q1 2004-Q3 2005
5 Q2 2004-Q4 2005
6 Q3 2004-Q1 2006
7 Q4 2004-Q2 2006
8 Q1 2005-Q3 2006
9 Q2 2005-Q4 2006
10 Q3 2005-Q1 2007
11 Q4 2005-Q2 2007
12 Q1 2006-Q3 2007
13 Q2 2006-Q4 2007
14 Q3 2006-Q1 2008
15 Q4 2006-Q2 2008
16 Q1 2007-Q3 2008
17 Q2 2007-Q4 2008
18 Q3 2007-Q1 2009
19 Q4 2007-Q2 2009
20 Q1 2008-Q3 2009
21 Q2 2008-Q4 2009

Sources: ECB estimates and calculations based on data from Consensus Economics.

Note: Time periods on the x-axis indicate the out-of-sample forecast horizon for average six-quarter-ahead consumer price inflation.

Box 2 Evaluation of the forecasting of bivariate indicator models over different time period (cont'd)

During the period of financial turmoil all forecasts have been characterised by large and increasing errors. In particular, as signalled by the large and positive errors, none of the forecasts was able to predict the sharp downturn in inflation after the default of Lehman Brothers. Money-based inflation risk indicators suffered from larger errors than the forecast by Consensus Economics, reflecting to a large extent the fact that the latter most likely embeds substantial expert judgment and can thus react more quickly to past forecast errors than the money-based forecasts that reflect the pure model outcomes. Relying on unadorned model outcomes means that, in the current situation in particular, the money-based forecasts cannot avoid being distorted by the strong volatility of inflation, as depicted in Chart 14. Moreover, given that the nature of the crisis and its origin in balance sheet problems, monetary variables may recently have shown variations that reflect balance sheet adjustments, but may have no immediate bearing on the inflation outlook.

4.3 ENHANCING THE MONETARY ANALYSIS BY ADDING STRUCTURAL INFORMATION

4.3.1 GENERAL CONSIDERATIONS

Section 2 of this chapter suggested that money has a comparative advantage in explaining the low frequency, persistent movements in inflation. By contrast, as soon as explanatory power is also sought for movements at business cycle frequencies or higher, the scope for other, in particular non-monetary variables, to contribute to better inflation indicators increases rapidly. In practice, it may be useful to combine information from monetary and non-monetary variables.

In this respect, Fischer et al. (2008) show that averaging money-based inflation indicators (derived using the bivariate model discussed above) with the forecasts from conventional macroeconomic projection exercises (incorporating expert judgment on shorter-term inflation dynamics) improves the overall ability to predict inflation. More specifically, money-based indicators have a comparative advantage in getting the (time-varying) mean of inflation right, whereas projections do better in predicting variability around that mean. Money-based inflation risk indicators should be given a higher weight whenever the main objective is to eliminate inflation forecast bias. By contrast, given the comparative advantage of conventional macroeconomic projections to incorporate possible shocks, these forecasts should be given a higher weight when the objective is to keep the variance of the forecast errors low. These considerations suggest that it is a very challenging balancing act to set up empirical models that include both monetary and non-monetary variables, since the nature of the information they impart is on different components of the inflation time series.

4.3.2 BAYESIAN VECTOR AUTOREGRESSIVE MODELS

Enhancements in this direction have been explored in the form of estimating large VARs with Bayesian techniques (BVAR), such as by Giannone et al. (2010) (see Annex 2). This model includes a large set of real, monetary and financial time series at both the aggregate and sectoral levels. Estimation of the model allows it to reproduce key stylised facts in the joint behaviour of these series, such as the short-term reactions of loans to non-financial corporations, loans to households, M1 and M3 to an interest rate shock. The model therefore supports the analysis of monetary developments at the cyclical frequency and their interaction with other macroeconomic time series. Such considerations support the identification of monetary trends by helping to identify and quantify cyclical effects in real time.

At the same time, the model's performance in forecasting the inflation rates is poor when compared with other models. By focusing on the business cycle regularities in money and credit data, the predictive power over longer-term inflation trends – which is the essence of the information content of money for inflation – is neglected.

Against this background, in practice the BVAR model has been used to explain the reactions of money and credit variables to cyclical shocks, such as changes in interest rates. For example, the model is used to "filter out" changes in M3 and M1 growth that are due to exceptional movements in the yield curve and thus most likely reflect portfolio allocation rather than money holders' spending transactions (only the latter would have an immediate link to inflation). A number of other interesting exercises are described in Annex 2.

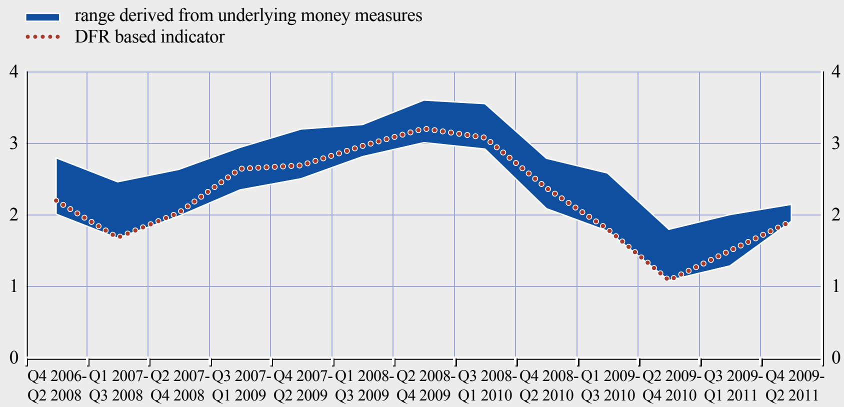
4.3.3 VECTOR ERROR CORRECTION MODELS

Using the new generation of money demand models described in Chapter 3 for forecasting inflation or constructing money-based inflation risk indicators is subject to caveats. Some of the models (such as the DFR model, see Annex 2 to Chapter 3) are specified in real terms and thus do not have an independent inflation equation. The model is hence used to generate time series (e.g. a measure of "excess" M3 growth defined by the model) that are used as input to bivariate indicator models. The best performance is achieved using the difference between actual (real) M3 growth and the four-quarter-ahead real M3 growth forecast produced by the DFR model.

Since it relies on growth rates rather than money stocks, this approach comes at the cost of losing information embedded in the level of money holdings. It nevertheless has the advantage of taking into account shorter-term monetary dynamics in the derivation of excess money, which are likely to be benign in terms of the outlook for price developments over the medium term. As shown in Chart 16, the performance of this inflation indicator over the six-quarter-ahead forecast horizon is comparable to that of the more conventional underlying measures of monetary growth that underlie the indicators shown in Chart 10.

Chart 15 Comparison of DFR forecast with a range of other bivariate indicator models

(annualised percentage changes)



Source: ECB estimates.

4.3.4 AUGMENTED PHILLIPS CURVE MODELS

The Phillips curve model depicted in Chart 4 distinguishes the factors driving inflation at different frequencies. In short, commodity prices typically explain the high frequency movements of inflation, while the output gap explains the business cycle movements. Monetary variables mainly explain the low frequency movements of inflation (e.g. as captured in shifting means). Monetary data can also have explanatory power at business cycle frequencies, although this may stem from capturing information in omitted or unobservable variables (such as output gap mis-measurement or credit spreads) and thus be of a different character to the information in underlying trend dynamics.

A more encompassing way to embed money into a reduced-form inflation equation is to allow for both equilibrium and disequilibrium components of money to impact on inflation. In such models, the equilibrium expansion of money would explain the mean of inflation, while the monetary overhang explains the movements around the mean. This view is implicit in the MWM model described in Annex 3 to Chapter 3, but an empirical implementation of the approach remains to be undertaken.

4.3.5 DYNAMIC STOCHASTIC GENERAL EQUILIBRIUM MODELS

In the conduct of the monetary analysis, a pragmatic approach is also adopted with regard to using large-scale dynamic stochastic general equilibrium (DSGE) models with money and credit (such as those described in Chapter 5) to derive an assessment of inflation risks. In these models, the mean of inflation is typically assumed to correspond to the inflation objective set by the central bank or (in empirical applications) to longer-term empirical trends. It is not directly linked to underlying monetary growth.

For example, rather than using the CMR model (see Chapter 5) employed in the ECB's monetary analysis to explain inflation developments owing to the evolution of money and credit, the model is used to quantify the contribution of various structural shocks to monetary growth. Some of these shocks originate directly in the financial and banking system, such as changes in the provision of liquidity services or portfolio shifts. Others affect mainly real-side consumption and investment decisions and only indirectly money (see Chart 3 in Chapter 5). This decomposition lends itself to the derivation of a measure of underlying monetary growth based on isolating the developments generated by those shocks that affect primarily portfolio decisions and that, as such, can be understood as a pure money demand shock with little impact on inflation.

4.3.6 ENHANCING THE MONETARY ANALYSIS BY MEANS OF NON-LINEAR SPECIFICATIONS

Most of the tools presented above are not used to capture directly the role played by money in explaining shifts in the time-varying mean of inflation. Constructing empirical models to capture such effects in the (relatively short) available euro area sample is complicated by the stability of inflation over this period, which implies that there have been no mean shifts in sample.

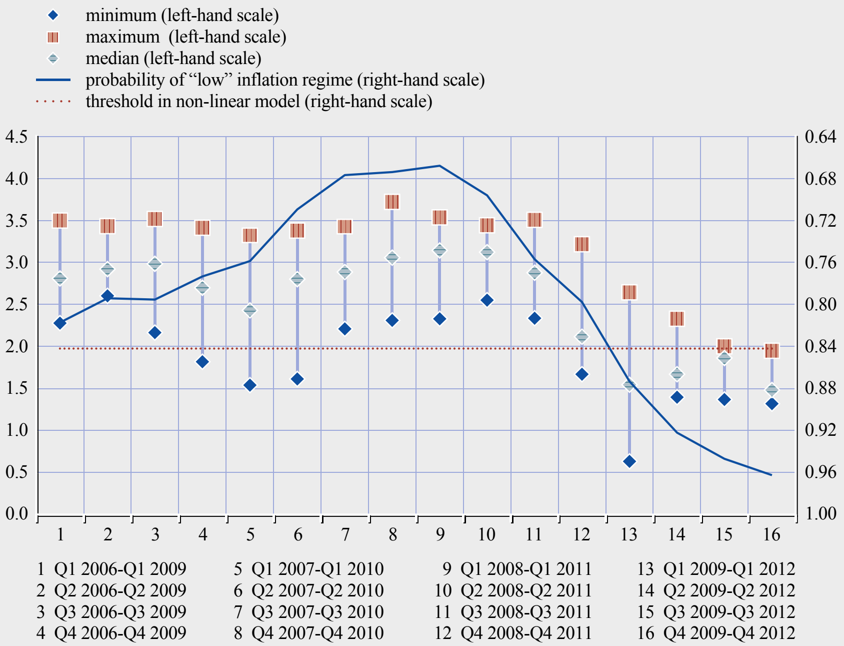
One approach that explicitly investigates the role of money in explaining shifts between distinct and persistent inflation regimes, rather than the precise and possibly small movements over the business cycle, is that by Amisano and Fagan (2010) (see Annex 1). In a Markov regime-switching framework, the model constructs money-based estimates of the transition probability from a low inflation regime to a high inflation regime. Estimates of this transition probability thus provide a warning indicator of risks to price stability that can be constructed and used in real time.

More precisely, the probability of transition between the two regimes is conditional on developments in a monetary indicator. They are modelled in the form of a non-linear Markov process. The monetary indicator used is headline M3 growth minus the (locally linear) trend growth rates of output and velocity. If the trend growth in output had remained broadly stable over time, this differential would reflect a deviation of M3 growth from its changing trend and thus correspond conceptually to changes in monetary overhangs. Given that this differential allows for changes in the trend of monetary growth, it implicitly abstracts from some of the strong money growth that has, for instance, led to the strong increases in the money gaps over recent years. Based on historical data since 1970, the model estimates state-conditional means in the low inflation regime of 1.6% and in the high inflation regime of 3.8%. Drawing on historical data implies some limitations for the model in periods of extreme inflation volatility, as a probability of one for a low inflation regime would be underpinned, for instance, when inflation is still very far away from deflation. This limitation simply reflects that there has been no experience with periods of deflation in the historical data.

In practice, the model is set up with a lag structure that implies that the transition probabilities generated for the end of the sample relate to the inflation regime of the next three years. Hence, they can be compared with results from the bivariate indicator model for average inflation in the next 12 quarters. Such a comparison

Chart 16 Comparison of inflation forecast pattern of non-linear and linear forecast models

(annualised percentage changes; probability)



Source: ECB.
Note: The state-conditional means of inflation in the low and high inflation states are estimated at 1.6% and 3.8% respectively. Owing to the lag structure of the model, the values presented for the fourth quarter of 2009 are predictions for early 2012.

points to a broadly similar pattern in the inflation risk indicators, suggesting that inflation risks were increasing on the upside of price stability until early 2008, then declined and eventually fell in line with price stability and a low inflation regime respectively (see Chart 16).

5 CONCLUDING REMARKS

The policy-relevant information in monetary developments about the outlook for risks to price stability is largely contained in the low frequency movements. Operationalising this relationship in the form of concrete inflation indicator tools has proved challenging.

Simple bivariate relationships between smoothed measures of inflation and smoothed measures of monetary growth have continued to support the ECB's monetary analysis in times when the statistical properties of other models have been in question. The robustness of a model over time is a valuable property in and of itself, but the bivariate indicator models can easily be viewed as too simple. Complementing benchmarks models with model averaging – possibly drawing on advanced Bayesian averaging – across a range of indicators has been seen as the appropriate way to synthesise the information content of money for inflation. This holds particularly as the outcomes of the individual models are "judgment-free" in the sense that they do not add expert information to the pure model outcomes.

The agenda to enhance the monetary analysis has given rise to extensions of the bivariate setting that go in three main directions: (a) from bivariate to multivariate models; (b) from models where the information from money is embedded in growth rates to models where it is (also) embedded in levels; and (c) from linear to non-linear models. Improvements and advances have been achieved for each of these dimensions, but none of the approaches constitutes a single "solution" or "best model". Moreover, it is fair to say that, while many of the tools ultimately provide a better understanding of the underlying trend in monetary developments, they fail to provide unified and complete systems for the analysis of both the trends in and cyclical co-movements of money and inflation.

REFERENCES

Ang, A., Bekaert, G. and Wei, M. (2007), "Do macro variables, asset markets, or surveys forecast inflation better?" *Journal of Monetary Economics*, No 54, pp. 1163-1212.

Amisano, G. and Fagan, G. (2010), "Money growth and inflation – a regime switching approach", *Working Paper Series*, No 1207, ECB.

Assenmacher-Wesche, K. and Gerlach, S. (2006), "Money at low frequencies", *Discussion Paper Series*, No 5868, CEPR.

Atkeson, A. and Ohanian, L.E. (2001), "Are Phillips curves useful for forecasting inflation?", *Quarterly Review*, Vol. 25(1), Federal Reserve Bank of Minneapolis, pp. 2-11.

Benati, L. (2004), "Evolving post-World War II UK economic performance", *Working Paper Series*, No 232, Bank of England.

Benati, L. (2008), "Investigating inflation persistence across monetary regimes", *Working Paper Series*, No 851, ECB.

Benati, L. (2009), "Long-run evidence on money growth and inflation", *Working Paper Series*, No 1027, ECB.

Benati, L. and Mumtaz, H. (2005), "The 'Great Stability' in the U.K.: Good Policy or Good Luck?", Bank of England, mimeo.

Bruggeman, A., Camba-Méndez, G., Fischer, B. and Sousa, J. (2005), "Structural filters for monetary analysis – the inflationary movements of money in the euro area", *Working Paper Series*, No 470, ECB.

Carstensen, K. (2007), "Is core money growth a good and stable inflation predictor in the euro area?", *Working Paper Series*, No 1318, Kiel Institute for the World Economy.

Clements, M. and Hendry, D. (1998), *Forecasting economic times series*, Cambridge University Press.

Cogley, T.W. and Sargent, T.J. (2005), "Drifts and volatilities: monetary policies and outcomes in the post-World War II US", *Review of Economic Dynamics*, Vol. 8, pp. 262-302.

Cristadoro, L., Forni, A., Reichlin, L. and Veronese, N. (2005), "A core inflation indicator for the euro area", *Journal of Money, Credit and Banking*, Vol. 37(3), pp. 539-560.

D'Agostino, A., Giannone, D. and Surico, P. (2006), "(Un)Predictability and macroeconomic stability", *Working Paper Series*, No 605, ECB.

ECB (2004), "Monetary analysis in real time", *Monthly Bulletin*, October, pp. 43-66.

ECB (2005), "Inflation forecasts derived from monetary indicators", *Monthly Bulletin*, March, pp. 20-21.

ECB (2006), "Inflation forecasts derived from monetary indicators", *Monthly Bulletin*, June, pp. 22-25.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008), "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*, European Central Bank, Frankfurt am Main, pp. 102-175.

Feldstein, M. and Stock, J. H. (1996), "Measuring money growth when financial markets are changing", *Journal of Monetary Economics*, Vol. 37(1), pp. 3-27.

Giannone, D., Lenza, M. and Reichlin, L. (2010), "Money, credit, monetary policy and the business cycle in the euro area", mimeo, ECB.

Goodhart, C.A.E, (2007), "Whatever became of the Monetary Aggregates", *Special Paper series*, No 172, LSE Financial Markets Group series.

Greiber, C., and Neumann, M.J.M. (2004), "Inflation and core money growth in the euro area", *Discussion Paper Series*, No 36, Deutsche Bundesbank.

Hofmann, B. (2008), "Do monetary indicators lead euro area inflation?" *Working Paper Series*, No 867, ECB.

Kim, C.-J. and Nelson, C. R. (1999), "Has the US economy become more stable? A Bayesian approach based on a Markov-switching model of the business cycle", *Review of Economics and Statistics*, Vol. 81, pp. 608-616.

Marquez, C.R. and Pina, J. (2002), "Does money Granger cause inflation in the euro area?", *Working Paper Series*, No 12-02, Banco de Portugal.

Masuch, K., Pill, H. and Willeke, C. (2001), "Framework and tools of monetary analysis" in Klöckers, H-J. and Willeke, C. (eds.) *Monetary analysis – tools and applications*, European Central Bank, Frankfurt am Main, pp. 117-144.

Nicoletti-Altimari, S. (2001), “Does money lead inflation in the euro area”, *Working Paper Series*, No 63, ECB.

Nobili, A. (2009), “Composite indicators for monetary analysis”, *Discussion Paper Series*, No 713, Banca d’Italia.

Pill, H., and Rautanen, T. (2006), “Monetary analysis – the ECB experience”, speech given at the research conference entitled The ECB and its Watchers VIII, available at: http://www.ifk-cfs.de/index.php?id=697

Reichlin, L., and Lenza, M. (2007), “On short-term and long-term causality of money and inflation – understanding the problem and clarifying some conceptual issues”, mimeo, ECB.

Stock, J.H., and Watson, M. (1998), “Diffusion indexes”, *Working Paper Series*, No 6702, NBER.

Stock, J.H., and Watson, M. (1999), “Forecasting inflation”, *Journal of Monetary Economics*, Vol. 44, pp. 293-335.

Stock, J.H., and Watson, M. (2005), “Why has US inflation become harder to forecast?” *Journal of Money, Credit, and Banking*, Vol. 39(1).

Wicksell, K. (1898), “Geldzins und Güterpreis”, Jena, second corrected edition.

Woodford, M. (2008), “Does a two-pillar Phillips curve justify a two-pillar monetary policy strategy?” in Beyer, A. and Reichlin, L. (eds.) *The role of money – money and monetary policy in the 21st century*, European Central Bank, Frankfurt am Main, pp. 56-82.

ANNEX I

A MONEY-BASED EARLY WARNING SIGNAL OF RISKS TO PRICE STABILITY

I INTRODUCTION[19]

The long-term co-movement between money growth and inflation is a well-established empirical regularity. It has been found to apply across a range of countries, as well as the euro area and across different time periods. This link has been documented in a number of studies (including Lucas (1980), Benati (2009) and Sargent and Surico (2008)). The evidence on the co-movement between money growth and inflation has typically been examined by looking at the relationship between smoothed measures, derived using either moving averages or frequency domain techniques. While these techniques are valuable in identifying the relevant empirical relationships, they suffer from an important limitation, namely that they may not be reliable at the end of the sample, which is precisely the point in time of most relevance to the policy-maker.

In the light of this drawback, a number of more standard forecasting techniques have also been used, which are based either on extended Phillips curve models (for example, Gerlach (2004)) or linear single equation forecasting models (Nicoletti Altimari (2001) and Fischer et al. (2008)). These studies suggest that money growth has in the past contained useful information about future inflation, enabling these forecasts to outperform naive predictors. However, in recent years – which have been characterised by relatively low and stable inflation – the relationship between money growth and inflation has weakened. With it the predictive power of money relative to naive benchmarks for future inflation has also declined in line with the experience of a broad range of other potential indicator variables (on this point, see Stock and Watson (2006) for the United States and Lenza (2006) for the euro area).

Do the weakened properties of money growth as a leading indicator for future inflation imply that money can now be safely disregarded by central banks? It is argued here that this would be an inappropriate conclusion. In a regime of low inflation, the reduced-form correlation between money growth and inflation may indeed be found to be weak, with money growth having limited value in terms of forecasting inflation – as long as the economy remains within the low inflation regime. This is not surprising, since, as pointed out by Estrella and Mishkin (1997), velocity shocks tend to blur the signals coming from money in

[19] Prepared by Gianni Amisano and Gabriel Fagan. The authors would like to thank Domenico Giannone, Michele Lenza, Huw Pill, Frank Smets and Oreste Tristani for their many helpful comments and suggestions.

low inflation environments. However, the experience of a number of countries attests to the fact that money growth has provided important and timely warning signals about the risk of the economy departing from a regime of price stability. Arguably, this risk is of greater concern to a stability-oriented central bank than variations in the inflation rate within a regime of low inflation.

This way of thinking leads to a modelling of the inflation process which is different from the standard linear approach employed in much of the literature. Instead of modelling variations in inflation around a constant mean (or treating inflation as a unit root process), inflation is characterised by a regime-switching model in which the economy can potentially switch between regimes of low and high inflation. The approach thus aims to develop a model that exploits the well-established, long-term co-movement between money and inflation, but which can be used to provide policy-makers with a money-based inflation warning indicator of shifts in inflation regime that is usable in real time.

This approach builds on the extensive literature in which inflation is modelled as a Markov-switching (MS) process (see, for example, Evans and Wachtel (1993) for the United States, Ayuso et al. (2003) for Spain, and Ricketts and Rose (2007) for the G7 countries). In this framework, inflation shifts from regimes of low to high inflation and vice versa. In this case, inflation is modelled using a Bayesian MS framework. In contrast to the standard MS model, however, Abiad (2003), as well as Kim and Nelson (1999) are followed in allowing the transition probabilities to depend on other observable variables – in this case, a smoothed measure of money growth (which can be calculated in real time).

In this setting, it is argued that inflation in a number of countries can be well represented as a regime-shifting process, characterised by two regimes, the first of which may loosely be described as price stability and the second as high inflation. Within a regime of price stability, money growth is not necessarily useful for predicting inflation in future periods. However, in this set-up, money growth is allowed to play an important role in signalling the probability that the economy will move from a low inflation to a high inflation regime – thus providing a warning indicator of the risks to price stability. In this regard, the experience in the euro area and a number of OECD countries can be used to illustrate how monetary growth could have provided important and timely warnings of shifts from a low to a high inflation regime.

The resulting indicator is based on the observed relationship between money growth and inflation. Such a relationship is only likely to be found in data for samples in which the central bank has not responded adequately to inflationary risks and has not been fully successful in maintaining price stability. If, by contrast (and as pointed out by Woodford (1994) among others), the central bank responds in a timely manner to the inflationary risks identified by analysis of money or other indicators and thereby successfully maintains price stability, standard empirical tests are likely to show weakened (or even negligible) leading indicator properties for future inflation. In such cases, an indicator based on historical data is best seen as a warning signal of inflationary risks rather than as a forecast of likely future inflation developments. This approach thus has many parallels with the literature on early warning systems for financial crises (see Kaminsky et al. (1988) for a review and Alessi and Detken (2009) for a recent application).

2 THE MODEL

This section contains a description of the model used as a basis for obtaining the early warning indicator. A more detailed and technical account of how the model is specified, estimated and validated can be found in Amisano and Fagan (2010). Inflation (y_t) is modelled as a stationary process that, conditional on an unobservable variable s_t, has AR(1) dynamics:

$$y_t = c_{s_t} + \phi y_{t-1} + \sigma e_t$$
$$c_{s_1} < c_{s_2}$$
$$e_t \sim NID(0,1)$$

where s_t is a Markov-switching discrete process describing the inflation regime. There are two possible regimes, which can be interpreted as: $s_t = 1$ (low inflation) and $s_t = 2$ (high inflation). This interpretation hinges on the restriction $c_{s1} < c_{s2}$.

Transition probabilities (henceforth TP) across regimes possibly depend on a set of conditioning variables, the early warning (henceforth EW) ($r \times 1$) indicator vector $\mathbf{z}_{t-1}$:

$$p(s_t = 1 | \underline{\mathbf{s}}_{t-1} = i, \underline{\mathbf{y}}_{t-1}, \mathbf{z}_{t-1}, \boldsymbol{\theta}) = p_{1j,t}$$
$$= \Phi(\boldsymbol{\gamma}_i' \mathbf{z}_{t-1}),$$
$$\Phi(\omega) = \int_{-\infty}^{\omega} \frac{1}{\sqrt{2\pi}} \exp\left\{ -\frac{1}{2}\omega^2 \right\} d\omega$$

In this way, the parameter γ_{ri} ($r = 1, 2..k_z$), i.e. the r^{th} element of vector γ_i, measures the sensitivity of probability $p_{1j,t}$ with respect to z_{rt-1}, i.e. the r-th element of the indicator variables vector $\mathbf{z}_{t-1}$. In the case in which there are two elements in the vector $\mathbf{z}_{t-1}$, an intercept term and a true EW variable z_{2t-1} then the mechanism generating time-varying transition probabilities requires four parameters, which are organised in the (2×2) $\boldsymbol{\Gamma}$ matrix. The parameters γ_{11} and γ_{12} can be thought of as state dependent intercepts, and γ_{21} and γ_{22} as state dependent slope coefficients. This specification is called EW-MS (early warning-Markov-switching) model. It is worth noting that the standard MS model used in the literature (which implies time invariant transition probabilities) is a special case of this model that holds when $\gamma_{21} = \gamma_{22} = 0$.

When using this specification in contexts where a small number of transitions are observed in the sample period, in order to increase the efficiency of the estimates, it might be worth ensuring that the slope coefficients are common across states:

$$\gamma_{21} = \gamma_{22} = \gamma_2$$
$$p(s_t = 1 | s_{t-1} = i, I_{t-1}) = \Phi(\gamma_{1i} + \gamma_2 z_{t-1}),\ i = 1,2.$$

In spite of this restriction, the specification is sufficiently flexible to generate sensible transition probabilities.

In order to better understand the mechanism, consider an example taken from the posterior mean estimate of the EW model for the United States (see Amisano and Fagan (2010)). It is assumed that the parameter values are:

$$\gamma_{11} = 0.99$$
$$\gamma_{21} = \gamma_{22} = \text{-}0.22$$
$$\gamma_{12} = \text{-}0.49$$

The transition probability matrix can be computed at different values for the $z_{2t\text{-}1}$ indicator, which is an adjusted and standardised measure of lagged money growth. Three points are taken into consideration: $z_{2t\text{-}1} = 0$, the sample mean of the standardised indicator, $z_{2t\text{-}1} = \text{-}2.08$, the minimum sample value for the EW attained in the second quarter of 1995 and $z_{2t\text{-}1} = 2.15$, the sample maximum value of the indicator which occurred in the second quarter of 1985. The vector of ergodic probabilities is also computed, $\pi(z_{2t\text{-}1})$, which would describe the ergodic probabilities of each state in the case that the indicator variable stayed indefinitely at level $z_{2t\text{-}1}$:

$$\mathrm{P}(z_{2t\text{-}1} = 0) = \begin{bmatrix} 0.81 & 0.19 \\ 0.33 & 0.67 \end{bmatrix}, \ \pi(z_{2t\text{-}1} = 0) = \begin{bmatrix} 0.64 \\ 0.36 \end{bmatrix}$$

$$\mathrm{P}(z_{2t\text{-}1} = \text{-}2.08) = \begin{bmatrix} 0.92 & 0.08 \\ 0.54 & 0.46 \end{bmatrix}, \ \pi(z_{2t\text{-}1} = \text{-}2.08) = \begin{bmatrix} 0.88 \\ 0.12 \end{bmatrix}$$

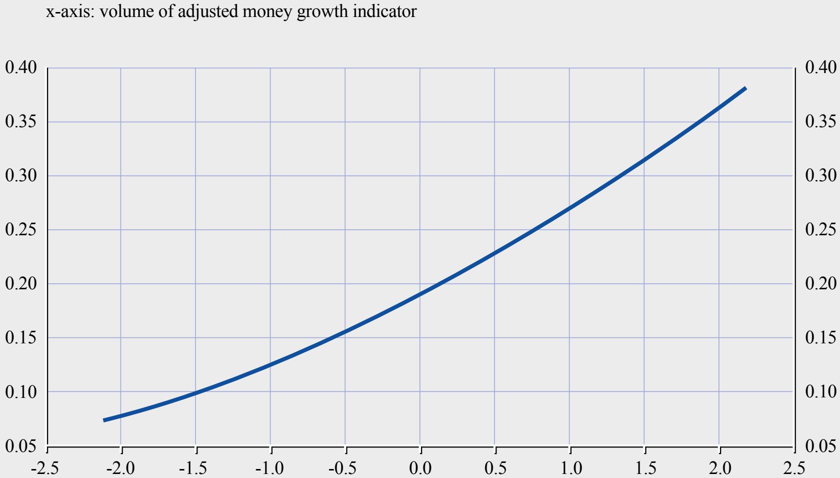
$$\mathrm{P}(z_{2t\text{-}1} = \text{-}2.15) = \begin{bmatrix} 0.62 & 0.38 \\ 0.16 & 0.84 \end{bmatrix}, \ \pi(z_{2t\text{-}1} = 2.15) = \begin{bmatrix} 0.30 \\ 0.70 \end{bmatrix}$$

It is possible to see that when $z_{2t\text{-}1} = 0$, the probability of remaining in a low inflation regime is 0.81, corresponding to an expected duration of the low inflation regime of five quarters and an ergodic probability of 0.64. When the money growth index is at its minimum (-2.08), the probability of staying in low regime is 0.92, corresponding to an expected duration of the low inflation state of 13 quarters, and the ergodic probability of the low inflation state is 0.86. In situations of very pronounced money growth, for example when the EW indicator is equal to 2.15, then the conditional probability of staying in a low inflation state is equal to 0.62, the expected duration of that regime is three periods and the ergodic probability is 0.30.

To sum up, the EW affects transition probabilities via the slope parameter. Higher values of money growth reduce probabilities of remaining in (or moving to) the low inflation regime. The theoretical relationship is illustrated in Chart A1.1.

Chart A1.1 Relationship between the money growth indicator and the probability of leaving a low inflation state

(probability)



Source: Amisano and Fagan (2010).

Note: Probabilities of leaving a low inflation state, $P_{12,t}$ are computed using the posterior mean values of the parameters $\gamma_{11} = .93 : \gamma_{21} = -0.44$, and the standardised in-sample values for the adjusted money growth indicator.

In order to estimate the model, a Bayesian approach based on simulation is adopted. Simulation-based Bayesian methods are well suited to estimating MS models.[20]

3 THE EMPIRICAL ANALYSIS

3.1 THE DATASET

Although this analysis focuses on the role of money growth as an indicator of inflation risks in the euro area, in order to provide evidence of the general applicability of the model, it is also estimated for various countries, namely Canada, Germany, the United Kingdom and the United States.

This group of countries was chosen for two reasons. First, data on the relevant variables are readily available for sufficiently long time spans. Second, focusing on a set of countries instead of a single country should throw light on the robustness of the results. In particular, the group of countries chosen have had diverse inflation experiences. Table 1 provides summary information on the series used, while Appendix A of Amisano and Fagan (2010) gives more details on the sources of the data and the transformations applied to them.

20 See, for example, Kim and Nelson (1999), Amisano and Giacomini (2007) and Geweke and Amisano (2010).

Table A1.1 Data used in the application and estimation results

Country	Initial date	Terminal date	Eff. sample start	Elasticity of P_{12} with respect to changes in Δm				Elasticity of P_{21} with respect to changes in Δm			
				Mean	s.d.	Lower	Upper	Mean	s.d.	Lower	Upper
Canada	1950 Q1	2009 Q4	1963 Q4	1.12	0.18	0.76	1.46	-1.15	0.21	-1.55	-0.72
Euro area	1950 Q1	2009 Q4	1963 Q4	0.21	0.13	-0.12	0.37	-0.36	0.33	-1.20	0.07
Germany	1950 Q1	1998 Q4	1963 Q4	1.04	0.19	0.58	1.35	-1.26	0.31	-1.80	-0.54
UK	1950 Q1	2009 Q4	1963 Q4	1.05	0.24	0.52	1.48	-1.04	0.29	-1.55	-0.43
USA	1950 Q1	2009 Q4	1963 Q4	0.42	0.21	0.06	0.88	-0.25	0.11	-0.49	-0.05

Source: Amisano and Fagan (2010).
Note: In this table a posterior mean, standard deviation and 95% posterior confidence bounds are reported.

In constructing this monetary indicator it is necessary to allow for changes in real output and velocity trends. The standard quantity equation in log differences is expressed as:

$$\Delta p_t = \Delta m_t + \Delta v_t - \Delta y_t$$

This approach follows the practice of the ECB (in calculating its reference value) or the former practice of the Deutsche Bundesbank (in calculating its monetary target). The rationale for this procedure is discussed more fully in Orphanides and Porter (2001). Specifically, a measure of adjusted money growth is defined, which is given by:

$$\Delta m_t^* = \Delta m_t - \Delta \tilde{y}_t + \Delta \tilde{v}_t$$

where $\Delta \tilde{v}_t$ and $\Delta \tilde{y}_t$ are time-varying estimates of the trend growth of, respectively, output and velocity, and Δm_t is money growth.

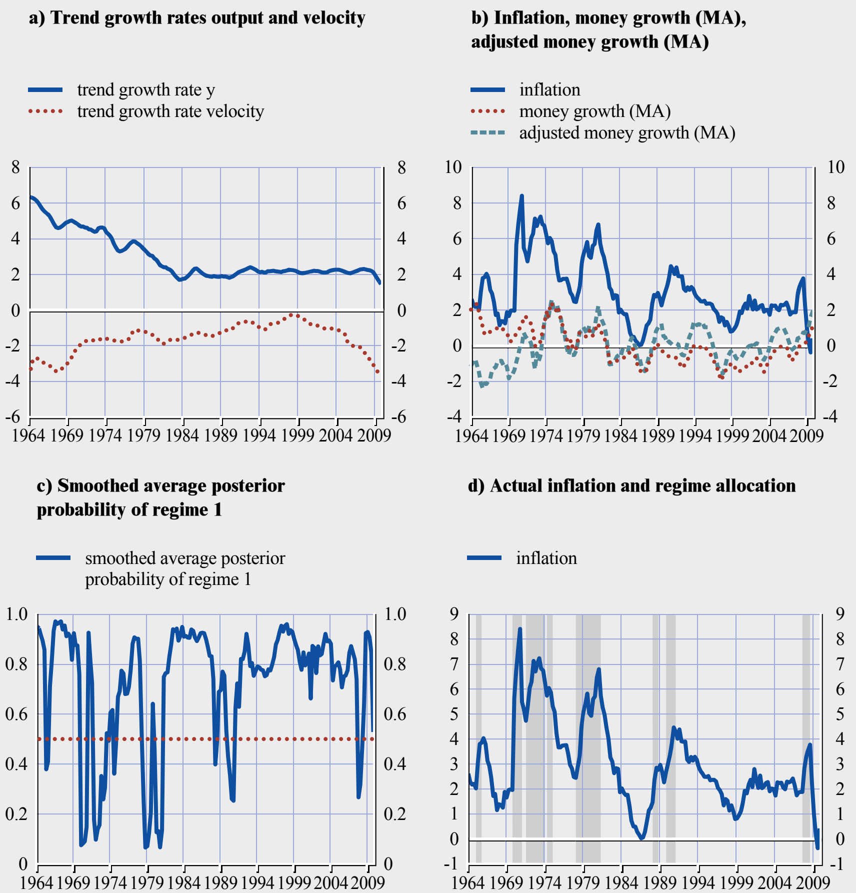
These trends need to be calculated using a method which: (a) allows for changes in trends; and (b) can be computed in real time. In this paper, $\Delta \tilde{v}_t$ and $\Delta \tilde{y}_t$ are computed as the sample means of Δv_t and Δy_t using a rolling window of $w=40$ observations. This is easier than using more sophisticated models, for instance an unobserved component model. The disadvantage is that the first 40 observations are lost in order to compute the rolling window-based adjustments. For this reason, data are used from the first quarter of 1950 for all countries being considered. This allows us to perform the velocity trend adjustment and to use an effective sample size that can start as early as the first quarter of 1963 accounting for lags.

The upper left panel of Chart A1.2 reports the estimated trend growth of output and velocity and the upper right panel depicts the standardised unadjusted and adjusted money growth indicators, together with the actual inflation series for the euro area. The differences between the adjusted and unadjusted money indicator series are, by definition, owing to the evolution in the trend growth rates of output and velocity.

In order to model the leading properties of money growth on inflation, the adjusted money growth indicator must be appropriately lagged. In addition,

Chart A1.2 Early warning model results for the euro area

(probability; annual percentage changes)



Source: Amisano and Fagan (2010).

Notes: Panel a: trend growth rates for output and velocity; panel b: inflation and money indicators (adjusted and unadjusted); panel c: smoothed probability of low inflation regime; and panel d: inflation series (shaded areas correspond to periods in which the model assigns high probability of high inflation regime).

since money growth may be affected by temporary shocks with no implications for future inflation, it is advisable to work with smoothed money growth indicators.

With regard to the causality relationship between money and inflation, the smoothing of inflation and lagging of money, Reichlin and Lenza (2007) offer a clear explanation that shows that, for the euro area data, the optimal predictive content of money on inflation is given between six and twelve quarters ahead and for a three-year average of inflation. In this context, the smoothness of inflation is of less direct relevance, since a model is used that is capable of assigning observed inflation to one of two possible regimes, but the use of an appropriately lagged and smoothed measure of money growth is relevant.

In synthesis, the monetary growth indicator is subject to the following transformations:

– the velocity and output growth rate adjustments are applied:

$$\Delta m_t^* = \Delta m_t - \Delta \tilde{y}_t + \Delta \tilde{v}_t$$

– $MA(q)$ is used on Δm_t^*:

$$\Delta m_t^{**} = \frac{\sum_{i=0}^{q} \Delta m_{t-i}^*}{q+1}$$

– it is lagged k periods and in the EW model the following is used:

$$\mathbf{z}_{t-1} = \begin{bmatrix} z_{1t-1} \\ z_{2t-1} \end{bmatrix} = \begin{bmatrix} 1 \\ \Delta m_{t-k}^{**} \end{bmatrix}$$

In the applications contained in this paper, it was decided to use $q=5$ and $k=9$. The particular choice of the lag order ($p=9$) was motivated by the belief that the monetary signal takes some time to unfold. Robustness with respect to other choices was examined and experience seems to show that results do not qualitatively depend on the choice of the lag and MA orders.[21]

3.2 ESTIMATION AND RESULTS

Regarding the priors used in the analysis, the interested reader is referred to Section 6.1 of Amisano and Fagan (2010). Here, it is sufficient to note that the prior of this approach is centred on the belief that low inflation regimes are more persistent and the prior on most parameters is very dispersed.

Turning to the analysis of the estimation results, the focus is on the posterior distribution of the estimated elasticities of the transition probabilities with respect to changes in money growth. In this way, it is possible to convey the size and the relevance of the effects of changes in the EW variable on the probabilities of switching regimes. Table A1.1 shows the posterior mean, standard deviation and bounds of the 95% posterior probability sets for the elasticities of transition probabilities at the end of the sample for all the countries being considered.

For the euro area, the posterior means for the elasticities of $p_{12,T}$ and $p_{21,T}$ are respectively 0.21 and -0.36. This tells us that, if the adjusted money growth indicator were to increase by 10%, this would impart a 2.1% increase in the probability of leaving the low inflation state. Another interesting aspect is the fact that, although the posterior 95% confidence set for both elasticities does include zero, the corresponding 90% confidence sets do not include zero, and this can be interpreted as informally supporting the conjecture that money growth is empirically relevant to predict regime changes. For all the other countries, slope coefficient elasticities of transition probabilities are all sizeable and relevant and their posterior 95% confidence sets never contain zero.

21 See Section 6.1 of Amisano and Fagan (2010).

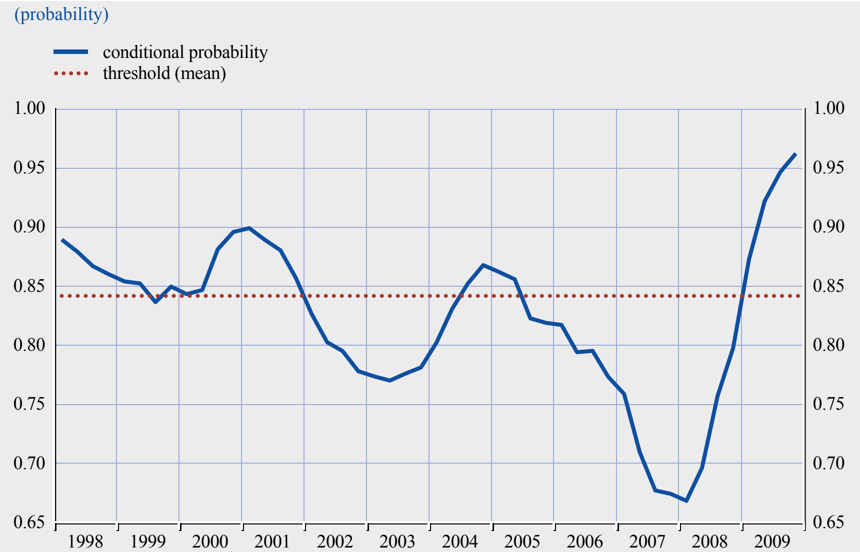
As regards state allocations produced by the estimated model for the euro area, in the bottom panels of Chart A1.2, it can be observed that the model assigns most of the early 1970s and the period from the late 1970s to the early 1980s to the high inflation state. It can be seen that Stage Three of Economic and Monetary Union started in a regime of low inflation and the risk to price stability remained very low until 2007. Then a sharp drop in the probability of low inflation can be observed in 2007. This was correctly signalled by the monetary growth acceleration that took place in 2005 and which reversed only in the course of 2008, leading to the recent change of regime from high to low inflation at the end of 2008.

3.3 OUT-OF-SAMPLE ASSESSMENT OF RISKS FOR PRICE STABILITY IN THE EURO AREA

The estimated model can produce forecasts for different probabilities that may be of interest, such as the conditional probabilities of leaving a given regime. Given that the model assigns the last observation in the sample to the low inflation regime, it is possible to use the model in a truly out-of-sample exercise in order to provide a real-time estimate of the risks of leaving the low inflation state. Chart A1.3 reports for the euro area the conditional probability (given observed money growth) of remaining in the low inflation regime implied by the estimated model. The data used ends in the fourth quarter of 2009; therefore, given the lag structure of the model, it is possible to predict this magnitude up to the first quarter of 2012.

The results show a sharp increase in this probability since 2008, reflecting the evolution of money growth over this period.

Chart A1.3 Conditional probability of the euro area staying in a low inflation regime



Sources: ECB calculations based on Amisano and Fagan (2010).
Note: The horizontal axis refers to the vintage of data available at the time the risk assessment is conducted.

4 CONCLUSION

Building on the existing literature that establishes a long-run link between inflation and monetary growth, this paper has developed a money-based early warning indicator for shifts in inflation regimes. The model is based on money growth with a correction for velocity and output trends that can be computed in real time. Inflation is modelled as a process characterised by two regimes – low and high inflation – in which the probability of shifting from one regime to the other depends on a measure of lagged money growth that can be computed in real time. The model was applied to data from Canada, the euro area, Germany, the United States and the United Kingdom using quarterly data from the early 1960s to the present, and its parameters were estimated using Bayesian techniques. The results obtained support the view that money growth provides timely warning signals of transitions between inflation regimes. A number of robustness checks confirm this overall conclusion.

REFERENCES

Abiad, A.G. (2003), "Early warning systems: a survey and a regime-switching approach", *Working Paper Series*, No 03/32, IMF.

Albert, J.H.A. and Chib, S. (1993), "Bayesian analysis of binary and polychotomous response data", *Journal of the American Statistical Association*, Vol. 88(2), pp. 669-679.

Alessi, L. and Detken, C. (2009), "Real-time early warning indicators for costly asset price boom/bust cycles – a role for global liquidity", *Working Paper Series*, No 1039, ECB.

Amisano, G. and Fagan, G. (2010), "Money growth and inflation – a regime-switching approach", *Working Paper Series*, No 1207, ECB.

Amisano, G. and Giacomini, R. (2007), "Comparing density forecasts via weighted likelihood ratio tests", *Journal of Business and Economic Statistics*, Vol. 25(2), pp. 177-190.

Ayuso, J., Kaminsky, G.L. and López-Salido, D. (2003), "Inflation regimes and stabilisation policies: Spain 1962-2001", *Investigaciones Económicas*, pp. 615-631.

Benati, L. (2009), "Long-run evidence on money growth and inflation", *Working Paper Series*, No 1027, ECB.

Evans, M. and Wachtel, P. (1993), "Inflation regimes and the sources of inflation uncertainty", *Journal of Money, Credit and Banking*, Vol. 25, pp. 475-511.

Estrella, A. and Mishkin, F.S. (1997), "Is there a role for monetary aggregates in the conduct of monetary policy?" *Journal of Monetary Economics*, Vol. 40(2), pp. 279-304.

Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008), “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*, European Central Bank, Frankfurt am Main, pp. 102-175.

Geweke, J. and Amisano, G. (2010), “Hierarchical Markov normal mixture models with applications to financial asset returns”, *Journal of Applied Econometrics*, forthcoming.

Gerlach, S. (2004), “The two pillars of the European Central Bank”, *Economic Policy*, Vol. 40, pp. 389-439.

Hofmann, B. (2008), “Do monetary indicators lead euro area inflation?” *Working Paper Series*, No 867, ECB.

Kaminsky, G., Lizondo, S. and Reinhart, C.M. (1998), “Leading indicators of currency crises”, *Staff Papers Series*, IMF.

Kim, C.-J. and Nelson, C.R. (1999), *State-space models with regime switching: classical and Gibbs-sampling approaches with applications*, MIT Press.

Lenza, M. (2006), “Does money help to forecast inflation in the euro area?” mimeo, ECB.

Lucas, R.E. (1980), “Two illustrations of the quantity theory of money”, *American Economic Review*, Vol. 70(5), pp. 1005-1014.

Nicoletti Altimari, S. (2001), “Does money lead inflation in the euro area?” *Working Paper Series*, No 63, ECB.

Reichlin, L. and Lenza, M. (2007), “On short-term and long-term causality of money to inflation: understanding the problem and clarifying some conceptual issues”, mimeo, ECB.

Orphanides, A. and Porter, R.D. (2001), “Money and inflation – the role of information regarding the determinants of M2 behaviour”, in Klöckers, H.J. and Willeke, C. (eds.) *Monetary analysis – tools and applications*, European Central Bank, Frankfurt am Main.

Ricketts, N. and Rose, D. (1995), “Inflation, learning and monetary policy regimes in the G-7 economies”, *Working Paper Series*, No 95-6, Bank of Canada.

Sargent, T.J. and Surico, P. (2008), “Monetary policies and low frequency manifestations of the quantity theory”, mimeo.

Stock, J. and Watson, M.W. (2006), “Why has US inflation become harder to forecast?” *Working Paper Series*, No 12324, NBER.

Woodford, M. (1994), “Non-standard indicators for monetary policy: Can their usefulness be judged from forecasting regressions?” in Mankiw, N.G. (ed.), *Monetary Policy*, University of Chicago Press.

ANNEX 2

MONEY, CREDIT, MONETARY POLICY AND THE BUSINESS CYCLE IN THE EURO AREA

I INTRODUCTION[22]

Characterising the behaviour of loans and monetary aggregates over the business cycle and the effect of monetary policy on their dynamics is a key step towards understanding the role of financial markets in the real economy.

This annex reports some results from a paper by Giannone et al. (2010), which characterises the joint dynamics of real, nominal, monetary, credit and financial variables from 1991 to the end of 2009 in the euro area. The aim of the paper is twofold: first, to establish stylised facts for a sample spanning at least ten years since the introduction of the euro (including the recent financial and economic crisis); and second, to develop a tool for regular policy analysis based on counterfactual exercises.

This analysis is semi-structural in the sense that a distinction is made between dynamics that are conditional on an unanticipated change of the stance of monetary policy (a shock in the policy rate) and dynamics that are conditional on the business cycle. The approach therefore both identifies features of the transmission mechanism of monetary policy and establishes some stylised facts regarding the cyclical behaviour of the variables considered.

A distinguishing feature of the analysis is the inclusion – in addition to the standard macroeconomic variables for real activity and prices – of disaggregated information on loans and interest rates – as well as for various monetary aggregates and their own rates of return. Asset prices and information on the term structure of interest rates at longer maturities are also included. The model thus encompasses as much detail as possible on real activity and financial intermediation for a sample that is long enough to make time series estimation feasible and available at a monthly frequency. This dataset is therefore richer than the standard data set used in macroeconomic and monetary analysis, but less detailed in the cross-sectional dimension than in micro-studies on banking.

22 Prepared by Domenico Giannone, Michele Lenza and Lucrezia Reichlin. This annex summarises some of the main findings of Giannone et al. (2010).

The main aim here, however, is not to understand the link between monetary aggregates and inflation in the long run, which is the focus of several other contributions in this volume. Rather, in a complementary exercise, the objective is to analyse features of the evolution of disaggregated monetary quantities over the business cycle and, in particular, how they respond to policy and cyclical changes. This annex also aims to investigate the interaction between the behaviour of monetary aggregates and loans and how this relates to the term structure of interest rates. Loans and money are the main items on the asset and liability sides (respectively) of the banking sector balance sheet and should therefore reveal features of banking intermediation.

This study is the first to include, in the same dynamic empirical model, the full available set of information on money, credit and the real economy. Other studies have analysed the transmission mechanism of monetary policy in the euro area. Extensive research was conducted during the early stages of the euro mostly on pre-euro data.[23] Several studies investigating the behaviour of US loans have been undertaken.[24] In that literature, differences in the response of loans to households and loans to businesses following a change of interest rates have been used as an identification device to discriminate between different "stories" on the credit channel.

This paper is also related to the literature on the pass-through of interest rates that emphasises how the sensitivity of lending rates to the policy rate depends on determinants such as the institutional sector of the borrower (firms, consumer, government), the use to which the loan is put (e.g. consumption versus house purchase) and structural financial features, such as the competitiveness of the banking sector.[25]

This analysis also aims to understand whether the characteristics of money and credit have changed during the recent financial and economic crisis. Once the stylised facts for the period preceding it have been established, it is then possible to see whether any deviation from these facts can be identified during the recent period of financial turmoil.

23 See, for example, the book edited by Angeloni et al. (2003), in particular the articles on the euro area (Peersman and Smets (2003)) and on individual countries (Mojon and Peersman (2003)), as well as a more recent study by Boivin et al. (2008). However, note that this latter study is based on quarterly data and does not contain data on loans.

24 See, for example, Bernanke and Blinder (1992), Bernanke and Gertler (1995), Christiano et al. (1996) and den Haan et al. (2007).

25 For a recent study with an extensive survey of the literature, see Sorensen and Werner (2006).

2 DATABASE AND MODEL

The dataset constructed consists of 39 monthly variables for the euro area, including macroeconomic variables (measures of real activity, consumer and producer prices in the euro area and the United States, exchange rates and consumer confidence); financial variables (euro area money market rates, among which the three-month EURIBOR is treated as a proxy for the policy rate, the yield curve and stock prices); and, crucially, disaggregated loans variables (different categories of loans to non-financial corporations and households) and their corresponding interest rates, as well as several money aggregates (M1, M2, M3 and sectoral holdings of deposits) and their own rate of return.

A very general multivariate linear model is adopted: a vector autoregressive (VAR) specification with 13 lags for the (log-)level of the variables. The estimation of a model with so many variables and possible dynamic interactions among them is problematic owing to the issue of estimating too many parameters given the sample information. In this situation, classical estimation methods are unstable and unreliable owing to a tendency to over-fit the data (this is known as the "curse of dimensionality" problem). In this approach, the "curse of dimensionality" problem is solved using Bayesian shrinkage, as suggested in De Mol et al. (2008) and Banbura et al. (2010). These papers show that, if the data are collinear – as is the case for macroeconomic variables – the relevant sample information is not lost when over-fitting is controlled for by shrinkage via the imposition of priors on the parameters of the model to be estimated.[26]

3 ESTABLISHING STYLISED FACTS FOR THE PERIOD 1991-2007

In order to define the pre-crisis transmission mechanism and cyclical properties of the euro area variables, the model is estimated using data until July 2007. The stylised facts on the monetary transmission mechanism are derived by studying the response of the different variables to an exogenous tightening in monetary policy, that is a monetary policy shock that increases the policy interest rate (here proxied by the three-month EURIBOR). The identification assumptions for the monetary policy shock are relatively standard (see, for example, Christiano et al. (1999)): nominal and real macroeconomic variables in the euro area and the United States are allowed to react to the monetary tightening only with a delay of one month, while all other financial, monetary and credit variables can react to the monetary tightening contemporaneously.

The study of the business cycle features of the euro area variables is instead conducted by looking at their response to the shocks that explain the dynamics of euro area real activity. In order to isolate only the effect of the shocks affecting

26 For technical details on the application described in this annex, please refer to the original paper by Giannone et al. (2010).

euro area real activity, two paths are computed: (a) the expectation of the variables of interest conditional on the observed path of euro area industrial production in the recent recession; and (b) their unconditional forecast. The difference between the two paths is only due to the shocks that explain the dynamics of euro area industrial production in the last recession. Hence, the difference between the two paths is interpreted as the response of the variables to a combination of cyclical shocks.

This annex focuses on the money and credit markets.[27] The main results with regard to their cyclical behaviour are as follows: (1) credit variables are all pro-cyclical, but loans to non-financial corporations exhibit a sizeable lag with respect to the cycle; (2) M1 is mildly anti-cyclical, while M3 hardly responds to the cycle; and (3) the three-month EURIBOR is pro-cyclical, while yields at longer maturities and lending rates are rather less responsive to the cycle. In the interest of space, for the charts and the complete analysis, the reader is referred to Giannone et al. (2010).

Turning to the response to the monetary policy shock, the following main results are highlighted and selected charts on impulse response functions are reported: (1) M1 responds negatively to a monetary policy tightening. This liquidity effect is very large and persistent. In fact, the findings that the liquidity effect is stronger than the transaction effect and that the three-month EURIBOR is pro-cyclical explain the counter-cyclicality of M1 reported above; (2) by contrast, M3 responds positively to a monetary contraction. In response to a tightening, a decrease in the term spread (between either the two-year or ten-year bond yield and the three-month EURIBOR) is observed. These findings suggest that an increase in policy rates leads to a portfolio reallocation from bonds to the shorter-term monetary assets in M3. Chart A2.1 shows the impulse response function of M1 (left-hand panel) and of M3 (right-hand panel) to a monetary policy shock; (3) loans to firms react positively to higher short-term interest rates on impact and only decline after a long lag (on average about a year); and (4) lending rates for all loans categories are sticky, reacting only with a delay to the increase in monetary policy rates. Chart A2.2 shows the reaction of a specific category of loans to households, namely loans for house purchases (left panel) and of short-term loans to non-financial corporations (right panel).

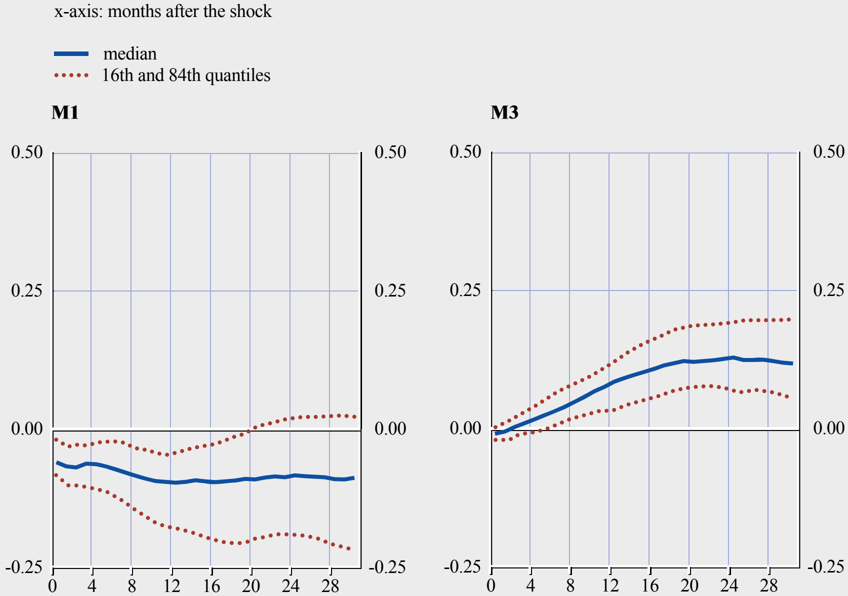
One interesting and potentially surprising result of this analysis is that loans to non-financial corporations initially increase in response to a monetary policy contraction: the impulse response is “hump-shaped”. The same result has been found in US data.[28] The literature has suggested various explanations for this positive response to higher short-term interest rates: Bernanke and Gertler (1995)

[27] Please refer to Giannone et al. (2010) for the full set of impulse response functions and the analysis of business cycle correlations.

[28] See Christiano et al. (1996), Bernanke and Gertler (1995) and, for a more recent assessment, den Haan et al. (2007).

Chart A2.1 Reaction of monetary aggregates to a monetary policy tightening

(deviations from baseline in percentages)



Source: Giannone, Lenza and Reichlin (2010).

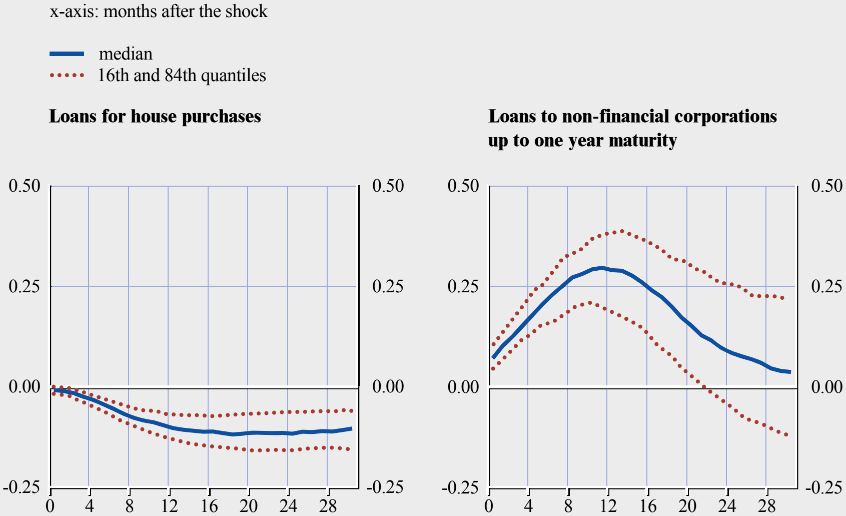
Note: The blue solid line is the median of the distribution of the impulse response function (IRF) of the variables to a one standard deviation monetary policy shock. The dotted lines represent the 16th and the 84th quantiles of the IRF distribution. The number on the horizontal axis refers to the number of months after the shock (which happens in month zero). The number of the vertical axis refers to the response of the log-level of the variables.

and Christiano et al. (1996) suggest that loans could increase in response to a monetary contraction since firms might increase their demand for loans to finance increased inventories or a reduced utilisation of the workforce. In addition, loans might increase in response to a monetary tightening as a result of firms drawing from pre-committed credit lines locked at the previous lower interest rate (front-loading). The stickiness of the lending rates and the importance of relationship banking in the euro area are in line with this explanation. An alternative explanation might be an endogenous shift of loan supply by banks.[29]

[29] Den Haan, Sumner and Yamashiro (2007), for example, find evidence that banks, in response to a monetary tightening, shift their portfolio from long-term and risky loans such as real estate loans towards short-term loans earning a higher rate of return.

Chart A2.2 Reaction of loans to a monetary policy tightening

(deviation from baseline in percentages)



Source: Giannone, Lenza and Reichlin (2010).
Note: The blue solid line is the median of the distribution of the impulse response function (IRF) of the variables to a one standard deviation monetary policy shock. The dotted lines represent the 16th and the 84th quantiles of the IRF distribution. The number on the horizontal axis refers to the number of months after the shock (which happens in month zero). The number of the vertical axis refers to the response of the log-level of the variables.

4 WHAT HAS CHANGED DURING THE CURRENT CRISIS?

The encompassing model estimated for the euro area in Giannone et al. (2010) captures the complex dynamic relationships between the macroeconomic, financial, credit and monetary variables in the euro area in the pre-crisis (i.e. pre-August 2007) period. In this section, it is used to assess whether the economic relationships described in the model still hold in the financial crisis/recession period.

In order to take into account the economic structure of the euro area prevailing before the financial crisis, the model is estimated with data until July 2007. Then, given the estimated VAR parameters, the expectation is computed of all the variables included in the model in the period from January 1999 to September 2009 that are conditional on the values of all variables until December 1998 and exclusively those of the real macroeconomic variables (i.e. industrial production in the euro area and the United States, and unemployment in the euro area) from January 1999 to September 2009.[30] In so doing, it is possible to condition the forecasts on the shocks that have driven the business cycle in the past decade in the euro area. Finally, the conditional expectations of all variables with the corresponding outcomes are compared.

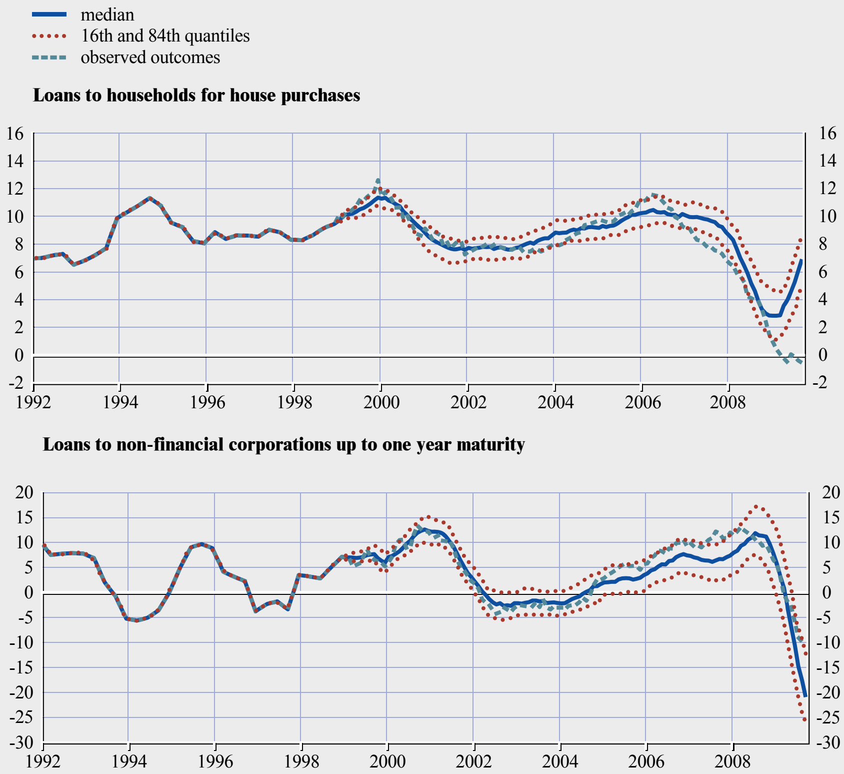
30 The algorithm used to compute conditional forecasts is based on the Kalman filter and is described in Banbura et al. (2010).

Owing to the fact that the estimated VAR parameters reflect the euro area economic structure prevailing until July 2007, the comparison of conditional forecasts and observed outcomes should be differently interpreted when looking at the pre and the post-crisis period. If, for a specific variable, large differences between outcomes and conditional expectations appear even in the pre-crisis period, the most likely conclusion is that the variable is not strongly cyclical, i.e. sources of fluctuations other than the shocks driving the business cycle are relevant in explaining its dynamics. The comparison of pre-crisis outcomes and expectations based on real activity variables can therefore be considered as another test of cyclicality of the variables included in the model.

If, instead, large discrepancies among outcomes and expectations appear in the post-crisis period, then it is more likely that these are owing to a change in the dynamic relationships linking the variables to the rest of the economy. Again, for the sake of brevity, the focus is mainly on money and credit markets. Chart A2.3 reports the results of the exercise described above for the annual growth rates of

Chart A2.3 Loans: expectations conditional on the business cycle and pre-crisis economic structure

(annual percentage changes)



Source: Giannone, Lenza and Reichlin (2010).

Notes: Variables are expressed in terms of annual growth rates. The blue solid line is the median, while the dotted lines represent the 16th and the 84th quantiles of the distribution of the conditional forecasts. The green dashed line refers to observed outcomes. The horizontal axis reports the dates (from January 1996 to September 2009), while the vertical axis shows the annual growth rates in percentage terms.

loans to households for house purchases (top panel) and loans to non-financial corporations up to one year maturity (lower panel).

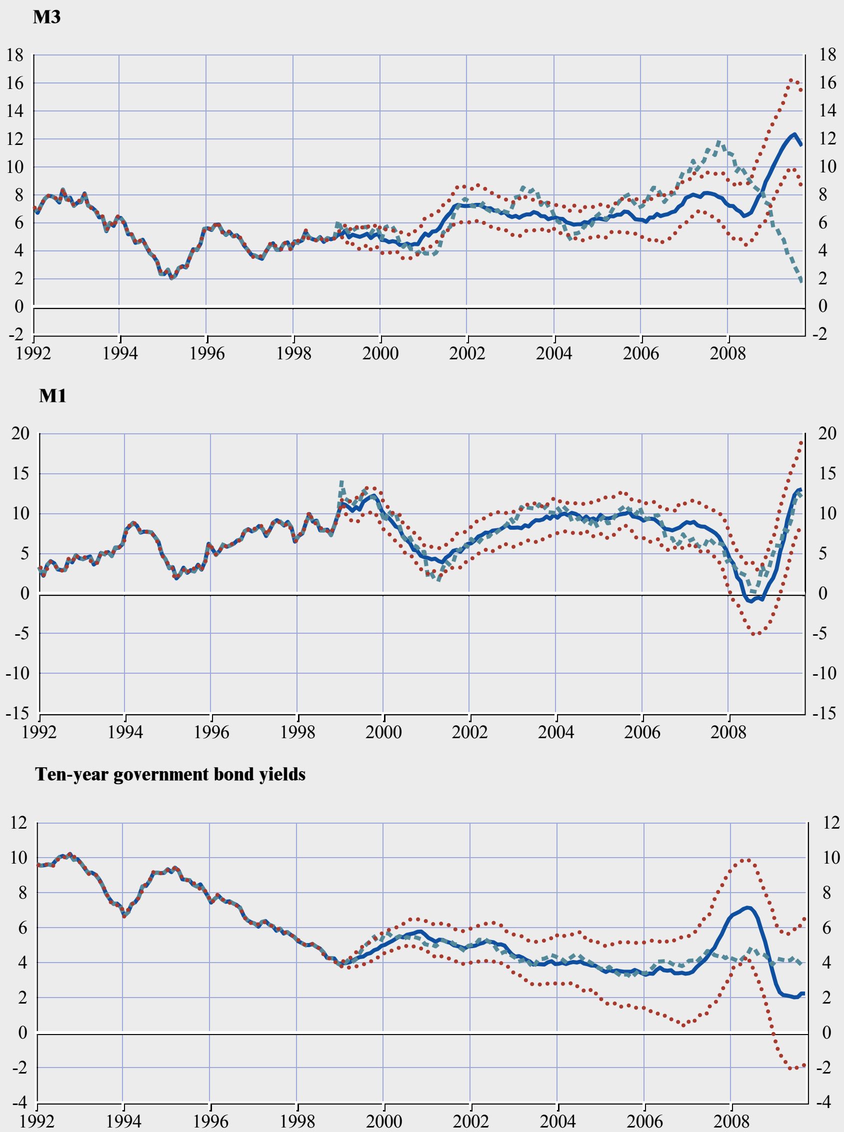
Chart A2.3 shows that the conditional forecasts and the outcomes for the annual growth rates of loans to non-financial corporations are very similar during the whole period under analysis, and no anomalies are detected during the crisis. Moreover, it seems that the evolution in loans after the crisis was not very surprising given the state of the business cycle. In other words, during the financial crisis, euro area credit markets do not seem to have behaved differently than expected given the state and outlook of the business cycle and the pre-crisis empirical regularities. Any apparent anomaly in the credit market may be considered as a manifestation of shocks that were much larger than in the past decades. The picture is slightly different for loans for house purchases, which have been higher than predicted (close to the upper bands) since 2004, and they continue to fall even after the model would have predicted a turning point on the basis of cyclical conditions (first quarter of 2009). Anomalies are also found in the development of the money aggregates.

Chart A2.4 reports the results of the same exercise for the annual growth rates of M3 (top panel), M1 (middle panel) and, in addition, the ten-year government bond yields (bottom panel). Chart A2.4 demonstrates that the evolution of M1 can be explained on the basis of the shocks driving the business cycle both before and after the crisis. Hence, M1 is a cyclical variable, and its relationship with the rest of the economy has remained stable during the crisis. The pre-crisis evolution of M3, however, is relatively more difficult to describe on the basis of the shocks driving the business cycle. More importantly, from mid-2006 the dynamics of M3 would have been very difficult to forecast. Although not reported here, the paper also documents that this discrepancy can be observed in short-term deposits for all sectors of the economy.

Both the recent sustained increase and decline in M3 growth seem difficult to reconcile with the pre-crisis economic relationships and the business cycle shocks. Interestingly, the only other set of variables that are difficult to reconcile with the pre-crisis economic relationships and the business cycle is the set of long-term bond rates. The lower panel in Chart A2.4, for example, shows that the observed ten-year government bond yield (green line) did not fluctuate as much as expected over the past three years given the state of the business cycle (and the associated monetary policy response). In particular, long-term bond rates were lower than expected in coincidence with the surprising increase in M3 and higher than expected in the period of strong decline in M3. Although this analysis does not allow for causal implications, these results are compatible with the existence of a link between broad money and prices of assets, consistent with the idea that the holding of broad money is to a relevant extent affected by portfolio considerations.

Chart A2.4 Money and interest rates: expectations conditional on the business cycle and pre-crisis economic structure

(annual percentage changes)



Source: Giannone, Lenza and Reichlin (2010).

Note: M1 and M3 are expressed in terms of annual growth rates while the ten-year bond rates are in levels. The blue solid line in the charts is the median, while the dotted lines represent the 16th and the 84th quantiles of the distribution of the conditional forecasts. The green line refers to observed outcomes. The horizontal axis reports the dates (from January 1996 to September 2009), while the vertical axis shows the annual growth rates or the level of the variables in percentage terms.

5 CONCLUSION

This annex has described the empirical framework proposed by Giannone et al. (2010) for the analysis of the joint dynamics of macroeconomic, financial, credit and monetary variables in the euro area. It has focused on the behaviour of monetary and credit variables over the business cycle and analysed their role in the monetary transmission mechanism. In particular, a set of stylised facts is established in these dimensions for the sample period 1991-2007.

Subsequently, changes in regularities that emerged during the recent financial crisis have been identified. The findings indicate that, although the credit markets went through a very relevant contraction during the crisis, bank loans to non-financial corporations nonetheless evolved in line with what would have been expected on the basis of pre-crisis economic relationships given the sharp decline in economic activity, whereas loans for housing declined more persistently than this model would have predicted conditionally on the observed business cycle conditions.

Moreover, the post-crisis evolution in broad money (M2 and M3) and bond rates also exhibited an anomalous persistent decline. The anomalous increase in broad money since 2006 and its subsequent anomalous persistent decline can be partly explained by the parallel anomaly in the behaviour of the long-term bond rate since 2006, which has not fluctuated as much as the model would have foreseen. The conjecture is that the behaviour of broad money reflects portfolio choices motivated by changes in the term structure. The main lesson to be drawn from this analysis is that the interaction between business cycle, monetary policy and the term structure induces complex changes in the composition of the assets (loans) and liabilities (monetary aggregates) of the banking sector and therefore in the functioning of financial intermediation. Monetary analysis at business cycle frequency, combined with the analysis of credit, can therefore be very informative for the understanding of the link between the real economy and the financial sector, and can help in detecting dysfunctional features in financial intermediation.

REFERENCES

Angeloni, I., Kashyap, K.A. and Mojon, B. (eds.) (2003), *Monetary policy transmission in the euro area*, Cambridge University Press.

Banbura, M., Giannone, D. and Lenza, M. (2009), "A large VAR for the euro area", ECB mimeo.

Banbura, M., Giannone, D. and Reichlin, L. (2010), "Large Bayesian VARs", *Journal of Applied Econometrics*, Vol. 25(1), pp. 71-92.

Bernanke, B.S. and Blinder, A.S. (1992), "The federal funds rate and the channels of monetary transmission", *American Economic Review*, Vol. 82(4), pp. 901-921.

Bernanke, B.S. and Gertler, M. (1995), "Inside the black box: the credit channel of monetary policy transmission", *Journal of Economic Perspectives*, Vol. 9(4), pp. 27-48.

Boivin, J., Giannoni, M.P. and Mojon, B. (2008), "How has the euro changed the monetary transmission?", *Working Paper Series*, No 14190, NBER.

Christiano, L.J., Eichenbaum, M. and Evans, C.L. (1996), "The effects of monetary policy shocks: Evidence from the flow of funds", *Review of Economics and Statistics*, Vol. 78(1), pp. 16-34.

Christiano, L.J., Eichenbaum, M. and Evans, C.L. (1999), "Monetary policy shocks: what have we learned and to what end?" in Taylor, J.B. and Woodford, M. (eds.) *Handbook of Macroeconomics 1*, Elsevier, pp. 65-148.

De Mol, C., Giannone, D. and Reichlin, L. (2006), "Forecasting using a large number of predictors: is Bayesian regression a valid alternative to principal components?" *Journal of Econometrics*, Vol. 146(2), pp. 318-328.

den Haan, W.J., Sumner, S.W. and Yamashiro, G.M. (2007), "Bank loan portfolios and the monetary transmission mechanism", *Journal of Monetary Economics*, Vol. 54(3), pp. 904-924.

Giannone, D., Lenza, M. and Reichlin, L. (2010), "Money, credit, monetary policy and the business cycle in the euro area", mimeo ECB.

Mojon, B. and Peersman, G. (2003), "A VAR description of the effects of monetary policy in the individual countries of the euro area", in Angeloni, I. Kashyap, K.A. and Mojon, B. (eds.), *Monetary policy transmission in the euro area*, Cambridge University Press.

Peersman, G. and Smets, F. (2003), "The monetary transmission mechanism in the euro area: more evidence from VAR analysis", in Angeloni, I. Kashyap, K.A. and Mojon, B. (eds.), *Monetary policy transmission in the euro area*, Cambridge University Press.

Sorensen, C.K. and Werner, T. (2006), "Bank interest rate pass-through in the euro area – a cross-country comparison", *Working Paper Seri*es, No 580, ECB.

CHAPTER 5

STRUCTURAL MODELS WITH AN ACTIVE ROLE FOR MONEY

1 INTRODUCTION[1]

Scenario analysis is a widespread practice in macroeconomic forecasting and strategic policy design. However, a quantification of the sensitivity of baseline projections to alternative paths regarding monetary – as opposed to real – variables is often hindered by the lack of models that combine real sector and monetary variables in a consistent setting. Developing a framework within which to construct and analyse monetary and financial scenarios can thus enrich monetary analysis.

This chapter discusses one model used at the ECB to measure the sensitivity of macroeconomic projections to alternative monetary scenarios.[2] The model is a version of a large-scale model in the dynamic optimising general equilibrium tradition documented in Christiano et al. (2003, 2007, 2010) (hereafter referred to as the "CMR model"). In the CMR model, real sector and pricing/wage-setting conditions interact with money-holding decisions and a liquidity-creating banking sector in a general equilibrium environment. The presence of a profit-maximising banking sector extending credit and operating a fractional-reserve-based transformation of base money into overnight deposits and short-term securities allows for the definition of a broad array of monetary aggregates. The model-defined interactions between liquidity demand – expressed by households and firms – and decisions by banks regarding the supply of money and credit provide the modelling infrastructure for the construction of the monetary scenarios that are used, among many other tools, to inform monetary analysis at the ECB.

The chapter is organised as follows. Section 2 gives a very broad overview of the model. Section 3 documents the empirical properties of the model and the results it produces with relevance for monetary analysis and policy conduct more broadly. Section 4 presents the methodology for constructing monetary scenarios. Section 5 documents how scenarios have been used in "real time". Section 6 concludes.

1 This chapter was prepared by Roberto Motto and Massimo Rostagno. Tobias Blattner and Pavel Gertler provided excellent data assistance. The views expressed are those of the authors and not necessarily those of the ECB or the Eurosystem.

2 For a more empirically-oriented approach, see the counterfactual scenarios conducted by Giannone et al. (2010), discussed in Annex 2 to Chapter 4.

2 THE MODEL

The model integrates financial intermediation and money creation into an otherwise canonical dynamic equilibrium model, of the type studied by Christiano et al. (2005) (hereafter referred to as the "CEE model"), and Smets and Wouters (2003, 2007). The real economy is made up of households, firms, capital producers and entrepreneurs. Households consume, supply differentiated work in a monopolisitic labour market, and allocate savings across assets with varying degrees of liquidity. Firms producing intermediate goods are monopolists and subject to a standard Calvo mechanism for price setting. They need to pay for working capital in advance of production. Capital producers combine undepreciated physical capital with new investment. The technology for converting investment into productive capital is subject to shocks to the "marginal efficiency of investment". Entrepreneurs have a special ability to operate capital. They acquire plant capacity from capital producers, extract production services from it – which they rent out to firms – re-sell the stock of undepreciated capital at the end of the production cycle, and accumulate net worth in the process. Net worth, i.e. their equity, is subject to financial wealth shocks and is used to pay for capital in the next production round. But, in order to carry out their activities efficiently, entrepreneurs need to borrow the fraction of the value of capital which they are not able to finance themselves. The financial system provides the credit necessary to cover this funding gap.

The financial sector is made up of many identical intermediaries, referred to below as "the bank". This combines features of a genuine commercial bank which engages in the production of inside money, and features that are more typical of an arms-length (shadow-banking) financial system of the sort described by Gorton (2009), Brunnermeier (2009), and Adrian and Shin (2010), among others. As part of its commercial banking activities, the bank grants loans to finance firms' working capital requirements, and issues demand deposits and very liquid securities which are redeemable on sight. The bank holds an inventory of cash as a fractional reserve against the production of sight liabilities. The bank obtains these cash balances from households' deposits of base money and from central bank liquidity injections. Bank efficiency in transforming cash into deposits and liquid securities – and the bank's preference for liquid balances – varies stochastically over time.

As part of its shadow-banking intermediation activity, the bank finances entrepreneurs' investment projects. As in Bernanke et al. (1999) (hereafter referred to as BGG), we assume that entrepreneurial loans are risky: returns on the underlying investments are subject to idiosyncratic shocks. A sufficiently unfavourable shock can lead to the borrower going bankrupt. The idiosyncratic shock is observed by the entrepreneur, but not by the bank, which, as in Townsend (1979), must pay a fixed monitoring cost in order to observe the entrepreneur's realised return. To mitigate problems stemming from this source of asymmetric information, entrepreneurs and the bank sign a standard debt contract. Under this contract, the entrepreneur commits to paying back the loan principal and a non-default interest rate, unless it declares default.

In case of default, the bank conducts a costly verification of the residual value of the entrepreneur's assets and seizes the assets as partial compensation.

We assume that the variance of the idiosyncratic shock that hits entrepreneurs' returns is the realisation of a time-varying process. This stochastic process, referred to as the risk shock, changes the cross-sectional dispersion of returns on entrepreneurial projects. By making the cross-sectional distribution of returns vary over time, this process produces time variation in bankruptcies, and thereby in credit risk. The risk shock has a realised and an anticipated "signal" component. In each period, economic agents observe the present realisation of risk and receive signals that update their perceptions of the future evolution of risk. The signals received at each time are correlated because, in forming expectations of future risk conditions, agents rely on a single source of information available at the time. That single source reflects the "mood of the day" and sets the general tone for current perceptions about the future.

The bank hedges against credit risk by charging a premium over and above the risk-free rate at which it can borrow from households. The risk-free rate that the bank views as its opportunity cost to lending is a contractual nominal interest rate that is determined at the time the bank liability to households is issued. Unlike in the BGG model, this rate is not contingent on the shocks that occur before the entrepreneurial loan matures.

The cost of borrowing fluctuates endogenously with the cycle. This reflects two general equilibrium mechanisms. The first one is a genuine BGG-type financial accelerator effect, which makes the contractual loan rate dependent on entrepreneurs' equity, i.e. the net worth that borrowers can pledge to secure the loan. The contractual interest rate is counter-cyclical because equity varies positively with the state of the cycle: the flow of entrepreneurial earnings depends on aggregate demand, boosts equity and increases the protection of the loan. The second mechanism is absent in the BGG model. This is due to the assumption that, in the model, banks' obligations to households are expressed in nominal terms, while loans to entrepreneurs are state-contingent. As a consequence, surprises to the price level can alter ex post the real burden of entrepreneurial debt because the bank is immunised from any risk related to macroeconomic uncertainty. This mechanism is referred to as the "Fisher deflation effect". It is an important source of nominal rigidity in the model and a prime financial factor shaping the model's dynamics. The Fisher and accelerator effect mechanisms reinforce each other in the case of shocks that move the price level and output in the same direction, and they tend to cancel each other out in the wake of shocks which move the price level and output in opposite directions.

The central bank steers the short-term interest rate in response to inflation, output growth, credit growth and money market liquidity conditions. The two latter components of the monetary policy feedback rule are unconventional. Reaction to credit introduces some elements of "leaning against the wind" into monetary policy. Reaction to interbank liquidity conditions allows for some degree of quantity-setting and price-taking behaviour in liquidity-providing operations on the part of the central bank.

The model is estimated using standard Bayesian methods, with data spanning the 1985-2008 period for the euro area. In the baseline estimation, 16 variables are treated as observables. These include monetary and financial variables such as the stock market (a proxy for the price of capital), a measure of the external finance premium, real credit growth, M1 and M3 growth, the outstanding stock of refinancing operations with the Eurosystem,[3] and the spread between the ten-year bond rate and the short-term interest rate.

3 EMPIRICAL PROPERTIES AND INFERENCE

A necessary condition for producing reliable results from model-based simulations is the coherence of the model with the data. This can be measured in several ways, both in sample and out of sample. Two ways of doing so are documented here. The first one is based on the standard metric of comparing the forecasts generated by the structural model with forecasts based on statistical methods that are known to be hard to beat in out-of-sample analysis. The second way of assessing the plausibility of the model is based on the in-sample historical decomposition (in terms of the estimated structural shocks) of the variables included in the model.

3.1 OUT-OF-SAMPLE ANALYSIS

The out-of-sample performance of dynamic stochastic general equilibrium (DSGE) models is generally assessed against benchmarks provided by time-series models. The reason is that DSGE models impose very stringent restrictions on account of the fact that they are derived from first principles (i.e. optimisation behaviour of all economic agents). This provides a better understanding of the results in sample, but at the same time may render such models less reliable in out-of-sample simulations if these restrictions are not fully supported by the data.

Chart 1 documents the out-of-sample performance of the model, measured in terms of root mean squared forecast errors (RMSFEs). The forecast evaluation is carried out in the following way.[4] The model is estimated up to the third quarter of 2001 and the first unconditional forecast is computed spanning a horizon of 12 quarters ahead. The forecast is evaluated against the actual data outcome. The sample is then updated by one observation and the exercise is repeated until the end of the available sample. This makes it possible to calculate the average performance of the model for each of the 12 periods considered in the horizon. The same exercise is performed with alternative models, both DSGE models and time-series models, and the results are compared. The two alternative DSGE models considered in the analysis are versions of the baseline model in which some channels are shut down. The financial accelerator model referred to in Chart 1 removes money, liquidity and the funding channel from

3 For the years 1985 to 1999, an aggregation of bank reserves held with the central banks of Germany, France, Portugal, Spain, Italy, the Netherlands and Finland, appropriately rescaled, is used.

4 For details, see Christiano et al. (2010).

Chart 1 Forecasting performance

(in terms of root mean squared forecast errors)

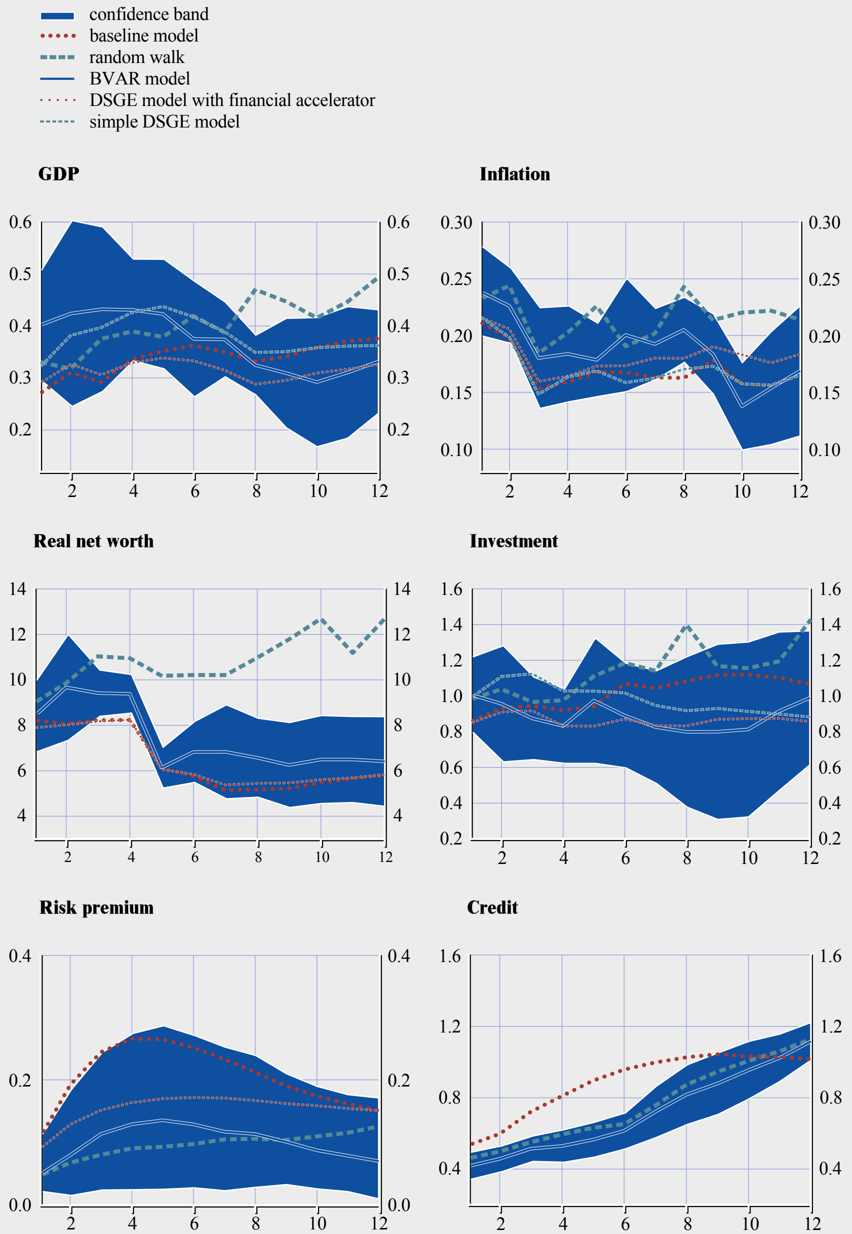
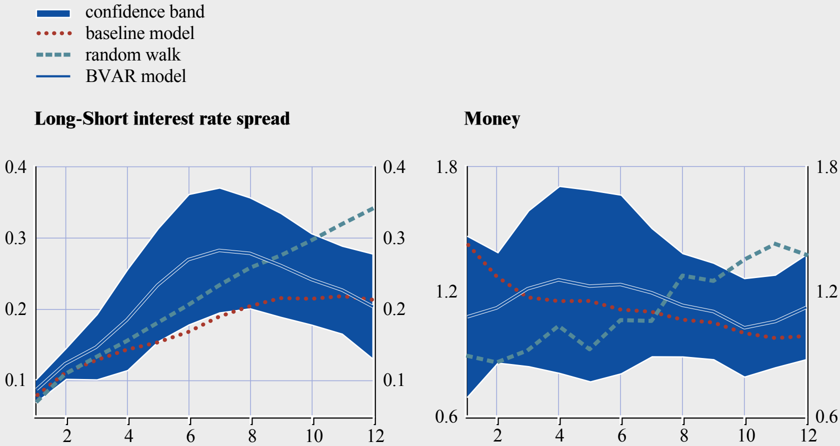


Chart 1 Forecasting performance (cont'd)

(in terms of root mean squared forecast errors)



Sources: Christiano, Motto and Rostagno (2010).

Note: The blue area represents a ±2 standard deviation band around the BVAR-generated RMSFEs.

the baseline model. This helps to focus on the contribution of those channels. The simple model shuts down further channels – mainly it removes credit extension and balance-sheet constraints from the financial accelerator model. In practice, the simple model is a version of the workhorse DSGE model developed by Christiano et al. (2005) and refined by Smets and Wouters (2003).

The time-series model used in this comparison of forecasting capabilities is a Bayesian vector autoregressive (BVAR) model. Such a model is widely recognised as one which makes successful forecasts, resting on the combination of the standard VAR framework and the use of priors that shrink the coefficients towards zero. The former provides flexibility in fitting the data, while the latter addresses the endemic problem of over-parameterisation which is typical of standard VARs. The BVAR model – with Minnesota priors – is estimated on the basis of the same 16 time series used to estimate the baseline DSGE model and over the same sample period as that used for the baseline estimation. Chart 1 also shows the results based on forecasts constructed on a random walk assumption for each of the variables. Finally, the blue area in Chart 1 represents a ±2 standard deviation band around the BVAR-generated RMSFEs. The model which performs the best for each forecasting horizon appears in the chart as the model with the lowest RMSFE.

Chart 1 shows that the performance of the baseline model is always statistically close to that of the BVAR, except for with regard to credit, where the model's RMSFEs exceed the upper bound of the tight statistical interval at horizons between four and seven quarters. The model variants considered in the assessment yield similar RMSFEs. Overall, the results suggest that the inclusion of financial and monetary variables and channels in the analysis does not come at the cost of a deterioration in the empirical properties of the model. Considering the volatility of some of the financial series included in the estimation of the baseline model, this is quite remarkable.

3.2 IN-SAMPLE ANALYSIS: HISTORICAL DECOMPOSITION IN TERMS OF STRUCTURAL SHOCKS

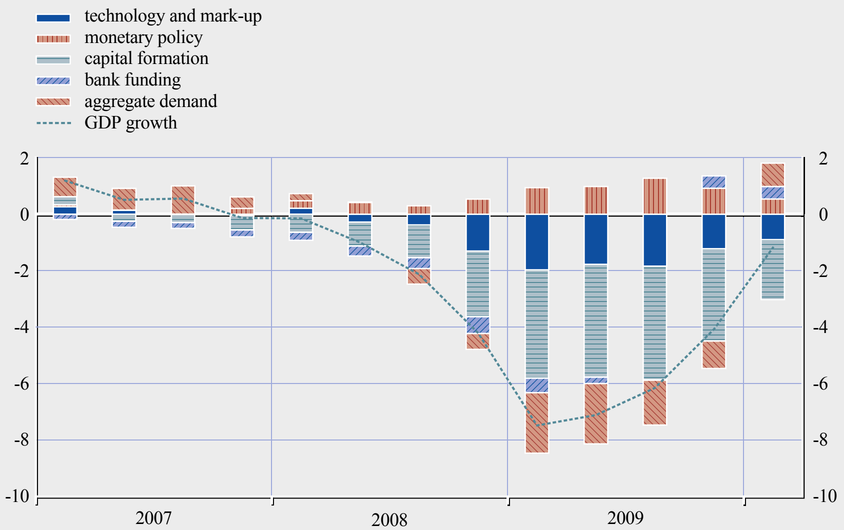
A by-product of the model's estimation is the estimate of the time series of the structural shocks identified in the model. This means that structural models can be used as a lens to interpret developments in macroeconomic variables in terms of underlying structural forces – for instance, technological forces and liquidity preferences. As such forces, often labelled "economic shocks", are usually unobservable, a model is required to carry out this exercise. Structural models offer the advantage that they can provide a coherent picture in which interrelations among the different sectors of the economy, shocks, private sector expectations and monetary policy can be simultaneously accounted for. The following two sections focus on two variables: GDP growth and money growth.

3.2.1 GDP GROWTH

Chart 2 displays GDP growth over the recent financial crisis and shows how the model can shed some light on the contribution of the different adverse forces that hit the euro area. The analysis is especially interesting because the financial sector was at the epicentre of the crisis, and most macro models in use in policy and private institutions do not account for lending and funding channels. In Chart 2,

Chart 2 Decomposition of real GDP growth

(annual percentage changes; percentage points)



Source: ECB computations.

Notes: The dashed 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. The last observation refers to the first quarter of 2010.

the data point for each quarter is broken down into the contributions from the economic shocks identified by the model. To ease exposition, shocks are grouped according to the economic margin and/or policy function on which they have an impact: consumption, capital formation, technology and pricing, bank funding and monetary policy. Each category is represented by a different colour. In each quarter the sum of the bars gives the actual data point (dashed line). The results are summarised below.

Shocks related to aggregate demand (labelled "aggregate demand") were closely associated with the deceleration and subsequent fall in output that began in the second quarter of 2008. Collectively, these shocks capture retrenchment in total consumption and the negative contribution from net foreign demand, which is accounted for in the model as an exogenous component to aggregate demand – and the corresponding exogenous shock is included in the demand category.

In line with established post-war trends, supply-side shocks (labelled "technology and mark-up") contributed pro-cyclically to the deceleration and subsequent fall in growth. This shock category includes temporary and permanent productivity shocks, as well as price and wage mark-up shocks.

Shocks that have an impact on capital formation represented the most significant drag on growth over the period under consideration. This group (labelled "capital formation") includes shocks which 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. The shock influencing the assessment of lending and borrowing risk, in particular, is a dominant component in the capital formation category. This shock is identified empirically by including credit and a measure of the external finance premium, and it aims to capture confidence effects with an impact on the economy's propensity to invest.

Shocks associated with bank funding conditions (labelled "bank funding") include factors which, in the model, influence banks' access to three complementary forms of funding: the issuance of checkable deposits included in M1, the issuance of other short-term deposits and marketable securities (M3-M1), and central bank refinancing.

While, according to the model, "capital formation" remained negatively influenced by borrowers' and lenders' risk considerations throughout the horizon covered in Chart 2, "bank funding'' ceased to be a negative source of growth in late 2009. In the model, this is due to two concurrent developments: strong M1 growth – facilitating the financing of bank assets via a relatively stable source of funding – and, notably, a sizeable decline in banks' demand for central bank refinancing in the second half of 2009. The model interprets the combination of these events – given the path of money market rates – as indicative of an alleviation of banks' liquidity constraints.

Monetary policy (labelled "monetary policy") was expansionary over the period under review. It should be noted that the monetary policy reaction in the model responds to anticipated inflation that deviates from the ECB's definition of price stability, output growth conditions, credit conditions and the demand for refinancing by banks. The adoption of the extraordinary liquidity measures in the fourth quarter of 2008 is captured by the model as a "shock", namely a deviation from past interest rates and liquidity provision practices. While in current conditions – with a positive level for the interbank overnight interest rate – the monetary policy impulse can still be measured by the deviation of the short-term interest rate from its norm, it should be noted that the model incorporates channels of monetary policy transmission, which act through liquidity effects. Chart 2 shows that these changes in liquidity-providing procedures together with an extraordinarily low money market interest rate more than offset the negative contribution of the shocks related to bank funding conditions as of late 2009. The results are highly model-specific – in particular, the dominant role of the shocks which hit the investment margin (bars labelled "capital formation") might capture confidence effects with a global dimension, which are not included in the model. Nevertheless, they point to an improvement in financial conditions over 2010 and are in line with other findings, such as those documented in the Bank Lending Survey.

3.2.2 M3 GROWTH

A similar decomposition in terms of structural shocks can be performed for the other variables included in the model. Chart 3 focuses on M3 growth. This analysis documents how the model has been used in practice to complement the real-time analysis of monetary developments. Chart 3 shows that M3 growth can be understood in terms of distinct historical phases.[5]

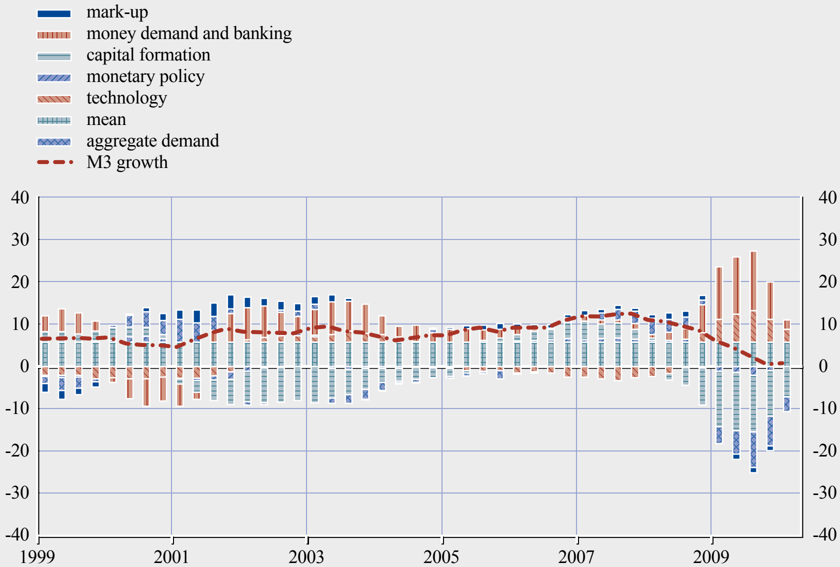
The strength of M3 growth during the period 2001-03 is largely explained by preferences for greater liquidity on the part of money holders, which can be seen in the increased demand for safe and liquid monetary assets from euro area residents at a time of heightened economic and financial market uncertainty. This boosting effect was partially offset by the adverse forces exerting a drag on aggregate demand and spending.

By contrast, the evolution of M3 growth in the period from mid-2004 to 2007 can be largely explained by real forces. A gradual improvement in the propensity to consume (included in the category labelled "aggregate demand") supported demand for the transaction instruments included in M3. Furthermore, the model also associates M3 growth in this phase with a more favourable valuation of financial wealth, which, in the model, eases collateral constraints and thus creates an incentive for firms to build up capital. These forces are the main component underlying the bars labelled "capital formation". They also reflect banks' increased propensity to supply both short-term loans to finance firms' working capital, and longer-term loans to fund gross fixed capital. The positive contribution of monetary policy shocks to M3 growth, particularly evident in 2006 and 2007, reflects the phase of the gradual removal of monetary accommodation initiated in 2005 which, to the extent it results in some flattening

5 To facilitate exposition of the factors driving monetary developments, Chart 3 presents a finer decomposition of the structural shocks compared with Chart 2.

Chart 3 Decomposition of M3 growth

(annual percentage changes; percentage points)



Source: ECB computations.
Notes: Each data point is broken down into the contributions from the shocks identified in the model. The last observation refers to the first quarter of 2010.

of the yield curve, led to an initial substitution of short-term assets within M3 for longer-term assets outside M3.

Moving to the recent crisis period, the analysis gives rise to several observations. First, the sheer size of the adverse financial shocks in the fourth quarter of 2008 and the first quarter of 2009 would have justified lower readings in M3 growth than the ones actually recorded. This is shown by the negative figures represented by the bars labelled “capital formation”. These shocks exerted a downward impact on output and thus on the need for money. In addition, the depressing effect on investment and capital exerted by these shocks meant that there was less of a need to create liabilities included in M3 that are used to make funds available to borrowers. Second, portfolio shifts as well as the increased effort made by the banking system to replace longer-term financing and wholesale financing with a larger deposit base are made visible in the chart by the bars labelled “money demand and banking”. The combined effect of these two types of shocks exerted a strong upward pull on M3 growth. Third, the contribution to M3 developments arising from the need to set aside liquid balances to finance current consumption declined in the course of 2008 and turned negative in the first quarter of 2009. According to the model, in the recent cycle the euro area’s propensity to consume reached its peak in the third quarter of 2007. Since then it has declined steadily. In the model, a lower propensity to consume leads to a decline in M3 growth on account of declining demand for liquid balances to finance current consumption expenditure (see the bars labelled “aggregate demand”). These shocks act through the most liquid component of M3.

Finally, the gradual removal of policy accommodation that occurred between 2005 and July 2008 began to exert downward pressure on M3 (see the bars labelled "monetary policy" starting from the fourth quarter of 2008). This pattern of response to policy tightening is consistent with empirical evidence provided by VAR analyses, which have shown that restrictive monetary policy exerts a rapid containing effect on M1 and an initial "perverse" boosting effect on M3. This suggested, back in late 2008, that in the course of 2009 the downward impact on M3 arising from the unwinding of past interest rate hikes would be compounded by the downward impact of the interest rate cuts initiated in the fourth quarter of 2008 – which also had an initial "perverse" dampening effect on M3. Chart 3 shows that this conjecture was indeed validated by the data.

As a caveat, the model, while rich in structure, remains stylised and cannot fully capture all the factors that contribute to money growth. For instance, the model omits the external dimension of monetary developments. Nonetheless, the exercise can complement real-time monetary analysis.

4 MONETARY SCENARIOS

Baseline projections produced at policy institutions are usually assembled largely by judgement rather than being the mathematical result of a specific model. This section reviews the way the CMR model can be used to construct scenarios that try to assess the sensitivity of baseline projections to alternative monetary developments. These scenarios are in the spirit of standard scenario analysis carried out at policy institutions. However, they focus on a dimension (the connection between the monetary and real and nominal side of the economy) on which standard models are silent.

The recent financial crisis provides a striking example of the usefulness of models that can trace out the transmission mechanism of shocks originating in the financial sphere and which propagate to the rest of the economy. However, interest in such scenarios is not confined to once-a-century events such as the recent financial crisis. They have a broader application. First, during the 1990 recession in the United States, Federal Reserve Board staff were concerned about banks' reluctance to extend credit. However, this credit constriction did not play a direct role in the MPS model (the model used by the Federal Reserve Board at the time). This remains the case in the FRB/US model (the model currently used by the Federal Reserve Board), making it difficult to factor credit developments into the analysis in a quantitative manner.[6] Second, the Asian and Russian crises of 1997 and 1998 are additional examples of episodes in which macro models that connect the monetary/financial sector and the real economy become extremely relevant. Third, the stock market boom-bust initiated in the second half of the 1990s provides a further example. Fourth, the rapid expansion of monetary aggregates between 2002 and 2004 in the euro area and the assessment of their implications for inflation and economic activity provide a case for the necessity of macro models that build in an active role for money and credit. Similarly,

6 See Reifschneider et al. (1997).

a structural model which builds in money is necessary to understand the implications of the collapse of the money multiplier associated with the provision of ample central bank liquidity in response to the recent financial crisis.

The following section provides some details on the methodology used to build the scenarios. The exposition and the scenarios that are quantitatively illustrated aim to provide some intuition in a rather didactical manner. Section 5 focuses instead on some specific scenarios that are rooted in historical contexts, and thus aim to describe the way the scenario can be formulated "in real time" to quantitatively assess some of the concerns that may prevail at a specific point in time among staff.

4.1 METHODOLOGY AND INTUITION

The methodology is based on a two-stage approach. In the first stage, the data sample is extended forward with "benchmark projections", which, for the purpose of the scenarios, are treated as actual data. In other words, the model is forced to replicate the extended time series, including projections, thus treating the non-historical portion of the augmented sample as if it were "in sample." In building the scenarios, the projections for the variables that are fed into the CMR model are taken, as much as possible, from the ECB/Eurosystem's macroeconomic projections. Variables not included in the projections are forecasted on the basis of several models, conditional on the path followed by the variables included in the official projections. In a second stage, having replicated the augmented data sample, monetary scenarios can be constructed in two distinct and yet complementary ways, as described below.

"SHOCK-BASED SCENARIOS"

The first way (described in Section 4.1.1) is based on "shock-based scenarios". This amounts to directly manipulating the string of innovations of monetary and financial shocks according to certain criteria. One such criterion is based on assessing the plausibility of the dynamics of shock innovations recovered when forcing the model to match, over the forecasting horizon, the benchmark projections. Another criterion is to assume that the economy will be hit by a string of shocks which are broadly similar in magnitude and timing to those estimated to have occurred in a specific historical episode that may resemble current circumstances, and which could repeat themselves. To avoid overburdening the discussion here, this sub-section focuses on the first criterion in order to provide intuition, and an application of the second criterion is discussed in Section 4.2.

The first criterion is reminiscent of the adjustment of residuals common in old-fashioned macro models. There is, however, an important difference. In structural models, "shocks" are usually unobserved structural exogenous sources of propagation. Such shocks differ from the "residual" of traditional macro models in that they derive from first principles and, as such, are not appended to a behavioural equation, but enter several model conditions and are linked by cross-equation restrictions. Consistent with the dynamic general equilibrium tradition, these structural shocks are usually assumed to follow an autoregressive process. The innovation component in the autoregressive process is assumed to be white noise. In the monetary scenarios described here, the focus is on the shocks that affect decisions relating to money holding and money creation, as well as financial decisions. For easy exposition and to provide intuition, the focus is initially on shocks to money demand ("money demand shock"*)* and to banks' money creation ("bank liquidity supply shock"*)*. These are collectively referred to as "monetary shocks". A discussion of financial shocks follows thereafter.

The estimated shock innovations turn out to be white noise for all the shocks included in the CMR model, except for the two monetary shocks, where some residual autocorrelation is found in the estimated innovations. This motivates the use of the first criterion in construction scenarios, i.e. exploiting residual information. Here, "exploiting information" regarding these two estimated shocks implies that the time profile of the estimated innovations for the two shocks over the projection horizon is assessed against past regularities and trends in search of a time pattern.

If there is in fact a time pattern in the shocks and it differs significantly from the one that the two monetary shocks are estimated to follow over the projection portion of the sample – over which the model is forced to match the benchmark projections – this difference is used as the starting point for the monetary scenario. Section 4.1.1 provides an illustrative application of this type of scenario. This exercise thus performs a sensitivity analysis around the following two questions. What if – unlike that which is implied in the benchmark projections replicated by the CMR model – the trends in the innovations in the two structural monetary shocks identified by the model over the period before the start of the projection horizon were in fact to continue during the projection horizon? Would this bring about a different path for inflation and economic activity?

"OBSERVABLES-BASED SCENARIOS"

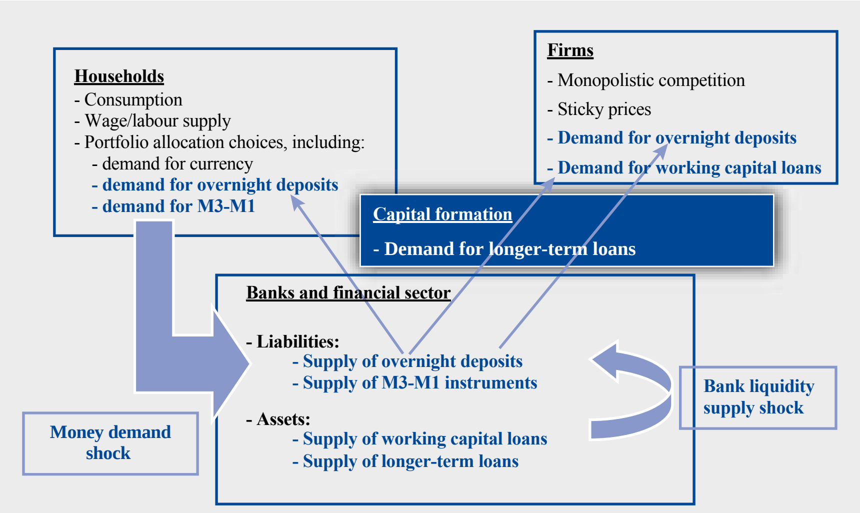
The second type of scenarios that can be designed are "observables-based scenarios", further details on which are given in Section 4.1.2. This way of designing scenarios is somewhat orthogonal to the "shock-based scenario" discussed above. These scenarios are designed to answer the following questions. What if – unlike that which is implied in the benchmark projections replicated by the CMR model – money were to depart from the path implicit in the benchmark? What would the implications be for the other macro variables and for the underlying shocks in the model? In the shock-based scenario, the focus is on the recent past in order to extract information – a time pattern – about the monetary shocks in isolation. Having identified that pattern, it is extended over the projection portion of the sample and the model is run to compute the implied path for all the endogenous variables, including inflation and GDP growth. In the observables-based scenario, the focus is on monetary observables, rather than latent monetary shocks. Relative to the shock-based scenario, this type of scenario involves reverse engineering. One imposes that monetary variables follow a path which is different from the one included in the benchmark projections and lets the model compute the implications for the other endogenous variables. One possible source for this alternative path for monetary variables is based on looking at recent history in search of regularities regarding the dynamics of monetary variables. Having identified a trend, the monetary variables can be made to follow this trend over the projection horizon. Of course, this raises the question of why the benchmark projection is inconsistent with such historical regularities in the first place. The point to stress here is that scenario analysis tries to capture the risk that a certain event may or may not materialise. It is not about the most likely event, which will be included in the benchmark projections. Some events may not be considered as the most likely outcome, but it may still be of interest to trace down their quantitative implications in the form of scenarios.

4.1.1 MONETARY SCENARIOS BASED ON ALTERING MONETARY SHOCKS

This section provides an illustration of how the shock-based scenario can be implemented in practice. The aim is mainly to provide a concrete example, rather than focusing on the plausibility of its calibration. A more plausible scenario of this kind is discussed in Section 5. The set-up of the scenario is as follows. It is assumed that it is the second quarter of 2007 and real-time data is being used. It is further assumed that staff have assembled the benchmark projections for the next two years (from the third quarter of 2007 to the fourth quarter of 2009). The time period chosen for this illustrative scenario is such that the projection horizon also falls over a period that is now part of history. For simplicity, the benchmark projections for money and credit used in the scenarios presented in this section were obtained using solely a time-series approach. This means that the assessment of monetary developments at the time the scenario is assumed to be carried out (i.e. the second quarter of 2007) may differ somewhat from that shown in the charts below.

As mentioned already, the first stage of our methodology for producing scenarios uses observable data series – including inflation, GDP growth, M3 and credit growth – to estimate a time-series process for each of the unobservable shocks that are used in the estimation. Among the shocks, two originate directly from the monetary side of the system and control quite tightly the development of M3 and M1, namely the money demand shock and the bank liquidity supply shock. The former has an impact on agents' preferences for more liquid instruments (savings deposits and marketable securities) that are included in the definition of M3 but excluded from M1. Given the quantitative importance of M3-M1 as a component of aggregate M3, the money demand shock – via its influence on M3-M1 – is an important driver of M3 as a whole. The bank liquidity supply shock, on the other hand, captures the evolving preferences of banks with regard to supplying liabilities with different liquidity characteristics, and has a close association with short-term working capital loans and M1. In Chart 4, the arrow on the left portrays the chain reaction that a money demand shock sets in motion in the model, leading from an increase in households' demand for M3-M1 instruments to an expansion in M3 via the banks' balance sheet identity. The smaller arrow on the right represents the transmission of a shock to banks' provision of liquidity. This shock hits banks' ability to provide short-term credit to firms – in the form of shorter-term loans which are not used to finance the

Chart 4 An illustration of a shock-based scenario



Source: CMR model.
Note: The first monetary scenario is based on manipulating the two monetary shocks. The money demand shock has an impact on households' demand for M3-M1 instruments (left arrow). The bank liquidity supply shock affects banks' preference for supplying shorter-term (working capital) loans in the form of overnight deposits (right arrow).

build-up of capital – and, via the balance sheet identity, leads to the creation of overnight deposits and to stronger credit and M1 growth.[7]

The CMR model encodes a demand for various monetary aggregates with different liquidity characteristics: currency, bank reserves, overnight deposits, savings deposits. These monetary components are then aggregated and matched to historical M1 and M3 series in the estimation process. The structural determinants of the demand for M1 and M3 in the model – consumption, income, the short-term interest rate and the price level – and the structural coefficients that link the determinants to M1 and M3 in the demand specifications, such as the liquidity preferences coefficient, are stable by construction. So, any prolonged spell of instability in the empirical association between M1 or M3, on the one hand, or income, inflation and the short-term interest rate, on the other, can be reproduced by the model through a string of shocks to the model's demand for M1 or M3 with appropriate time-series properties. If, over certain periods, M1 or M3 data diverge from the path predicted by the model for structural money demand, the stochastic residuals to the model's demand for M1 or M3 as generated by the estimation over those periods are likely to display "small sample" statistical patterns that would not necessarily coincide with the properties that they are supposed to display over the whole sample (or asymptotically).

[7] For a more complete description of the mechanics of the economic shocks in the model, see Christiano et al. (2010).

Indeed, one of the two monetary shocks discussed in this section, namely the money demand shock, is instrumental in replicating two salient features of the euro area monetary landscape over the last quarter of a century: the seemingly constant and smooth downward evolution of M3 velocity up until the early 2000s, and the observationally abrupt acceleration in its decline thereafter.

Chart 5 plots the time series of the money demand shock up to 2007 as estimated in real time. The equation below documents the first-order autoregressive representation that is given to that shock, and to almost all other shocks used in the estimation[8]:

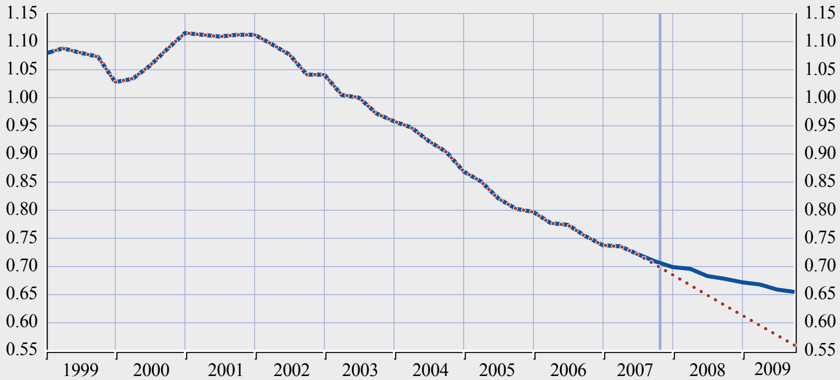
$$\xi_t^m = \rho\, \xi_{t-1}^m + \varepsilon_t^m$$

where ξ_t^m is the shock to money demand at time t, the time process of which is shown in Chart 5, and ε_t^m is the time-t (i.i.d.) innovation to the shock process. As mentioned already, for the great majority of the shocks estimated by the CMR model, the estimated innovations turn out to be white noise. However, for the two monetary shocks, and in particular the money demand shock, these innovations still contain residual correlation over the most recent period. The residual correlation motivates the construction of the scenario as this can be exploited over the projection horizon. Charts 5 and 6 give rise to two primary observations.

8 All the shocks are assumed to follow a first-order autoregressive representation, with the exception of the monetary policy shock, which is assumed to be white noise, and the financial shock, which has an "expectational" component.

Chart 5 The money demand shock

(estimated and fitted trend)



Source: ECB computations.

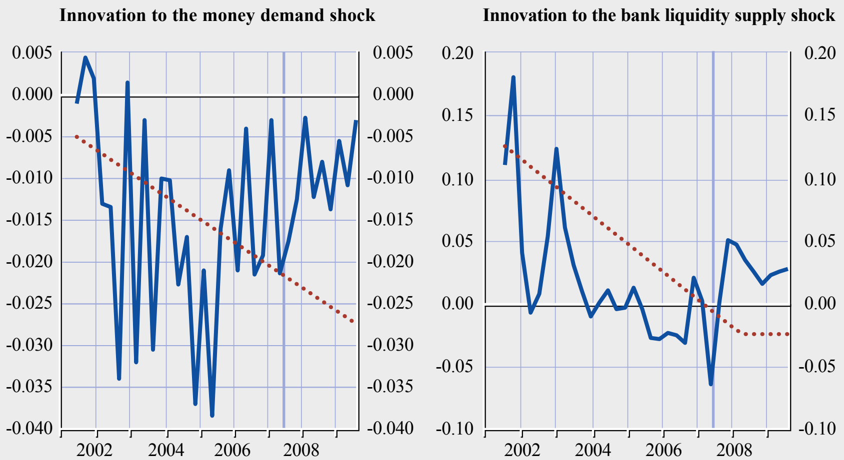
Notes: The blue solid line shows the CMR model's estimation of a money demand shock over the period prior to the third quarter of 2007, and over the projection horizon (from the third quarter of 2007 to the fourth quarter of 2009), during which time the model is forced to match the projections. The red dotted line shows the money demand shock resulting from a forward projection of a linear trend fitted to the estimated innovations to the money demand shock between the third quarter of 2001 and the first quarter of 2007, appropriately rescaled. The vertical bar indicates the last historical data observation (for the second quarter of 2007) considered in the analysis: data to the right of the vertical bar correspond to quarters where the model is forced to match benchmark projections.

The first is that the money demand shock follows a clear downward trend over the last historical portion of the sample, i.e. until the first half of 2007 (observations to the left of the vertical bar). This trend in the shock process – added to the picture and visible as the red straight line over the projection period – reveals that in order for the model to match the continuous decline in M3 velocity in the data, the demand for money in the model needs to be continuously shocked in the direction of increasing the attractiveness to money holders of instruments included in M3. This is accomplished in the model estimation by a string of fitted innovations to the money demand shock, ε_t^m, that are persistently negative. These innovations are shown in Chart 6 below (first panel).[9]

The second observation, visible in Chart 6, is that the sequence of innovations to the money demand shocks generated by the model when it is forced to match the benchmark projections for the period from the third quarter of 2007 to the fourth

9 The problem associated with the residual autocorrelation, which is present in the innovations to the monetary shocks, and in particular the money demand shock, could be tackled in two ways. The model could be respecified by refining the modelling of money-holding decisions. The second and less favourable option would be to incorporate a stochastic trend for velocity or to allow for more flexible shock processes.

Chart 6 Shock-based scenario: extrapolating past patterns of innovations to the money demand and bank liquidity supply shocks



Source: ECB computations.

Notes: The blue solid lines in the two panels show the CMR-estimated innovations to the money demand and bank liquidity supply shocks, respectively, over the period between the third quarter of 2001 and the fourth quarter of 2009. In the first panel, the red dotted line represents the path that the innovations would follow if they lay on a linear trend fitted to the estimated innovations (between the third quarter of 2001 and the first quarter of 2007), appropriately rescaled and extended beyond the third quarter of 2007. In the second panel, the red dotted line represents values that the innovations would take on if they lay on a linear trend fitted to the estimated innovations (between the third quarter of 2001 and the first quarter of 2007), and appropriately rescaled so that the benchmark innovation and the one on the trend are the same in the second quarter of 2007. The same path is extended beyond the second quarter of 2007 up to the second quarter of 2008 and subsequently truncated at its value for the second quarter of 2008.

quarter of 2009 marks a departure from what would be considered to be an "average experience", i.e. extrapolating into the future, beyond historical data, the behaviour of the money demand shock observed in the most recent past.

A comparison of the solid line – which depicts the shocks that the model generates when forced to match the forecasts – and the dotted line – which, as mentioned, simply represents a forward extension of recent history – suggests that the inclusion of monetary forecasts might force monetary shocks onto projection paths that, extrapolating from the recent past, can be considered atypical. This is confirmed by looking at the implied path of estimated innovations to both the money demand shock and the bank liquidity supply shock in the two panels of Chart 6. Both sets of innovations to the two monetary shocks show negative values in the last portion of the historical sample. However, over the projection period beginning in the third quarter of 2007, the fitted innovations display a clear inversion. This reflects the standard tendency of projections to out-of-sample mean reversion. This moderation, in turn, is responsible for the tendency of the time path of the monetary innovations shown in Chart 6 to normalise to the right of the vertical bar.

In order to construct the scenario, the model is simulated under three alternative counterfactual assumptions. The first assumption is that all shocks except for the two structural monetary shocks, i.e. to money demand and to banks' provision of liquidity, are to follow the path identified by the CMR model in order to match benchmark projections over the period from the third quarter of 2007 to the fourth quarter of 2009. The second is that, over the projection period, the innovations to the money demand shock are to decline at a pace that reflects the rate at which the innovations would decline along the interpolated linear trend displayed in the first panel of Chart 6. The innovations to the bank liquidity supply shock are to follow the solid line in the second panel of Chart 6 until the second quarter of 2008 and subsequently stabilise at the value reached in that quarter.[10] The third assumption is that monetary policy unfolds endogenously and adjusts to the changing state of the economy in line with the systematic policy reaction function embedded in the model.

Chart 7 documents the outcome of this counterfactual simulation. Relative to the benchmark, the alternative monetary scenario entails a gradual but persistent edging-up of GDP-price inflation, more moderate growth of real GDP and a marked acceleration in the growth rate of M1. After a sizeable but temporary flare-up in the remainder of 2007 to rates above those seen in the recent past, the growth rate of M3 is projected to temporarily decelerate before stabilising around levels consistent with the reference value.

What are the channels at work? The continuation into the future of the money demand innovations that, prior to the second quarter of 2007 – according to the CMR model – helped explain the observed behaviour of M3 velocity, was expected to continue boosting the yearly growth rates of M3 for the rest of 2007.

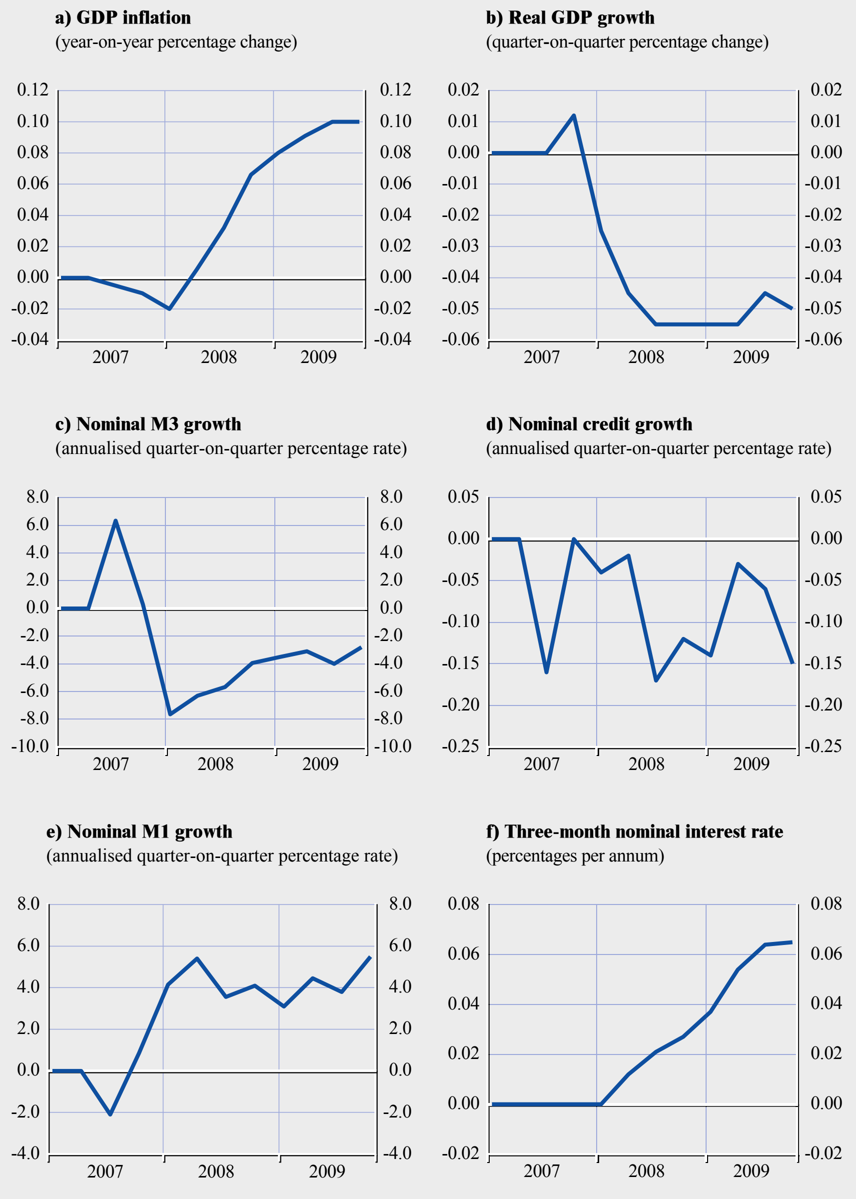
10 As the chart shows, such a process can be consistent with almost unchanged quantities for total bank-intermediated credit.

Starting in early 2008, however, the impulse coming from the money demand shock would be outweighed by the countervailing impact of the bank liquidity supply shock. This shock controls banks' shifting preferences for supplying different types of monetary liabilities to households and firms. A negative innovation to this parameter is associated with a shift in banks' liabilities away from longer-term deposits and money-market securities – included in M3, but not in M1 – towards shorter-term deposits that are closer substitutes for currency. As such a shift has a close counterpart (on the asset side of the model's banks) in loans that are not related to physical capital formation, the model interprets the drift in the banking shock as a tendency of banks in the euro area to change the composition – if not the total scale, as evident from Chart 7 – of bank credit towards forms of funding that are more accessible to a broader public of potential borrowers.[11] A negative trend in the banking shocks was the model's way to capture the then ongoing re-intermediation of banks in the euro area, i.e. an expansion of the share of bank-intermediated credit in the amount of credit accruing to less sophisticated categories of retail borrowers, such as mortgagers. As this re-intermediation process was unlikely to proceed in the future at the same pace that – according to the model – it followed in the preceding quarters, the scenario is actually built on the assumption that the innovations to the banking technology shock would have remained negative but would stabilise in absolute terms in the course of 2008 (second panel of Chart 6).

In the model, negative innovations to the banking technology shock represent a two-fold source of inflationary pressures. A first-order boost for inflation stems directly from the higher potential for liquidity creation through these retail forms of funding relative to alternatives. Retail lending is more strictly associated with M1 creation, as such loans are generally made available by the depository institution that extends them to borrowers in the form of checkable deposits. This mechanism provides holders with a monetary asset that has a powerful transactions motive, which in turn translates into a tighter connection with spending. But there is also an indirect, second-order, knock-on effect on inflation. The shift to retail banking is costly in the model, as it goes hand in hand with a diversion of funds available for loans from wholesale forms of finance – where the overall managing costs for banks are small – to more labour and capital-intensive forms of retail lending. The model translates the process of bank re-intermediation that has been visible since at least 2005 – when the fitted innovations to the bank liquidity supply shock became persistently negative – into a trend of continued growth in banks' operating costs. According to the model, such costs are eventually transferred to firms, which either pass them on to their customers in the form of higher prices, or cut back on the scale of production. This explains the combination of moderately higher inflation and lower growth that is visible in the counterfactual scenario shown in Chart 7.

11 The rate at which the counterfactual innovations to the bank liquidity supply shock along the dotted line of the second panel of Chart 6 decline up to the second quarter of 2008 reflects the rate at which the innovations would decline along a linear trend fitted from the third quarter of 2001 to the first quarter of 2007. The reason for constructing this counterfactual on the assumption that the decline in the innovations to the banking technology shock stabilises at the value reached by the second quarter of 2008 is explained below.

Chart 7 Results of the shock-based scenario



Source: ECB computations.
Notes: The lines represent the difference between the scenario outcome and the benchmark projections. The scenario assumes that the money demand and bank liquidity supply shocks evolve according to a path of time decline that reflects that implicit in a trend fitted over the period from the third quarter of 2001 to the first quarter of 2007 and that they stabilise at the value reached along that path in the second quarter of 2008 respectively.

4.1.2 MONETARY SCENARIOS BASED ON OBSERVABLES: SIMULATING HIGH MONEY AND CREDIT GROWTH

The previous section constructed a monetary scenario by altering the profile of the underlying, *unobserved* monetary shocks over the projection period. However, sensitivity analysis around benchmark projections can also be carried out by postulating a different path for monetary *observables*, and conditioning the projection of the model on this alternative path. This latter avenue is explored in this section, focusing on M3 and credit growth.

As in the previous section, this section provides an illustration of how the "observables-based scenario" can be implemented in practice. The aim is mainly to provide a concrete example, rather than focusing on the plausibility of its calibration. A more plausible scenario of this kind is discussed in Section 5. The set-up of the scenario is as follows. It is assumed that it is the second quarter of 2007 and real-time data is being used. As in the previous section, it is assumed that staff have assembled the benchmark projections for the next two years (from the third quarter of 2007 to the fourth quarter of 2009), and the benchmark projections for money and credit used in the scenarios are based on a purely time-series approach.

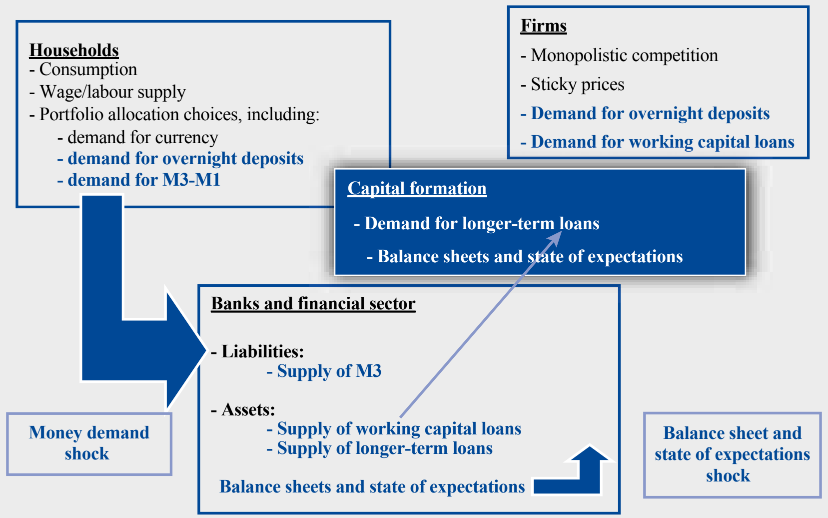
A strong M3 and strong credit scenario is constructed to investigate what would happen if – unlike that which is implied in the benchmark projections – M3 and credit growth were to stabilise not too far from the elevated figures recorded in the few quarters preceding the projection horizon. Chart 8 illustrates how this alternative scenario is engineered through an appropriate manipulation of two economic shocks in the model. The first shock (left arrow) is the same "money demand shock" as that activated in the scenario discussed in Section 4.1.1. The other shock (right arrow) is rooted in the financial accelerator structure of the model. In the CMR model, banks extend credit to borrowers who are responsible for the build-up of physical capital (the capital formation function in Chart 8). Owing to information frictions in the credit market, the availability of and the conditions applied to longer-maturity credit are a function of the borrowing firms' balance sheet conditions and of the state of expectations regarding prospective profit and stock market gains. While both the current and the expected state of borrowers' conditions are determined endogenously in the model – i.e. they adjust to all the shocks that hit the economy – an exogenous force, here referred to as a "financial shock", can proxy for independent shifts in credit market conditions.

This shock – represented by the right arrow in Chart 8 – has a more complex time-series representation than the other shocks as it has an "expectational" component characterised by a signal received by agents in the model.[12]

In summary, an appropriate manipulation of money demand and financial shocks can deliver a scenario of consistently high M3 growth and growth in loans to the private sector, as depicted in Chart 9 by the red dotted lines (while the blue solid lines represent the benchmark projections replicated by the CMR model). Specifically,

12 For a detailed description of the properties of "signals", see Christiano et al. (2010).

Chart 8 Observables-based scenario: engineering high M3 and credit growth in the CMR model

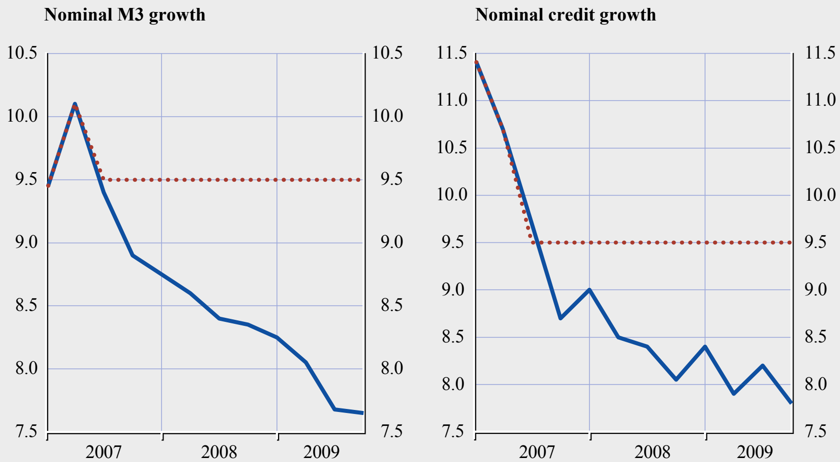


Source: CMR model.

Notes: The scenario is based on manipulating the two shocks in order to engineer a constant rate of growth for M3 and credit. The money demand shock has an impact on households' demand for M3-M1 instruments (left arrow) and results in high M3 growth. The impact of the shock on balance sheets and stock market expectations results in a shift of negotiating power between lenders and borrowers in favour of the latter (bottom arrow). This causes a rise in credit and stock market growth.

Chart 9 Simulating a scenario of high M3 and credit growth: assumptions

(annualised quarter-on-quarter growth rate)



Source: ECB computations.

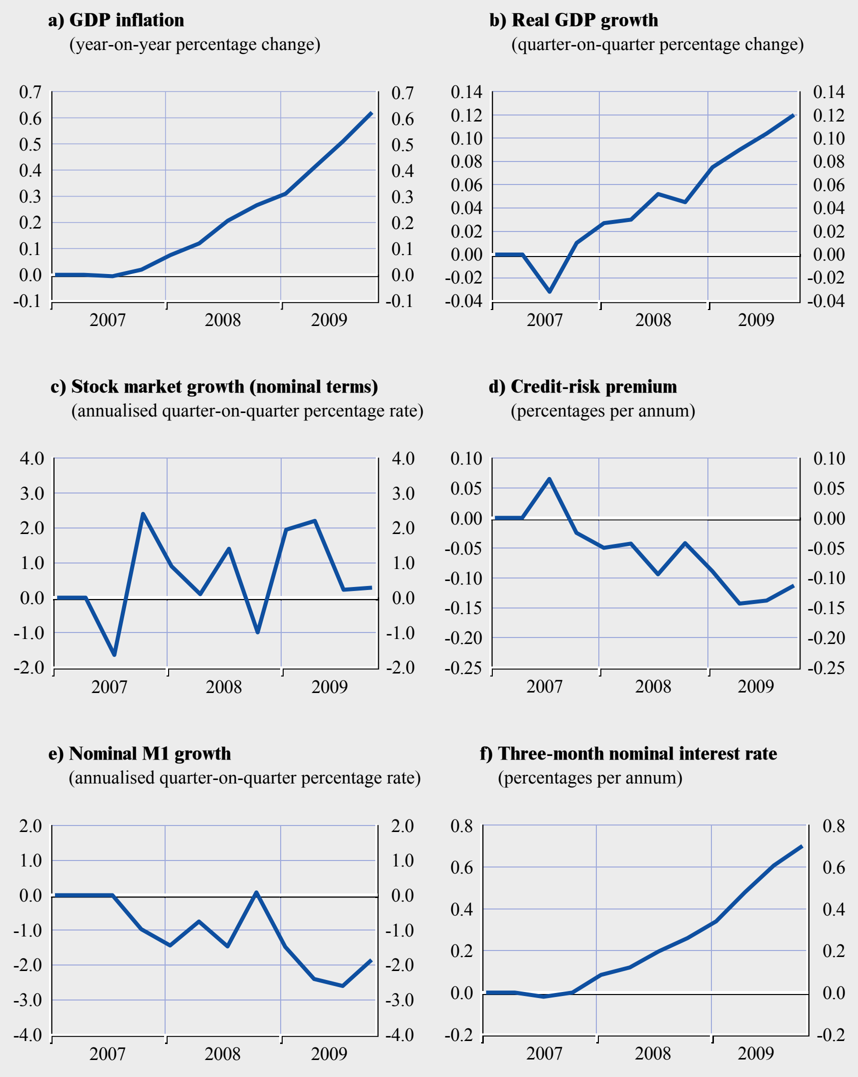
Notes: The solid blue lines show the benchmark projection for M3 growth (left) and credit growth (right), while the red dotted lines represent the alternative high money/high credit growth scenario, in which both rates of growth are simulated to be constant at 9.5%. Benchmark projections were obtained using solely a time-series approach.

in this scenario, both the growth rate of nominal M3 and the growth rate of loans to the private sector are stabilised at 9.5%, not too far from the average growth rate recorded in 2006 and the first half of 2007.[13]

Chart 10 shows the outcome of the simulation for GDP price inflation, GDP growth, the nominal three-month interest rate, the credit-risk premium and the

13 One way to evaluate the plausibility of the scenario is to look at the path followed by the shock innovations in order to meet the path assumed for the conditioning variables, i.e. money and credit.

Chart 10 Simulating a scenario of high M3/high credit growth: results



Source: ECB computations.
Note: The lines represent the difference between the scenario outcome and the benchmark projections.

quarterly rate of the real stock market index growth. The transmission from accelerated money and credit growth – relative to the assumptions embodied in the benchmark – runs as follows. Higher preference for liquidity increases the liquidity overhang that is present in the model economy. Such a liquidity overhang spills over to the real side of the economy owing mainly to the link existing in the model between portfolio decisions and consumption decisions. Technically, this arises from households' preferences for stabilising consumption velocity in the model, given the state of expectations regarding future inflation and output growth. There is also a further channel at work on account of the fact that changes in the household portfolio alter the composition of funds available to banks, which, in the model, are prevented from being freely allocated to different types of loans.

At the same time, in the alternative scenario, the creation of credit is strongly encouraged by a wave of optimism regarding the current and prospective conditions in the credit market. This leads to a decline in the credit-risk premium and generates a pattern of stock market revaluation relative to the benchmark (see Chart 10). The stock market boom fuels price pressures, which cannot be completely offset over the relatively short horizon under consideration by the interest rate hike generated endogenously by the model. The model quantifies the inflationary risks associated with the scenario of high money/high credit growth as around half of a percentage point – in year-on-year terms – by the end of the projection horizon.

5 SCENARIO ANALYSIS: "REAL-TIME" APPLICATION

This section builds on the methodology and intuition provided in the previous section and presents some scenarios that are closer to the ones actually implemented by staff in real time. The scenarios discussed in this section take the perspective of the third quarter of 2007. At the time, the financial turmoil had just erupted, manifesting itself in August 2007 through distress in money markets. Initially, there was minimal spillover to other segments. However, it was not clear whether such distress would be reabsorbed quickly or would initiate a cascade effect. There was also the question of whether it would affect only the financial markets, or if it would compromise the soundness of the banking system. The latter is reminiscent of past banking crises (for example in the United States in the late 1980s, in Nordic countries in the early 1990s, and in Japan in the 1990s). It was still too early to see the macroeconomic impact of the financial turbulence in hard data or even in surveys. This had two implications. First, the baseline projections, based on the most likely outcome and rooted in models with no role for funding or lending channels, encountered problems in taking on board the potential effects of the turmoil. Second, the assessment of the potential macroeconomic implications of the turbulence had to be addressed via scenarios, i.e. "risks" around the baseline projections, and based on macro models with funding and lending channels.

How would the turmoil evolve? Would it be more similar to the 1997-98 turbulence caused by the Asian and Russian crises or to the stock market crash of 2000? Or would it be a full-blown banking crisis? These were the pressing questions at the time. The CMR model was well suited to simulate such scenarios, as it accounts for the balance sheet and bank lending channels, which are key to the transmission from the banking and financial side to the macroeconomy.

This section documents four scenarios. The first and last – in line with the monetary scenario described in Section 4.1.2 – are borne out of a simulation of alternative paths for monetary and financial variables. The other two scenarios – more in line with the exercise described in Section 4.1.1 – are constructed on the basis of a manipulation of the underlying shocks.

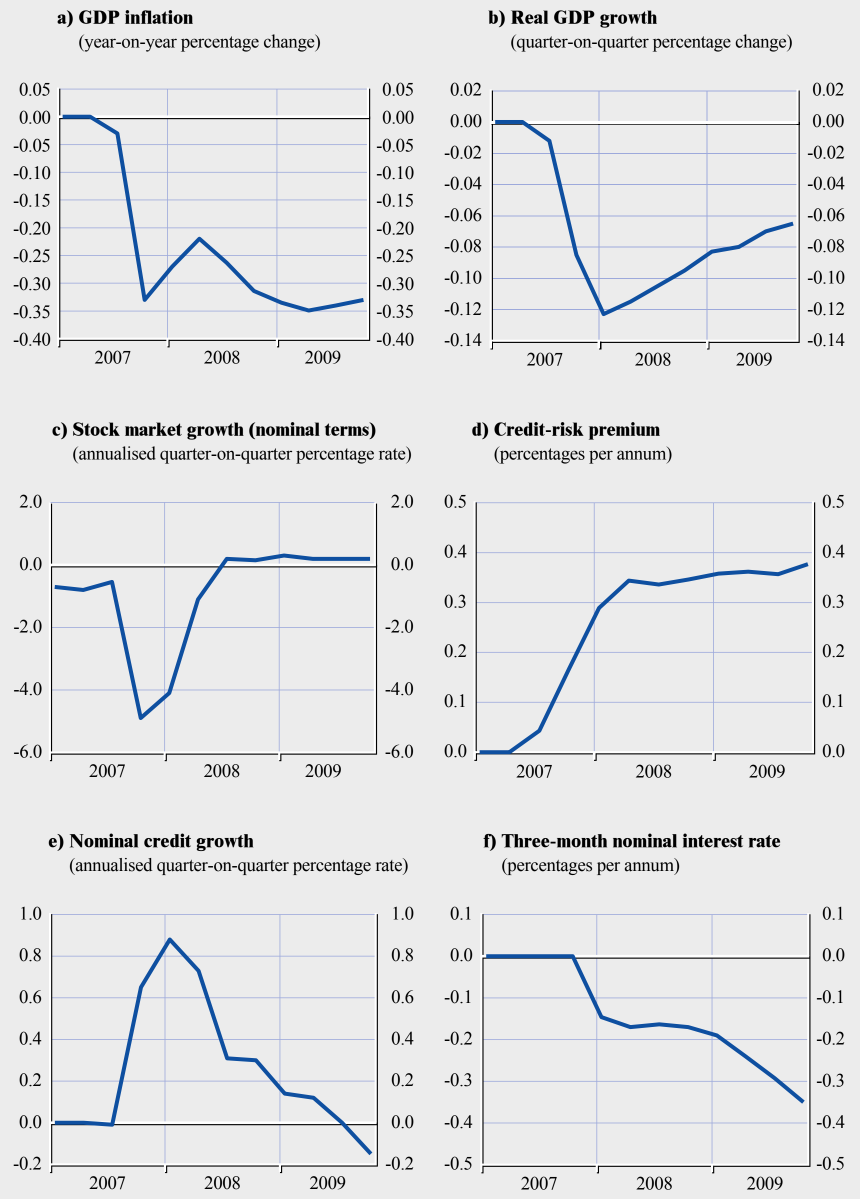
5.1 SIMULATING A SCENARIO OF MILD FINANCIAL MARKET TURMOIL

The scenario constructed in this section tries to match two features that are often associated with market turbulence. The first is a significant appreciation of both equity and credit risk. The scenario assumes that, starting in the third quarter of 2007, the stock market will undergo an overall 10% decline beyond that already incorporated in the benchmark projections. In addition, the scenario assumes a permanent increase in the credit-risk premium of some 40 basis points over and above the correction already incorporated in the benchmark.[14] The second feature is strong M3 growth. This reflects portfolio shifts and the search for liquid assets that generally occur as a result of panic on the markets. In particular, the scenario assumes that the growth rate of M3 remains high, matching the average M3 growth rate in 2006 (8.7%). In this scenario, monetary policy is assumed to evolve endogenously in response to the changing state of the economy. Technically, this scenario is produced by altering the profile of two shocks: financial and money demand shocks.

As the transmission mechanism of the shocks involved in this scenario has already been discussed in the previous sections, this section focuses on the outcome of this specific scenario. Chart 11 shows the difference between the counterfactual and the benchmark paths of GDP inflation, GDP growth, the evolution of the stock market index, credit growth and the credit risk premium. The cumulative drop in the stock market of 10% (over three quarters) beyond the drop already included in the benchmark is displayed in the third panel of Chart 11. Even though the growth rate of the stock market (shown in Chart 11) is back to the benchmark in the second quarter of 2008, its level remains below the benchmark. The credit risk premium that needs to be paid in order to obtain funds to finance the accumulation of physical capital in the model is assumed to be up by some 40 basis points. The downward effect on real economic activity is quantified as a decline in the growth rate of GDP of 0.3% on average (on an annual basis). The effect on inflation is rather contained, with an average drop of 0.2% (on an annual level). Nominal credit growth rises before declining toward the benchmark as the financial shock dissipates. The reason is that, in the model,

14 In its estimation, the model includes a measure of the cost of borrowing, calculated by taking an average of the spreads paid on a number of instruments used for borrowing credit, including corporate bonds and bank loans.

Chart 11 Simulating a scenario of mild financial market turmoil



Source: ECB computations.
Note: The lines represent the difference between the scenario outcome and the benchmark projections.

investment in physical capital has a long gestation lag and it is costly to suddenly stop an investment plan that is under way, especially when the future prospects of corporate profits remain favourable (as in the scenario considered here). The decline in the stock market simulated in the scenario leads to a shift from raising funds on the stock market to raising funds through bank loans, even if the terms of the contract loans have deteriorated.

An inspection of the time profile of the shocks that have been altered in order to generate the scenario shows that the magnitude of the fluctuations in the shocks did not damage the reliability of the model.

5.2 FINANCIAL SCENARIOS BASED ON SIMULATING HISTORICAL PRECEDENTS

Alternative scenarios considered at the time of the financial market turbulence attempted to consider what would happen if history were to repeat itself. In other words, they investigated the possibility of the sequence of financial shocks suffered by the euro area economy in relevant historical precedents resurfacing in the present situation in exactly the same form.

This section considers two episodes that occurred in the previous decade and looks at the ensuing financial shocks, since these events are natural candidates when trying to understand a financial turmoil.

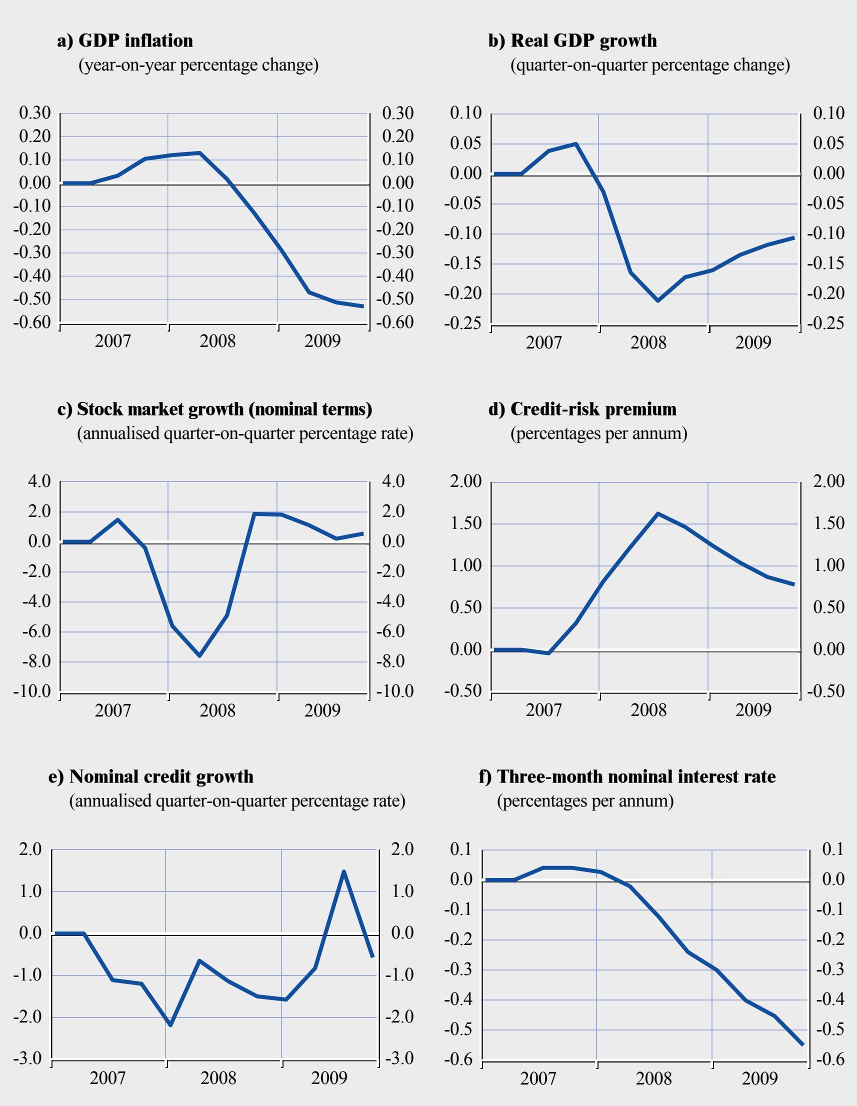
The first precedent is the stock market correction that took place between the second quarter of 2000 and the second quarter of 2001, excluding the further collapse triggered by the terrorist attack on 11 September 2001 and the subsequent prolonged phase of severe stock market decline in 2002. More specifically, the simulation is based on a situation in which the euro area suffers shocks in the five quarters between the third quarter of 2007 and the third quarter of 2008 by precisely the same string of innovations to the two shocks mentioned above which the model estimates for the five quarters between the second quarter of 2000 and the second quarter of 2001. Between the fourth quarter of 2008 and the end of the simulation period (i.e. the fourth quarter of 2009), the model is subject to the same sequence of innovations as in the benchmark estimation for those quarters. The purpose of this analysis is the simulation of a reversal of past trends in equity and credit markets on the basis of the underlying shocks.

The second precedent is the severe but temporary resurfacing of financial risk that occurred in August and September 1998, when the Russian default and devaluation exacerbated the ongoing Asian financial crisis and, in a matter of weeks, led to the collapse of the hedge fund Long-Term Capital Management. For the period from the third quarter of 2007 to the first quarter of 2008, the model is fed with the innovations to the same two shocks already mentioned which the model estimates for the period from the third quarter of 1998 to the first quarter of 1999. After the first quarter of 2008, the innovations are again equal to those estimated for those quarters in the benchmark. This provides an example of a very benign situation in which the early strong correction in financial prices and risks is promptly reversed, with a final outcome that more than completely offsets the original shocks. Unlike the previous scenarios, this simulates an event that – while disconcerting at the time it happened – turned out, over a longer-run perspective, to be something closer to a hiccup than to a major financial crisis. It did not dent the underlying economic growth, nor did it leave a mark in equity valuations or credit market behaviour.

In both exercises monetary policy is assumed to evolve according to the estimated reaction function to the alternative state of the economy. This is grounded on the notion that, when replicating a historical scenario, as is the case here, the behaviour of the monetary authority should also be specified in a way that is closest to its (average) reaction pattern, as exemplified in the estimated reaction function.

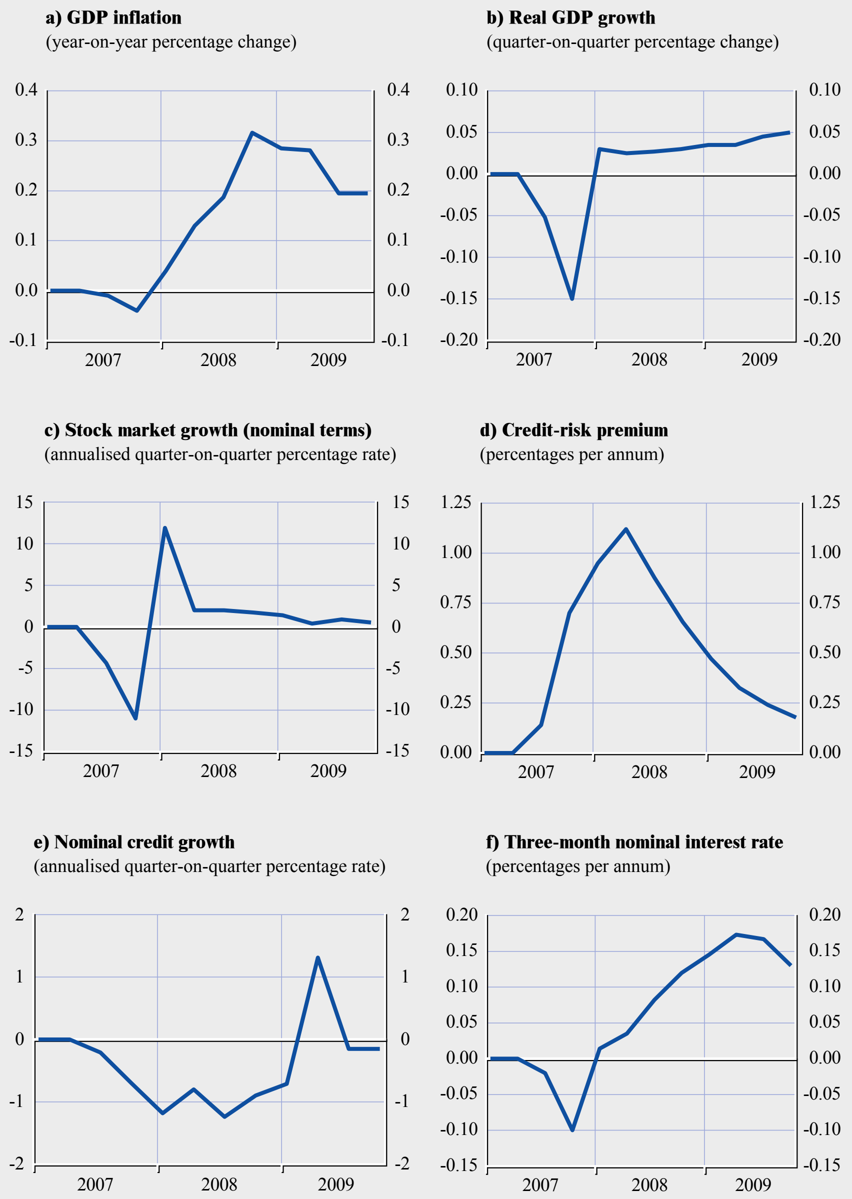
The results are reported in Charts 12 and 13. Chart 12 shows the outcome of the first exercise. Here, the relatively more protracted and severe destruction of stock market value, in conjunction with expectations of further stock market

Chart 12 Replicating the financial shocks that took place between the second quarter of 2000 and the second quarter of 2001



Source: ECB computations.
Note: The lines represent the difference between the scenario outcome and the benchmark projections.

Chart 13 Replicating the financial shocks that took place between the third quarter of 1998 and the first quarter of 1999



Source: ECB computations.
Note: The lines represent the difference between the scenario outcome and the benchmark projections.

losses looking forward and the sharp re-appreciation of the investment risk that the model estimates to have occurred after the second quarter of 2000, determines an appreciable and steady decline in inflation. Credit growth also moderates as the anticipation of further losses in equity value and the concomitant widening of the credit risk premium – which tightens the real credit conditions that apply to corporate borrowing despite the endogenous easing of policy – discourages the uptake of loans. Annual real GDP growth declines by around 0.4/0.6 percentage points relative to the benchmark in 2008 and 2009.

The 1998-99 scenario is depicted in Chart 13. Here, after initially dropping beyond the negative levels incorporated in the benchmark projections, the stock market experiences a strong rebound boosted by the sharp turn-around in confidence estimated by the model to have occurred – after the initial two quarters of the 1998 episode – in the first quarter of 1999. As a consequence, after an early softening of real GDP growth in the third and fourth quarter of 2007, growth resumes and stays close to its benchmark levels over the latter part of the projection horizon, while inflation also recovers and eventually overshoots its benchmark levels, propelled by the strong rebound in the stock markets – which, by the end of the projections, completely offsets the 2007 losses – and by a gradual decline in the credit risk premium. Tighter credit conditions persist for two quarters until the financial market uncertainty dissipates in the course of the third quarter. At that point, risk spreads and market volatility promptly retreat from crisis levels with a moderate impact on consumption and investment and thus economic growth. The latter drop in spreads more than offsets the impact on tight credit conditions arising from the endogenous firming of policy. Credit growth also recovers quickly and stabilises at levels above the benchmark.

Several other scenarios of this type were carried out in real time in an attempt to assess the economic fallout and the implications for the risks to price stability that could materialise were the financial turmoil to end up in a full-blown banking crisis, such as those that unfolded in the worst banking crises of the last century. These scenarios became especially relevant after March 2008 and even more so after September 2008. They helped to cross-check the baseline projections with information obtained from monetary analysis, which in turn helped with the formulation of contingency plans.

5.3 MONEY MULTIPLIER: SCENARIO-BASED ANALYSIS

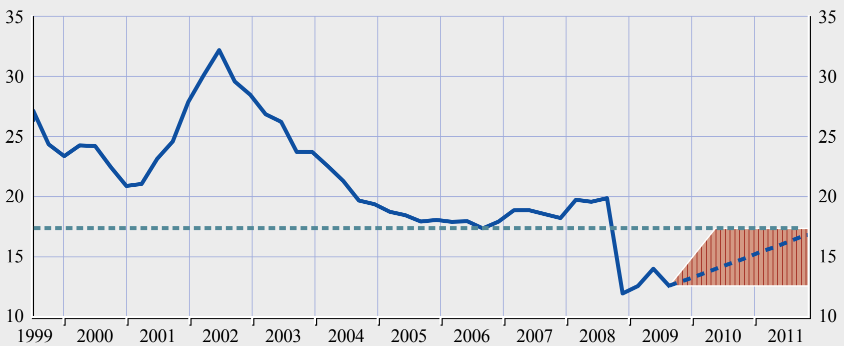
The extraordinary provision of liquidity by the Eurosystem following the intensification of the financial crisis in autumn 2008 led to a sudden reduction of the money multiplier, i.e. the ratio of M3 created by banks over the liquidity that they obtain from central bank refinancing operations (one component of high-powered money). The concomitant decline of M3 growth further contributed to a reduction of the multiplier. The size of the multiplier is often treated by observers as exogenous, driven by a mechanistic link between the size of high-powered money and endogenous money. This view has led some commentators to argue that, when banks realise that liquidity is widely accessible and in fact they have more liquidity for each unit of M3 created than they strictly need, "excess" liquidity held in the form of idle central bank balances will be mechanically turned into "productive" uses with an associated rise in M3 and credit, and thus inflationary pressure. First, this mechanistic link ignores the fact that the money multiplier is the result of agents' decisions, both on the side of supply of and demand for items in commercial banks' balance sheet, taking into account overall economic and financial conditions – mainly the prevailing degree of uncertainty.

For instance, the decision by banks to hold part of their assets in the form of idle balances with the central bank is the result of trading-off higher returns from alternative investments with the benefit of holding excess reserves that can be immediately mobilised in case of unexpected funding pressure. Second, the mechanistic view of the multiplier implicitly assumes that normalisation of the multiplier can occur only via a rise in M3 rather than through a withdrawal of liquidity by the central bank. This assumption is without foundation. The Eurosystem can drain liquidity at the desired speed at any moment. Third, the traditional view of the money multiplier does not allow in any case for a quantification of the possible risks to price stability associated with a normalisation of the multiplier. A macro model is needed for making such a quantitative assessment.

Depending, on the one hand, on alternative assumptions about banks' desire for maintaining idle balances in the future, and on the speed of liquidity drainage by the central bank on the other hand, alternative scenarios can be constructed. Simulations based on the CMR model can be used to assess the risks to price stability associated with these scenarios. It should be noted that, in the model simulations, the scenarios are rooted in the decisions taken by economic agents rather than being based on mechanical links, as in the traditional theory of the money multiplier. Hence, given a benchmark projection for M3, a legitimate question is that of what would happen if uncertainty were to decline and banks realised that liquidity had been abundant and expected it to remain abundant, and they were thus to bring the multiplier back to more normal levels faster than expected in the benchmark, in order to boost their profits.

Chart 14 displays the stylised case in which, as of the fourth quarter of 2009, the money multiplier (proxied by M3 over Eurosystem liquidity) is assumed to revert back to its minimum value observed since 1999 (see horizontal dashed line in the chart) over the following two years. There are many alternative paths that

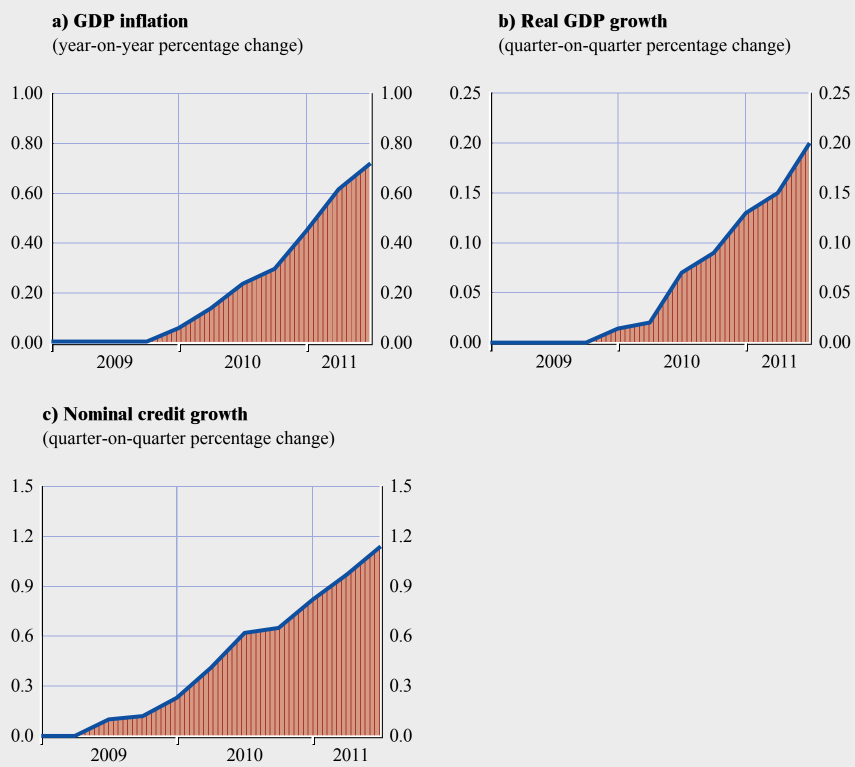
Chart 14 Money multiplier: alternative paths towards normalisation



Source: ECB calculations.

Note: The blue solid line represents the ratio of M3 over liquidity obtained by banks from the Eurosystem's monetary policy operations. As of the fourth quarter of 2009, the shaded area brackets possible alternative paths for the money multiplier. The dashed line is based on the assumption that the multiplier returns to its lowest level observed in sample (marked by the horizontal dashed line) by the end of 2011.

Chart 15 Scenario results: normalisation of the money multiplier via a rise in M3



Source: ECB computations.
Note: The shaded area represents the difference between the scenario outcomes and the benchmark projections.

feature a different speed of adjustment, and these are bracketed in the chart by the edge of the shaded area, which also includes the extreme case of no adjustment at all. For any given path, two polar cases are that: (i) the ratio increases because M3 expands and the outstanding stock of central bank refinancing is left constant; and (ii) at the other extreme, the ratio rises because the extent to which banks make recourse to central bank refinancing declines, and M3 growth remains at the benchmark. In this latter case, banks would simply run down the excess reserves they hold with the central bank.

Chart 15 shows the results based on the assumption that the money multiplier follows the dashed line in Chart 14. In the event of polar case (ii) described above, the increase in the multiplier is brought about by banks voluntarily cutting down their excess borrowing from the central bank. This will have no discernible impact on the economy, under the assumption that the policy rate remains at the benchmark. This approximates a situation of full normalisation of the financial sector with an associated disappearance of banks' funding uncertainty – in practice the economy is back to its pre-crisis state. In terms of Chart 15, which displays the difference between the scenario outcome and the benchmark, this means zero impact.

In case of polar case (i) described above, banks stabilise their borrowing from the central bank at prevailing high levels and gradually raise the supply of deposits and – as a counterpart to that – credit to the economy. This leads to upside risks to inflation and GDP growth on account of the significant increase in M3 and credit. In Chart 15, this corresponds to the upper edge of the shaded area. Outcomes that fall somewhere between these two polar cases lie within the shaded area shown in Chart 15.

6 CONCLUDING REMARKS

This chapter has documented how structural models incorporating liquidity and credit can be used, in real time, to provide useful information for cross-checking baseline projections by means of scenarios, and to provide some interpretation of recent developments by means of structural decompositions. The chapter has focused on some specific applications. Other applications relevant for monetary analysis, such as the structural interpretation of the loans to money ratio, or disentangling demand and supply credit shocks, have not been discussed here, but have revealed interesting insights in real time.

Overall, the results reviewed in the chapter provide encouragement and support for the ongoing efforts to further strengthen the avenue of research based on structural models incorporating money. At the same time, structural modelling remains just one approach within a much more comprehensive monetary analysis.

REFERENCES

Adrian, T. and Shin, H.-S. (2010), "Financial intermediaries and monetary economics", in Friedman, B. and Woodford, M. (eds.), *Handbook of Monetary Economics*, forthcoming.

Bernanke, B.S., Gertler, M. and Gilchrist, S. (1999), "The financial accelerator in a quantitative business cycle framework", in Taylor, J.B. and Woodford, M. (eds.), *Handbook of Macroeconomics*, Elsevier, Amsterdam, pp. 1341-1393.

Brunnermeier, M. (2009), "Deciphering the liquidity and credit crunch 2007-08", *Journal of Economic Perspectives*, 23(1), pp. 77-100.

Christiano, L.J., Motto, R. and Rostagno, M. (2003), "The Great Depression and the Friedman-Schwartz hypothesis", *Journal of Money, Credit and Banking*, 35(6), pp. 1119-1198.

Christiano, L.J., Eichenbaum, M. and Evans, C. (2005), "Nominal rigidities and the dynamic effects of a shock to monetary policy", *Journal of Political Economy*, Vol. 113, pp. 1-45.

Christiano, L.J., Motto, R. and Rostagno, M. (2007), "Shocks, structures or policies? The euro area and the US after 2001", *Journal of Economic Dynamics and Control*, 32(8), pp. 2476-2506.

Christiano, L.J., Motto, R. and Rostagno, M. (2010), “Financial factors in economic fluctuations”, *Working Paper Series*, No 1192, ECB.

Giannone D., Lenza, M. and Reichlin, L. (2010), “Money, credit, monetary policy and the business cycle in the euro area”, mimeo.

Gorton, G.B. (2009), “Information, liquidity and the (ongoing) panic of 2007”, *American Economic Review*, 99(2), pp. 567-572.

Reifschneider, D., Stockton, D. and Wilcox, D. (1997), “Econometric models and the monetary policy process,” *Carnegie-Rochester Conference Series on Public Policy*, 47(1) pp. 30-39.

Smets, F. and Wouters, R. (2003), “An estimated stochastic general equilibrium model of the euro area”, *Journal of the European Economic Association*, Vol. 1, pp. 1123-1175.

Smets, F. and Wouters, R. (2007), “Shocks and frictions in US business cycles: A Bayesian DSGE approach”, *American Economic Review*, 97(3), pp. 586-606.

Townsend, R. (1979), “Optimal contracts and competitive markets with costly state verification”, *Journal of Economic Theory*, Vol. 21, pp. 265-293.

ANNEX

THE ROLE OF FINANCIAL CONDITIONS FOR MONETARY POLICY

1 INTRODUCTION[15]

This annex complements the discussion in the main text with an analysis of the normative implications of the interaction between credit conditions and the macroeconomy. The analysis in this annex is based on the model described in De Fiore and Tristani (2009) (hereafter referred to as the "DT model"). The DT model, although much smaller, retains two important features of the CMR model discussed in the main text,[16] namely nominal rigidities in price setting and an explicit market for nominal credit. As illustrated below, the interaction between these two features has important policy implications. At the same time, the DT model embodies an even more highly-stylised banking sector. In spite of the obvious costs in terms of realism, the choice of a simpler model has the advantage of permitting the derivation of analytical results, which is intuitively appealing.

The discussion in this annex revolves around themes brought to the fore of the policy debate by the recent financial crisis. They relate to the role of financial markets in the conduct of monetary policy. How should monetary policy respond to shocks that originate in financial markets? From a more general perspective, how should a central bank react to financial developments in its pursuit of price stability? The annex illustrates some key channels through which financial market conditions and financial shocks have an effect on inflation and output developments. It then discusses whether and how financial market conditions ought to have a bearing on monetary policy decisions. A key question is related to whether financial shocks that increase credit spreads can generate a large enough inefficient economic reaction to warrant aggressive cuts in policy interest rates.

The annex is organised in three sections. The first provides a short description of the model environment and discusses the model's equilibrium conditions. Special attention is devoted to a comparison of these equilibrium conditions with those which would arise in a standard New Keynesian model where credit conditions have no effect on the macroeconomic equilibrium. The second section analyses the role of financial frictions in the optimal conduct of monetary policy. The main focus is on a comparison of the macroeconomic implications of a real and a financial shock under two alternative scenarios: the optimal policy, and a simple policy rule. A final section draws some concluding remarks.

15 This annex was prepared by Fiorella De Fiore and Oreste Tristani.
16 See Christiano et al. (2003, 2005, 2009).

2 THE ENVIRONMENT

The DT model can be characterised as the simplest possible extension of the basic New Keynesian set-up, in which the assumption of frictionless financial markets is relaxed. As a result, many simplifying assumptions of the basic New Keynesian model are retained, including the assumption of a fixed capital stock. Financial conditions become relevant because asymmetric information and default risk lead banks to optimally charge a lending rate above the risk-free rate when extending loans to the private sector. Loans are denominated in nominal terms, so that monetary policy affects firms' financing costs.

The economy is inhabited by a representative, infinitely-lived household and by a continuum of risk-neutral entrepreneurs. The household owns firms producing differentiated goods in the retail sector, while entrepreneurs own firms producing a homogeneous good in the wholesale sector.

Financial market imperfections take the form of asymmetric information about productivity between wholesale firms and banks. Wholesale firms' production is subject to idiosyncratic productivity shocks, which are known to the firm, but unobservable to banks. Since entrepreneurs dispose of an exogenously given amount of internal resources, they need to raise external funds to finance production (the wage bill). Owing to the idiosyncratic shock, they face a risk of default on their debt. In case of default on the debt, banks must pay a monitoring cost to verify that the firm was effectively hit by a negative idiosyncratic productivity shock. The optimal contractual arrangements between banks (lenders) and firms (borrowers) in this "costly state verification" environment are standard loans.

As in the standard New Keynesian model, the economy is also characterised by nominal rigidities. Firms in the retail sector buy the homogeneous good from wholesale firms in a competitive market and use it to produce differentiated goods. Because of this product differentiation, retail firms acquire some market power and become price makers. However, they are not free to change their price at will, because prices are subject to Calvo contracts. Retail goods are then purchased by households and entrepreneurs for their own consumption.

The log-linearised equilibrium conditions which characterise aggregate dynamics in the model with financial market imperfections nest those of the benchmark New Keynesian model with frictionless financial markets, but include two new features. The first is that firms' marginal costs become an increasing function of the credit spread and the nominal interest rate, as well as of the output gap as in the benchmark New Keynesian model. The second noticeable feature arising from financial market imperfections is that all exogenous disturbances, including technology shocks, generate a trade-off between output and inflation stabilisation.

More specifically, when utility is logarithmic in consumption and linear in leisure, the log-linearised equilibrium conditions of the model can be summarised by the following system of equations:[17]

$$\hat{\Delta}_t = \delta_1^{-1}\left[\left(1+\frac{Y}{c}\right)\tilde{Y}_t - \frac{e}{c}R_t + \xi_{2,t}\right]$$

$$\tilde{Y} = E_t\tilde{Y}_{t+1} - \left(1+\frac{e}{c}\right)\left(\hat{R}_t - E_t\pi_{t+1} - \hat{r}_t^e\right) - \left(\alpha_1 - \alpha_2\frac{e}{c}\right)\left(\hat{\Delta}_t - E_t\hat{\Delta}_{t+1}\right) + \frac{e}{c}\left(\hat{R}_t - E_t\hat{R}_{t+1}\right) + v_t$$

$$\pi_t = \bar{\kappa}\left[\tilde{Y}_t + \hat{R}_t + (\alpha_1+\alpha_2)\hat{\Delta}_t - \xi_{1,t}\right] + \beta E_t\pi_{t+1}$$

where $\alpha_1 > 0$, $\alpha_2 > 0$, $\bar{\kappa} > 0$ and δ_1 are constant coefficients that depend on the structural parameters of the model; c and e denote steady state household and entrepreneurial consumption respectively; $\tilde{Y}_t$ denotes the output gap, π_{t+1} the inflation rate, $\hat{R}_t$ the policy rate, $\hat{\Delta}$ the spread between the lending rate charged by banks to firms and the policy rate, and $\hat{r}_t^e$ the real interest rate which would prevail in the efficient equilibrium. The terms $\xi_{1,t}$, $\xi_{2,t}$ and υ_t are composite stochastic disturbances that combine the action of a technology shock, a_t, and of a financial shock (a shock to the monitoring costs incurred by banks, μ_t).

The first equation describes the equilibrium in the loan market. It shows that the spread between the loan rate and the policy rate depends on excess aggregate demand (in a positive manner under a standard model calibration). An increase in the demand for retail (and thus also for wholesale) goods implies an implicit tightening of the credit constraint, since the exogenously given amount of internal funds must now be used to finance a higher level of production. The increased default risk generates a larger spread. For the same reasons, the spread decreases with the nominal interest rate. An increase in the latter variable generates a reduction in the demand for final goods and thus in the demand for input of wholesale goods. For a given amount of internal funds, leverage and the risk of default fall, reducing the spread.

The second equation is a forward-looking IS curve describing the evolution of the output gap. This equation is similar to the standard IS curve that would arise in the standard New Keynesian model and which is given by:

$$\tilde{Y}_t = E_t\tilde{Y}_{t+1} - (\hat{R}_t - E_t\pi_{t+1} - \hat{r}_t^e)$$

As in the standard New Keynesian model, the output gap is negatively related to the real interest rate, since an increase in the latter induces households to postpone their consumption. Again as in the standard New Keynesian model, the output gap also increases when positive output gaps are expected in the

[17] Variables with a hat represent the log-deviation of the variable from its steady state value and variables with a tilde denote the log-deviation of the variable from the value that it would take in the efficient equilibrium. The latter is an equilibrium where banks can verify firms' productivity without incurring any costs (which corresponds to the case of a frictionless financial market) and prices are flexible (see De Fiore and Tristani (2009) for further details).

future. The presence of financial frictions, however, implies that the output gap also depends on the expected change in the nominal interest rate and the credit spread, and on the composite shock, υ_t. A higher spread is contractionary (if it is not expected to fall in the future) because it induces an increase in bankruptcy rates and a fall in entrepreneurial consumption. A higher (temporary) nominal interest rate tends instead to have a small expansionary effect – over and above the standard contractionary real interest rate effect on households' consumption – because it is passed on to prices and generates higher entrepreneurial profits and consumption.

The third equation represents an extended Phillips curve. Once again, it is similar to the standard curve which arises in the standard New Keynesian model:

$$\pi_t = \bar{\kappa}\widetilde{Y}_t + \beta E_t \pi_{t+1}$$

In the basic New Keynesian Phillips curve, the output gap is the sole determinant of inflationary pressures. A positive gap reflects excess demand for final goods and rising marginal (wage) costs for monopolistic firms, which are passed on to prices.

In the extended Phillips curve of the DT model, the output gap continues to affect inflation. However, financial conditions now also affect inflation, as indicated by the presence of the nominal interest rate and the credit spread in the equation. An increase in the nominal interest rate generates some inflationary pressure because, ceteris paribus, it increases firms' financing costs. Similarly, a higher credit spread implies a higher cost of external finance and thus exerts independent pressure on inflation.

The credit spread and the nominal interest rate act as endogenous "cost-push" terms in the economy. While pushing up marginal costs and inflation, an increase in either term also exerts downward pressure on economic activity. For the nominal interest rate, this happens through the ensuing increase in the real interest rate, which induces households to postpone their consumption to the future. For the credit spread, the main channel of transmission to aggregate demand is a fall in the real wage, through which firms try to offset the increase in financing costs.

All three equations characterising the macroeconomic equilibrium in the DT model are also affected by exogenous disturbances, which act as exogenous "cost-push" factors in the Phillips curve. More specifically, technology shocks are also partly inefficient through their effect on the credit market. This is in contrast with the standard New Keynesian model, in which they only generate efficient variations in output. The reason is that the output expansion that typically follows a positive technology shock generates the need for an increase in external finance and in leverage, hence leading to an increase in the credit spread. In turn, the higher credit spread will affect output and inflation through the channels described above.

3 WELFARE ANALYSIS

Under particular assumptions on the relative weight given to households (ς) and to entrepreneurs ($1 - \varsigma$) in the central bank's objective, it is possible to derive the following second-order approximation to the central bank's objective function:

$$W_{t_0} \cong \varsigma\left[x - \frac{1}{2} E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} L_t\right] + t.i.p.$$

where *t.i.p.* denotes terms independent of policy and

$$L_t = \kappa_\pi \pi_t^2 + \frac{1}{2}\left[\frac{Y}{c}(\tilde{Y}_t - y^*) - \frac{e}{c}(\hat{R}_t + \delta_3 \hat{\Delta}_t - \delta_4 \hat{\mu}_t)\right]^2 + \frac{e}{c}\frac{Y}{c}(\hat{Y}_t^e + y^*)(\tilde{Y}_t - \hat{R}_t - \delta_3 \hat{\Delta}_t)$$

Here, variables without a time index denote steady-state values. $\hat{Y}_t^e$ is the efficient level of output, and y^* is the log-difference between output in the actual steady state and in the efficient one, i.e. $y^* \equiv \log Y - Y^e$. Finally, $x > 0$, $\kappa_\pi > 0$, $\delta_3 > 0$ and δ_4 are appropriately defined coefficients.

The loss function above highlights that welfare is affected by the volatility of both inflation and the output gap, as in the benchmark New Keynesian case with frictionless financial markets. However, it is also affected by the volatility of the nominal interest rate and of the credit spread. The novel terms are those with a coefficient proportional to $\frac{e}{c}$, which vanish when entrepreneurs disappear from the economy.

These novel terms include elements proportional to the squared nominal interest rate, the squared spread and a number of cross products. These terms imply that both an interest rate smoothing and a "spread smoothing" motive characterise optimal policy. At the same time, these terms are relatively small in a standard calibration, where households' consumption takes up the largest proportion of output. Under normal circumstances, therefore, concerns regarding the smoothing of the interest rate are unlikely to be predominant compared with the objective of maintaining price stability.

In the remainder of this section, optimal policy is characterised under the two assumptions of discretion and commitment.

3.1 OPTIMAL MONETARY POLICY UNDER DISCRETION

The problem of the central bank under discretion is to choose policy in a way that maximises the central bank's objective function, subject to the system of equilibrium conditions described in the previous section. Optimal policy under discretion can be characterised by the following "target rule":

$$\pi_t = v_e(\hat{Y}_t^e + y^*) - v_\pi\left[(\tilde{Y}_t - y^*) - \frac{e}{Y}(\hat{R}_t + \delta_3 \hat{\Delta}_t)\right] - v_\pi \frac{e}{Y}\delta_4 \hat{\mu}_t$$

for appropriately defined parameters v_π and v_e. It is useful to note that, in the case where financial markets are frictionless, $v_e = 0$ and $e/Y = 0$. The optimality condition then becomes $\pi_t = v_\pi(\tilde{Y}_t - y^*)$, which corresponds to standard results in the New Keynesian case.[18] The New Keynesian target criterion implies that the central bank will choose to engineer a constant, positive inflation rate, given the output/inflation trade-off implicit in the Phillips curve. Any rise in inflation above that level would be met by a policy response that would produce a negative output gap.

In the DT model, the target criterion which would be followed by a central bank under discretion is affected by the existence of financial frictions. While the output gap remains important, both other endogenous variables and shocks limit the ability of the central bank to use the output gap to achieve the desired level of inflation. In response to a surge in inflation, the policy implications on the spread $\hat{\Delta}_t$ must also be taken into account.

In addition, exogenous shocks, including both the financial shock $\hat{\mu}_t$ and technology shocks (through the efficient level of output $\hat{Y}_t^e$), affect the target criterion. This implies that, unlike in the benchmark New Keynesian case, the optimal inflation rate may vary, over the short term, in the face of these shocks.

3.2 OPTIMAL MONETARY POLICY UNDER COMMITMENT

Optimal monetary policy under commitment can only be characterised numerically. For this purpose, the model is calibrated in line with existing literature (see De Fiore and Tristani (2009) for further details on the calibration). The optimal response to two shocks is studied here, namely aggregate productivity shocks and a financial shock. Both shocks are assumed to be persistent (i.e. with a correlation coefficient of 0.9).

The optimal response to shocks is compared with a response that follows a simple Taylor rule, which ignores financial conditions. An empirical specification often used includes interest rate smoothing.[19] More specifically, the rule takes the form:

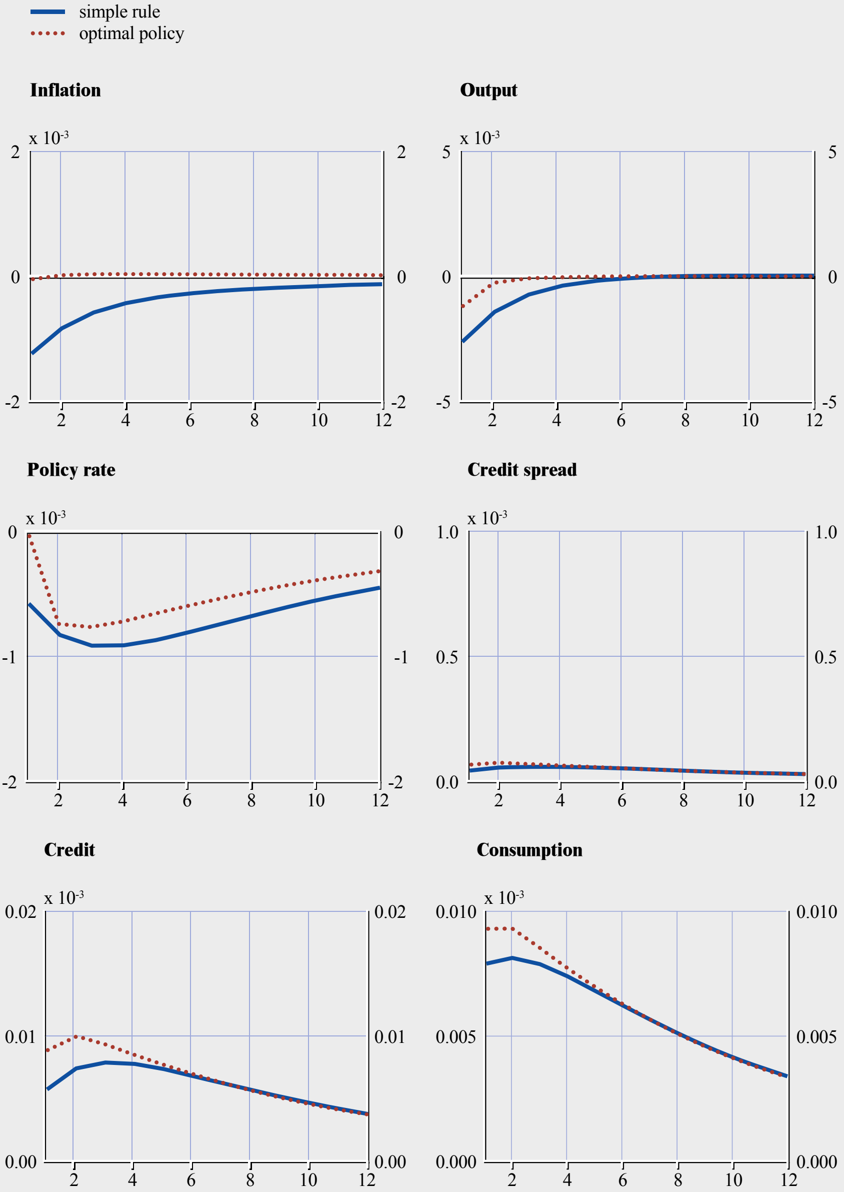
$$\hat{R}_t = (1 - 0.8)(2.0 \cdot \pi_t + 0.1 \cdot \tilde{Y}_t) + 0.8 \cdot \hat{R}_{t-1} + u_t^p$$

where u_t^p is an i.i.d. monetary policy shock.

Chart A1 displays impulse responses to a technology shock. It is well-known that optimal policy in the New Keynesian model would ensure complete stabilisation of inflation and the output gap. To achieve this outcome, the policy interest rate would have to fall on impact and then return slowly to the baseline. In the model with credit frictions, almost complete inflation stabilisation remains optimal in response to technology shocks. However, the path of the policy interest rate that achieves this outcome is somewhat different, since the policy rate is kept constant for one period. The Taylor rule would also prescribe slow monetary easing, but it would be less effective in keeping inflation expectations anchored. A period

18 See, for instance, Woodford, M. (2003), Chapter 7, p. 471.
19 See Smets and Wouters (2007).

Chart A1 Impulse responses to a technology shock under optimal policy within different models



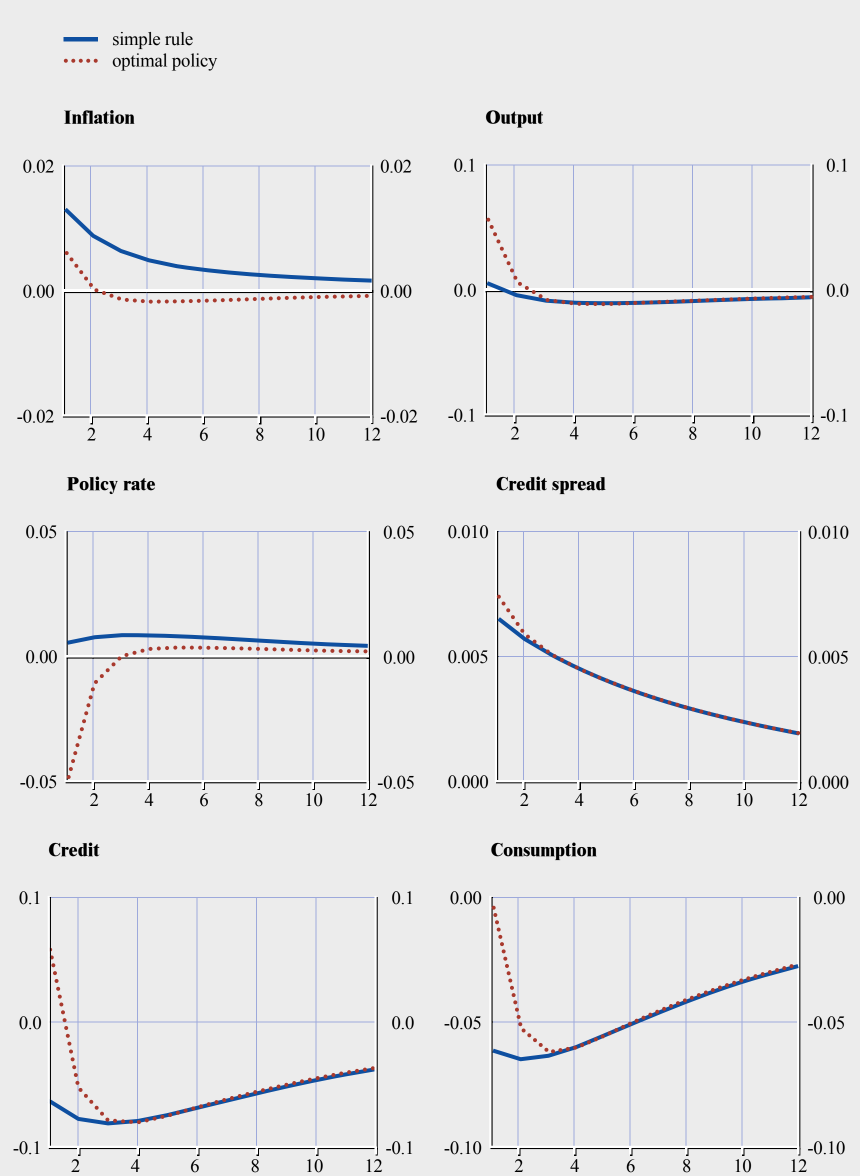
Source: ECB computations.

Note: Linear terms in the second-order expansion of utility are set to zero through an appropriate steady-state subsidy and a specific Pareto weight.

of moderate deflation would ensue, real rates would increase and the output gap would be negative and larger than under optimal policy.

Chart A2 displays impulse responses to a negative financial shock (an increase in $\hat{\mu}_t$) under the optimal policy and under the simple rule. This shock is representative of a broader array of "financial shocks" which could be defined in the model,

Chart A2 Impulse responses to a μ_t shock in the credit channel model: the Taylor rule vs. optimal policy



Source: ECB computations.

Note: Linear terms in the second-order expansion of utility are set to zero through an appropriate steady-state subsidy and a specific Pareto weight.

notably shocks to the value of internal funds or to the level of idiosyncratic economic uncertainty. The increase in $\hat{\mu}_t$ acts like a classical cost-push shock: it depresses households' consumption while creating inflationary pressures and exerting downward pressure on wages. Households react to the lower wage rate with a reduction in consumption: in the calibration used to produce the charts, consumption falls one-to-one with the real wage.

In the DT model, therefore, the depressionary effects of an adverse financial shock do not arise directly through the higher cost of working capital induced by higher loan rates. The main channel through which the adverse financial shock is transmitted to the real economy has to do with the fact that surviving firms, i.e. firms which do not go bankrupt, need to make higher profits in order to finance the higher cost of finance. It is the ensuing reduction in real wages which produces the main squeeze on aggregate demand.

The policy response under a Taylor rule is to increase interest rates to meet the inflationary pressure. In spite of this response, inflation rises by 1 percentage point, partly owing to the effect of the nominal interest rate on the cost of external finance. The increase in $\hat{\mu}_t$ also leads to an increase in bankruptcy rates, while the amount of credit falls.

Compared with the responses under the Taylor rule, those obtained under optimal policy are striking because the policy interest rate moves in the opposite direction. Interest rates are cut immediately and very aggressively and remain low for approximately one year, in spite of the inflationary pressure. The main reason for this policy response is that the financial shock is inefficient, hence the fall in households' consumption is entirely undesirable. The marked expansion in monetary policy is aimed at smoothing the path of households' consumption after the shock. At the same time, the interest rate cut counters inflation through its effect on the cost of external finance, even if it tends to fuel inflation through the aggregate demand stimulus.

All in all, compared with the Taylor rule case, households' consumption moves very little on impact and only reaches levels consistent with those attained under the Taylor rule after three quarters. At the same time, the increase in inflation is less pronounced and less persistent than under the Taylor rule.

4 CONCLUDING REMARKS

This annex summarised the findings of De Fiore and Tristani (2009) on the implications of financial market conditions for macroeconomic dynamics and optimal monetary policy.

The DT model demonstrates that, in general, monetary policy ought to pay attention to the evolution of credit market conditions, as captured, for example, by changes in credit spreads. On the one hand, these changes matter because they affect firms' marginal costs and thus have an impact on output and inflation.

On the other hand, they matter because of their impact on entrepreneurial and household consumption.

Therefore, there might be good reasons for a central bank to react to an adverse financial shock with aggressive easing. These types of shocks create an inefficient recession, and the negative consequences of this for consumption can be reduced. Even if this aggressive easing may generate some inflation in the very short term, price stability remains optimal over the medium term.

The numerical findings presented in this annex should, however, be interpreted as an illustrative example. Their precise quantitative features should be cross-checked against those derived from more complex models with more realistic characteristics.

REFERENCES

Christiano, L.J., Motto, R. and Rostagno, M. (2003), "The Great Depression and the Friedman-Schwartz hypothesis", *Journal of Money, Credit and Banking*, 35(6), pp. 1119-1198.

Christiano, L.J., Eichenbaum, M. and Evans, C. (2005), "Nominal rigidities and the dynamic effects of a shock to monetary policy", *Journal of Political Economy*, Vol. 113, pp. 1-45.

Christiano, L.J., Motto, R. and Rostagno, M. (2007), "Shocks, structures or policies? The euro area and the US after 2001", *Journal of Economic Dynamics and Control*, 32(8), pp. 2476-2506.

De Fiore, F., and Tristani, O. (2009), "Optimal monetary policy in a model of the credit channel", *Working Paper Series*, No 1043, ECB.

Smets, F. and Wouters, R. (2007), "Shocks and frictions in US business cycles: A Bayesian DSGE approach", *American Economic Review*, 97(3), pp. 586-607.

Woodford, M. (2003), *Interest and prices*, Princeton University Press.

CHAPTER 6

INTERLINKAGES BETWEEN MONEY, CREDIT AND ASSET PRICES AND THEIR IMPLICATIONS FOR CONSUMER PRICE INFLATION: RECENT EMPIRICAL WORK

I INTRODUCTION[1]

Asset prices naturally play an important role in the ECB's monetary analysis, since their interrelationship with money and credit developments affects the information content that the latter variables have for the assessment of risks to consumer price inflation.

Over the past decade, asset markets have played a growing role in macroeconomic dynamics. Policy-makers have become increasingly aware of the fact that sizeable changes and significant periodic corrections in asset prices may lead to financial and, ultimately, macroeconomic instability. For example, rapidly rising asset prices are often associated with an easing of credit conditions, increased spending (on account of wealth increases and a relaxation of credit constraints) and, ultimately, inflationary pressures. The bursting of an asset price bubble, however, could imply significant financial losses by institutions and investors, and a sharp drop in aggregate demand, leading to deflationary risks via both direct wealth effects and instability in the financial sector. A zero lower bound on nominal interest rates, as well as heightened uncertainties with respect to the monetary transmission mechanism in times of turmoil, could then make it more difficult for central banks to maintain price stability. The interaction between asset prices and monetary developments is therefore worthy of close attention.

The analysis of asset prices – in particular, equity and real estate prices, as well as, to a lesser degree, bond prices and exchange rates – poses many challenges. In this respect, it is particularly important for central banks to understand the underlying sources of asset price changes. For example, the implications of share price developments for the stance of monetary policy would depend on whether share prices are being driven by supply, demand or other "fundamental" economic shocks.

1 This chapter was prepared by Carsten Detken, Dieter Gerdesmeier and Barbara Roffia. We would like to thank Stefan Gerlach, Takushi Kurozumi and participants in the ECB colloquium "Enhancing the monetary analysis" in Frankfurt on 26-27 April 2010. The paper does not necessarily reflect the views of the ECB or the Eurosystem.

This chapter focuses on periods characterised by financial imbalances. In such a context, it is crucial to evaluate whether asset price changes are driven by (a) surprise changes in current and/or expected future fundamentals, (b) unrealistic expectations about future fundamentals, or (c) factors unrelated to developments in current and expected fundamentals. In the remainder of this chapter, asset price surges stemming from the latter two drivers (i.e. those given under (b) and (c) above) are referred to as "bubbles". The eventual bursting of such a bubble – which is inevitable, since it is associated with asset price developments unsupported by fundamentals – can be destabilising for both the financial system and the real economy.

Unfortunately, at a more practical level, it has to be recognised that distinguishing fundamental from non-fundamental sources of asset price movements in real time is an extremely difficult task. Estimates of the equilibrium value of asset prices determined by underlying fundamentals are surrounded by a high degree of uncertainty.

Rather than relying on such equilibrium estimates, the starting point of the analysis presented in this chapter is a particular historical data regularity, namely that boom-bust cycles in asset prices are often associated with excessive money and credit developments. The aim of the chapter is to describe a number of empirical analyses that explore the relationships between asset prices, money and credit, as well as consumer prices, and also to review some of the theoretical channels at work.

Moreover, the chapter sheds light on some important policy discussions. The most pertinent question in this context is whether a central bank should change monetary policy in response to asset price developments in order to contain the potential emergence of a bubble at an early stage. More specifically, the issue is whether policy should be tightened even if no upward risks for consumer price inflation have been identified over the usual inflation forecasting horizon of one to two years. In the literature, this is usually discussed under the label "leaning against the wind" (of asset price surges).

Even if a theoretical case can be made for leaning against the wind, a number of practical concerns emerge from a policy perspective: is it possible in real time to identify whether observed asset price developments constitute a potential threat to financial stability, the real economy and thus price stability in the long run? In this respect, it is of crucial importance for central banks to have early indicators to assess the possible implications of large asset price movements and the building-up of financial imbalances in the economy. Moreover, central banks also have to confront the question of whether leaning against the wind can be incorporated into their overall monetary policy strategy without blurring the primary objective of maintaining price stability. In particular, this question concerns potential challenges for communication with the public, both in general and especially with regard to monetary analysis.

The chapter is structured as follows. Section 2 briefly investigates the theoretical channels linking money and credit aggregates to asset prices and, ultimately, consumer prices. Section 3 summarises the available evidence on asset price misalignments and investigates the stylised facts linking asset price misalignments and macroeconomic instability. Section 4 provides an overview of the early warning properties of money and credit developments for asset price boom-bust cycles, focusing on more recent studies. Finally, Section 5 expands on the central bank's response to asset price misalignments and on the role of asset prices within the ECB's monetary policy strategy.

2 THEORETICAL CHANNELS LINKING MONEY AND CREDIT, ASSET PRICES AND CONSUMER PRICES

In order to address the above questions, it is useful to discuss the links and potential causalities between money and credit aggregates, asset prices and consumer prices, which are illustrated in a stylised way in Chart 1.

As discussed in Chapter 3 of this volume, asset prices affect money demand as part of a broader portfolio allocation problem, whereby the returns on various assets influence money holdings.[2] Moreover, credit developments could be influenced by asset price dynamics, including those generated via some self-reinforcing mechanisms. For example, during asset price booms, the balance sheet positions of financial and non-financial companies improve and the value of collateral increases, permitting a further extension of bank credit for firms' investments. Banks' leverage ratios fall with rising asset prices, allowing them to issue new liabilities (possibly increasing broad money).[3] The additional funds of financial and non-financial companies might partly be invested in the booming asset, which would lead to further asset price increases – a self-reinforcing mechanism. The balance sheet channel suggests that firms and households may be constrained in their borrowing because of asymmetric information in credit markets, giving rise to adverse selection and moral hazard problems. The lower the net worth of firms and households, the tighter the constraints will be, given that there is less collateral available to secure loans. This phenomenon is also referred to as the "financial accelerator".[4] In addition, expectations of rising future income and the associated demand for housing may increase the expected fundamental property prices, thus leading to an increase in credit demand (see arrow 1 in Chart 1).

At the same time, the causality might also run in the opposite direction (arrow 2 in Chart 1). For example, rising demand for assets stemming from increasingly leveraged investment positions may augment asset prices in a world with financial frictions.[5] Furthermore, a high level of money holdings might signal a large amount of liquidity being invested in potentially higher-yielding

2 See, in particular, Annexes 2 and 3 to Chapter 3.
3 See Adrian and Shin (2008).
4 See Bernanke et al. (1998) and the discussion in Chapter 5.
5 For example, Allen and Gale (2000) show how current or anticipated future credit expansion can trigger an asset price bubble by enhancing risk-shifting behaviour.

opportunities, which could then fuel a bubble once a trend has been triggered and herding behaviour sets in. At the heart of this could be a real portfolio balance effect of other non-monetary financial intermediaries (OFIs): too much liquidity on their balance sheets would trigger the desire for portfolio reallocation, increasing the share of other assets.[6] Another link between money and credit, on the one hand, and asset prices, on the other hand, could be due to the so-called "risk-taking" channel of monetary transmission.[7] While low interest rates are usually associated with high money growth, they have also been found to trigger a loosening of credit standards, which in turn could allow for more leveraged investments, thus potentially increasing asset prices. Persistently low interest rates could also reduce asset risk premia through the search-for-yield behaviour of investment managers. Another reason for artificially low risk premia is a perceived central bank put option based on investors' expectations of being bailed out by the central bank in the event of a bust.

As regards the ultimate impact of money, credit and asset price developments on consumer prices, direct and indirect effects have to be distinguished. On one side, there is a direct link between money and credit, on the one hand, and consumer prices, on the other hand, which works through the standard transmission channels in the presence of financial frictions such as, for instance, a cash-in-advance constraint (see arrow 3). On the other side, several indirect effects can be at work. For example, asset prices affect consumer prices indirectly through a wealth effect on the side of consumers and via a Tobin's q effect on firms' investment.[8] Asset prices may also affect consumer prices through the link between residential property prices and wages. Higher house prices raise the cost of living for workers, causing them to demand higher wages. If firms react to higher wage demand by raising their prices, the prices of goods and services will eventually increase. Linked to this is the effect that stock prices may have on investment and consumption via confidence effects. For example, a rise in stock prices may signal a positive outlook for future economic activity and employment, which may boost consumer confidence and actual consumption spending. At the same time, if an asset price boom turns into a bust big enough to trigger systemic financial instability, deflationary risks can appear and a negative link between previously rising asset prices and consumer price inflation could emerge (see arrow 4).

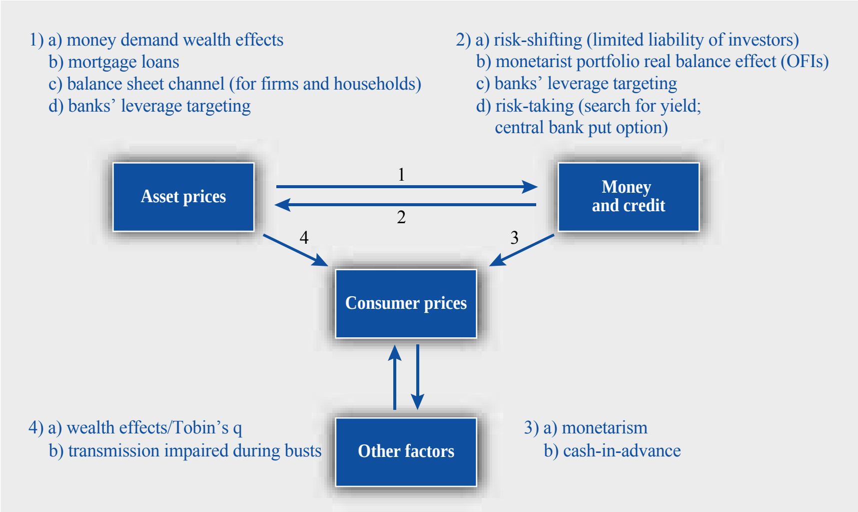
While the underlying trend in money and credit growth will be positively linked with consumer price inflation in the long run (arrow 3), deviations from trend money and credit developments have been found to lead costly asset price boom-bust cycles, and may thus be associated with deflationary – rather than

6 See Congdon (2005). It is worth noting that transactions within the money-holding sector would not reduce the amount of money in the economy, while the portfolio adjustment would occur through changes in asset prices.

7 See Borio and Zhu (2008).

8 See Tobin (1969). Tobin's q is defined as the market value of capital relative to the replacement cost of capital. If q rises because of an increase in equity prices, firms can buy more capital for the equity they issue. This makes it more attractive for firms to acquire new capital in such a situation, which increases investment demand, and may in turn feed through into higher goods and services prices (assuming demand effects dominate supply effects).

Chart 1 Links between money/credit and asset and consumer prices



Source: Authors' own considerations.

inflationary – risks at the time the bubble bursts (arrows 2 and 4). Furthermore, the possibility of significant non-linearities exists, such that, at times (for example, in asset price boom periods) money and credit growth would predominantly fuel *asset price* inflation (arrow 2), while strong monetary growth would in normal times be reflected in subsequent *consumer price* inflation (arrow 3). Such a non-linearity would make the early warning and leading indicator properties of money and credit dependent on the prevailing bubble or no-bubble regime. Chart 1 clearly reveals the links with two other topics on the ECB's agenda of enhancing its monetary analysis: money-based inflation indicator models (arrow 3) and money demand studies introducing wealth variables (arrow 1), which might be developed further by taking into account the non-linearities created by asset price boom episodes.

Such considerations help to explain why finding a simple bivariate indicator relationship between monetary growth and inflation is challenging, especially in the more recent data (see the discussion in Chapter 4). That said, all the mechanisms described in the preceding paragraph associate excess money, credit and asset price growth with threats to macroeconomic and price stability. Since monetary policy decisions in the event of an asset price bust will be challenging, given the potentially different threats to price stability at different horizons, a premium is therefore placed on pre-emptive actions to contain the emergence of asset price bubbles. In short, "prevention is better than cure". As a result, the need for early warning information on asset price dynamics and the potential emergence of bubbles – where monetary variables can play a leading role – is crucial.

In general, financial assets are valued according to the discounted present value of the future cash flow that investors expect to derive from holding the asset. The discount rates applied to future cash flows are the expected rates of return that investors demand for holding the asset in their portfolios. If stock prices equal the discounted present value of (rationally) expected future dividends, then they are said to be efficiently priced. In the literature, this is associated with the "efficient market hypothesis", which states that asset prices are always in equilibrium and that it is impossible for any investor to consistently "beat" the market since it is expected that asset prices adjust almost immediately to any new information affecting future cash flows.

The view of highly efficient asset markets is, however, increasingly being challenged by the field of behavioural finance, which has evolved into a separate branch of financial analysis. More specifically, behavioural finance highlights certain inefficiencies, such as under-reactions or over-reactions to information, as causes of market trends and – in extreme cases – the occurrence of bubbles and crashes. Psychological effects have also been found to play a role in asset price determination. Taken together, numerous examples of unexplained abnormal returns have been identified as having been due to limited investor attention, over-confidence or over-optimism, herding instinct and noise trading. Today, few question the possibility that asset price bubbles can and do exist.

The literature has classified different types of bubble. A bubble due to investors overreacting to a string of positive earnings news, leading to overly optimistic earnings and dividend expectations, has been labelled an "intrinsic bubble". Bubbles can result from positive feedback trading, i.e. from investors buying stocks with the expectation that observed price increases will continue, with the result that stock prices may in fact increase further on account of higher demand, thus giving rise to further expectations of future price rises, and so forth. In this case, self-fulfilling expectations are the main driving force behind a bubble that feeds itself once triggered by some extraneous event: this is an "extrinsic bubble".

Detecting asset price misalignments is a difficult exercise, even if undertaken ex post. All studies confirm that the identification and quantification of asset price and/or financial imbalances represents an extremely difficult task, in particular from an ex ante point of view. Even ex post, different criteria can be used, each involving some degree of arbitrariness. The basic problem is that an assessment of the rationality of expectations of future fundamentals at each point in time is very hard, if not impossible. Thus, various methods have been developed to derive proxies for equilibrium asset prices.

An approach commonly used to assess the level of stock prices is to evaluate stock valuation ratios (such as the dividend yield and price/earnings ratios) from a historical perspective. One would expect that, over time, such valuation ratios eventually revert to a long-run equilibrium level. This long-run equilibrium level is calculated in the dividend discount model by means of the long-run growth potential of dividends or corporate earnings and the long-run levels of real interest rates and the equity risk premium. Alternatively, this long-run equilibrium could be calculated using a simple statistical approach.

Recent studies have used various de-trending methods to filter the cyclical from the trend component.[9] The trends are often calculated recursively, i.e. are updated at each point in time, in order to capture only information available at the time of the assessment (a "pseudo real-time" exercise).[10] The rationale for this method rests on a few assumptions. First, there is an implicit acknowledgement that it is difficult, if not impossible, to derive equilibrium asset prices with reference to the underlying fundamental variables. Second, it uses a time-varying trend as a proxy for the underlying fundamental developments, as trending fundamentals should be the only reasonable explanation for trending asset prices. Third, significant deviations from the trend are then considered excessive and are expected to be reversed at some point.

Following the calculation of the long-run equilibrium, an over or under-valuation in the stock market would be indicated when current valuation ratios are considerably out of line with the estimated long-run equilibrium level. More precisely, if asset prices deviate too swiftly from long-run developments, the period is labelled a boom if the gap is significantly positive, or a bust if the gap is significantly negative. In order to be deemed a boom or bust, the gap must usually exceed a certain threshold with some persistency.

However, the comparison of current and equilibrium levels cannot provide sufficient proof of a stock market bubble. Extraordinarily high price/earnings ratios may, for example, be justified by correct expectations of extraordinary growth of corporate earnings over an extended future period of time. In these circumstances, the price/earnings ratio would be expected, over time, to decline from the initially high level towards its long-run average, driven mainly by the materialisation of earnings expectations, but not by a sharp drop in stock prices following the bursting of a bubble. Nevertheless, historical comparisons can provide some indications of periodic market excesses pushing valuation ratios far beyond thresholds set by historical patterns and, as the next section will show, these methods have worked surprisingly well in practice to identify periods which are followed by financial instability. It can, therefore, be concluded that, by historical standards, exceptionally swift and persistent asset price developments usually deserve careful monitoring, using all available information and tools – from econometric models to anecdotal evidence – to infer whether a potentially dangerous bubble is building up. In order to acknowledge the use of the statistical approach to proxy for equilibrium asset prices, recent ECB work has labelled the periods identified on the basis of

9 See Gourinchas et al. (2001), Mendoza and Terrones (2008), Adalid and Detken (2007), Gerdesmeier et al. (2009), and Agnello and Schuknecht (2009).

10 The decomposition into trend and cycle is to some degree arbitrary, depending on the specific filter method and parameters chosen. That is why this approach must be considered a crude and very pragmatic attempt to circumvent the problem of identifying a boom and/or a bust.

trend estimates as asset price "booms" rather than "bubbles", in order to stress the swiftness and persistence of price changes, rather than the deviation from fundamentals.

With regard to the real economic effects, history has shown that some boom-bust cycles in asset prices can harm the entire economy. For example, whenever the building-up of a bubble is associated with excess credit and liquidity creation – as is often the case – asset price crashes can become the cause of deflationary trends, as observed in some economies in the past.[11]

In this respect, a number of studies have recently been analysing historical boom-bust cycles in asset prices in order to detect regularities with regard to the costliness of booms, and to assess the potential for identifying dangerous booms at an early stage. A recent IMF survey[12] analyses periods of bust in housing and equity markets and reaches the following stylised conclusions in terms of macroeconomic consequences: (i) housing price busts appear to be less frequent than equity price busts, and housing price peak-to-trough periods last longer, on average, than corresponding periods for equity prices (four years for the former compared with two and a half years for the latter); (ii) price declines during housing (equity) price busts are in the order of around 30% (45%), on average, and 40% (25%) of housing (equity) price booms have been followed by busts; (iii) the output losses associated with asset price busts are substantial, with losses incurred during a typical housing (equity) price bust amounting to about 8% (4%) of GDP; (iv) losses seem to be distributed differently according to the type of asset price bust: bank-based financial systems incur larger losses than market-based financial systems during housing price busts, while the opposite is true for equity price busts; and (v) all major banking crises in industrial countries during the post-war period coincided with housing price busts.

Some additional and complementary information can also be derived from another study which focuses, in particular, on aggregate asset price boom periods.[13] By distinguishing between high and low-cost booms, the following stylised facts are detected: (i) high-cost booms typically last around a year longer than low-cost booms (four years versus three years), and are accompanied by a stronger real estate price boom-bust cycle, and higher inflation only towards the end of the boom phase; (ii) in the early stages of a boom, real money growth and real credit growth are higher for high-cost booms; and (iii) during high cost booms, the stance of monetary policy is typically loosened significantly more than during low-cost booms.

11 See ECB (2005).

12 See Helbling and Terrones (2003).

13 See Adalid and Detken (2007). It should be noted that combining two different markets (such as the housing and equity markets) in a single indicator can, in some cases, be misleading. This happens, for instance, when the two markets move sharply in opposite directions, so that the developments in the composite indicator would mask diverging trends and may not flag the risk existing in one of the two markets. See, for example, Borgy et al. (2009) and Kannan et al. (2009).

It is also important to stress that monetary stability and financial stability are closely interlinked, insofar as a monetary policy regime that guarantees aggregate price stability tends, as a by-product, to promote the stability of the financial system in the long run. Nevertheless, the financial imbalances that preceded crises have also built up in periods of low consumer price inflation. If anything, consumer price inflation has more often been below trend than above trend at the onset of past costly asset price booms.[14]

Seen from a financial stability perspective, it is worth noting that all major banking crises in industrial countries in the post-war period coincided with housing price busts, whereby the latter are less frequent than equity price busts, but more costly in terms of output losses. Moreover, when comparing the above-mentioned asset price busts with the banking distress episodes highlighted by Bordo et al. (2001), it appears that these two episodes were concomitant in many cases, while the banking distress periods followed the asset price busts with a slight delay in only a few cases.

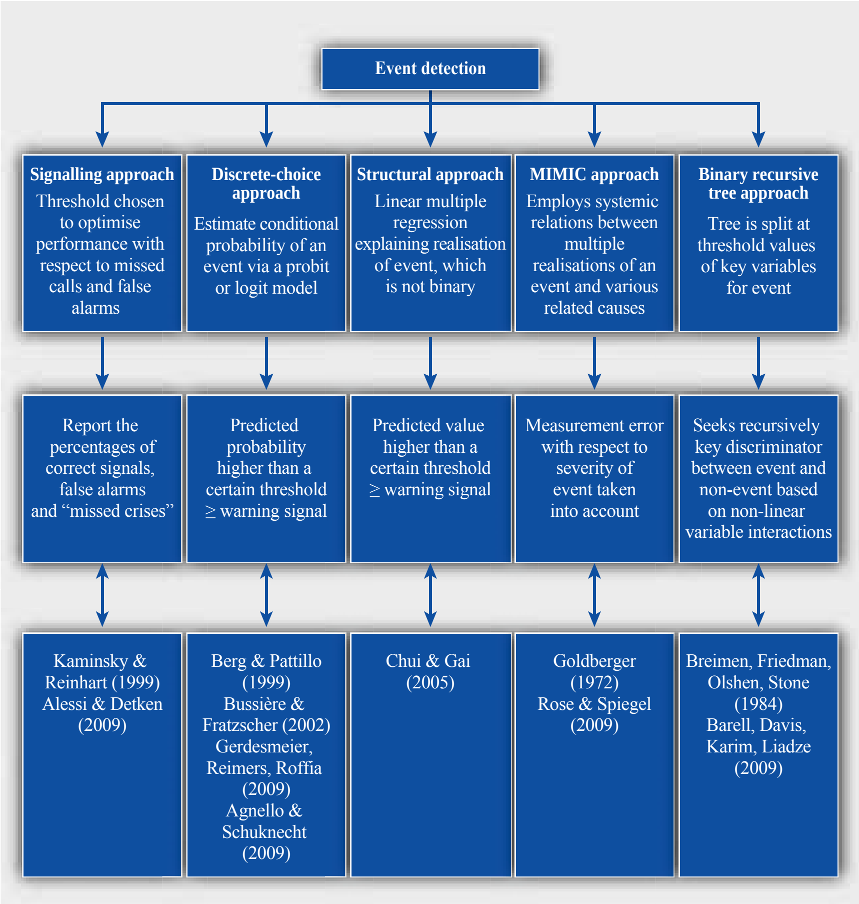
4 MONEY AND CREDIT AS EARLY WARNING INDICATORS

As pointed out by pioneering studies on the topic many years ago (and as already anticipated in Section 2 above), boom-bust cycles in asset markets have historically been closely associated with large movements in monetary and credit aggregates.[15] In the literature, several approaches have been used to predict asset price bubbles and busts in different asset prices.

One approach, labelled the "signalling approach" (see Chart 2), defines discrete thresholds for each indicator variable, so that a warning signal for the occurrence of a boom or bust within a given period is issued when the indicator breaches that threshold.[16] The threshold could be defined, for example, as a certain percentile of the indicator's past distribution. It is then possible to calculate the respective noise-to-signal ratios, i.e. the ratio of the share of false alarms to the share of good signals. In most of the studies adopting this approach, the threshold levels are chosen to minimise this noise-to-signal ratio. Other studies aim at striking a balance between type I and type II errors with respect to policy-makers' relative preferences. In particular, if the threshold is set at too high a value, this leads to fewer signals and, therefore, to the possibility of missing some busts. Conversely, if the threshold is too low, small fluctuations in the variables would issue more frequent alarms, some of which would, however, turn into false alarms ex post. In the case of Alessi and Detken (2009), the thresholds that would signal booms are set at each point in time using an optimisation procedure (i.e. one that minimises a particular loss function of the policy-maker) based on the fixed optimal percentile to the distribution of the data available up to each point in time. Thresholds for each indicator are thus time and country-dependent, and,

14 See Adalid and Detken (2007), Table A1, p. 41.
15 See Fisher (1932) and Kindleberger (1978).
16 See Kaminsky and Reinhart (1999).

Chart 2 Designing early warning indicator models



Source: Adapted from Chui and Gai (2005).

as they are based on past observations, they are "quasi real-time". In this respect, it is worth noting that the analysis takes careful account of the information available at each point in time, by using only data already released. This is done by using differently lagged data for different series, which proxies for true data availability at the time. Furthermore, all trends are calculated recursively, i.e. by using only data available up to the period under consideration.

An alternative "discrete-choice approach" makes use of probit/logit regression techniques to evaluate an indicator's contribution to predicting a boom or bust. As stressed by Berg and Pattillo (1999), this approach has several beneficial features.[17] First, the discrete-choice approach allows a test of the usefulness of the threshold concept. Second, this method allows correlations between different

17 See also Bussière and Fratzscher (2002) for an early warning model for predicting exchange rate crises based on a multinomial logit model.

indicator variables to be taken into account. Finally, the approach allows the statistical significance of individual variables to be evaluated. This methodology consists of running bivariate and multivariate probit regressions on the panel data set and comparing several specifications of the probit models, whereby an assessment of the specifications is made on the basis of probability scores and goodness-of-fit. For example, Gerdesmeier et al. (2009) test various candidate indicator variables separately, and in conjunction with others, in order to find the best combination that leads to higher goodness-of-fit, better statistical properties and statistical test performance, as well as lower noise-to-signal ratios. In the same vein, Agnello and Schuknecht (2009) apply this methodology to predict housing price boom and bust episodes.[18] As with the application of the signalling approach, these models have been derived with due consideration of information constraints at each point in time by being recursively tested and including the indicator variables in a lagged manner. In any respect, the set-up of all these models allows for a real-time application of such analysis.

Overall, the signalling and discrete-choice approaches can be seen as complementary and are often, given that there is no clear evidence of a superior performance of one or the other, applied in parallel. This ambiguity regarding the relative performance of the two approaches is also a feature of the recent financial crisis.

The major difference between the two approaches lies in the degree of non-linearity in the relationship between the predicted variable and the indicators. In the signalling approach, the indicators trigger a signal only if they exceed a threshold, while larger indicators in the discrete-choice approach continuously increase the probability of the event occurring. Obviously, one could also estimate an early warning model in a linear framework based on macroeconomic variables on both sides and define some thresholds for the issuance of a signal. Chui and Gai (2005) call this the structural approach.

Two other approaches have also been employed in the existing literature, but less frequently so: the multiple indicators multiple cause (MIMIC) approach and the binary recursive tree (BRT) approach. The MIMIC approach[19] was recently employed by Rose and Spiegel (2009) in the context of the financial crisis. This approach incorporates measurement error on the severity of a crisis and implies a regression of a variety of crisis manifestations on different causes of the crisis, which are effectively combined in one factor. The BRT approach[20] applies search algorithms to determine thresholds of variables best suited to splitting the events into crisis and non-crisis episodes, using different variables recursively. A recent application to the financial crisis can be found in Barrell et al. (2009).

It is fair to say that the economic literature is divided about the ability of early warning models to predict financial crises, especially out of sample. Recent work by the Bank for International Settlements (BIS) and the ECB supports an

18 See Kannan et al. (2009), who also derive the conditional probability of a bust within a particular time horizon using a probit analysis.
19 See Goldberger (1972).
20 See Breiman et al. (1984).

optimistic view, in line with the conclusions of Reinhart and Rogoff (2009), who favour "the establishment of an effective and credible early warning system capable of producing relatively reliable signals of distress from the various indicators in a timely manner".[21]

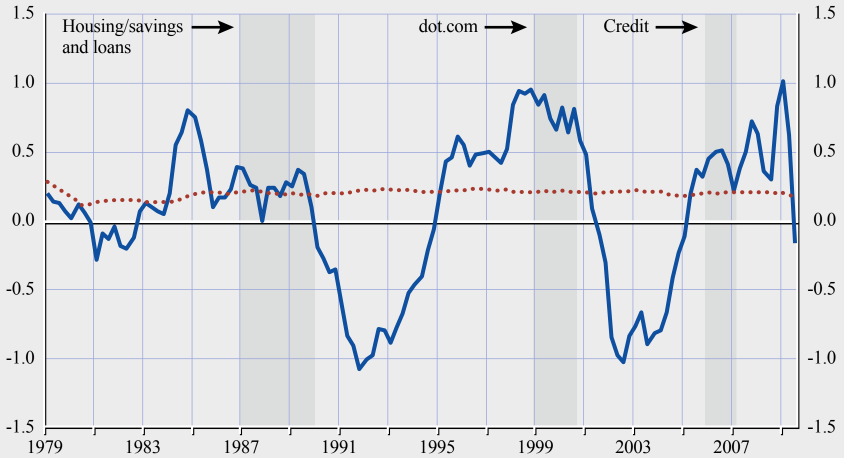
Generally speaking, one robust finding across different approaches is that various measures of excessive credit creation (for example, the deviation of the credit-to-GDP ratio from its trend, global credit growth de-trended, etc.) are good leading indicators of the build-up of financial imbalances in the economy. The recent ECB studies mentioned above[22] (and reported in greater detail in the annexes to this chapter) demonstrate that credit indicators correctly issued a warning signal in between 74% and 82% of the periods followed by booms or busts, while issuing a false alarm in between 26% and 32% of the periods not followed by booms or busts. Up to 95% (70%) of the costly asset price booms (busts) would have been predicted by a warning signal in at least one of the six (eight) quarters preceding the boom (bust). Two of these studies find credit to perform better than money, despite the fact that credit usually lags business cycles in normal times.

These studies implicitly confirm that leverage is one of the key indicators able to predict costly asset price boom-bust cycles. An example of this is given in Charts 3 and 4 below. As regards the first study by Alessi and Detken (2009), the global credit-to-GDP (ratio) gap has been found to be the single best indicator (with an average lead time of 5.5 quarters) for those asset price bubbles that are followed by busts which are costly in terms of GDP losses (see Chart 3).[23] In the second study by Gerdesmeier et al. (2009), the domestic credit-to-GDP gap and/or the credit growth gap, the investment-to-GDP ratio, the annual changes in the long-term interest rate and the house price/ equity price gaps have been found to signal asset price busts likely to occur in the next two years. In this respect, the panel probit model based on these variables and applied to euro area data can then be used to derive the conditional probability of a bust occurring in the euro area in the next two years (see Chart 4).

The importance of debt and leverage for financial crises confirms the findings of Reinhart and Rogoff (2009). The results are in line with studies conducted at the BIS, which look at indicators to predict future banking distress.[24] The indicators for such episodes are found to be based on the coexistence of unusually strong and protracted increases in credit and asset prices, with a reasonably good performance out of sample, as indicated by their ability to point to potential banking distress ahead of the current crisis.

21 Reinhart and Rogoff (2009) p. 281.
22 In this context, see also Kannan et al. (2009) and Kurozumi et al. (2010).
23 The authors define a boom as a period of at least three consecutive quarters in which the real value of the index exceeds the recursive trend plus 1.75 times the recursive standard deviation of the series (the latter being calculated with a very slowly adjusting Hodrick-Prescott filter, with $\lambda = 100,000$).
24 See Borio and Drehmann (2009).

Chart 3 The global private credit gap and its optimal threshold for detecting costly asset price booms

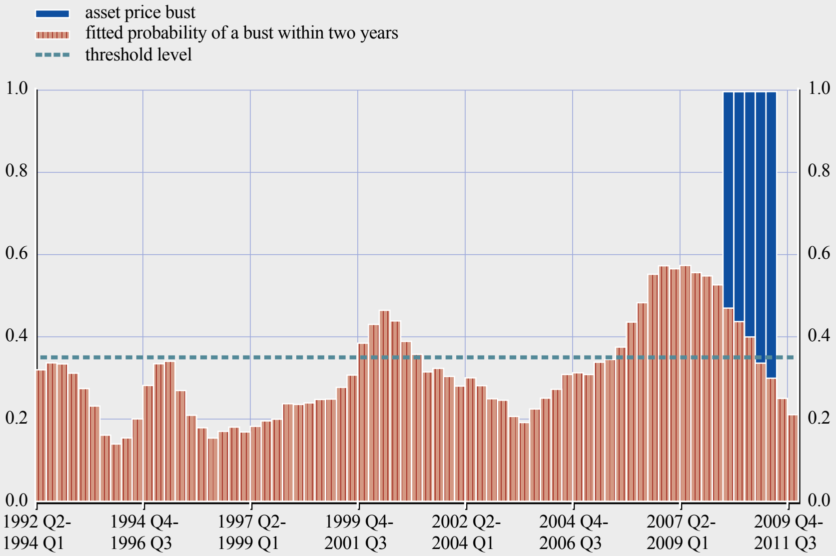


Source: Alessi and Detken (2009).

Notes: The blue line is the (recursively) de-trended private credit-to-GDP ratio across 13 main industrialised OECD countries, PPP-GDP weighted (i.e. Australia, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, New Zealand, Spain, Switzerland, the United Kingdom and the United States). The red dotted line is the optimal, time-varying threshold. The grey areas are widespread boom episodes in which at least eight countries experience a boom.

Chart 4 Probability of an asset price bust in the euro area over the next two years, based on a probit model

(percentages)



Source: Gerdesmeier et al. (2009).

Notes: The red area represents the fitted probability for the euro area stemming from the probit model (specification B) in Gerdesmeier et al. (2009), including the following countries: Australia, Canada, Denmark, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. The blue area represents the detection of a bust, with the threshold level set at 0.35 (i.e. 35%).

As the build-up of asset price bubbles is seemingly best identified by credit developments, it is no surprise that monetary aggregates, representing summary indicators for the short to medium-term liabilities on banks' balance sheets, also possess good indicator properties.[25] Indeed, excessive money creation has likewise been singled out as an important indicator by some studies, although evidence is more mixed in this regard. This is possibly attributable to the fact that substitution effects between money and other assets can sometimes be substantial, particularly in times of high financial turbulence and uncertainty. Therefore, notwithstanding the fact that the interactions between monetary and asset price developments are rather complex, these results point to the need for a close monitoring of the nature of movements in money, credit and asset prices, complemented by a broader analysis of monetary conditions.[26]

5 CONCLUDING REMARKS: CENTRAL BANKS' RESPONSE TO ASSET PRICE MISALIGNMENTS

An important debate, which has gained momentum over the past few years, is ongoing with respect to the role that asset prices should play in the formulation of monetary policy, given how their volatility can jeopardise the stability of the financial system and potentially undermine macroeconomic and, ultimately, price stability. One policy view postulates that it is better to wait for the bubble to burst on its own, and then to ease monetary policy aggressively to provide support to the banking system and the economy. In this respect, a sharp easing of monetary policy after the bubble has burst is supportive of both price stability and financial stability, although at the possible expense of creating moral hazard and excessive risk-taking in future boom times, when market participants will price in the value of public rescue operations ex ante.

An alternative approach long discussed in academia and policy circles is whether a central bank should "lean against the wind", which can be defined as the use of the policy rate in response to financial imbalances, in order to maintain price stability over the medium to long term, while accepting possibly increased consumer price volatility in the short to medium term. The idea is to contain a potential asset price bubble and, thereby, to avoid the possible negative repercussions for price stability and the economy in general that might result from a future asset price bust.

Traditionally, however, there has been a great deal of scepticism about "leaning against the wind" for at least three – at first sight – very legitimate reasons. First, as argued above, it is very hard to identify an asset price bubble in real time. In particular, a tight policy response to asset price increases may end up destabilising the economy unnecessarily if the asset price valuation is driven by fundamentals. Second, the policy interest rate is often considered too blunt a tool to contain potential bubbles. Raising policy rates will depress the prices of many

25 See also Schularick and Taylor (2009), who take a long-term perspective, using data for the period from 1870 to 2008.

26 See, for example, Borio and Lowe (2002, 2004), and Bordo and Jeanne (2002).

assets – including those not booming, as well as the real economy and consumer prices. Furthermore, in times of market euphoria, the policy rate might have to be raised significantly in order to have a measurable effect on booming asset prices. These considerations lead to doubts about the effectiveness and efficiency of a leaning-against-the-wind policy. Finally, it has been argued that it is not evident that asset price boom-bust cycles are necessarily a bad thing for real long-term growth in all countries. In economies with serious inefficiencies in the – bank or market-based – intermediation processes of allocating savings to investment opportunities, raising the value of collateral might temporarily circumvent these inefficiencies as long as the boom lasts. The benefits from the realisation of additional, in principle efficient, projects could, on average, outweigh the costs incurred during the bust phases. This is in line with some of the theoretical findings in the bubble literature, which show that bubbles can emerge as an efficient response to existing inefficiencies in the economy.

The above-mentioned arguments all reflect valid concerns and cannot be easily dismissed.[27] Nevertheless, recent empirical and theoretical counterarguments to the above three main lines of scepticism shift the balance in favour of the view that leaning against the wind should not be disregarded on principle, even if the economic science is still divided on these issues.[28]

This notwithstanding, several arguments to counter the above-mentioned scepticism can be put forward. First of all, the uncertainty surrounding the assessment as to whether an asset price surge or boom represents a bubble is not necessarily larger than that in the case of other important economic concepts used heavily in monetary policy-making, such as the calculation of the output gap. Recent studies at the BIS and the ECB have shown that simple statistical methods focusing on swift asset price movements could often serve as proxies to identify potentially dangerous periods of financial market exuberance.

Second, with respect to the scepticism regarding the effectiveness and efficiency of monetary policy, it should be noted that, in this context, three new monetary transmission channels have recently been identified, each of which can reasonably be expected to raise the effectiveness of monetary policy during financial boom periods. These three channels relate to (a) risk-taking behaviour, (b) the signalling effects of monetary policy and (c) the breaking of herding behaviour.

The risk-taking channel (see Borio and Zhu (2008)) refers to excessive risk-taking by financial market participants in times of low interest rates. For example, with respect to the recent credit crisis, Adrian and Shin (2008) have argued that the profitability of the business model of some structured investment vehicles, which led to massive increases in leverage and maturity mismatch, could have been curtailed significantly by a tighter monetary policy.

27 See Assenmacher-Wesche and Gerlach (2010) for a sceptical view.

28 It should be noted that several members of the ECB's Executive Board discussed this issue at a relatively early stage, showing some sympathy for the principle of leaning against the wind, while explaining the implicit link to the monetary analysis underlying the ECB's monetary policy strategy. See Issing (2003), Trichet (2005) and, more recently, Papademos (2008a), Stark (2009) and Trichet (2009).

The latter could have slowed down the issuance of asset-backed securities, as the supply of funds for securitisation activity had become very sensitive to financial market conditions.

At the theoretical level, a signalling channel has been suggested by Hoerova et al. (2009), who show that potentially small increases in the policy rate could have large effects on investment behaviour. In this model, monetary policy actions convey a central bank's information effectively, which, in turn, enables more efficient investment and better coordination among investors. In a related approach, Loisel et al. (2009) analyse the potential for herding behaviour when investors observe decisions of other entrepreneurs. Investors are more likely to fuel the bubble the more other entrepreneurs have been following the same trend before them. The authors find that raising policy rates may be effective in stopping herding and may, instead, persuade investors to base decisions on their own information set.

As regards the empirical support for these channels, some evidence has recently been provided that confirms the existence of the risk-taking channel.[29] These studies tend to find that riskier loans are issued in the wake of a period of low interest rates. The effectiveness of the other two theoretical channels is difficult to assess at the current stage, as very few central banks have actually implemented policies akin to leaning against the wind in the past.[30]

The third counterargument fielded against traditional scepticism about leaning against the wind relates to the costs of asset price boom-bust cycles. In theory, the consequences of bubbles for welfare are ambiguous.[31] Bubble paths can be consistent with individual optimising behaviour in general equilibrium.[32] But existing theoretical models use rather specific assumptions to allow for bubbles in general equilibrium, and tend to abstract from important aspects that make bubbles costly in the real world.[33] The fiscal burden of future generations and/or the increase in moral hazard caused by all kinds of public intervention are usually treated outside the models examining welfare implications of asset price bubbles. Furthermore, the scarce empirical evidence suggesting that bubbles are beneficial for long-term growth prospects only refers to a few developing countries. The reason is that developing countries' financial market inefficiencies and lending frictions are so large that circumventing some of these frictions during asset price booms can have a net beneficial effect. Admittedly, not all boom-bust cycles are detrimental and have significant real effects. That is also one of the reasons why mechanical asset price targeting is not a sensible option. The experience gained in the current crisis, however, would suggest that boom-bust cycles with the potential to trigger systemic crises do exist, and thus constitute a serious threat to global economic growth.

29 See, for example, Jimenez et al. (2007).

30 Some empirical evidence seemingly supporting the argument that monetary policy is too blunt an instrument, because the effects on asset prices are too small in comparison with the (negative) effects on the real economy, is not convincing in view of the Lucas-critique argument. Only in a policy regime in which the principle of leaning against the wind has explicitly been adopted could a test be conducted regarding the effectiveness of the signalling and herd-breaking channels.

31 See Fahri and Tirole (2009).

32 See Tirole (1985).

33 See Santos and Woodford (1997).

With respect to the appropriate policy reaction to the build-up of financial imbalances, there is a broad consensus among economists that monetary policy would hardly be the first best line of defence against, for example, systemic asset price cycles. This task would rather fall to regulatory and supervisory policies. But this does not diminish the importance of the issue for monetary policy-makers. It is almost certain that there will be situations in the future in which the central bank will have to reflect upon whether monetary policy should not supplement the former policies by leaning against the wind. If the past is any guide, monetary policy might be needed to support regulatory and supervisory policies on account of the fact that the latter will occasionally lag behind innovation-driven financial market developments, or because regulatory and supervisory policies are implemented too cautiously or too slowly.

Against this background, it is worth noting that the prominent role of money and credit in its monetary policy strategy[34] helps the ECB to assess developments in asset prices and the degree to which they pose a risk for price stability in the more distant future.[35] The ECB's monetary analysis, in particular, is a framework for the analysis of excess liquidity and credit creation, which may (among other channels of relevance for monetary policy) contribute to the emergence of unsustainable developments in asset valuations, and thus have implications for the appropriate policy stance. Detecting and understanding this link helps the ECB to form an opinion on whether an observed movement in asset prices might already reflect the fuelling of an unsustainable bubble. Constructed measures of "excess liquidity" and "excess credit" formation provide valuable quantitative evidence for the central bank. For example, such evidence may signal a looser monetary policy stance than that derived from the economic analysis and the projections of consumer price inflation. This, in addition to the more standard measures of asset price overvaluation explained earlier, would help to corroborate suspicions that a bubble might be forming. And, more generally, cross-checking between economic and monetary analyses – as embodied in the ECB's strategy – lengthens the horizon over which the ECB traces likely developments in consumer prices.

REFERENCES

Adalid, R. and Detken, C. (2007), "Liquidity shocks and asset price boom/bust cycles", *Working Paper Series*, No 732, ECB.

Adrian, T. and Shin, H.S. (2008), "Liquidity and leverage", *Staff Report*, No 328, Federal Reserve Bank of New York.

Agnello, L. and Schuknecht, L. (2009), "Booms and busts in housing markets: determinants and implications", *Working Paper Series*, No 1071, ECB.

Alchian, A. and Klein, B. (1973), "On a correct measure of inflation", *Journal of Money, Credit and Banking*, 1(5), pp. 173-191.

34 See ECB (2005).
35 See Moutot and Vitale (2009).

Allen, F. and Gale, D. (2000), "Bubbles and crises", *Economic Journal*, Vol. 110, pp. 236-255.

Alessi, L. and Detken, C. (2009), "'Real-time' early warning indicators for costly asset price boom-bust cycles: a role for global liquidity", *Working Paper Series*, No 1039, ECB.

Assenmacher-Wesche, K. and Gerlach, S. (2010), "Monetary policy and financial imbalances: facts and fiction", *Economic Policy*, 25(63), pp. 437-482.

Barrell, R., Davis, E.P., Karim, D. and Liadze, I. (2009), "Bank regulation, property prices and early warning systems for banking crises in OECD countries", mimeo.

Berg, A. and Pattillo, C. (1999), "Predicting currency crises: the indicators approach and an alternative", *Journal of International Money and Finance*, 18(4), pp. 561-586.

Bernanke, B. (2010), "Monetary policy and the housing bubble", speech presented at the annual meeting of the American Economic Association, Atlanta.

Bernanke, B. and Gertler, M. (2000), "Monetary policy and asset price volatility", in Federal Reserve Bank of Kansas, *New challenges for monetary policy*, Kansas City.

Bernanke, B., Gertler, M. and Gilchrist, S. (1998), "The financial accelerator in a quantitative business cycle framework", *NBER Working Paper Series*, No 6455, National Bureau of Economic Research.

Bordo, M. and Jeanne, O. (2002), "Boom-busts in asset prices, economic instability and monetary policy", *NBER Working Paper Series*, No 8966, National Bureau of Economic Research.

Bordo, M., Eichengreen, B., Klingebiel, D. and Martinez-Peria, M.S. (2001), "Is the crisis problem growing more severe?", *Economic Policy*, Vol. 32, pp. 51-82.

Borgy, V., Clerc, L. and Renne, J.-P. (2009), "Asset-price boom-bust cycles and credit: what is the scope of macro-prudential regulation", *Document de travail*, No 263, Banque de France.

Borio, C. and Drehmann, M. (2009), "Assessing the risk of banking crises – revisited", *Quarterly Review*, BIS, March.

Borio, C. and Zhu, H. (2008), "Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism?", *Working Paper Series*, No 268, BIS.

Breiman, L., Friedman, J.H., Olshen, R.A. and Stone, J.C. (1984), *Classification and regression trees*, Wadsworth.

Bussière, M. and Fratzscher, M. (2002), "Towards a new early warning system of financial crises", *Working Paper Series*, No 145, ECB.

Bussière, M., Frankel, J. and Mulder, C. (2009), "In defense of early warning signals", mimeo.

Chui, M. and Gai, P. (2005), *Private sector involvement and international financial crises: an analytical perspective*, Oxford University Press.

Congdon, T. (2005), *Money and asset prices in boom and bust*, Institute of Economic Affairs, London.

Detken, C. and Smets, F. (2004), "Asset price booms and monetary policy", in Siebert, H. (ed.), *Macroeconomic policies in the world economy*, Springer, Berlin, pp. 189-227.

Diamond, D.W. and Rajan, R.G. (2008), "The credit crisis: conjectures about causes and remedies", *American Economic Review*, 99(2), pp. 606-610.

ECB (2005), "Asset prices and monetary policy", *Monthly Bulletin*, April.

Fahri, E. and Tirole, J. (2009), "Collective moral hazard, maturity mismatch and systemic bailouts", *NBER Working Paper Series*, No 15138, National Bureau of Economic Research.

Fisher, I. (1932), *Booms and depressions*, Adelphi, New York.

Gerdesmeier, D., Reimers, H.-E. and Roffia, B. (2009), "Asset price misalignments and the role of money and credit," *Working Paper Series*, No 1068, ECB.

Goldberger, A. (1972), "Structural equation methods in the social sciences", *Econometrica*, Vol. 40, pp. 979-1001.

Goodhart, C. and Hofmann, B. (2000), "Do asset prices help to predict consumer price inflation?", *Manchester School*, pp. 122-140.

Gourinchas, P., Valdes, R. and Landerretche, O. (2001), "Lending booms: Latin America and the world", *Economia*, 1(2), pp. 47-99.

Helbling, T. and Terrones, M. (2003), "When bubbles burst", *World Economic Outlook*, Chapter 2, IMF.

Hoerova, M., Monet, C. and Temzelides, T. (2009), "Money talks", *Working Paper Series*, No 09-18, Federal Reserve Bank of Philadelphia.

Issing, O. (2003), "Monetary and financial stability: is there a trade-off?", speech presented at the BIS conference on Monetary Stability, Financial Stability and the Business Cycle, BIS, Basel.

Jimenez, G., Ongena, S., Peydro-Alcalde, J.L. and Saurina, J. (2007), "Hazardous times for monetary policy: what do twenty-three million bank loans say about the effects of monetary policy on credit risk?", *CEPR Discussion Paper Series*, No 6514, Centre for Economic Policy Research.

Kaminsky, G. and Reinhart, C. (1999), "The twin crisis: the causes of banking and balance of payments problems", *American Economic Review*, 89(3), pp. 473-500.

Kannan, P., Rabanal, P. and Scott, A. (2009), “Macroeconomic patterns and monetary policy in the run-up to asset price busts”, *Working Paper Series*, No 09/252, IMF.

Kindleberger, C. (1978), *Manias, panics and crashes: a history of financial crises*, Wiley, New York.

Kiyotaki, N. and Moore, J. (1997), “Credit cycles”, *Journal of Political Economy*, 2(4), pp. 297-333.

Kurozumi, T., Nishizaki, K. and Otani, A. (2010), “Financial imbalances and monetary policy: a counterfactual analysis of Japan’s asset price bubble in the later 1980s”, mimeo.

Loisel, O., Pommeret, A. and Portier, F. (2009), “Monetary policy and herd behaviour in new-tech investment,” mimeo.

Mendoza, E., and Terrones, M. (2008), “An anatomy of credit booms: Evidence from macro aggregates and micro data”, *NBER Working Paper Series*, No 14049, National Bureau of Economic Research.

Mishkin, F.S. (1990), “What does the term structure tell us about future inflation?”, *Journal of Monetary Economics*, 25(1), pp. 77-96.

Moutot, P. and Vitale, G. (2009), “Monetary policy strategy in a global environment”, *Occasional Paper Series*, No 106, ECB.

Papademos, L. (2008a), “Financial market excesses and corrections: a central banker’s perspective”, speech presented at the International Research Forum on Monetary Policy, Frankfurt.

Papademos, L. (2008b), “Opening address”, 5th ECB Central Banking Conference, Frankfurt.

Reinhart, C.M. and Rogoff, K.S. (2009), *This time is different*, Princeton University Press.

Rose, A. and Spiegel, M. (2009), “Cross-country causes and consequences of the 2008 crisis: early warning”, mimeo.

Santos, M.S. and Woodford, M. (1997), “Rational asset pricing bubbles” *Econometrica*, 65(1), pp. 19-58.

Schularick, M. and Taylor, A. (2009), “Credit booms gone bust: monetary policy, leverage cycles and financial crises, 1870-2008”, *NBER Working Paper Series*, No 15512, National Bureau of Economic Research.

Stark, J. (2009), “Monetary policy before, during and after the financial crisis”, speech presented at the University of Tübingen.

Tirole, J. (1985), “Asset bubbles and overlapping generations”, *Econometrica*, 53(6), pp. 1499-1528.

Tobin, J. (1969), “A general equilibrium approach to monetary theory”, *Journal of Money, Credit and Banking*, Vol. 1, pp. 15-29.

Trichet, J.-C. (2005), “Asset price bubbles and monetary policy”, MAS lecture, Singapore.

Trichet, J.-C. (2009), “Credible alertness revisited”, Federal Reserve Bank of Kansas City symposium on Financial Stability and Macroeconomic Policy, Jackson Hole.

ANNEX 1

BOOMS AND BUSTS IN HOUSING MARKETS: DETERMINANTS AND IMPLICATIONS[36]

The study by Agnello and Schuknecht (2009) analyses housing market booms and busts in 18 industrialised countries over the period from 1970 to 2007. The sample includes Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Ireland, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States. After identifying boom and bust episodes as major and persistent deviations of real housing price series from long-term trends, the authors estimate a panel probit model to examine what the main determinants of booms and busts are, and to what extent they impact on the probability of such events.

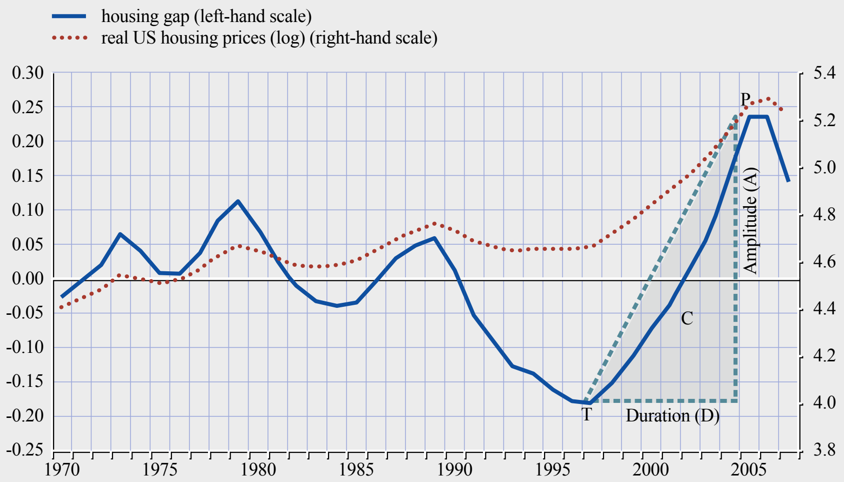
The method used to identify booms and busts consists of two steps. First, the procedure involves a "de-trending" of real housing price series and the identification of their "cycles", i.e. expansions and contractions. Second, based on the so-called "triangular methodology" proposed by Harding and Pagan (2002), the authors define the characteristics of the cyclical phases of housing markets in terms of persistence, magnitude and severity. The persistence is computed as the temporal distance between turning points in the de-trended real housing price series, while the magnitude is measured as the size of the change in the levels of the series from peak (*P*) to trough (*T*), and from trough to peak. Finally, the severity (or intensity) combines the persistence and magnitude for each phase *i* via a triangle where the base is the persistence (D_i), the height is the magnitude (A_i), and the severity is obtained as $C_i = D_i \times A_i \times 0.5$. Chart A1.1 illustrates the approach for the United States and, notably, the housing market boom that took place there in the late 1990s and early 2000s.

By separately sorting the values of C_i for upturns (C_i^u) and downturns (C_i^d), booms and busts are identified as those episodes falling into the first quartile of the empirical distributions of C_i^u and C_i^d. The characteristics of the identified booms and busts are reported in Table A1.1.

Analysing the identified booms and busts in more detail, the authors find that, over the period from 1970 to 2007, nine out of twenty-five identified boom episodes were immediately followed by busts. Looking at the (average) values of macroeconomic variables across boom-bust episodes (see Table A1.2), they find that, on average, real growth per capita was almost 3% lower during busts than during booms. Another significant difference is in real credit growth, which had averaged about 7% during the boom before falling to -2.2% in the bust.

[36] This annex was prepared by Luca Agnello and Ludger Schuknecht.

Chart A1.1 US housing market and triangular approximation



Source: Own calculations.

Notes: The housing price gap denotes the de-trended real housing price series. P and T indicate the peak and trough respectively. The shaded area C is the severity measure. Sample period: 1970-2007.

Table A1.1 Booms and busts

Boom phases					Bust phases				
Country	Years	Persistence	Magnitude	Intensity indicator [1]	Country	Years	Persistence	Magnitude	Intensity indicator [1]
SE	1997-2007	11	67.08	368.929	JP	1992-2006	15	-45.47	-341.055
FR	1998-2006	9	51.36	231.112	NL	1979-1985	7	-78.95	-276.339
UK	1997-2004	8	47.58	190.333	CH	1990-1999	10	-44.17	-220.842
NL	1971-1978	8	47.09	188.38	IE	1980-1987	8	-50.93	-203.702
ES	1986-1991	6	62.55	187.664	NO	1987-1993	7	-57.59	-201.556
US	1998-2005	8	41.95	167.793	UK	1990-1996	7	-56.85	-198.991
NO	1994-2001	8	40.73	162.914	BE	1980-1985	6	-58.06	-174.184
UK	1983-1989	7	43.31	151.592	NZ	1975-1980	6	-53.48	-160.434
ES	1999-2006	8	37.19	148.766	DK	1987-1993	7	-45.42	-158.977
IT	1999-2007	9	32.67	147.01	ES	1992-1998	7	-44.64	-156.233
NZ	2002-2007	6	48.76	146.279	FI	1990-1993	4	-71.45	-142.892
DK	1994-2001	8	34.36	137.422	SE	1980-1985	6	-44.48	-133.432
AU	1998-2004	7	36.97	129.41	IT	1993-1998	6	-40.36	-121.084
CA	2001-2007	7	36.93	129.264	IT	1982-1986	5	-47.12	-117.791
IE	1995-2000	6	40.56	121.674	FR	1991-1997	7	-30.05	-105.188
CH	1983-1989	7	34.70	121.459	ES	1979-1982	4	-52.38	-104.754
IT	1987-1992	6	40.12	120.354	FI	1974-1979	6	-33.00	-99.002
NL	1996-2001	6	31.10	93.311	US	1990-1997	8	-24.17	-96.672

Table A1.1 Booms and busts (cont'd)

	Boom phases					Bust phases			
Country	Years	Persistence	Magnitude	Intensity indicator [1]	Country	Years	Persistence	Magnitude	Intensity indicator [1]
JP	1986-1991	6	27.42	82.267	UK	1974-1977	4	-47.48	-94.955
CA	1986-1989	4	37.64	75.28	NO	1975-1983	9	-20.15	-90.684
DK	1983-1986	4	37.58	75.167	DE	1979-1982	4	-42.76	-85.514
SE	1986-1990	5	29.87	74.687	JP	1974-1978	5	-33.97	-84.922
FI	1996-2000	5	27.40	68.494	FR	1981-1985	5	-26.02	-65.054
FI	2002-2007	6	22.35	67.048	DE	2000-2007	8	-14.11	-56.455
FI	1987-1989	3	44.41	66.611	SE	1991-1993	3	-35.61	-53.408
Averages		**7**	**40.07**	**138.129**	**Averages**		**7**	**-43.95**	**-141.765**

Source: Own calculations.

Notes: The countries in the table are Australia (AU), Belgium (BE), Canada (CA), Denmark (DK), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), New Zealand (NZ), Norway (NO), Spain (ES), Sweden (SE), Switzerland (CH), the United Kingdom (UK) and the United States (US).

1) Computed using triangular approximation. Sample period: 1970-2007.

Interestingly, when looking at recent boom episodes (see last row of Table A1.2), the authors note that the average real economic growth per capita and credit growth did not differ much from the boom parts of earlier property price cycles. Therefore, they conclude that if past experience provides guidance, a pattern could be expected for the ongoing post-boom period that is similar to that of earlier ones: real GDP growth per capita would be very low and real credit growth would be negative over the average of the bust, which could last for the best part of a decade.

In order to identify factors that can serve as early warnings of booms and busts, and to analyse their predictive power, the authors estimate two separate panel probit models. The first (the boom model) looks at boom versus non-boom episodes, while the second (the bust model) looks at bust versus non-bust phases.

Table A1.2 Boom-bust phases in industrialised countries in the period from 1970 to 2007

					Average values over the boom-bust periods		
Sample of 9 countries		**Persistence**	**Magnitude**	**Intensity indicator [1]**	**Real GDP per capita (growth)**	**Short-term interest rates**	**Real credit (growth)**
Averages	Boom	5.8	40.79	118.69	3.13	9.19	6.87
	Bust	7.3	-51.44	-185.54	0.26	7.39	-2.20
	Difference	1.5	-10.65	-66.85	-2.87	-1.80	-9.07
Memo item:	Latest booms (average)	7.5	39.80	153.98	2.67	4.04	6.58

Source: Own calculations.

Note: 1) The sample of boom-bust countries includes Denmark, Finland, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Characteristics of the latest boom episodes are computed as the average values of the most recent boom episodes experienced by the following countries: Australia, Canada, Denmark, Finland, France, Ireland, Italy, the Netherlands, New Zealand, Norway, Spain, Sweden, the United Kingdom and the United States.

Therefore, these models differ only with respect to the definition of the dependent binary variable,[37] whereas the set of driving factors (i.e. the independent variables) of boom and bust episodes is the same.[38] Specifically, the authors consider the following set of controls: (a) the macroeconomic fundamentals, including real GDP per capita, short-term interest rates, domestic and global liquidity; (b) the population growth rate; and (c) structural financial indicators that account for the degree of credit market deregulation[39] and for the fragility of the banking system.[40] Results of the panel probit analysis are informative. First, a high level of GDP per capita, a high level of liquidity (both at the local and at the "global" level) and lower interest rates increase (decrease) the likelihood of boom (bust)

[37] Basically, in the boom model, the binary dependent variable takes the value of one if a boom occurs, and zero otherwise. Similarly, in the bust model, the dependent variables take the value of one only if a bust occurs, and zero otherwise.

[38] It should be noted that, in order to avoid potential endogeneity problems, one-period lagged variables enter the models.

[39] The basic assumption tested is that a high level of deregulation may, in principle, impact on the competition level in the banking sector and broaden households' access to mortgage credit (see Diamond and Lea (1992)), thereby increasing the probability of booms.

[40] Using the information on banking crises that have occurred since 1970 (see, for example, Caprio and Klingebiel (2003) and Laeven and Valencia (2008)), the authors test whether the occurrence of such crises exacerbates the effects of bust episodes.

Table A1.3 Determinants of booms and busts in the housing market

Explanatory variables		Dependent variable: incidence of booms/busts in housing markets					
		Models					
		Booms			Busts		
		(1)	(2)	(3)	(4)	(5)	(6)
Economic fundamentals	Lagged real GDP per capita (growth)	0.3646 3)	0.3551 3)	0.3480 3)	-0.1991 3)	-0.1746 3)	-0.1696 3)
		[0.0558]	[0.0583]	[0.0612]	[0.0416]	[0.0430]	[0.0439]
	Lagged short-term interest rate	-0.1435 3)	-0.1776 3)	-0.1403 3)	0.0966 3)	0.1243 3)	0.1078 3)
		[0.0217]	[0.0252]	[0.0276]	[0.0200]	[0.0232]	[0.0275]
	Lagged local real credit (growth)	0.0236 2)	0.0224 2)	0.0247 2)	-0.0451 3)	-0.0440 3)	-0.0386 3)
		[0.0098]	[0.0102]	[0.0121]	[0.0135]	[0.0136]	[0.0138]
	Lagged global liquidity (M3 growth)	0.2667 3)	0.2460 3)	0.2554 3)	-0.1876 3)	-0.1631 3)	-0.1736 3)
		[0.0618]	[0.0637]	[0.0662]	[0.0577]	[0.0591]	[0.0604]
Demographic	Lagged population growth		0.9842 3)	1.0257 3)		-0.6599 2)	-0.5211 1)
			[0.3238]	[0.3703]		[0.2602]	[0.2680]
Structural indicators	Deregulation (dummy)			0.5716 1)			-0,0778
				[0.3156]			[0.2397]
	Banking crises (dummy)			-1.2954 3)			0.6092 3)
				[0.3512]			[0.2280]
	Pseudo R-squared	0.26	0.27	0.31	0.22	0.24	0.25
	Quadratic probability score (QPS)			0.38			0.36

Source: Own calculations.

Notes: Panel probit estimation.

1) Significant at 10%; 2) Significant at 5%; 3) Significant at 1%. Column 1 reports coefficient estimates of a model where only fundamentals are accounted for. In Column 2, the influence of the demographic factor has also been considered. Finally, Column 3 reports estimates of the extended model that also includes structural financial indicators.

Table A1.4 Boom and bust predictions

Horizon	Number of correctly predicted events: Booms (as of mid-1990s)	Number of correctly predicted events: Busts (as of late 1980s)
1st year	7 out of 15	3 out of 15
2nd year	12 out of 15	8 out of 15
3rd year	14 out of 15	10 out of 15

Source: Own calculations.

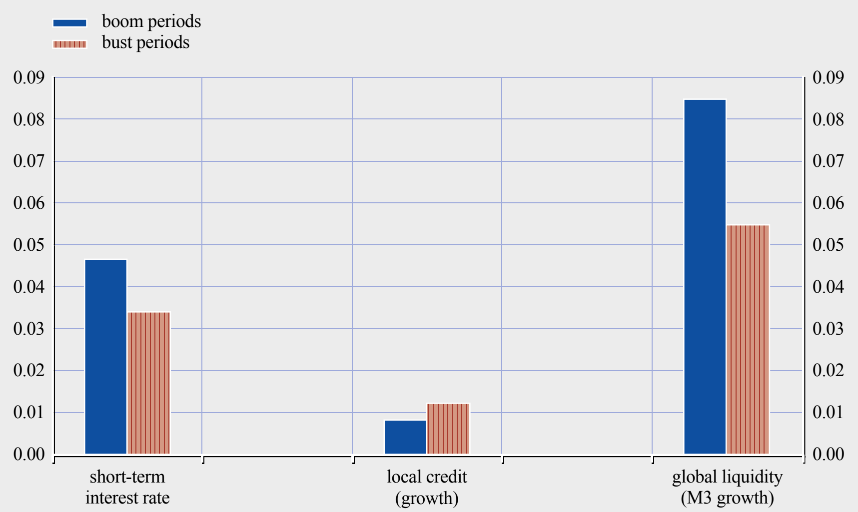
episodes. Moreover, regulatory policies that slow down money and credit growth are also expected to curtail boom probabilities (see Table A1.3).

Second, the model is quite successful in identifying boom episodes at an early stage. In fact, the estimated models predict booms and busts in almost all cases at the latest in the third year (see Table A1.4).

Interestingly, looking at the marginal contribution (i.e. the *elasticities*) of each leading indicator in determining the occurrence of booms and busts (see Chart A1.2), the study concludes that interest rate policies can have a significant influence on the probability of booms and busts occurring, either directly or indirectly via their effect on money and credit. Finally, the importance of global liquidity suggests that cross-border externalities of overly lax policies in boom periods may be significant.

This study falls into a line of research on the determinants of boom-bust cycles (see also the two other annexes that describe the models developed by Gerdesmeier et al. (2009) and Alessi and Detken (2009)). The findings have important policy implications. First, by focusing on major and persistent deviations from trend, the

Chart A1.2 Marginal effects (at mean)



Source: Own calculations.

method used for the identification of booms and busts identifies only those that are likely to have important macroeconomic implications. Second, the estimated probit models have a strong record in identifying notably booms at an early stage. Third, the statistical significance of interest rate and liquidity variables confirm a potential role for monetary and supervisory policies if the objective is to prevent major boom-bust cycles.

REFERENCES

Agnello, L. and Schuknecht, L. (2009), "Booms and busts in housing markets: determinants and implications", *Working Paper Series*, No 1071, ECB.

Alessi, L. and Detken, C. (2009), "'Real-time' early warning indicators for costly asset price boom-bust cycles: a role for global liquidity", *Working Paper Series*, No 1039, ECB.

Caprio, G. and Klingebiel, D. (2003), "Episodes of systemic and borderline financial crises", World Bank, mimeo.

Diamond, D.B. and Lea, M.J. (1992), "Housing finance in developed countries: an international comparison of efficiency", *Journal of Housing Research*, 2(1), pp. 1-14.

Gerdesmeier, D., Reimers, H.-E. and Roffia, B. (2009), "Asset price misalignments and the role of money and credit", *Working Paper Series*, No 1068, ECB.

Harding, D. and Pagan, A. (2002), "Dissecting the cycle: a methodological investigation", *Journal of Monetary Economics*, Vol. 49, pp. 365-381.

Laeven, L. and Valencia, F. (2008), "Systemic banking crises: a new database", *Working Paper Series*, No 08-224, IMF.

ANNEX 2

"REAL-TIME" EARLY WARNING INDICATORS FOR COSTLY ASSET PRICE BOOM-BUST CYCLES: A ROLE FOR GLOBAL LIQUIDITY

1 INTRODUCTION[41]

Alessi and Detken (2009) address a traditional argument against "leaning against the wind" policies (see Section 5 of this chapter), namely the lack of appropriate *real-time* information.

More precisely, the study addresses four questions. First, do indicators exist that, when used in the simplest early warning indicator (signalling) approach, provide useful information to enable decision-makers to predict potentially costly asset price booms in a timely manner? This question is addressed using historical data, but in an as realistic as possible "real-time" experiment. Second, are financial or real indicators more useful in predicting costly asset price cycles? Third, considering the information content of financial variables, are global or domestic indicators better suited to provide early warning signals? And fourth, do money or credit-based liquidity indicators show a superior performance in predicting costly asset price boom-bust cycles?

With respect to deciding on what is an acceptable performance for an indicator, this analysis goes beyond the standard way of searching for indicators with noise to signal ratios below 1, but explicitly takes into account the preferences of policy-makers, i.e. their relative aversion with respect to type I and type II errors.[42] Based on these preferences, a measure of usefulness is introduced, which results in a far tougher criterion to assess the performance of the indicators.

2 "REAL-TIME" SIGNALLING APPROACH AND RISK AVERSION

The signalling approach described in Kaminsky et al. (1998) and Kaminsky and Reinhart (1999) has frequently been employed to predict foreign exchange and banking crises, but not for predicting asset price boom-bust episodes. The advantage of studying asset price cycles is that there are a sufficient number of them and that one can also explore the characteristics of the group of relatively more costly cycles in comparison with those of the less costly cycles.

41 This annex was prepared by Lucia Alessi and Carsten Detken.

42 Demirgüç-Kunt and Detragiache (1999) introduced the loss function approach to the early warning literature. See also Bussière and Fratzcher (2008) and Borio and Drehmann (2009) for more recent applications.

The signalling approach is one of the two threshold approaches using a binary dependent variable. The other approach is the discrete-choice (probit/logit) model.[43] In the signalling approach, a warning signal is issued when an indicator exceeds a threshold, here defined by a particular percentile of an indicator's own distribution. This approach assumes an extreme non-linear relationship between the indicator and the event to be predicted.

Each quarter of the evaluation sample for each indicator falls into one of the following quadrants of the matrix below.

	Costly boom-bust cycle (within the next six quarters)	**No costly boom-bust cycle (within the next six quarters)**
Signal issued	A	B
No signal issued	C	D

"A" denotes the number of quarters in which an indicator provides a correct signal, "B" the number of quarters in which a wrong signal is issued. Correspondingly, "C" is the number of quarters in which the indicator does not issue a signal despite a costly boom-bust cycle starting within the subsequent six quarters. "D" denotes the number of quarters in which the indicator does not provide any warning signal, and rightly so.

A/(A+C) is the number of good signals expressed as a ratio of all quarters in which a costly boom-bust cycle followed within six quarters. B/(B+D) represents the share of bad signals as a ratio of all quarters in which no such booms followed. B/(B+D) can be considered the share of type II errors (event not occurring, but signal issued, as share of B+D), or simply the share of false alarms. Correspondingly, C/(A+C) is labelled the share of type I errors (event occurring, but no signal issued, as share of A+C), or simply the share of missed costly boom-bust cycles.

Kaminsky et al. (1998) and the literature following their seminal contribution assess the usefulness of an indicator by computing the adjusted noise-to-signal ratio (aNtS), defined as [B/(B+D)]/[A/(A+C)]. A useful indicator is supposed to have an aNtS <1. A value of 1 would result if an indicator provides purely random signals.

The criterion of aNtS <1, however, is only a necessary condition for an indicators' usefulness in practice, as: (a) the resulting type I and type II errors might be unacceptable to policy-makers, given their preferences; and (b) the gain associated with receiving signals from an indicator, as compared with ignoring it, which also depends on preferences, might be irrelevant.

43 See Chui and Gai (2005) for a survey, Edison (2003) for relevant discussions and Annex 3 to this chapter.

A loss function is defined for a central banker to analyse the usefulness and to rank indicators.[44] The loss function is defined as:

$$L = \theta \frac{C}{A+C} + (1-\theta) \frac{B}{B+D} \qquad (1)$$

θ is the parameter revealing the policy-maker's relative risk aversion between type I and type II errors. The loss can be easily interpreted. It is the preference-weighted sum of type I and type II errors. A θ lower than 0.5 reveals that the central banker is less averse towards missing a signal for a costly asset price boom-bust cycle than towards receiving a false alarm.

The usefulness (Usef) of an indicator can then be defined as:

$$\text{Usef} = \min[\theta;\, 1-\theta] - L \qquad (2)$$

A central banker can always realise a loss of min[θ;(1−θ)] by disregarding the indicator. If θ is smaller than 0.5, the benchmark is obtained by ignoring the indicator, which amounts to never having any signals issued, so that A=B=0. The resulting loss, according to equation (1), is θ. If θ exceeds 0.5, the benchmark for the central bank is to assume that there is always a costly boom developing, i.e. to assume that a signal is always issued, so that C=D=0. The resulting loss is (1–θ). An indicator is then useful to the extent that it produces a loss lower than min[θ;(1–θ)] for a given θ.

Another difference to the standard literature using the signalling approach is that the performance of the indicators reported here is based on "real-time" analysis. Indeed, at each point in time, the thresholds for the indicators are set on the basis of past observations. Trends are calculated recursively only, using available data up to each point in time. Therefore, the signals obtained are as they would have been obtained in the period they refer to. There is, however, one notable exception and one caveat. The percentiles of the distribution beyond which a warning signal is issued are optimised ex post for each indicator, using all relevant boom-bust cycles in the evaluation sample of the period between 1979 and 2002. Unfortunately, a strictly real-time approach, i.e. choosing the optimal percentile of the distribution at each point in time, is not feasible. Indeed, it would be necessary to have, at each point in time, at least one past costly asset price boom-bust cycle in order to evaluate the indicator's performance. In the approach used here, the specific indicator thresholds for each quarter are derived by applying the fixed optimal percentile to the distribution of the data available up to each specific point in time. Thresholds for each indicator are thus time and country-dependent.

44 See for comparison variations in Demirgüç-Kunt and Detragiache (1999) and Bussière and Fratzscher (2008).

The caveat is that the most recent vintage of data is used, and not a true real-time data set with unrevised data. Nevertheless, conservative lags are used to proxy for standard publication lags, and thus real-time data availability.

3 IDENTIFICATION OF ASSET PRICE BOOMS

We start by mechanically defining asset price boom episodes for 18 OECD countries in the period from the first quarter of 1970 to the fourth quarter of 2007.[45] The real aggregate asset price indices have been provided by the Bank for International Settlements (BIS) and are weighted averages of equity prices, residential and commercial property prices, and are deflated with the national consumption deflators.[46] An aggregate asset price boom is defined as a period of at least three consecutive quarters in which the real value of the index exceeds the recursive trend plus 1.75 times the recursive standard deviation of the series. The recursive trend is calculated with a very slowly adjusting Hodrick-Prescott filter (λ=100,000), taking into account only data up to the respective quarter.

A distinction is then made between aggregate asset price booms that have little consequences for the real economy and those that have significant effects. The definition of a high-cost boom is chosen in such a way as to reasonably split the sample of 45 booms, for which there was three years of post-boom GDP data, into two groups so that the low-cost booms can function as a control group.[47] A high-cost boom is defined as a boom that is followed by a three-year period, in which overall real GDP growth has been at least three percentage points lower than potential growth. In this way, the sample of 45 classifiable booms (out of 60 identified booms) is divided into 29 high-cost and 16 low-cost booms.

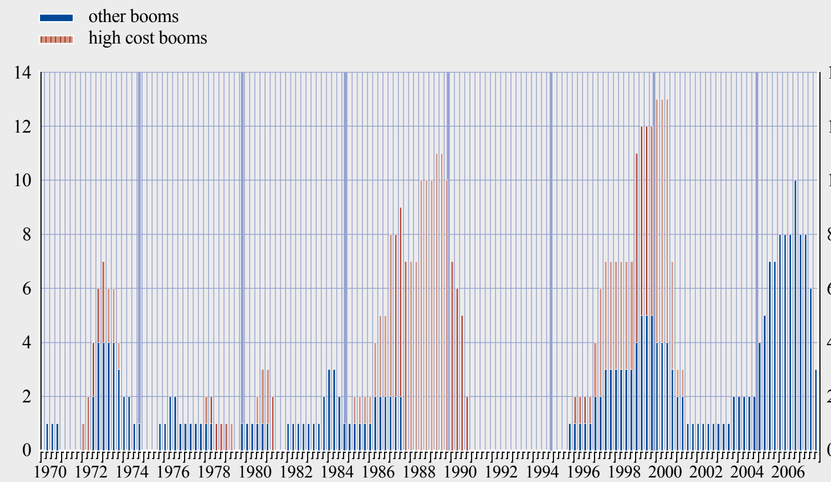
Chart A2.1 shows the number of countries experiencing aggregate asset price booms at each point in time. There have basically been three major waves of asset price booms since the 1980s. In terms of the number of countries affected, the first wave peaked in 1989, the second in 2000 and the third in early 2007. While the first wave of cycles were all high-cost booms, only about 60% of the second wave has been classified as such. The third wave could not be classified explicitly, as three-year post-boom GDP data are not yet available, but an out-of-sample exercise was performed to detect indicators which would predict it to be high-cost.

45 The countries are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Japan, the Netherlands, Norway, New Zealand, Spain, Sweden, Switzerland, the United Kingdom and the United States.

46 Aggregate instead of individual asset class price indices are used as growing financial imbalances were also of interest, which could potentially be addressed by means of timely adjustments to the monetary policy stance. As the interest rate is a relatively blunt tool affecting the whole range of asset prices, it is more likely to be used in episodes when a boom is identified in an aggregate index.

47 15 of the identified booms cannot be classified because three years of post-boom GDP data are not (yet) available.

Chart A2.1 Number of countries (out of 18) experiencing aggregate asset price booms



Source: Own calculations.

4 DATA AND INDICATORS

A set of 18 real and financial variables, and up to six different transformations of these variables – overall 89 indicators – are tested with regard to their suitability as early warning indicators for high-cost asset price boom-bust cycles within a six-quarter forecasting horizon. Variables related to the real side of the economy are GDP, consumption, investment and housing investment (all in real terms). Financial variables are consumer price-deflated equity, housing and aggregate asset prices, the term spread, real effective exchange rates, real and nominal three-month interest rates and ten-year bond yields, real M1, real M3, real private credit and real domestic credit. Furthermore, real money and credit growth rates from endogenous business cycle and asset price components are corrected by means of recursive VAR models.[48] In addition, consumer price inflation is also evaluated. Moreover, GDP (at PPP) weighted averages of the 18 countries of seven financial variables (private credit, M1, and M3 all as ratios to GDP, nominal short rates, and the VAR shocks for M1, M3 and private credit growth) are tested, which have been labelled global financial variables.

Several transformations of the variables are computed in order to check for their forecasting performance. Variables are used (if applicable) as year-on-year growth rates, six-quarter cumulated growth rates, deviations ("gaps") from a recursive HP trend, deviations from a HP trend of the ratio to GDP and levels. For housing prices, both seasonally adjusted and non-seasonally adjusted data are used. All other variables, except aggregate asset prices, equity prices, exchange rates and interest rates, are seasonally adjusted.

48 See Adalid and Detken (2007) for a description of the methodology for deriving these shocks. Here, however, the VARs are estimated recursively to mimic real-time data availability, and six-quarter moving averages of the derived shocks are used.

In order to proxy for data availability at the time decisions have to be taken, a publication lag of one quarter is generally assumed. This means that an indicator is calculated for each quarter, with variables lagged by one quarter. Housing price indices are different, however. For some countries, private residential housing prices are available only annually or biannually, and publication lags vary significantly. Given the country-specific information collected, the following lags are applied in the analysis: most countries' housing and aggregate asset price indices are applied with a one-quarter lag, except in the case of France, Italy, Japan and Denmark, for which two-quarter lags are used, and Germany, which is lagged by four quarters.

5 RESULTS

The following procedure is used to compare the forecasting performance for high-cost boom episodes within a six-quarter horizon for the 89 indicators: in a first step, the percentile is optimised in order to calculate the thresholds for each indicator by means of a grid search for the best percentile in the range of [0.05-0.95] in steps of 0.05. It is imposed that the percentile has to be the same for all countries in the sample. The common percentile chosen is the one that minimises the aggregate loss function (1) over all countries. The evaluation statistics reported are the average statistics across countries.

A ranking of the 89 indicators is computed for different values of θ (0.2, 0.3, 0.4, 0.5, 0.6 and 0.8). The evaluation period is the period from the first quarter of 1979 to the first quarter of 2002. There are 24 high-cost booms in this evaluation window.

When computing the resulting figures for A, B, C and D of the matrix shown above, boom periods as of the fourth consecutive quarter were excluded from the evaluation, since a warning signal would, by then, not really be useful anymore and it might not be advisable to mix early warning signals with signals during an established boom episode.

Table A2.1 summarises the most important information for the single best indicator for different θ. Constructing early warning indicators in this simple

Table A2.1 Selected results for the best indicators: global M1/GDP, global private credit/GDP and real GDP

	Usef	Good calls	False alarms		Usef	Good calls	False alarms
	θ=0.2				θ=0.3		
GlobM1	0.03	0.38	0.06	GlobM1	0.07	0.38	0.06
	θ=0.4				θ=0.5		
GlobPC	0.14	0.82	0.32	GlobPC	0.25	0.82	0.32
	θ=0.6				θ=0.8		
GlobPC	0.17	0.88	0.41	GDPR	0.07	0.99	0.63

Source: Own calculations.

Notes: GlobM1: global M1/GDP; GlobPC: global private credit/GDP; GDPR: real GDP. All indicators are recursively de-trended.

way seems to provide useful information for the prediction of costly asset price booms in the case of relatively balanced preferences of the policy-maker. For example, Table A2.1 reveals that taking the average over all countries with balanced risk aversion between type I and type II errors (θ=0.5), using the global private credit gap, defined as the PPP-GDP weighted average of de-trended private credit to GDP ratios, would reduce the preference-weighted errors, i.e. the loss, by 25 percentage points in comparison with a situation in which the policy-maker would ignore the indicator. The private credit gap would signal a costly asset price boom in 82% of quarters that are actually followed by a costly boom within six quarters. The private credit gap would issue a false alarm in 32% of the cases in which no costly boom follows. Furthermore, the analysis reveals that the average lead time is 5.5 quarters (not shown in Table A2.1). Most importantly, 95% of the booms are signalled in at least one of the six preceding quarters (or in one of the first three boom quarters).

Table A2.1 also reveals that the usefulness of the early warning model is not very great when policy-makers have a clear preference for either type I or type II errors. Overall losses are lowest for very low and very high θ, but the gain in computing an early warning indicator, in comparison with disregarding it, is only marginal for θ equal to 0.2, 0.3 and 0.8. In the case of rather unbalanced preferences, the aversion to one or the other type of errors is so high that it is hard to beat the benchmark, which is disregarding the indicator. This holds true despite the fact that aNtS are excellent by the standards of the literature, i.e. much closer to zero than to one.

An additional argument suggesting that the aforementioned indicators are useful can be derived when the ten low-cost booms in the chosen evaluation period are used as control group. The best five indicators for the overall average (θ=0.4) are transformations of the real aggregate asset price index that is used to define the boom episodes. It is not surprising that the aggregate asset prices themselves are able, at some threshold, to predict a boom. The interesting point is that with respect to low-cost booms, there is no other variable that contains more information, in contrast to the high-cost boom exercises.[49] This seems to suggest that there is genuine information in private credit gaps, for instance, for predicting costly asset price boom episodes.

With respect to the question as to whether real or financial variables contain more information for predicting costly asset price boom-bust cycles, the results suggest that financial indicators perform better. Global private credit gaps and, for the three lower θ, also the global M1 gap dominate. Focusing on euro area countries only, the dominance of financial variables is even more evident.

49 An interesting observation, which is compatible with the previous argument, is that the higher θ, the more prominent the aggregate asset price index appears in the ranking of indicators, which is also visible in Table 1. This shows that the more averse the policy-maker is to missing a boom, the more difficult it is for any other indicator to provide relatively more useful warning signals than the asset price index itself.

Concerning the question as to whether the more useful financial variables are global or domestic variables, the verdict is very clear for the results of the 18 countries. Global credit and global money are the best indicators. Focusing on euro area countries only, de-trended domestic long and short-term nominal interest rates, as well as domestic inverse M1-velocity gaps and cumulated M1 growth rates, are often nearly as useful as the global private credit gaps. But overall, global liquidity measures, especially but not only those based on credit, seem to be the best indicators. This result is certainly linked to the strong international correlation of asset price booms.[50]

What remains is the question as to whether money or credit-based liquidity measures perform better. The results suggest that the differences between money (M1) and private credit are not very large, but that, overall, the global credit gap is the best early warning indicator. The fact that M1 performs better than M3 requires further investigation with respect to the underlying reason for the indicator property of money. M1 focuses on the monetary policy stance, while M3 would suggest the role of money as a summary statistic of banks' balance sheets.

It was also tested whether joint indicators can further improve the usefulness of the signalling approach. Joint indicators imply that a warning signal is issued only when both indicators exceed their respective optimal thresholds (see Borio and Lowe (2002)). The matrix grid search is performed and all percentile combinations of two joint indicators each in the range [0.05-0.95] were tested with 0.05 steps in order to find the combination minimising the loss function for six different values of θ. The focus was on the two best indicators, the global private credit gap and the global M1 gap, and these were combined with 16 of the better-performing indicators.

Table A2.2 presents the results for the best joint and single indicators for the weighted average of the euro area countries, requiring all countries to adopt the same percentiles per indicator for $\theta=0.4$. The usefulness of joint indicators improves only slightly over the single best indicator. Improvements of the aNtS are more sizable (reduction close to 50%), which is achieved by eliminating a large number of false alarms. The overall best indicator (at $\theta=0.4$) for the

50 See also Ciccarelli and Mojon (2010) who find evidence of a large global component in domestic consumer price inflation.

Table A2.2 Comparison of the best joint and single indicators – global private credit/GDP (de-trended) and the real long-term interest rate (de-trended)

Indicators	Usefulness	Booms called	Good calls	False alarms	aNtS	Coefficient of variation across countries
GlobPC and LRR	0.19	0.63	0.60	0.09	0.14	0.76/0.67
GlobPC	0.17	0.63	0.63	0.14	0.23	0.38

Source: Own calculations.
Notes: GlobPC: global private credit/GDP (de-trended); LRR: real long-term interest rate (de-trended).

weighted euro area average would set a simultaneous 90th percentile threshold for the global private credit gap and a 55th percentile threshold for de-trended (negative of) real long-term bond yields (i.e. a de-trended real bond yield only slightly lower than the median). 60% of periods in which a costly boom followed within six quarters have been correctly signalled. False alarms are issued in only 9% of periods not followed by a costly boom. The aNtS is 0.14, and the average lead time (not shown) 5.4 quarters. Interesting to note is that the coefficient of variation of the optimal percentile derived for each country separately is much larger for both of the joint indicators (0.76 and 0.67 respectively) than for the single indicator (0.38).[51] This suggests that selecting a common threshold for a group of countries might be more robust with a single-indicator approach.

Finally, an out-of-sample exercise is carried out by using the best indicators to analyse whether the most recent wave of asset price booms in the period from 2005 to 2007 would have been predicted to be high-cost. In this respect, the global private credit gap had been sending persistent and early warning signals, while the global money (M1) gap had not. From a global perspective, the tightening of monetary policies in the second half of the 2000s was clearly visible in developments of M1 during the evaluation window, while credit growth was still strong enough to exceed the derived optimal threshold.

6 CONCLUDING REMARKS

The results show that some indicators perform very well with regard to standard evaluation criteria such as the aNtS, even if the optimal percentiles are forced to be the same for all countries (all 18 countries and the eight euro area countries respectively). The usefulness of the indicators for a policy-maker, however, depends crucially on his/her relative preferences with respect to missed crises and false alarms. In the case of relatively balanced preferences, the best indicator reduces the preference-weighted sum of type I and type II errors by as much as 25 percentage points in comparison with a situation in which the indicator is ignored.

With respect to the other three questions mentioned earlier, the results of this analysis would suggest that financial variables contain more information for predicting costly asset price booms than the real indicators tested, that global financial indicators perform better than domestic ones and that global credit outperforms global money, though often by a very small margin.

The evidence presented in this study shows that the often claimed unavailability of timely warning indicators is unlikely to be a major hindrance for policies of “leaning against the wind”, if these were deemed to be desirable by policy-makers.

51 This is a result that is also typical for the other joint indicators evaluated.

REFERENCES

Adalid, R. and Detken, C. (2007), "Liquidity shocks and asset price boom/bust cycles", *Working Paper Series*, No 732, ECB.

Alessi, L. and Detken, C. (2009), "'Real-time' early warning indicators for costly asset price boom-bust cycles: a role for global liquidity", *Working Paper Series*, No 1039, ECB.

Borio, C. and Lowe, P. (2002), "Asset prices, financial and monetary stability: exploring the nexus" *Working Paper Series*, No 114, BIS, Basel.

Borio, C. and Drehmann, M. (2009), "Assessing the risk of banking crises – revisited", *Quarterly Review*, March, BIS, Basel.

Bussière, M. and Fratzscher, M. (2002), "Towards a new early warning system of financial crises", *Working Paper Series*, No 145, ECB.

Chui, M. and Gai, P. (2005), *Private sector involvement and international financial crises*, Oxford University Press.

Ciccarelli, M. and Mojon, B. (2010), "Global inflation", *Review of Economics and Statistics*, 92(3), pp. 524-535.

Demirgüç-Kunt, A. and Detragiache, E. (1999), "Monitoring banking sector fragility: A multivariate logit approach with an application to the 1996-97 banking crisis", *Policy Research Working Paper*, No 2085, World Bank.

Edison, H. (2003), "Do indicators of financial crises work? An evaluation of an early warning system", *International Journal of Finance and Economics*, 8(1), pp. 11-53.

Kaminsky, G., Lizondo, S. and Reinhart, C.M. (1998), "Leading indicators of currency crises", *Staff Papers*, 45(1), IMF, pp. 1-48.

Kaminsky, G. and Reinhart, C. (1999), "The twin crises: the causes of banking and balance-of-payments problems", *American Economic Review*, 89(3), pp. 473-500.

ANNEX 3

AN EARLY WARNING INDICATOR MODEL FOR ASSET PRICE MISALIGNMENTS: THE ROLE OF MONEY AND CREDIT

I IDENTIFYING ASSET PRICE BUSTS [52]

This annex summarises the analysis of Gerdesmeier et al. (2009), focusing on the selection and prediction of "asset price bust" episodes. This focus is motivated by the view that busts are more damaging for macroeconomic stability, recognising that not all booms in asset prices end in busts.[53] By implication, the analysis does not discriminate between high and low-cost busts, in contrast to the distinction between high and low-cost booms in other studies.

A variety of approaches has been used in the literature to identify asset price busts. For instance, Bordo and Jeanne (2002) define a bust as a period in which the three-year moving average of the growth rate of asset prices is smaller than the average growth rate less a multiple (1.3 in the case in question) of the standard deviation of growth rates. In a similar vein, a study by the IMF (2009) defines busts as periods in which the four-quarter trailing moving average of the annual growth rate of asset prices, in real terms, falls below a fixed threshold, which is set at -5% for house prices and at -20% for stock prices. These thresholds are roughly equal to the average growth rate of the respective asset prices across the whole sample less one times the standard deviation of the growth rates.

The selection of episodes of asset price busts in Gerdesmeier et al. (2009) is based on a combination of the methodologies presented in the literature.[54] In particular, several studies have focused separately on stock prices or house prices. In other cases, the composite asset price indicator constructed at the Bank for International Settlements (BIS) has been used, which is calculated as the weighted average of equity, residential and commercial property prices, deflated with the national consumption deflators.[55] This indicator was developed for several of the major industrialised countries, thereby summarising the information contained in the separate movements of the three asset prices, i.e. equities and residential and commercial property. The intention is that such

52 Prepared by Dieter Gerdesmeier and Barbara Roffia.
53 In the signalling approach, this issue is usually taken into account by differentiating between "high-cost" and "low-cost" booms (see, for example, Detken and Smets (2004)).
54 See the methodologies developed by Berg and Pattillo (1999) and Andreou et al. (2007).
55 See Borio et al. (1994) and Arthur (2005).

an index would facilitate the comparison of the broad asset price movements over time and across countries, give some empirical content to notions of general asset price inflation and deflation, and highlight patterns of behaviour that would otherwise remain undetected.

The composite asset price indicator is calculated by combining the stock price index with the house price index (both in the form of quarter-on-quarter growth rates) as follows:

$$C = \o_1 \cdot \textit{Stock prices} + \o_2 \cdot \textit{House prices} \tag{1}$$

where $\o_1$ is normalised to 1 and $\o_2 = \sigma_{sp}/\sigma_{hp}$ (i.e. the ratio of the standard deviation of the two variables). The weight is calculated recursively throughout the sample period in order to take into account the information available up to each moment in time. This approach is a standard practice in the literature on currency crises, whereby the bust indicators are usually obtained by statistical analysis of the exchange rate and official international reserve series, whereby the weighting scheme is the inverse of the variables' conditional variance. A bust is defined on the basis of this composite indicator, and it is denoted as a situation in which the composite indicator has declined at the end of the rolling period (specifically, of r=12 quarters) to below its mean (denoted as $\bar{C}$) minus a factor of $\delta = 1.5$ times the standard deviation (σ_c) in the period from 1 to $(t+r)$ with respect to its maximum reached in the same period, i.e.:[56]

$$Dum_{t+r} = 1 \; iff \; C_{t+r} \leq \bar{C}\Big|_t^{t+r} - \delta\sigma_c\Big|_{1t}^{t+r} \tag{2}$$

where a bust is denoted with a value of 1 of the "dummy bust" variable (*dum*). Given the interest in predicting a bust several months ($T=8$ quarters) ahead, a new "bust dummy" (*C8*) is defined by making use of the previously derived dummy (*dum*)[57]:

$$C8_t = 1 \; iff \sum_{K=1}^{8} dum_{t+k} > 0, \tag{3}$$

where the signalling horizon is defined as the period within which the indicator would be expected to be able to signal a bust up to eight quarters ahead. Thus, a signal that is followed by a bust within two years is labelled as a "good" signal, while a signal not followed by a bust within that period of time is called a "false" signal.

Based on a sample comprising 17 OECD countries[58] and covering the period from the first quarter of 1969 to the third quarter of 2008, Table A3.1 reports the overall number of crises (93) detected with this method. More precisely,

56 The threshold used generally comprises between one and three standard deviations below the mean. The greater the value of the factor, the smaller the number of identified busts.

57 See Berg and Pattillo (1999) for more details.

58 Australia, Canada, Denmark, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

Table A3.1 Asset prices busts detected using the composite indicator

(based on a sample of 17 countries)

Country	No of busts	Country	No of busts	Country	No of busts
AU	6	IT	2	ES	6
CA	7	JP	6	SE	6
DK	4	NL	6	CH	6
DE	6	NZ	5	UK	3
FR	3	NO	9	US	6
IE	6	PT	4		

Source: Own calculations.

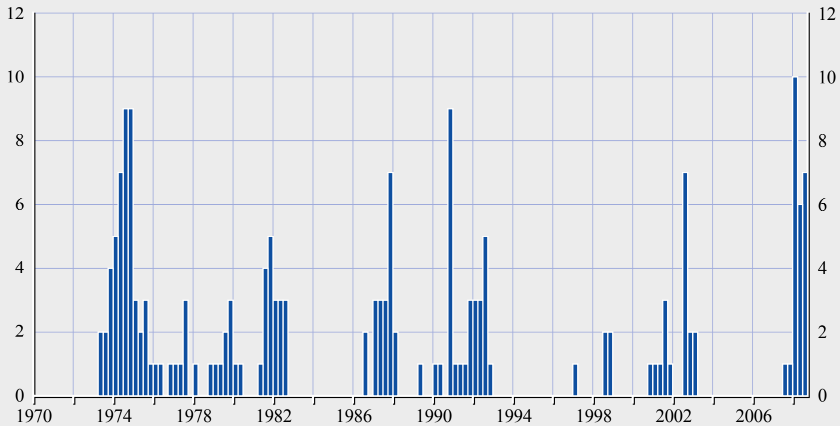
Note: The countries in the table are: Australia (AU), Canada (CA), Denmark (DK), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), the Netherlands (NL), New Zealand (NZ), Norway (NO), Portugal (PT), Spain (ES), Sweden (SE), Switzerland (CH), the United Kingdom (UK) and the United States (US).

the countries in the southern and central part of Europe (i.e. France, Germany, Italy, Portugal, Spain and Switzerland) account for about 30% of the crises, while 16.5% of the crises seem to occur in the three largest currency areas excluding the euro area (i.e. Japan, the United Kingdom and the United States). The rest of the crises are accounted for by the countries of northern Europe (i.e. Denmark, Ireland, the Netherlands, Norway and Sweden) (33%) and the remaining overseas countries (20%).

When looking at the occurrence of the financial crises over time, they seem, at the aggregate level, to be concentrated more around the early/mid-1970s (oil crisis), the early and late 1980s (1987 stock market crash), the mid-1990s (period of banking and currency crises), early 2000 (the bursting of the dot-com bubble) and very much towards the end of the sample in 2008 (see Chart A3.1). More precisely, the crises, varying from a number of two to nine, are in parts common to almost all countries (as in the case of the early 1980s), while at the

Chart A3.1 Number of countries experiencing asset price busts

(based on a sample of 17 countries)



Source: Own calculations.

recent end of the sample period, 13 of 16 countries experienced the occurrence of a bust in the second half of 2008. The maximum number of countries recorded a bust in the first quarter of 2008, while 13 countries experience a bust in the first three quarters of 2008. Of course, it must be noted that, when looking at the developments in the composite indicator at the disaggregate level, the occurrence of a bust may be driven by specific developments in one of the two markets comprising the aggregate indicator. For instance, as regards the bursting of the 2000 dot-com bubble, not all countries experienced a bust. This is mainly due to the fact that in those countries in which the bust is not detected, the housing market was on an expansionary trend, thus counterbalancing – at least partly – the stock market developments. Finally, the length of the crises also varies across the countries, lasting either two quarters or more than one year. Overall, these observations lead to the conclusion that analysis that takes into account heterogeneities across countries and time has to be adopted.

2 SOME RESULTS OF A PROBIT-TYPE APPROACH

In this section, analysis based on a panel probit approach is presented, whereby the conditional probability of a bust is evaluated directly on the basis of a given set of indicators. The idea is to separate time periods into bust times and tranquil/normal times, and then to map a set of indicators (suggested a priori by theoretical considerations) into a known probability distribution of these episodes, in order to evaluate the likelihood of a bust using a probit model. As stressed by Berg and Pattillo (1999) and mentioned in the main text of this chapter, this approach has several advantages. First, it allows the usefulness of the threshold concept to be tested formally; second, it allows predictive variables to be aggregated more satisfactorily into one composite indicator index, taking into account correlations between different variables; and third, it is a framework within which the statistical significance of individual variables and the constancy of coefficients across time and countries can be tested.

For the empirical exercise, a panel data sample is used, which has the advantage of incorporating information across countries, as well as across time.[59] More formally, the probit equation takes the following general form:

$$Prob(C8_{it}=1)=\alpha_{it}+\beta_{it}\cdot X_{it}+\varepsilon_{it} \tag{4}$$

where X_t consists of the fundamental variables and ε_t stands for the error term.[60] In line with some of the earlier literature, the fundamental variables are grouped

[59] See Baltagi (1995) who explicitly discusses the advantages of using panel datasets in general.

[60] However, in the literature, it has been pointed out that the standard errors of the probit estimates of early-warning-system models are incorrect because of serial correlation in the context of panel probit regressions. For this reason, in the estimations shown here, the heteroskedasticity and autocorrelation corrected (HAC) procedure, as developed by Berg and Coke (2004) which produces accurate estimates, is applied, following the methodology proposed by Estrella and Rodrigues (1998).

(in both nominal and real terms) in four categories.[61] The "monetary variables" category comprises broad money and credit, the "real variables" category investment, consumption and GDP, the "financial variables" category the long-term and short-term interest rates, stock prices and the price-earnings ratio, as well as the dividend yields and the (nominal and real) effective exchange rates, and the "prices" category all the deflators, consumer prices and house prices.[62] The dataset used for the analysis consists of quarterly data collected for the countries over the sample period mentioned in the previous section.[63] The variables are measured in different ways, either as annual percentage changes, or as the deviation from a trend, or as the ratio to GDP.[64]

Using probit techniques, the probability of the occurrence of a bust in the next eight quarters is estimated, whereby the bust is defined using the method outlined in the previous section. As regards the standard errors of the probit estimates, the heteroskedasticity and autocorrelation corrected (HAC) procedure is applied.

In order to compare the performance across the several probit models, besides looking at the significance of the coefficients and the McFadden R-squared, the evaluation procedures suggested by Jacobs et al. (2008), who use the quadratic probability score (QPS), and the log probability score (LPS) analysed by Diebold and Rudebusch (1989) are applied. These scores give an indication of the average closeness of the predicted probabilities and the observed realisations, which are measured by a binary variable (the bust dummy *C8*). Let P_t be the prediction probability of the occurrences of bust (or no bust) event by the model at time t and $C8_t$ the zero-one dummy derived earlier. The QPS and LPS tests are then defined as:

$$QPS = \frac{1}{T}\sum_{t=1}^{T} 2(P_t - C8_t)^2 \quad (5)$$

$$LPS = -\frac{1}{T}\sum_{t=1}^{T} ((1 - C8_t)\ln(1 - P_t) + C8_t \ln(P_t)) \quad (6)$$

61 See, for example, Kumar et al. (1998).

62 To calculate the trend, use is made of the Christiano-Fitzgerald filter (2003), since the Hodrick-Prescott filter is known to suffer from an end-of-sample problem.

63 For a few variables in some countries, the starting point may be slightly later. The main sources of the series are the BIS, DataStream, the euro area-wide model (AWM), the ECB (both official and internal databases), Eurostat, Global Financial Data, the IMF's International Financial Statistics, the national central banks of the respective country, the OECD's Main Economic Indicators and Economic Outlook, and Reuters.

64 For instance, the ratio of credit to GDP is used as a proxy for a leading indicator that captures the influence of banking crises, with credit expanding prior to a bust and contracting afterwards.

where T is the sample size. The quality of a model increases as QPS and LPS move close to 0. More precisely, the QPS ranges from 0 to 2, with a lower QPS implying a more accurate forecast. A value of 0 corresponds to perfect accuracy.[65]

Turning to the probit estimations, in the first step, each of the aforementioned categories of variables is analysed separately. The further procedure then entails combining in pairs the significant variables from the monetary category – more specifically, the credit aggregates which turned out to be superior to the monetary aggregates – with each of those significant variables from the other categories. Finally, the significant variables for each category are selected and combined with the monetary category into one equation. Generally speaking, the signs of the coefficients should be interpreted as having an increasing or decreasing effect on the probability of a bust. Overall, the credit variable seems to be a key driving factor. In order to verify this hypothesis, the main preferred specifications are run without this variable, but this leads to a substantial decrease in the explanatory power and the measures for the quality of the model.

The two final preferred specifications are shown in Table A3.2. Both specifications contain credit aggregates (either in terms of annual changes or as a growth gap),

[65] See Rudebusch and Williams (2008). The implied loss function of the QPS is quadratic and symmetric, which may not be appropriate, as a forecaster may be penalised more heavily for missing a sign of a bust (making a type II error) than for signalling a false alarm (making a type I error). The LPS has a logarithmic loss function and corresponds to the loss function used in the probit regression, so that it has the advantage of coordinating the in-sample estimation criterion with the out-of-sample loss function. The LPS penalises large mistakes more heavily than the QPS and takes a value between zero and infinity, with 0 reflecting perfect accuracy. The advantage of the QPS and LPS is that they do not need an ad hoc threshold value.

Table A3.2 Best specifications from the multivariate probit model

			Specification A				
Variables	Expected sign	Estimated coefficient	t-statistic gmm	t-statistic ml	McFadden R-squared	qps	lps
Annual changes in credit	+	0.016	1.403	2.540	0.075	0.391	0.578
Annual changes in credit (-4)	+	0.024	2.434	3.907			
Investment-to-GDP ratio	+	0.023	1.846	5.650			
Annual changes in nominal stock prices (-1)	+	0.006	3.268	4.442			
Annual changes in nominal LT	+/-	0.126	4.029	6.247			
c	?	-1.444	-5.143	-14.378			
			Specification B				
Variables	Expected sign	Estimated coefficient	t-statistic gmm	t-statistic ml	McFadden R-squared	qps	lps
Nominal credit growth gap	+	0.071	3.428	8.376	0.096	0.378	0.562
Nominal house prices gap (-1)	+	0.029	1.844	5.176			
Annual changes in nominal LT	+/-	0.125	3.551	6.108			
Investment-to-GDP ratio	+	0.020	1.878	5.777			
c	?	-0.978	-3.724	-11.285			

Source: Own calculations.

changes in nominal long-term interest rates and the investment-to-GDP ratio. It can be shown that all coefficients have the expected signs and are statistically significant. The McFadden R-squared is rather low but comparable to that in other studies using the same methodology.[66] The equation containing credit in annual changes also includes the stock prices, but has a slightly lower McFadden R-squared, while the other equation contains house prices, which are significant at conventional significance levels. It is important to note that the credit variable seems to be a key driving factor in both equations. In fact, when running both specifications excluding the credit variable, the explanatory power decreases substantially for both equations, as do the measures for the quality of the model.[67] In addition, when using a purely autoregressive specification including only lagged stock and house prices, both the explanatory power and the quality of the model decrease.[68]

Overall, these results support the importance that credit aggregates have – together with monetary aggregates – in the context of monetary analysis, insofar as they enable central banks to assess longer-term risks to price stability, including emerging financial imbalances, large asset price cycles or other threats to financial stability.

From a forward-looking perspective, designing a good forecasting model requires balancing two types of error: the number of false alarms (i.e. predicted crises which do not materialise) and the number of failures (i.e. unanticipated crises). In the discrete-choice approach used here, the expected value of crises, given a set of indicators, is a probability measure. Greene (2003) notes that there is no correct answer regarding the value that should be assigned to the optimal threshold level of the probability. In the literature, a threshold level of 25% is often selected.[69] In the case of this exercise, Table A3.3 reports the percentage of the predicted crises, missed calls and false alarms, as well as the noise-to-signal ratios, based on a more conservative threshold of 35%. The results suggest that, for the two specifications selected, the models are able to predict correctly around 66%-70% of the crises, while the missed calls for crises are in the range of 25%-30%. The false alarms are of a similar size to the missed calls, while the noise-to-signal ratio is in the range 36%-41%.[70]

66 The latter result might be due to the fact that the equation deals with the forecasting of efficient markets. Besides, the R-squared reported with panel-dataset models should be evaluated from a cross-sectional perspective rather than a time series perspective.

67 More precisely, the following numbers result for specification A: McFadden R-squared 0.05, QPS 0.41 and LPS 0.59; and for specification B: McFadden R-squared 0.07, QPS 0.39, LPS 0.58. In addition, all specifications would indicate a lower number of crises and miss a quite higher number of them with respect to their correspondent model with credit.

68 In this case, the McFadden R-squared was 0.05 and the QPS and LPS were 0.41 and 0.60, respectively.

69 In Berg and Pattillo (1999), for example, the choice of a threshold of 25% leads to an accuracy of predicting crises of about 73%, while that of false alarms is at 41%.

70 In a number of cases, the noise-to-signal ratio could be made arbitrarily small by tightening the selectivity of the threshold. However, this underscores the risk of basing conclusions exclusively on a minimisation of this ratio. Of course, the choice of the threshold could be carried out more formally by assigning specific weights to the costs of type I and type II errors (see, for example, Borio and Lowe (2002)).

Table A3.3 Selected statistics of best specifications of the multivariate probit model

(in percentages)

Specifications	Noise-to-signal ratio	Crises called	Missed crises	False alarms
Specification A	0.41	66.33	30.29	28.36
Specification B	0.36	70.21	26.41	26.22

Source: Own calculations.

3 "PSEUDO REAL-TIME" EXERCISE: A EURO AREA APPLICATION

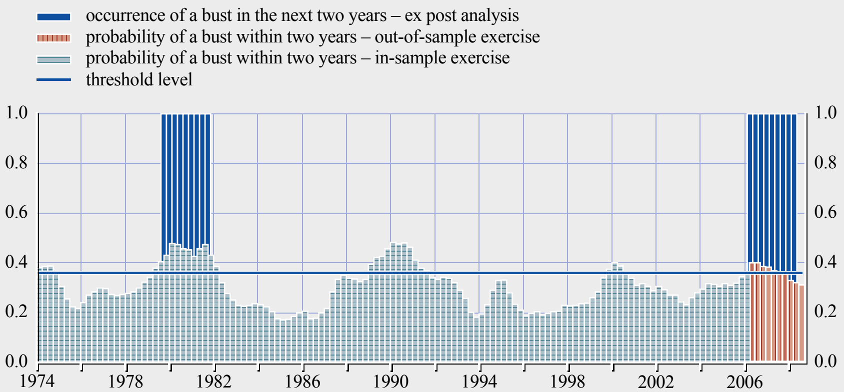
Generally speaking, the results so far show that the model has a good fit from an ex post perspective, which does not necessarily, however, imply that the model also has good forecasting abilities in real time. In order to address this issue, a real-time exercise for the euro area is carried out.[71] More precisely, the model is estimated up to the fourth quarter of 2006 and – on the basis of the coefficients and the actual values of the explanatory variables – the probability that the model would have predicted a bust to occur in the euro area within the subsequent two years is estimated.

The results of this exercise are shown in Chart A3.2. Two periods of busts are detected for the euro area (one of which is the most recent period), which suggests that, at the aggregate euro area level, developments in some

71 See ECB (2009).

Chart A3.2 Out-of-sample forecast of the probability of asset price busts in the euro area

(Q1 1970 – Q3 2008)



Source: Own calculations.

Notes: The blue area represents the fitted probability stemming from a probit model, as in specification B in Gerdesmeier et al. (2009), including the following countries: Australia, Canada, Denmark, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. The green area represents the detection of a bust. The threshold level is set at 0.35 (i.e. 35%).

countries are counterbalanced by developments in others. As can be seen from the chart, the model would have predicted the most recent bust to occur within a two-year-ahead horizon, with a probability higher than 40%, clearly above the selected threshold level. However, it should be noted that, while the model predicts a bust to occur within the subsequent two years, it does not provide any information on the length of the bust, nor on the question as to when the bust period will be over and normal conditions will be re-established.

REFERENCES

Andreou, I., Dufrénot, G., Sand-Zantman, A. and Zdzienicka-Durand, A. (2007), "A forewarning indicator system for financial crises: the case of six central and eastern European countries", *Working Paper Series*, No 901, William Davidson Institute.

Arthur, S.V. (2005), "Experience with constructing composite asset price indices", *BIS Papers*, No 21, BIS, Basel.

Baltagi, B.H. (1995), *Econometric analysis of panel data*, Wiley.

Berg, A. and Coke, R.N. (2004), "Autocorrelation-corrected standard errors in panel probits: an application to currency crisis prediction", *Working Paper Series*, No 04/39, IMF.

Berg, A. and Pattillo, C. (1999), "Predicting currency crises: the indicators approach and an alternative", *Journal of International Money and Finance*, 18(4), pp. 561-586.

Bordo, M.D. and Jeanne, O. (2002), "Monetary policy and asset prices: does 'benign neglect' make sense?", *International Finance*, 5(2), pp. 139-164.

Borio, C. and Lowe, P. (2002), "Asset prices, financial and monetary stability: exploring the nexus", *Working Paper Series*, No 114, BIS, Basel.

Borio, C., Kennedy, N. and Prowse, S.D. (1994), "Exploring aggregate asset price fluctuations across countries, measurement, determinants, and monetary policy implications", *BIS Economic Papers*, No 40, BIS, Basel.

Christiano, L. and Fitzgerald, T.J. (2003), "The band pass filter", *International Economic Review*, 44(2), pp. 435-465.

Detken, C. and Smets, F. (2004), "Asset price booms and monetary policy", *Working Paper Series*, No 364, ECB.

Diebold, F.X. and Rudebusch, G. (1989), "Scoring the leading indicators" *Journal of Business*, 62(3), pp. 369-391.

ECB (2009), "Tools to detect asset price misalignments", *Financial Stability Review*, Special feature D, ECB.

Estrella, A. and Rodrigues, A.P. (1998), "Consistent covariance matrix estimation in probit models with autocorrelated errors", *Staff Reports*, No 39, Federal Reserve Bank of New York.

Gerdesmeier, D., Reimers, H.-E. and Roffia, B. (2009), "Asset price misalignments and the role of money and credit", *Working Paper Series*, No 1068, ECB.

Greene, W.H. (2003), *Econometric analysis*, 5th edition, Prentice Hall.

IMF (2009), "Lessons for monetary policy from asset price fluctuations", *World Economic Outlook*, Chapter 3.

Jacobs, J.P.A.M., Kuper, G.H. and Lestano, L. (2008), "Currency crises in Asia: a multivariate logit approach," *Asia-Pacific financial markets: Integration, innovation and challenges*, Kim, S.-J., McKenzie, M. (eds.), *International Finance Review*, 8, pp. 157-173.

Kumar, M., Moorthy, U. and Perraudin, W. (1998), "Predicting emerging market currency crises", Birkbeck College, mimeo.

Rudebusch, G.D. and Williams, J.C. (2008), "Forecasting recessions: the puzzle of the enduring power of the yield curve", *Working Paper Series*, No 2007-16, Federal Reserve Bank of San Francisco.

CHAPTER 7

CROSS-CHECKING AND THE FLOW OF FUNDS

1 INTRODUCTION AND MOTIVATION[1]

In April 2007 the Governing Council endorsed the pursuit of an agenda to enhance the ECB's monetary analysis. The agenda was structured along four broad avenues. Cross-checking based on financial flows was identified as an element of the fourth avenue, alongside alternative approaches proposed to underpin cross-checking, such as the use of dynamic stochastic general equilibrium (DSGE) models with financial frictions for monetary and financial scenario analysis (see Chapter 5). It also stands alongside the established research agenda on the nexus between money, credit and asset prices, which aims, among other things, to develop early warning indicators for financial boom-bust cycles (see Chapter 6).

Flow-of-funds accounts are a component of the national accounts system reporting the financial transactions of the economy, classified by sectors and financial instruments. The origins of flow-of-funds analysis are usually seen in Copeland's (1952) NBER volume "A study of money flows in the United States", which provided the basis for the US Flow of Funds Accounts compiled by the Federal Reserve and which prompted similar efforts to broaden the foundations of monetary analysis by central banks in Europe over the following decades (Baffi (1957), Banca d'Italia (2008), Honohan and Dunne (1981/2)). The distinctive feature of flow-of-funds analysis is the explicit emphasis on financial transactions and its comprehensive coverage of the financial system (Bain (1973) and Dawson (1996)). The advantage of the latter is reinforced by the growing importance of non-bank financial institutions that has been observed over recent years in essentially all major economies, though to different degrees.

The flow-of-funds accounts are based on accounting identities, which means that total sources of funds must equal total uses of funds, both for each instrument and each sector. The accounts make it possible to a certain extent to track funds as they move from sectors, such as households, that serve as sources of funds (net lenders), through intermediaries (financial corporations) or financial markets to sectors that use the funds to acquire physical and financial assets (non-financial and financial corporations, government, rest of the world). From these flows, changes to sectoral (net) asset positions can be derived and the composition of the balance sheets assessed. Furthermore, the flow-of-funds accounts also cover financial transactions with the rest of the world and thus enable an assessment of the significance of global financial flows to the domestic economy.

1 This chapter was prepared by Bernhard Winkler. Thanks are due to Gabriel Fagan and Philippe Moutot for their useful comments, to the flow-of-funds and euro area accounts teams at the ECB, and to Jesper Berg and John Muellbauer, who acted as discussants and co-presenters at the colloquium "Enhancing the monetary analysis" on 26/27 April 2010. The views expressed in this chapter are those of the author and do not necessarily reflect those of the European Central Bank.

As the economic importance and complexity of financial sectors and markets grew, financial systems became increasingly prone to crisis, spurring renewed academic and policy interest in flow-of-funds analysis in the wake of the crisis. Indeed, Bezemer (2009) presents anecdotal evidence suggesting that flow of funds-based analysis helped anticipate the financial crisis, while analysis based on mainstream macro-models largely ignored financial developments. Much of the empirical work on the origins and evolution of the financial crisis is based, to some extent, on flow-of-funds data (Adrian and Shin (2009), He et al. (2010), Pozsar et al. (2010) and Shin (2010)).

The flow-of-funds accounts, by themselves, are, however, not informative about the underlying drivers of financial processes, nor can they be used to forecast the implications of flow-of-funds developments for economic dynamics and vice versa. To this end, empirical tools for flow-of-funds analysis have to be developed. The most commonly adopted modelling approach for flow-of-funds analysis involves the use of empirical macroeconomic portfolio balance models in the spirit of Tobin (1969), which are incorporated, for instance, in some central banks' macroeconometric models (see Annex 1). Alternatively, the role of specific structural shocks, such as monetary policy shocks, for financial dynamics can be assessed on the basis of vector autoregressive models (e.g. Christiano et al. (1996), Eickmeier and Hofmann (2009)), as set out in Annexes 4 and 5.

Against this background, the framework of the flow of funds provides a natural platform for cross-checking and "bridging" the two pillars of the ECB's monetary policy strategy, drawing on the consistent sectoral framework of the integrated euro area accounts (EAA) introduced in June 2007. Analysis based on the financial accounts can, on the one hand, complement and enrich monetary analysis based on the MFI balance sheet by allowing portfolio behaviour and financing decisions to be considered across a broader set of financial instruments and across a wider spectrum of financial intermediation channels, as discussed in Annex 1. On the other hand, analysing the interaction between financial transactions or balance sheets and real variables or asset prices can also contribute to economic analysis, for example via the role of financial projections within the Eurosystem macroeconomic projection exercises, as set out in Annex 6.

Flow-of-funds analysis is a natural extension of and complement to monetary analysis. As recalled in Chapter 1, the original version of the equation of exchange, MV=PT, e.g. in Fisher (1911), was formulated in terms of total transactions in the economy, i.e. comprising both real and financial transactions (as well as intermediary transactions along the production chain). Only subsequently was the transaction variable replaced (or approximated) by a measure of income Y for practical reasons, as recognised by Friedman, as well as in the early work of Keynes. In particular, the decision to replace T with Y reflected the difficulty of separating out real and financial transactions underlying T or, conversely, of distinguishing empirically between different kinds of deposits M depending on purpose. This has important implications for the interpretation of monetary developments whenever the accounting identity is "reincarnated" as a quantity theory linking money and prices on the assumption of constant or stable velocity trends. Conceptually, the quantity equation might, in principle, be split into two relationships, with one part of the monetary balances used for real transactions, hence directly affecting prices in the market for goods and services, and another part used for financial transactions, which may directly affect asset prices.[2] Both the monetarist tradition (especially Brunner and Meltzer (1966 and 1974) and Congdon (2005)) and the Keynesian theory of liquidity preference have long emphasised the dual motive of holding money for both transactions and "speculative"/portfolio purposes. From a normative perspective, the monetarist prescription rests on the direct link between the transaction role of money and nominal income and the transmission – subject to long and variable lags – from money to prices. Recalling the distinction between real and financial transactions, this suggests that money growth in excess of productive potential (or credit not used to increase real investment in productive capacity but used for financial acquisitions) may be reflected in inflation in the market for goods and services and/or in asset markets.

Against this background, flow-of-funds analysis is relevant in a number of ways.

First, it captures all transactions in financial asset flows included in T – on top of real transactions related to Y – on the right-hand side of the equation of exchange.

Second, it brings the portfolio allocation between M and the stock of non-monetary assets into the picture (typically bonds and equity, but housing and commodities can be considered as additional asset classes) on the left-hand side of the equation. Hence, flow-of-funds analysis links the role of money in savings and portfolio decisions with the role of money for income and spending. This is consistent with the long-held monetarist notion of money as a quantity proxy for a broader spectrum of asset demands and returns and risk premia in financial markets. It also reflects the core Keynesian postulate of the fundamental interdependence of goods and money markets (replacing the classical notion of money as a veil), with no guarantee that the interest rate clears both markets simultaneously. Both these insights have been lost in the so-called "New Keynesian" synthesis over the last decades, which has suppressed the LM curve and rendered money (as well as financial quantities and financial intermediation) redundant relative to the information contained in interest rates, relegating the role of money to a footnote in standard textbooks on monetary policy. This contrasts, in particular, with the earlier Yale tradition of modelling the flow of funds (Brainard and Tobin (1968)), which links a general equilibrium model of the portfolio choice of money, bonds and equity to sectoral saving and investment balances and hence the real economy.[3]

Third, flow-of-funds analysis – by extending the analysis of portfolio behaviour across a broader range of assets and financial intermediaries in addition to

2 Werner (1997) proposes two separate equations, replacing money with credit, which can be more easily split by purpose.

3 See Papademos and Modigliani (1990) for an overview of the rich spectrum of monetarist and Keynesian traditions in monetary theory, which also points to extensions to sectoral flows and balance sheets and the role of non-bank financial intermediation, prior to the onset of the money-free "New Keynesian" synthesis.

deposit-taking banks – can offer insights into the behaviour of velocity in the context of the quantity equation and into structural changes and innovation that may affect the degree of liquidity of different asset classes and the capacity of the financial system to create inside money, credit and leverage on and off bank balance sheets (see Chapter 1). Hence, a comprehensive analysis of the flow of funds can provide additional insights at both low and high frequencies (e.g. when analysing portfolio shifts and substitution in financing flows, as well as when identifying structural changes in patterns of intermediation in the financial system).

The financial crisis has also underlined the need to monitor balance sheet indicators and interlinkages in order to identify risks to macro-financial stability. Some of the most insightful work on the origins and evolution of the financial crisis has been based on flow-of-funds data, in particular in the United States. As far back as November 2006, at the ECB's central banking conference on the role of money, H.S. Shin pointed to the "leverage targeting" behaviour of US broker-dealers (investment banks) as a crucial pro-cyclical element of the credit and asset boom at the time. Subsequently, in a series of papers, he highlighted the interaction of sectoral flows and balance sheets, as available from the flow of funds, in the propagation of the sub-prime crisis through financial intermediaries and feedback loops to the wider economy (see Adrian and Shin (2008a) and (2008b), and Shin (2009)), with important implications inter alia for the design of financial regulation (Brunnermeier et al. (2009)). Eichner et al. (2010) draw on the US equivalent of the euro area integrated accounts to trace the build-up of sectoral financial imbalances in the context of the US housing boom. Looking at the US flow of funds in conjunction with international investment positions can also shed light on the international dimension of the crisis (Brender and Pisani (2009)), as borrowing by US households had its counterpart in excess savings elsewhere, which were intermediated by a surge in securitised products globally and the associated spreading of risks. Similarly, the Asian crisis in 1997 (Allen et al. (2002)) and the earlier and ongoing Japanese experience with a protracted balance sheet recession and deflation can only be understood by examining the behaviour of the assets and liabilities of non-financial corporations and financial sectors in Japan, as available from the flow of funds (Koo (2008) and Hattori et al. (2009)).

Thus from the perspective of both the original formulation of the equation of exchange and the experience with the financial crisis, flow-of-funds analysis is a natural and essential element of the deepening and broadening of monetary analysis at the ECB. At the same time, fully fledged financial accounts – as part of the integrated euro area accounts – have only been available since June 2007. It must therefore be acknowledged that the agenda presented here is less well established than work under the other avenues presented in this book.

The remainder of the chapter is organised as follows. Section 2 places flow-of-funds analysis within the conceptual framework of the ECB's two-pillar strategy as an element for cross-checking monetary and economic analysis. Section 3 provides some examples of the use of flow of funds to complement monetary analysis and economic analysis against the background of the financial crisis. Section 4 briefly reviews the main results of the flow-of-funds agenda as presented in more detail in the accompanying annexes. Section 5 presents two experimental examples of scenario analysis that have recently been proposed based on the flow-of-funds projection framework, motivated by corporate net lending and developments in the money/wealth ratio respectively. Section 6 offers concluding remarks.

2 THE ECB'S TWO-PILLAR STRATEGY, CROSS-CHECKING AND THE FLOW OF FUNDS

The two-pillar approach became a defining feature of the ECB's stability-oriented monetary policy strategy soon after its inception, with the first public mention of the two pillars dating back to the press conference on 13 October 1998. The two pillars of the strategy have been explained as giving expression to different paradigms or approaches to the analysis of the inflation process and are typically associated with different time horizons. The economic pillar captures models of inflation which focus mainly on real economic variables, such as the interplay of demand and supply in the goods and labour markets, which is seen to affect inflation over short to medium-term horizons. The monetary pillar is based on the role of money in explaining the evolution of price developments over the medium to long term.

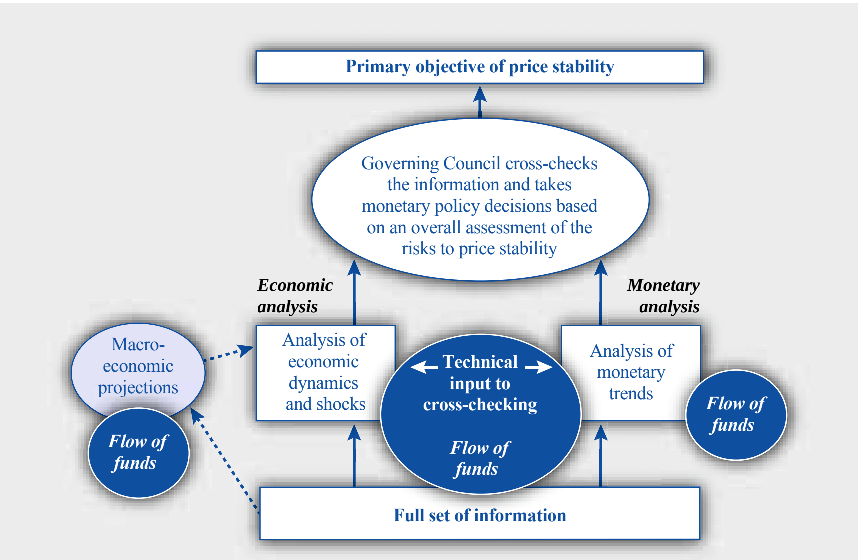
The two-pillar approach was innovative in two main ways. While recognising the important input for the analysis of inflation of mainstream models and approaches as reflected in the economic analysis, it assigned a prominent, or at any rate distinct, role to monetary analysis – which had been the target of much criticism in the academic community. Simultaneously, it opened up the possibility of conflicting messages from the two pillars and viewed this as an advantage rather than an inconvenience from the point of view of robustness. Accordingly, these elements implied a need for the Governing Council to undertake cross-checking when assessing the results of monetary and economic analysis in making policy decisions. The ECB's two-pillar approach, in conjunction with an emphasis on the medium-term orientation of monetary policy, thus presented some distinct features as compared with a standard direct inflation-targeting strategy.

In the academic literature, inflation targeting was widely characterised as reacting to deviations of inflation forecasts from inflation at some specified horizon and in the context of a specific class of mainstream economic models in terms of an instrument rule or as an optimising target rule. In this vein, a formal characterisation of ECB-style cross-checking has been proposed by Beck and Wieland (2007) and (2008) as a monetary policy switching rule that improves robustness in the face of heightened uncertainty surrounding the output gap, which otherwise determines policy in normal circumstances. Alternatively, in a context where mainstream models are considered to encompass insufficient information, the ECB's two-pillar strategy can be characterised as a "procedural rule" (ECB (2001)) which ensures that information from money and credit and the associated longer-term perspective is not overlooked or crowded out in monetary policy deliberations. Thus, the strategy provides a safeguard against a disproportionate focus on the short-term economic situation and acts as a simplifying organising device for the processing and presentation of a very large amount of information to structure both internal and external communication (Winkler (2000)).

From this angle, the two-pillar structure indeed enshrines a commitment to accord prominence or salience to monetary developments within the decision-making process and to continuously explain monetary developments to the public (Issing (2000)). The explicit need for cross-checking in the decision-making process establishes an antidote to confirmation bias, "groupthink", the dominance of prevailing conventional views, short-termism and a tendency to suppress cognitive dissonance and discordant views, which were widespread phenomena in underestimating risks in the run-up to the crisis at both private and public sector institutions. As documented in the psychological literature on decision-making, the framing of decision problems, e.g. whether policy is cast as a reaction to an encompassing projection or in terms of cross-checking across a two-pillared information set, may matter for the outcome, where the decision frame that a decision-maker adopts is "controlled partly by the formulation of the problem and partly by the norms, habits and personal characteristics of the decision-maker" (Kahneman and Tversky (1981)). From this perspective, the need for cross-checking is a defining characteristic of the ECB's two-pillar approach, which balances the communication requirements of clarity and simplicity, on the one hand, and openness and the need to acknowledge uncertainty, complexity and limits to knowledge, on the other (Winkler (2002)).

In the context of the ECB's monetary policy strategy, cross-checking is the prerogative of the Governing Council, while at the technical level tools and procedures may be designed to support such cross-checking, e.g. via scenario analysis presented to the Governing Council. Hence, the task of cross-

Chart 1 Flow of funds and the ECB's monetary policy strategy



Source: ECB.

checking, which at the ECB's inception could in principle be limited to a simple comparison of "headline" messages from the two pillars, amounts to giving procedural as well as analytical content to contrasting as well as cross-fertilising analysis under the two pillars. It can be thought of as providing tools and a platform (analytical and/or procedural) which relates the two pillars to each other without blurring their distinct contributions. Ideally, the two pillars "talk" to each other and to policy-makers in the most productive and informative manner. Against this background, the flow of funds in conjunction with the integrated euro area sector accounts offer a natural platform and fertile territory for cross-checking, as illustrated in the central circle of Chart 1, as well as contributing to monetary analysis (complementing the analysis of bank balance sheets and portfolio behaviour) and economic analysis (namely as part of regular macroeconomic projection exercises), as also indicated in Chart 1. From a practical perspective, cross-checking can be understood simply as the activity of reconciling different pieces of information from different perspectives, but within an overall coherent framework. From this angle, the flow of funds and, more generally, the integrated euro area accounts offer a platform for cross-checking in a number of dimensions.

i) Cross-checking based on a sectoral perspective

Embedding the analysis of M3 and counterparts more explicitly within the broader context of financial flows allows portfolio and financing behaviour by institutional sector to be identified. Cross-checking financial flows *across institutional sectors* within the integrated accounting framework helps identify inconsistencies and develop a coherent and consistent picture across sectors, including the rest of the world. For example, not all sectors can sell risky assets simultaneously in a "flight to safety", and changes in assets and liabilities and saving/investment imbalances must match across sectors. A sectoral breakdown therefore permits a better presentation and understanding of overall monetary and economic aggregates.

Identifying the behaviour of monetary, financial and non-financial variables *within institutional sectors* helps overcome the limitations of the representative agent approach by allowing a more disaggregated interpretation of both the monetary and macro aggregates, while offering an integrated perspective on economic agents' real and financial decisions. This is achieved in the euro area accounts by bringing together both economic and financial flows and balance sheets, which ensures stock-flow consistency (e.g. on interest flows and property income) and permits, for example, the exploration of the role of valuation changes in assets and liabilities for savings behaviour, or the link between liquid asset holdings and consumption or investment.

ii) Cross-checking in the projection process

Financial projections have been produced since autumn 2003 as an integral part of the regular macroeconomic projections exercises, as set out in Annex 6. Given that the financial projections are derived to be consistent with the real projection baseline, one way to cross-check the projections is to identify feedback channels from the evolution of financial flows and balance sheets, as implied by the baseline, to real variables (such as wealth effects, credit channels or leading indicator properties of money and credit). Such feedback channels typically not well-captured in standard macro-models could, in principle, be considered through informed judgement in the projection baseline, in the risk assessment, or by exploring alternative scenarios based on financial flows and balance sheets.

iii) Analytical approaches to cross-checking

Semi-integrated cross-checking. Within the flow-of-funds projection framework currently in place as part of the quarterly projection exercises, the projections obtained for major items of financial flows and balance sheets are consistent with the assumptions used in and results derived from the real-side projections and thus play a subordinate role. In the absence of an all-encompassing and fully integrated model, cross-checking in this context amounts, first, to assessing the plausibility of the path for financial flows and balance sheets implied by the real projections and, second, to identifying possible channels for feedback from the financial projections to real variables. In this context, monetary/financial scenarios can be based on alternative paths for the evolution of financial flows or on alternative views on the interaction of financial flows and balance sheets with real variables (in combination with alternative tools or models).

Integrated cross-checking. Scenario analysis can, alternatively, be based on a single fully fledged dynamic stochastic general equilibrium (DSGE) model augmented to incorporate financial frictions (as is the case for the CMR model), which otherwise can broadly be nested within standard benchmark models such as the new area-wide model (NAWM) used in the context of the baseline projection (see Chapter 5). The CMR model is used to replicate the baseline, and shocks are introduced to motivate alternative scenarios, with special attention to alternative paths for monetary and financial variables. The scenarios can be contrasted with the financial projections included in the baseline, while the flow-of-funds projection system can also be used to enrich CMR-based scenarios.

Independent cross-checking across pillars. Cross-checking can involve comparing and reconciling the implications of two independent models or forecasting frameworks – such as the real-side projections of inflation and money-based inflation risk indicators – inter alia by identifying scenarios that can reconcile the different views (for example, via channels that are not considered in the respective independent baselines). This could, in principle, entail mutually adjusting conditioning assumptions affecting the path for money and inflation or flow-of-funds variables common to both projections.

Section 5 of this chapter (as well as Annex 6) provides some examples of the use of the flow-of-funds system for scenario analysis. It is necessary to recognise, however, that suitable techniques and tools to support cross-checking remain to be developed further.

The financial crisis, which was largely off the radar screens of "workhorse" mainstream economic models and conventional "best practice" inflation-targeting approaches, has underlined the value of a diversified approach to policy-making and of drawing on a range of perspectives and models. The crisis, furthermore, has highlighted the need to take a medium and longer-term perspective in order to take into account risks to price stability related to the build-up of financial imbalances. The crisis also vindicated paying particular attention to money and credit aggregates and the analysis of bank balance sheets as embodied in the ECB's monetary pillar. It highlighted the nexus between monetary and financial stability and the role of the financial sector as an originator and propagator of macro-financial shocks.

The financial crisis also illustrated the value of flow-of-funds analysis for complementing economic and monetary analysis, by highlighting the importance of financial flows and sectoral balance sheets for understanding the behaviour of money and asset price dynamics and the real economy. The study of inter-sectoral balance sheet linkages and risk exposures has also been identified as a useful tool for financial stability analysis (see Annex 2).

As set out in more detail in Annex 1, a flow-of-funds approach complements the analysis of money demand by considering a broader spectrum of asset classes in order to identify portfolio shifts driven by changes in relative returns, changes in liquidity preference or structural changes in savings patterns/financial innovation. Moreover, a more complete picture of household portfolios can be obtained by identifying indirect asset holdings via institutional investors, such as insurance companies and pension funds. In addition, the financial crisis highlighted the role of non-bank financial intermediaries, namely in the United States, in propagating financial shocks in the context of securitised finance, which blurred the distinction between bank and market-based financial systems on account of financial globalisation. Flow-of-funds data and other international banking data pointed to a rapid pre-crisis growth of cross-border gross exposures in deposits and securities, to a large extent within the financial sector, with a sharp unwinding during the crisis. International portfolio flows, in conjunction with the increased role of (financial and housing) wealth and the impact of financial innovation, may also account for the statistical instability that appeared in traditional money demand equations (see Chapter 3, De Santis and Favero (2010), and Devereux and Yetman (2010)).

The flow-of-funds framework can, furthermore, extend and complement the established research agenda on money, credit and asset prices by looking at a more comprehensive range of assets and the interplay of demand and supply factors across financial and non-financial sectors (see Chapter 6). It can thus help identify patterns of unsustainable boom-bust dynamics in the interaction of asset prices, leverage/debt dynamics and liquidity that cannot be easily understood either in the mainstream macro-models or in traditional monetary analysis. In order to make sense of the financial crisis, the flow-of-funds data and accounting framework have been used to illustrate the interplay of securitised finance, repo markets and financial intermediation chains in the shadow and wholesale banking systems in the United States, which substantially amplified liquidity beyond that captured by traditional aggregates (see Adrian and Shin (2009) and Gorton and Metrick (2009)).

The experience of the financial crisis thus underlined the value of the comprehensive perspective of the flow of funds for identifying changing patterns in financial intermediation and leverage across different institutional sectors of the economy. Against this background, extending VAR-based analysis to include a range of flow-of-funds variables could help to establish stylised facts as a benchmark to assess the interaction of real and financial variables in the monetary policy transmission process, as well as possible substitution effects across financial instruments and sectors (beyond money and bank credit).

Explicit use of accounting-based flow-of-funds models continues to be found in the post-Keynesian Cambridge tradition (Godley and Lavoie (2006) and Eatwell et al. (2009)), while the Yale approach to the modelling of the flow-of-funds matrix, pioneered by Brainard and Tobin (1968) and Tobin (1969), remains the most prominent framework for examining asset demand and portfolio choice in conjunction with savings and income. However, econometric implementations of comprehensive estimated flow-of-funds asset demand matrices within macro-models have proved challenging in the past (Green and Murinde (2003)) and several of the older approaches are deemed not to be up to the professional standards of the mainstream (e.g. with regard to general equilibrium modelling, microfoundations or intertemporal consistency).

At the same time, the crisis has prompted doubts about mainstream DSGE models, which typically combine nominal rigidities with market clearing assumptions in micro-founded representative agent settings. This approach contrasts with the richer, earlier traditions in macroeconomics, where rationing and coordination failure took centre stage (Gordon (2009)). Assuming that market economies are inherently stable around steady state, DSGE models would not appear to offer a natural basis to capture endogenous financial cycles and financial instability as witnessed in the financial crisis. The experience of the financial crisis has, on the one hand, spurred attempts within the prevailing paradigm to refine new generations of DSGE models with financial frictions, seeking to incorporate a rudimentary financial sector and balance sheets linked to risk premia (Adam and Vines (2010)), which could potentially be partly mapped into a sectoral flow-of-funds structure. On the other hand, the crisis has rekindled interest in earlier literature, outside the mainstream paradigm, which allows for departures from the assumption that market economies are self-stabilising and, instead, highlights the possibility of self-reinforcing credit cycles (see, for example, Kindleberger (1978), Schularick and Taylor (2009) and the earlier Austrian view of the business cycle) or endogenous financial instability (Minsky (1986) and Hume and Sentance (2009)).

The financial crisis has thus prompted a renewed interest in the flow of funds. Accounting identities are very useful reminders that things have to add up: assets have to be matched by liabilities; expanding debt on balance sheets leads to rising payment flows; in a closed system any one sector will only make outsized profits at the expense of other sectors; the relationship between finance and the real economy cannot remain out of kilter for long, and so on and so forth. Many key elements for understanding the financial crisis, such as the role of financial intermediaries, the impact of balance sheets and leverage, the possibility of default and the disruption of markets, have hardly been considered by the prevailing class of mainstream models. The challenge remains, therefore, to bring financial flows and balance sheets back into the picture and to link financial quantities with asset prices and risk premia (Piazzesi and Schneider (2007) and Adrian et al. (2010)). This does not necessarily imply a need to resume attempts to model the flow of funds in a comprehensive manner, as in the earlier literature of the 1960s and 1970s. It may be sufficient to focus on a few key elements of financing, leverage and asset accumulation and to link them back to portfolio choice in the context of monetary analysis or in conjunction with savings, investment and consumption decisions in the context of economic analysis. Going in this direction suggests departures from common consumption Euler equations derived from standard representative agent models of intertemporal optimisation with rational expectations (Muellbauer (2010)).

Even in the absence of well-established models, the flow of funds and the euro area accounts are useful as a comprehensive map of the economic landscape and for prompting "systemic" surveillance. Eichner et al. (2010) have likened the role of the equivalent sector accounts in the United States to the broad but systematic reconnaissance of satellite pictures that help to identify the build-up of economic and financial imbalances or gaps in the less illuminated parts of the system, which would then call for careful inspection based on more granular data sources. From the perspective of the ECB's strategy, certainly rapid money and credit growth in the pre-crisis period provided warning that a storm was brewing off the beaten track of the macroeconomic mainstream.

A few examples may illustrate where the euro area accounts have already come into play at the ECB, complementing and enriching monetary and economic analysis.[4]

First, as the financial crisis broke, the ECB was in the very fortunate position of having excellent and timely data on bank balance sheets at its disposal and regularly analysing these data as part of its ongoing monetary analysis. Much less was known about other financial intermediaries – which have remained at a smaller scale in the European context – and insurance corporations and pension funds. However, within the financial accounts, both of these sub-sectors were included in the context of the monetary analysis even in the absence of more detailed primary sources[5], where gaps had been identified as important priorities well before the outbreak of the crisis.

4 See González-Páramo (2009). For an overview of flow-of-funds analysis at the ECB prior to the introduction of the integrated accounts and before the financial crisis, see Be Duc and Le Breton (2009). For an introduction to the EAA, see the November 2007 issue of the ECB's Monthly Bulletin and, since May 2009, the box on EAA releases published on a quarterly basis in the ECB's Monthly Bulletin.

5 See, for example, Moutot et al. (2007).

Second, information on the financial investment of the money-holding sectors complements the analysis of portfolio behaviour in the context of the ECB's monetary analysis. It has been particularly interesting to look into possible portfolio shifts from risky assets to money holdings by households, as in the wake of the equity bubble bursting and the period of heightened uncertainty after the 11 September terrorist attacks. After the Lehman shock in September 2008, a flight into safe and liquid assets could be observed, which subsequently reversed as liquidity preference receded and risk appetite returned and as the yield on deposits diminished.

Third, as regards non-financial corporations, conversely, the monetary data showed a decline in deposits, as companies initially drew down their liquidity buffers in the wake of Lehman's collapse, while deposit growth subsequently picked up again and liquid balances were restored as earnings recovered. On the basis of the EAA data, the broad picture on the drawing-down of liquid assets can be confirmed when debt securities and mutual fund shares are included with monetary assets. At the same time, on the financing side, the broader perspective of the EAA suggests that corporations may have been able to buffer, to some extent, the impact of the financial crisis – namely the reduced cash flow (and thus less internal financing) and more difficult access to bank lending – by greater recourse to market-based funding (since corporate bond issuance picked up markedly) and recourse to inter-company loans (estimated on the basis of the EAA). In addition, trade credit between non-financial corporations suffered but still appeared to decline less than GDP.

Fourth, the euro area's financial structure was a key element in shaping the ECB's choice of "non-standard" measures. The predominantly bank-based system of financial intermediation in the euro area made it natural for the ECB to concentrate efforts on easing the strains in the banking sector through the provision of liquidity and by adapting the collateral requirements in refinancing operations to target an instrument, in the case of covered bonds, that play a significant role in securing longer-term funding for the banking sector. Information on financial structure was based, inter alia, on the euro area accounts, such as the observation that banks accounted for around 70% of financing provided to non-financial corporations in the euro area over the period 2004-08, while the figure was much lower in the case of the United States (see the April 2009 issue of the ECB's Monthly Bulletin).

Fifth, the regular macroeconomic projection exercises include financial projections which trace the evolution of transactions and sectoral balance sheets consistent with the assumptions and growth and inflation profile provided by the real projections. Most attention is typically focused on the household and non-financial corporations sectors, the outlook for loan developments, indebtedness, debt service burden and household net worth. In the wake of the financial crisis, attention to financial variables has increased in order to take into account possible credit supply effects and the impact of deleveraging and balance sheet repair by financial and non-financial sectors. Various balance sheet indicators/leverage ratios and estimates of debt service burden developed for the financial projections are also regularly analysed in the ECB's Financial

Stability Review and, more recently, a risk-adjusted flow-of-funds model has been introduced as a tool to assess interlinkages between sectoral balance sheets and default risks (see Annex 2).

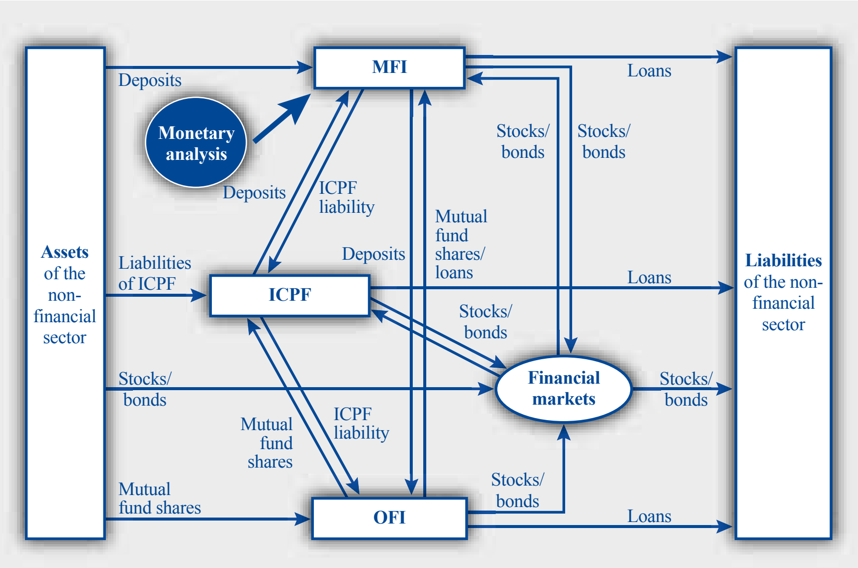
4 OVERVIEW OF WORK CARRIED OUT UNDER THE FLOW-OF-FUNDS AGENDA

Work under the flow-of-funds agenda since the Governing Council seminar on monetary analysis in April 2007 and the introduction of the integrated euro area accounts in June 2007 has proceeded along four main lines. First, on the theoretical side, modelling approaches to the flow of funds were explored or revisited, in particular in relation to monetary analysis and portfolio choice (see Annex 1) and macro-financial risk analysis (see Annex 2). Second, on the practical side, the regular analysis of the euro area accounts was established from a cross-sectoral perspective (drawing on a cross-divisional team) both for internal briefing purposes and external publication in the Monthly Bulletin. Based on this regular ongoing work, Annex 3 looks at some key features of the financial crisis in the euro area in the light of the euro area accounts. Third, empirical work to establish stylised facts on the monetary policy transmission and flow-of-funds variables was undertaken based on VAR and factor-augmented vector autoregression (FAVAR) analysis as a benchmark for international comparison and possible use in forecasting (see Annexes 4 and 5). Finally, the established financial projection framework was significantly enhanced and used on an experimental basis for monetary/financial scenario analysis (see Annex 6 and Section 5).

Chart 2 illustrates how the flow-of-funds data and analytical perspective can enrich and complement established monetary analysis by looking at a broader set of instruments for portfolio choice and a wider range of financial intermediation channels, in particular by including the ICPF (insurance companies and pension funds) and OFI (other financial intermediaries, including investment funds, leasing companies and financial vehicle corporations) sectors alongside the analysis of MFI balance sheets and by analysing the portfolio behaviour of households and non-financial corporations in more detail (see Annex 1).

First, analysis of the flow-of-funds data provides insights into the structure of the euro area financial system, such as the relative importance of monetary financial intermediaries, non-monetary financial intermediaries and markets for the financing of the non-financial sectors. At a conceptual level, the value added of analysing monetary (and financial) developments within a broader portfolio balance approach results from studying asset allocation behaviour and explicitly modelling the substitution across different instruments along the lines of a portfolio balance model as proposed by Tobin and Brainard, which provides a framework to analyse demand shifts between asset classes. The nature of financial instruments with respect to substitution and complementarity across assets can be incorporated in the framework by an appropriate specification of parameter values on the own rate and the rate on the alternative investments.

Chart 2 Monetary analysis in the broader context of the flow of funds



Source: ECB, adapted from Deutsche Bundesbank (1995).

Second, the flow-of-funds framework has been identified as a key element in analysing cross-sectoral linkages and risk exposures for financial stability purposes, as set out in Annex 2. The flow-of-funds framework can be used to underpin a network approach to risk analysis by drawing on estimated bilateral sector-level exposures in conjunction with contingent claim analysis to derive risk-adjusted balance sheets and trace the propagation of volatility shocks across the system. This approach highlights the interconnectedness in cross-sectoral claims and the transmission of risks in the context of macro-prudential analysis. The network of bilateral exposures can be used to simulate balance sheet contagion across sectors and to build sector-level risk indicators as a function of leverage and asset volatility. The results show that, under mark-to-market accounting, cash-flow shocks can spread quickly and correlation among sector-level risk indicators surges during a crisis.

Third, in line with the emphasis on matching organisational procedures and analytical perspectives in order to enhance cross-checking, regular briefing on and analysis of the accounts is performed by a team comprising sectoral experts from different divisions. Thus, a quarterly briefing note is distributed to the Executive Board, a box on the accounts appears in the Monthly Bulletin at a quarterly frequency (since May 2008), special articles based on euro area accounts data have been published (in the November 2007 and April 2009 issues of the Monthly Bulletin), and balance sheet indicators are used regularly for the purposes of Governing Council briefings and the Financial Stability Review. The flow-of-funds agenda also included a major drive towards further enhancement of the data, for example on specific items of analytical interest, such as trade credit, non-financial assets, seasonal adjustment and "who-to-whom" information, and addressed the remaining discrepancies between financial and non-financial accounts in a consistent and transparent manner.

Annex 3 provides an illustration of how the euro area accounts have been used to trace the evolution of the financial crisis over recent years, such as the impact of valuation gains and losses on sector behaviour in the run-up to and in the wake of the crisis. The analysis provides an integrated perspective on real and financial variables that have an impact on individual sectors, as well as patterns of substitution in financing and portfolio choices across financial markets and sectors. Examples include the respective roles of financial investment and housing equity in driving asset accumulation by households, as well as the changing pattern in financial intermediation towards market instruments in the wake of the crisis, as banks substituted debt securities for loans on their balance sheets, while households reversed their earlier "flight" into deposits by moving out of monetary assets and back into riskier assets in view of the steep yield curve and low returns on deposits. Examining the financing of non-financial corporations by source and use of funds showed that the steep decline in bank loans was partly buffered by recourse to market financing, inter-company loans and trade credit, as well as by drawing down liquidity buffers on the asset side and expanding the share of capital investment financed out of retained earnings once the shock to cash flows subsided. Furthermore, it showed how governments (and central banks) have effectively taken over as financial intermediaries by massively expanding their balance sheets and the associated dis-intermediation away from banks towards market-based debt instruments.

Fourth, the agenda sought to establish stylised facts on the role of flow-of-funds variables in monetary policy transmission. This involves comparisons with earlier work done on US and Italian data (see Annex 4). Such studies investigate how financial assets and liabilities react to monetary policy impulses and how different sources and uses of funds may buffer shocks and substitute across instruments over the cycle. Annex 4 estimates a VAR model for the euro area economy (covering the sample since 1999, for which fully harmonised euro area accounts data are available) along the lines of earlier studies by Christiano, Eichenbaum and Evans (1996) for the United States, and Bonci and Columba (2008) for Italy. The results do not exhibit any price or liquidity puzzles, which are often present in this literature. The findings highlight increased net borrowing by non-financial corporations in the first year after a hike in interest rates, prompting firms to increase loan financing (from all other sectors) and debt issuance in the short term, while also drawing down holdings of currency and deposits and expanding loans granted (mainly inter-company loans). By contrast, loans to households decline on impact, even though borrowing in net terms also goes up initially. This is driven mainly by a reduced accumulation of deposits and mutual fund shares (in conjunction with portfolio shifts into debt securities). The observed overall positive effect on loans to the non-financial private sector vanishes, however, when looking only at loans granted by MFIs. Examining a broader range of financial instrument can thus offer additional insights into how monetary policy is transmitted and buffered via substitution channels within the flow of funds.

Fifth, for the purpose of empirical analysis, backdata for the four major euro area economies were constructed from 1990 and alternative approaches such as BVAR and FAVAR analysis explored with respect to financial flows and balance sheet variables, also with a view to their possible use for forecasting purposes. Annex 5 summarises the preliminary results obtained adopting a FAVAR methodology, drawing on a total of 93 flow-of-funds series, 13 balance sheet items (BSI) series and 129 macro series for a sample period from the first quarter of 1991 to the third quarter of 2009 as a basis for one observable and five unobservable factors. The approach covers notional stocks of assets and liabilities of the euro area private sector, i.e. households, non-financial corporations, MFIs, OFIs, ICPFs and financial corporations as the aggregate of the three financial sectors. The results of the impulse response functions are subject to a price puzzle, but confirm the different impact of monetary policy shocks on households and non-financial corporations with respect to loans, as well as total liabilities and total assets. They also highlight substitution effects into greater issuance of debt securities by non-financial corporations (as is the case in the United States) and differences in the debt issuance response between the MFI and OFI sectors. This exercise illustrated how the approach could be extended to derive unconditional flow-of-funds projections, where the FAVAR including flow-of-funds variables often yielded better forecasts of macro variables (compared with the results when these variables were excluded) and outperformed autoregressive benchmarks.

Sixth, the agenda included a comprehensive overhaul and upgrading of the financial projection framework in place since 2003 in the context of the ECB's macroeconomic projection exercises, as documented in Annex 6. This also involved the use of flow-of-funds tools in monetary/financial scenarios around the flow-of-funds baseline projections, as illustrated in Section 5.

The ECB's financial projections were enhanced from September 2008 to include full sectoral coverage at a quarterly frequency with an increased emphasis on balance sheet and leverage indicators and financial sectors, alongside the traditional focus on financing flows, interest payments and net wealth of the non-financial sectors. The projections are based on a combination of vector error correction models (VECM), error correction models (ECM) and ordinary least squares models (OLS) for the main instruments on the liability side, some judgement and the use of accounting identities to enforce consistency. They are used in the internal forecast process for qualitative cross-checking of the baseline, i.e. to assess the overall plausibility of the resulting projected financial developments, to cross-check the real and nominal sides with the financial developments during the forecast period and to provide feedback on different domestic demand components, sectoral saving and net lending/borrowing, as well as asset prices to baseline projections. For instance, financing data for households and non-financial corporations are available much earlier than data on GDP and its sub-components, as well as house prices, and are not revised afterwards. This means that, for example, the latest data on MFI loans granted to households and non-financial corporations in conjunction with the implied model residuals (on equations used to project these items) for the most recent quarter and the short-term forecasts for these items could be used, in principle, to adjust the baseline projections on private consumption, business and residential investment, as well as house prices. Recently the financial projection framework has also been used to underpin monetary and financial scenarios in conjunction with other tools (see Section 5).

5 EXAMPLES OF MONETARY/FINANCIAL SCENARIOS BASED ON THE FLOW OF FUNDS

Regular financial projection exercises, as undertaken at the ECB since 2003 (and substantially enhanced in 2008), and as well established at the Federal Reserve Board (incorporating greater detail) and at the Banco de España (in a more limited format), provide a framework for using the flow of funds as a useful consistency check in view of the limited ability to capture the role of financial factors in standard macroeconomic models. Such flow-of-funds projections are constructed "bottom up" from available equations for individual financial instruments, mainly on the financing side, and draw on accounting identities to ensure consistency and completeness. While the flow-of-funds projections are essentially derived post-recursively taking the real-side projections as given, they provide a basis for cross-checking plausibility and can, in principle, feed back into the baseline and/or the risk assessment. In addition, the financial projection framework (also drawing on the links with non-financial sectoral flows) can be used to underpin monetary/financial scenario analysis, typically in conjunction with other tools and methods employed for monetary analysis.

5.1 SCENARIO BASED ON THE FLOW OF FUNDS OF NON-FINANCIAL CORPORATIONS

This example, based on monetary and financial scenario analysis undertaken on an experimental basis during the first half of 2010, illustrates the use of scenarios based on the flow of funds as a framework to identify and explore consistency issues along three dimensions: between financial and non-financial developments for a given sector, in this case the non-financial corporate sector; the interaction via financial flows across different institutional sectors; and, finally, the implications of the scenario for output and inflation in a general equilibrium context using the CMR model (as explained in Chapter 5 and omitted here).

The scenario focuses on alternative ways in which the positive net lending position of the non-financial corporations (NFCs) sector, observed in recent data and assumed to persist in a benchmark scenario, may become a source of upside risk to the macroeconomy and inflation. The sharp improvement in firms' financial positions from mid-2009, when they turned their traditional net borrowing position into net lending, could be explained by firms swiftly cutting costs, lowering dividends and reducing interest payments at a time when income and profits were stabilising, as well as by their seeking to rebuild liquidity buffers in the wake of the crisis and amid heightened uncertainty. However, a net substantial lending position persisting for several years would be unprecedented in the history of the euro area.

It is thus plausible to think that such "excess" retained earnings may find alternative uses, which could have different implications for economic activity and inflation. First, the funds could be distributed to shareholders in the form of dividends. This may represent an upside risk to consumption in the likely event that households save part of these funds and spend the remainder. Second, the funds could be used to pay back debt. This would reduce firms' leverage and possibly make them more willing to take up future investment opportunities as soon as they arise. Third, the funds could be used to pay higher compensation of employees or to reduce price markups, thus transferring real income to households, and again generating upside risks to consumption (albeit having opposite implications for inflation in the case of reduced markups). Fourth, an increasing part of the funds may be absorbed by higher tax payments, if fiscal consolidation proceeds more than assumed in the benchmark scenario. Finally, a natural use of these "excess" retained earnings by the NFC sector could be to increase real investment. Indeed, in the euro area non-financial corporations typically finance the bulk of fixed capital investment out of retained earnings. This is especially the case in the early phases of economic recovery, since recourse to external financing picks up only later in the cycle, in line with the "pecking-order" theory of corporate finance.[6]

The scenario can also be interpreted beyond the risks to output and prices in the short to medium term. In a context of monetary analysis, for example, excess asset accumulation by corporations could indicate a preference for higher liquidity buffers, including monetary assets, in the wake of the crisis, rather than being a precursor to greater investment. At the same time, the recent pattern of substitution of market instruments for bank loans and deposits, which ran in parallel to the increase in retained profits by corporations, may have been temporary or may indicate a longer lasting disintermediation of assets and liabilities across sectors in the wake of the crisis, as firms turn to market funding, investors return to risky assets in place of low-yielding deposits, and government bonds crowd out private sector loans on bank balance sheets.

This scenario also implies a different investment/financing pattern in the economy. The distribution of net lending/net borrowing across sectors changes to show net borrowing for the NFC sector, instead of the atypical net lending position shown in the benchmark scenario. The exact way the lending configuration changes depends on the specific impact that the scenario has on the various sectors' expenditure and income.

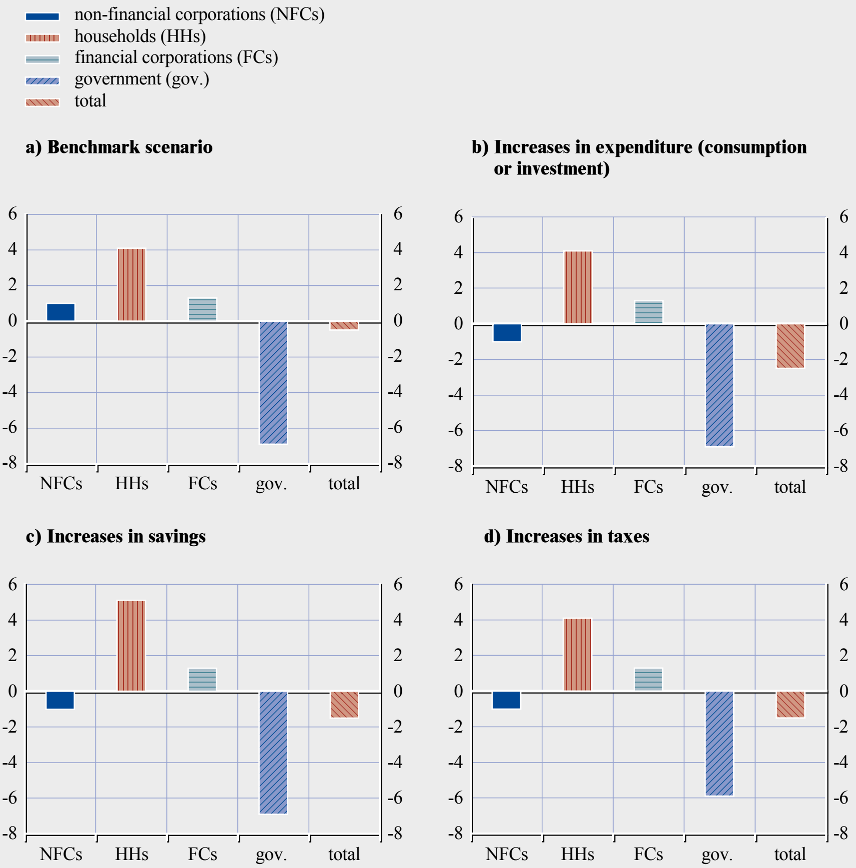
Chart 3 shows three alternative lending patterns, together with the benchmark configuration. Panels b to d show the "first order" impact of the various possible sub-scenarios (i.e. alternative ways of releasing the captive funds) on net lending by sector. First, in panel b, an overall impact on expenditure

6 It should be noted that part of the excess funds could also flow into investment abroad. Such investment in the form of foreign direct investment would be accounted for as equity as part of the NFCs' financial position and would hence be consistent with the asset accumulation implied by the benchmark scenario.

is assumed, either through investment or consumption, with the rest of the world providing the funds for government financing that, in the benchmark scenario, are directly or indirectly provided by NFCs. This would result, from a financial point of view, in inflows of debt securities from non-residents to finance the public debt. From a trade account perspective, this sub-scenario would be reflected in smaller net external demand offsetting the larger domestic demand resulting from the increase in expenditure. In panel c, households are assumed to take over the government's financial needs by making use of the excess funds, which would be transferred in full to households in the form of dividends or other transfers. Finally, panel d shows a third possible response, namely that the income released by NFCs is used for fiscal consolidation (through higher taxes), resulting in lower government borrowing requirements. A more realistic portrait of the overall impact on sectoral net lending/net borrowing would lie somewhere in between the three panels, as part of the excess NFC savings would be used for investment and part would

Chart 3 Net lending/net borrowing by sector: alternative uses of "excess NFC net lending"

(net lending/net borrowing; percentage of GDP)



Source: ECB.

be transferred to households as dividends, employee compensation or reduced margins. In turn, part of those funds transferred to households would be used for consumption or residential investment, another part for taxes and another for savings.

5.2 SCENARIO BASED ON PORTFOLIO REBALANCING

This second example illustrates how the analysis of portfolio trends and financing composition that the flow of funds enables can shed additional light on money developments and on their implications for growth and prices.

The scenario is motivated by the observation that the share of monetary assets in financial wealth in the euro area remains high by historical standards. Hence, the scenario explores the possibility that money holders divert their funds into longer-term assets outside M3 until monetary assets return to a "normal" share in their overall financial assets. This would imply continued subdued developments in M3 growth relative to overall financial wealth developments in a general context of portfolio rebalancing. The outflows could be directed towards housing, bond and stock markets, with an impact on the corresponding asset prices as well. This would represent a shift of investors' wealth towards a more risky and illiquid configuration and would also be consistent with a general process of disintermediation of the investor/borrower relationship bypassing the banking sector.

Another indication of an upside risk based on a process of wealth rebalancing can be found in the price/earnings ratio (PER), which is low by historical standards, indicating weak expectations for future profits and/or a high equity risk premium. A correction could be envisaged in the medium term as GDP growth recovers and confidence returns. Higher expected returns and/or a lower risk premium would increase stock prices. At the same time, further rebalancing forces might lead to a reallocation of funds from bonds to equity, in addition to a shift from money into non-monetary assets, causing bond yields to rise.

The net effect of the wealth rebalancing on inflows into non-monetary assets would depend on the extent to which the renewed demand for such assets is translated into increased asset supply (increased financing through non-monetary liabilities)[7] or into asset price increases (note that the process of rebalancing the wealth structure could also be achieved through asset price adjustments, as well as through transactions). Moreover, the final effect on total financing will depend on the extent to which the supply of non-monetary assets by borrowers is provided at the expense of bank credit.

[7] Note that "demand for assets" refers to portfolio allocation decisions and "supply of assets" refers to borrowers' demand for funds (i.e. liabilities). This terminological choice, driven by the analytical needs of portfolio allocation considerations, is at odds with common uses of the term "supply" in money and credit discussions. The usual supply of bank credit would refer to demand for loan assets by MFIs under a portfolio choice perspective.

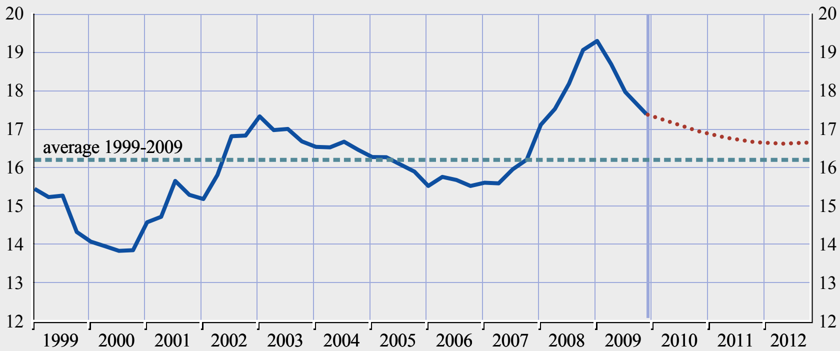
Incentives for borrowers to increase the supply of non-monetary assets – and hence engage in financial disintermediation – form part of the line of reasoning behind the scenario presented in Section 5.1. The persistence of an environment of low interest rates and a steep yield curve in conjunction with the impact of liquidity support and the ECB's security purchase programme across asset markets may render it more profitable for financial institutions to engage in market activities and carry trade rather than lending to the private sector based on deposits. In such an environment, a market-led recovery bypassing the banking system could occur. A market-based recovery is also consistent with the financial sector benefiting from asset revaluations, write-ups of previously impaired assets, higher fee income and reduced write-downs on loans and asset portfolios. This might be seen as setting the stage for a renewed expansion in balance sheets and a renewed financial boom-bust cycle driven by asset markets along the lines more typically observed in market-based financial systems compared with traditional relationship-oriented, bank-based systems. In the event of such structural disintermediation, low growth in money and bank loans could thus – if looked at in isolation – significantly understate the risks to growth, price stability and financial stability.

Chart 4 shows a quantification of a scenario around these ideas, calculated on the basis of the aforementioned money to wealth ratio. This ratio, although lower than at the end of 2008, was still at a high 17.5% at the end of 2009. This compares with the average of 16.2% for the period from 1999 to 2009. The scenario assumes that this financial wealth composition – biased towards money if compared with historical records – will gradually reverse as the money holding sector restructures its portfolio towards the historical mean.

As mentioned above, the impact of lenders' wealth rebalancing on overall funds available for financing depends, inter alia, on its relative effect on prices and quantities, which in turn depends on the price elasticity of supply (of non-monetary

Chart 4 Ratio of M3 to financial wealth of the money-holding sectors

(percentages)



Source: ECB.

assets) by borrowers.[8] Moreover, the ex post effect on total funds depends on whether the supply of non-monetary assets by borrowers ends up adding to the baseline bank credit or substituting the latter. This also depends on cross-price elasticities of supply by borrowers, and considerations relative to the demand for intermediated funds by lenders, i.e. on banking credit supply factors. In order for the money ratio to meet its target value, it is necessary to assume how such a convergence process would be divided among three elements: the substitution of money for non-monetary assets, an increase in wealth (volume change) and an increase in prices.

6 CONCLUSIONS AND OUTLOOK

Comprehensive data on financial flows and balance sheets have been available for the euro area since the introduction of the euro area accounts in June 2007. Cross-checking based on the flow of funds has thus probably been the least well established among the avenues pursued in the enhancement of monetary analysis. At the same time, the financial crisis has underlined the importance of taking into account developments across a broad range of financial intermediation channels for both monetary and economic analysis. This chapter has provided an overview of the use of flow-of-funds analysis developed at the ECB over the past three years in terms of conceptual work and empirical studies, as well as practical use in forecast and scenario analysis.

First, the chapter addressed the relationship between monetary analysis and the flow of funds in the context of a broad-based portfolio analysis of monetary and non-monetary asset holdings across sectors, against the background of the original transaction-based formulation of the equation of exchange. The chapter then highlighted the usefulness of the flow of funds as a framework for analysis, even if attempts in earlier literature to build fully-fledged models of the flow-of-funds matrix appeared to be overly ambitious in view of instability in asset demand, including money, in the context of financial innovation. Second, the chapter sought to establish empirical stylised facts on the role of financial flows and balance sheets in monetary policy transmission. Third, the accounts provide a comprehensive platform for cross-checking real, monetary and financial developments from a practical perspective, in particular in the context of regular projection exercises and monetary-financial scenario analysis.

The financial crisis has spurred renewed interest in the role of financial flows and balance sheets in the propagation of shocks both in terms of understanding portfolio behaviour and asset markets in the context of monetary analysis and in understanding real-financial linkages in the context of economic analysis. Much work remains to be done by statisticians and national accountants to fill gaps and improve the detail and timeliness of the dataset, by the economics profession in developing new models and tools for macro-financial analysis alongside mainstream modelling, and by central bank practitioners to make the

8 In an extreme scenario, a hike in the demand for non-monetary assets might be fully translated into an increase in asset prices. In such a case, the adjustment to the ratio of M3 to financial wealth would occur via an increase in the value of the denominator, namely financial wealth.

best use of the flow of funds and sectoral accounts to underpin cross-checking, forecasting and scenario analysis. In the case of the euro area, improvements are envisaged in terms of timeliness, with current publication at 120 days after the reference quarter being reduced so that comprehensive estimates are available in under 90 days, together with further enhancement in the details and counterpart sector information and the incorporation of improved primary data sources, such as on insurance companies and pension funds as well as investment funds.

Therefore, flow-of-funds analysis, in the context of the integrated euro area accounts, is well placed to further augment and enrich monetary and economic analysis by offering a more comprehensive map of the macro-financial landscape. In the wake of the financial crisis, such a map appears more essential than ever to navigate the turbulent trajectory of a changing financial system in conjunction with the steady compass provided by the long-run link between money and prices at the heart of monetary analysis.

REFERENCES

Adam, C. and Vines, D. (2010), "Remaking macroeconomic policy after the global financial crisis: a balance-sheet approach", *Oxford Review of Economic Policy*, Vol. 25, pp. 507-552.

Adrian, T. and Shin, H.S. (2008a), "Liquidity and leverage", *Staff Reports*, No 328, Federal Reserve Bank of New York.

Adrian, T. and Shin, H.S. (2008b), "Financial intermediaries, financial stability and monetary policy", Proceedings of the Federal Reserve Bank of Kansas City Symposium at Jackson Hole, 2008.

Adrian, T. and Shin, H.S. (2009), "Financial intermediaries and monetary economics", *Staff Reports,* No 398, Federal Reserve Bank of New York.

Adrian, T., Moench, E. and Shin, H.S. (2010), "Financial intermediation, asset prices, and macroeconomic dynamics", *Staff Reports,* No 442, Federal Reserve Bank of New York.

Allen, M., Rosenberg, C., Keller, C., Setser, B. and Roubini, N. (2002), "A balance sheet approach to financial crisis", *IMF Working Paper*, No 02/210.

Baffi, P. (1957), "Monetary analysis in Italy", *International Monetary Fund Staff Papers*, No 5.

Bain, A.D. (1973), "Surveys in applied economics: flow of funds analysis", *Economic Journal,* Vol. 83, pp. 1055-1093.

Banca d'Italia (2008), *Financial accounts: history, methods, the case of Italy and international comparisons*, Rome.

Be Duc, L. and Le Breton, G. (2009), "Flow-of-funds analysis at the ECB – framework and applications, *Occasional Paper Series*, No 105, ECB.

Beck, G. and Wieland, V. (2007), "Money in monetary policy design: a formal characterization of ECB-style cross-checking", *Journal of the European Economic Association*, Vol. 5, pp. 524-533.

Beck, G. and Wieland, V. (2008), "Central bank misperceptions and the role of money in interest-rate rules", *Journal of Monetary Economics*, Vol. 55, pp. S1-S17.

Bezemer, D. (2009), "No one saw this coming: understanding financial crisis through accounting models", *MPRA Papers*, No 15892, Munich Personal RePEc Archive, June.

Bonci. R. and Columba, F. (2008), "Monetary policy effects: new evidence from the Italian flow of funds", *Applied Economics*, Vol. 40, pp. 2803-2818.

Brainard, W. and Tobin, J. (1968), "Pitfalls in financial model-building", *American Economic Review,* Vol. 58, pp. 99-122.

Brender, A. and Pisani, F. (2009), *Globalised finance and its collapse*, Dexia Asset Management, Belgium.

Brunner, K. and Meltzer, A.H. (1966), "A credit market theory of the money supply and an explanation of two puzzles in monetary policy", *Rivista Internazionale di Scienze Economiche e Commerciali*, Vol. 5, pp. 405-432.

Brunner, K. and Meltzer, A.H. (1974), "Money, debt and economic activity", *Journal of Political Economy*, Vol. 80, pp. 951-977.

Brunnermeier, M., Crockett, A., Goodhart, C., Persaud, A.D. and Shin, H.S. (2009), "The fundamental principles of financial regulation", *Geneva Report on the World Economy*, International Center for Monetary and Banking Studies and Centre for Economic Policy Research.

Christiano L.J., Eichenbaum, M. and Evans, C. (1996), "The effects of monetary policy shocks: evidence from the flow of funds", *The Review of Economics and Statistics*, Vol. 78, pp. 16-34.

Congdon, T. (2005), "Money and asset prices in boom and bust", The Institute of Economic Affairs, London.

Copeland, M. (1952), *A Study of Moneyflows in the United States*, National Bureau of Economic Research, New York.

Dawson, J. (ed.) (1996), *Flow of funds analysis – A handbook for practitioners*, M.E. Sharpe, Armonk (NY), London.

De Santis, R.A. and Favero, C.A. (2010), "Money, output and asset prices: a two-country portfolio model for the euro area and the United States", paper presented at the 2010 Econometric Society World Congress held in Shanghai, 17-21 August 2010.

Deutsche Bundesbank (1995), *Die Geldpolitik der Bundesbank*, October, p. 43.

Devereux, M. and Yetman, J. (2010), "Leverage constraints and the international transmission of shocks", *NBER Working Paper Series*, No 16226.

ECB (2001), “Issues related to monetary policy rules”, *Monthly Bulletin*, October.

ECB (2007), “The introduction of quarterly sectoral accounts statistics for the euro area”, *Monthly Bulletin*, November.

ECB (2009), “The external financing of households and non-financial corporations: a comparison of the euro area and the United States”, *Monthly Bulletin*, April.

Eichner, M., Kohn, D. and Palumbo, M. (2010), “Financial statistics for the United States and the crisis: what did they get right, what did they miss, and how should they change?”, *Finance and Economics Discussion Paper Series*, No 2010-20, Federal Reserve Board.

Eickmeier, S. and Hofmann, B. (2010), “Monetary policy, housing booms and financial (im)balances”, *Working Paper Series*, No 1178, ECB.

Fisher, I. (1911), “The Purchasing Power of Money”, *American Statistical Association*, Vol. 12, pp. 818-829.

Godley, W. and Lavoie, M. (2006), *Monetary economics: an integrated approach to credit, money, income, production and wealth*, Palgrave/Macmillan.

González-Páramo J.M. (2009), “National accounts for monetary policy-making: reflections on the use of the euro area accounts in the light of the financial crisis”, speech at Eurostat conference *Reading the present to prepare the future*, Brussels, 16 September.

Gordon, R.J. (2009), “Is modern macro or 1978-era macro more relevant to the understanding of the current economic crisis?”, mimeo, Northwestern University.

Gorton, G. and Metrick, A. (2009), “Securitized banking and the run on repo”, *Yale ICF Working Paper*, No 09-14.

Green, C. and Murinde, V (2003), “Flow of funds: implications for research on financial sector development and the real economy”, *Journal of International Development*, Vol. 15, pp. 1015-1036.

Hattori, M., Shin, H.S. and Takahashi, W. (2009), “A financial system perspective on Japan’s experience in the late 1980s”, *IMES Discussion Paper E Series*, No 2009-E-19, Institute for Monetary and Economic Studies, Bank of Japan.

He, Z., Khang, I. and Krishnamurthy, A. (2010), “Balance sheet adjustment in the 2008 crisis”, *NBER Working Paper Series*, No 15919.

Honohan, P. and Dunne, J. (1981/1982), “The flow of funds 1972-1977”, *Journal of the Statistical and Social Inquiry Society of Ireland*, Vol. 24, part IV, pp. 175-216.

Hume, M. and Sentance, A. (2009), “The global credit boom: challenges for macroeconomics and policy”, *Discussion Paper*, No 27, External MPC Unit, Bank of England.

Issing, O. (2000), “Communication challenges for the ECB”, speech at the conference *The ECB and its watchers II*, Frankfurt, 26 June.

Kahneman, D. and Tversky, A. (1981), "The Framing of Decisions and the Psychology of Choice", *Science*, Vol. 211(4481).

Kindleberger, C. (1978), *Manias, panics and crashes: A history of financial crises*, John Wiley, New York.

Kiyotaki, N. and Moore, J. (1997), "Credit cycles", *Journal of Political Economy*, Vol. 2, Winter, pp. 297-333.

Koo, R. (2008), *The holy grail of macroeconomics: lessons from Japan's Great Recession*, John Wiley & Sons, Singapore.

Minsky, P.H. (1986), *Stabilizing an unstable economy*, Yale University Press, New Haven.

Muellbauer, J. (2010), "Household decisions, credit markets and the macroeconomy: implications for the design of central bank models", *BIS Working Papers*, No 306, Bank for International Settlements.

Moutot, P., Gerdesmeier, D., Lojschová, A. and Von Landesberger, J. (2007), "The role of other financial intermediaries in monetary and credit developments in the euro area", *Occasional Paper Series*, No 75, ECB.

Papademos, L. and Modigliani, F. (1990), "The supply of money and the control of nominal income", in Friedman, B. and Hahn, F. (eds.), *Handbook of Monetary Economics*, Vol. 1, Elsevier Science, pp. 399-494.

Piazzesi, M. and Schneider, M. (2007), "Asset prices and asset quantities", *Journal of the European Economic Association*, Vol. 5, pp. 380-389.

Pozsar, Z., Adrian, T., Ahcraft, A. and Hayley, B. (2010), "Shadow banking", *Staff Reports,* No 458, Federal Reserve Bank of New York.

Schularick, M. and Taylor, A. (2009), "Credit booms gone bust: monetary policy, leverage cycles and financial crises, 1870-2008", *NBER Working Paper Series*, No 15512, National Bureau of Economic Research.

Shin, H.S. (2009), "Securitisation and financial stability", *Economic Journal*, Vol. 119, March, pp. 309-332.

Shin, H.S. (2010), "Financial intermediation and the post-crisis financial system", *BIS Working Papers*, No 306, Bank for International Settlements.

Tobin, J. (1969), "A general equilibrium approach to monetary theory", *Journal of Money, Credit and Banking*, Vol. 1, pp. 15-29.

Werner, R. (1997), "A quantity theorem of disaggregated credit, with evidence from Japan", *Kredit und Kapital*, Vol. 30, pp. 276-309.

Winkler, B. (2000), "Which kind of transparency? On the need for clarity in monetary policy-making", *Working Paper Series*, No 26, ECB.

Winkler, B. (2002), "Which kind of transparency? On the need for effective communication in monetary policy-making", *ifo Studien*, Vol. 48, pp. 401-427.

ANNEX I

MONETARY ANALYSIS AND THE FLOW OF FUNDS

1 INTRODUCTION[9]

Monetary and financial quantities are important for the transmission of monetary policy in the presence of financial frictions, as observing interest rates and stock prices alone may not provide a comprehensive picture of financing conditions. In fact, the size and the structure of balance sheets affect the ability of economic agents to borrow or lend, i.e. bring forward or delay expenditure. However, traditional textbook macroeconomic models used in the analysis of monetary policy typically pay little attention to financial frictions. For instance, in the standard New Keynesian framework (see Clarida et al. (1999)) capital markets are assumed to be free of frictions and complete and thus have no separate role in the analysis. By contrast, the macroeconomic portfolio balance model, based on the flow-of-funds statistical system, explicitly models the interaction of the demand for and supply of funds and thus attempts to analyse the information embodied in the financial flow data.

The financial flows across sectors of the economy are recorded in the flow-of-funds accounts, which track funds as they move from sectors, such as households, that serve as sources of funds (net lenders), through intermediaries (financial corporations), to sectors that use the funds to acquire physical and financial assets (non-financial corporations, government, rest of the world).[10] For the euro area, the integrated euro area accounts provide consistent balance sheet positions for the household, non-financial corporations, financial corporations, government and rest of the world sectors. The accounts permit an analysis of non-financial activities, such as gross capital formation, and financial transactions (issuance of debt). The principle underlying the financial and non-financial accounts is that total sources of funds must equal total uses of funds, both for each instrument and for each sector.

This annex is organised as follows. First, the link between the flow-of-funds accounts and a stylised version of the macroeconomic portfolio balance models is illustrated. Then, the empirical implementation by various national central banks (NCBs) of the portfolio balance approach in large-scale macroeconometric models is reviewed and related to the ECB's current flow-of-funds analysis framework.

9 Prepared by Julian von Landesberger.
10 See also Teplin (2001).

Finally, the areas of interaction between the flow-of-funds analysis and monetary analysis are considered.

2 THE FLOW-OF-FUNDS SYSTEM AND THE PORTFOLIO BALANCE MODEL

James Tobin and co-authors proposed a framework based on the flow-of-funds accounting matrix (see Table A1.1) that brings the columns of the table to life by assuming the existence of functions relating sectoral portfolio and saving decisions to relevant economic determinants, and treats the rows as a set of simultaneous market clearing equations (i.e. sum to zero) in a general equilibrium system of wealth holding. In order to derive the sectoral behaviour, the agents within a sector are assumed to be homogenous, i.e. a representative household or representative non-financial corporation. To ensure that the developments in stocks and flows are consistent, the flows are determined by the sector's *wealth allocation* decision across asset classes. The holdings of instruments by a sector are explained by the economic behaviour of the sector, i.e. in terms of a sectoral asset demand function. The flows recorded in the matrix reflect the changes to the holdings of each instrument by the respective sector.

In order to move from an accounting system (identity) to an analytical framework, a set of assumptions need to be postulated. First, for a given instrument, the holdings of each sector are divided into two groups according to whether the holdings are under the sector's control (i.e. which determines the demand for an asset) or are passively determined. A second assumption would aim at aggregating very close substitutes, for instance "currency and deposits" and "gold and foreign currencies", in order to simplify the analysis. For example, focusing on the non-financial sector as the "controlling sector" and reducing the number of assets

Table A1.1 Net flows of financial assets by sector

(Q4 2007; EUR billions)

	Households	Non-financial corporations	General government	Financial corporations	Rest of the world	Net demand
Gold and foreign currencies	0	0	0	-1	1	0
Currency and deposits	158	70	-58	-260	90	0
Debt securities	37	2	61	-83	-17	0
Shares and other equity	-43	-1	-3	113	-66	0
Insurance technical reserves	59	-2	0	-61	3	0
Other accounts receivable	-46	28	-27	28	16	0
-Loans	-88	-168	11	291	-46	0
Net financial assets	78	-70	-16	28	-18	1

Source: ECB.

Table A1.2 Demand by instrument

	r_{C+D}	r_B	r_{Eq}	r_{Ins}	Y	W_{t-1}	S
Currency and deposits	a_1	b_1	c_1	d_1	e_1	f_1	g_1
Debt securities	a_2	b_2	c_2	d_2	e_2	f_2	g_2
Shares and equity	a_3	b_3	c_3	d_3	e_3	f_3	g_3
Insurance reserves	a_4	b_4	c_4	d_4	e_4	f_4	g_4
Financial wealth	0	0	0	0	0	1	1

to four gives a system of asset demand relationships, which can be summarised in a simpler portfolio adjustment matrix. [11]

The parameters a_i-g_i (i=1,…, 4) in Table A1.2 capture the respective adjustment behaviour of the demand for an asset in relation to changes in the determinants of demand (listed at the top of the column). The share of wealth that investors will wish to hold in an instrument depends on their total wealth at the end of the previous period W_{t-1}, current period savings S, the level of income Y and the yields (including expectations of capital gains and losses) perceived on all the various instruments.

A certain number of "balance sheet" constraints are also inherent to this system:

1. The parameters $f_1,\ldots,f_4$ must sum to unity since all wealth must be held in an existing instrument. Similarly, the parameters $g_1,\ldots,g_4$ must sum to unity as all savings must be accumulated in some form. Brainard and Tobin (1969) for example, assumed that saving in financial assets initially takes place only in the form of currency and deposits and is later distributed across the other instruments.

2. With respect to the interest rate effects, the instruments are generally assumed to be imperfect substitutes. The parameters $a_1,\ldots,d_1$ to $a_4,\ldots,d_4$ must then sum to zero. Furthermore, a_1, b_2, c_3 and d_4 are known to be positive, while the parameters for the alternative yields are non-positive. An increase in the yield of one instrument will induce a shift into this instrument and reduce the sum of holdings of the other instruments.

Additional restrictions can be imposed on individual parameters in the light of theoretical considerations reflecting the transmission of monetary policy. For example, Friedman (1978) imposes symmetry restrictions on the asset demand parameters for returns, such that for instance $a_2 = b_1$.[12] Such equality conditions imply that an increase in the return on deposits reduces bond holdings to the same extent as an increase in the return on bonds would reduce deposit holdings. A system of financial asset demands with a symmetric parameterisation of returns effects implies that investors exhibit constant mean risk aversion with respect to expected wealth.[13]

11 This section draws on Goodhart (1989), pp. 269-271.

12 Alternatively horizontal adding-up constraints can be imposed, see Godley and Lavoie (2007).

13 Roley (1983).

Given the constraints (1 and 2) and knowing all but one asset demand relationship allows us to consider the parameters of this residual relationship as predetermined. In principle, this is an application of Walras' Law, allowing one market to be ignored in the model. While the example is based on asset demand equations, per se, the system could also be set up using demand equations for alternative forms of financing (i.e. from the liability side).

The macroeconomic portfolio balance approach described above embodies, in the first row of Table A1.2, the demand for currency and deposits, which could be seen as a proxy for the demand for money. The explanatory factors are in line with standard money demand theories and with the theoretical underpinnings used in the specification of empirical money demand models.

At a conceptual level, the added-value of analysing monetary (and financial) developments within this framework results from the enforcement of a consistent explanation of the allocation behaviour and the explicit modelling of the substitution behaviour across the different instruments. Assuming that the approach correctly captures the portfolio allocation of the sector, the approach provides a framework to analyse demand shifts between asset classes. The nature of financial instruments with respect to substitution and complementarity can be incorporated in the framework by an appropriate specification of parameter values for the own rate and the rate on the alternative investments.

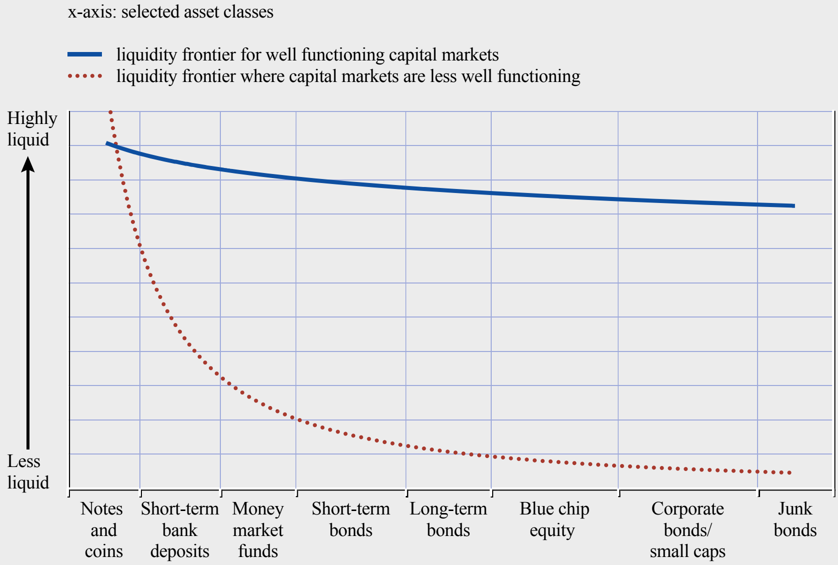
The degree of substitutability between instruments will in part reflect their relative capital certainty, which in turn is related to the volatility of their price. The macroeconomic portfolio balance approach takes this aspect into account through the return on the instruments, defined as the total return on the instrument, i.e. including gains and losses. The degree of substitutability between currency and other assets is, in particular, an important element when choosing which assets to include in the definition of money. At the same time, the degree of substitution between money and other assets will be of crucial importance in determining the role of money in the economy.

The degree of substitutability between financial and monetary instruments increases as the cost of conversion into monetary instruments declines, rendering the two assets more similar, if only differentiated by their ability to meet unexpected payment demands. This ability is traditionally emphasised when the uniqueness of money in the economy is justified, but applies to money narrowly defined. By contrast, a broad definition of money in the economy will, in general, include assets with a high degree of substitutability with respect to currency, which are primarily means of saving. Bank accounts (deposit liabilities) are an obvious example (see Chart A1.1), but others can be included as well. As liquidity on financial markets increases, the cost of transforming an instrument into money diminishes, which means it is likely to be included in a specific measure of money. [14]

14 On the definitions of liquidity and the interaction between funding liquidity and financial market liquidity, see Brunnermeier and Pedersen (2005).

Chart A1.1 Liquidity spectrum

(percentages)



Note: Asset classes are ordered by a priori considerations with regard to their liquidity.

There is however no absolute standard to judge what liquidity is, but rather a continuous scale. In analysing monetary liquidity empirically, one needs to take a stand on where the dividing line between liquid (monetary) and less liquid (financial) assets falls, which turns in large part on how one views the financial market liquidity of the spectrum of instruments considered. In the definition of traditional monetary aggregates, this leads to a binary weighting of the assets, whereby those included are weighted by unity, while those excluded are attributed a zero weight. Alternatively, all instruments could be weighted according to their relative substitutability with money (degree of moneyness) and then aggregated, thereby replacing the strict differentiation with a more gradual approach.

More importantly, the elements incorporated in the macroeconomic portfolio balance model (financial flows and asset returns) provide a framework to analyse the link between asset price developments implied by certain observed financial flows for a given macroeconomic environment and stock of wealth.

3 EMPIRICAL IMPLEMENTATION OF PORTFOLIO BALANCE SYSTEMS

In order to incorporate the financial system into their large-scale macroeconometric models, some Eurosystem NCBs, in the late 1980s and early 1990s, added estimated versions of portfolio balance equation systems to their real economy models. This required the estimation and/or the calibration of the demand equations. Different estimation strategies were employed with:

– the Banque de France's MEFISTO model constructed using cointegration techniques;

– De Nederlandsche Bank's MORKMON model [15] and the Deutsche Bundesbank's macroeconometric model [16] employing econometric methods that incorporated cross-equation restrictions in the estimation.

In order to simulate the interaction with the real economy and derive the reaction of the portfolio allocation to monetary policy and macroeconomic shocks, the models were generally appended with a set of equations capturing the interest rate pass-through and thereby linking the monetary policy instrument with the relevant returns/asset prices on longer-term and riskier assets.

As mentioned by Goodhart (1989), the insights from such simultaneous equation modelling of portfolio adjustment proved to be rather limited, with most further empirical work on quantifying asset demand being done in the context of single equation or single asset models. Furthermore, as pointed out by Green and Murinde (2000), interest rate elasticities and speeds of adjustment of actual to desired asset holdings are often signed incorrectly or are appreciably lower than intuition would suggest is plausible. In addition, Green and Kiernan (1989) showed that multicollinearity and measurement error among interest rates can produce estimated coefficients which are far too small and wrongly signed. However, these problems are almost inevitable given the set-up of the estimation with several rates of return and assets which are close substitutes. More recent work by Ramb and Scharnagl (2010) investigates, based on a Financial Almost Ideal Demand System, the wealth structure of German households. With regard to long-run wealth elasticities and interest-rate elasticities, the authors find that portfolio shifts in the long run are mainly determined by changes in interest rates. The wealth elasticities obtained indicate that currency (and transferable deposits) and savings deposits and shares are wealth-inferior assets. By contrast, time deposits and debt securities are wealth-luxury financial assets. Such analysis can contribute to the understanding of household portfolio decisions and thus provide information on an important element in the transmission of monetary policy.

4 MONETARY ANALYSIS AND THE FLOW-OF-FUNDS ANALYSIS FOR THE EURO AREA

Can the analysis of the flow of funds benefit monetary analysis? Within the ECB's monetary policy strategy, monetary analysis helps to identify medium to longer-term trends in inflation that are used to cross-check the assessment of short to medium-term risks to price stability obtained from the ECB's economic analysis. In interpreting monetary developments, it is important to distinguish short-term "noise" in the monetary data from the policy-relevant "signal" embodied in the persistent monetary trends. To this end, the flow-of-funds analysis represents a useful tool for monetary analysis. First, it offers information on the sources of

15 See Fase, Kramer and Boeschoten (1992).
16 For details, see Tödter and Wewel (1991).

financing of the non-financial private sector, i.e. whether financing is obtained through a money-creating expansion of bank credit or from other sources. Second, it provides an insight into the importance of portfolio shifts between money and non-monetary financial assets.

As described by Bê Duc and Le Breton (2009), changes in the money holdings by non-MFIs can be attributed to two mechanisms: a "credit effect" due to borrowing from MFIs and, to a lesser extent, from non-residents, which leads to a balance sheet expansion of households and firms as they increase their holdings of assets and a "portfolio shift effect" representing the shift between money and non-monetary assets in the total assets held by non-MFIs. The following identity illustrates the two effects: $\delta M = \delta TA \times (M/TA) + \delta (M/TA) \times TA$, where M stands for money, TA stands for total assets and δ for the change. The first term represents the "credit effect" resulting from an expansion of the balance sheet, while the second term represents the substitution effect or "portfolio shift effect". [17]

Indeed, substitution effects that can be explained on the basis of return differentials between money and other assets would in general be considered temporary, while substitution effects resulting from uncertainty and risk aversion would have other implications and may have more protracted effects on money growth. The portfolio balance approach would also indicate if the increase in money holdings were a result of a reduction in equity holdings or in insurance technical reserves. The information would qualify the interpretation of the change in money holdings as it would entail a different reduction in the profile of risks of the money-holding sector's asset holdings. The portfolio balance approach also allows an analysis of whether the changes in holdings result from increases in wealth and thus affects several financial instruments simultaneously – albeit maybe with different proportions. Overall, the portfolio balance approach resembles the analytical framework needed to assess monetary developments in real time with respect to their underlying forces.

Ideally, the macroeconomic portfolio balance approach – brought to life using the integrated euro area accounts data – would complement in real time the monetary analysis, at a time when extracting the monetary trends (signal) is at its most difficult. However, given the lagging nature of the flow-of-funds data, the generation of confirmatory information on past assessments is often only possible. A case in point is the evidence on the period of extraordinary portfolio shifts between 2001 and 2003. In retrospect, the flow-of-funds data provided additional information on the relevant counterpart, non-monetary securities sold by the money-holding sector in order to hold monetary assets, and also on the sectors mainly involved in the portfolio shifts.

Furthermore, the emphasis of the current flow-of-funds analysis/projection framework is on explaining the evolution of the money-holding sector's liability positions, while the asset holdings are often derived only indirectly. This direction of analysis does not seem to suggest that the asset demand behaviour

[17] See Bê Duc and Le Breton (2009), p. 15.

exhibited by the money-holding sector can provide separate information on the motives for holding deposits of the individual sectors.

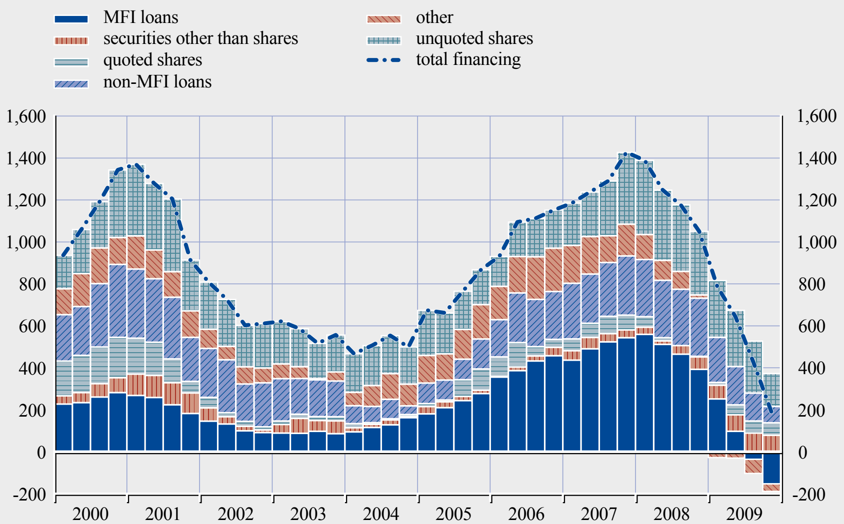
At the same time, these drawbacks do not preclude a number of alternative uses of the flow-of-funds data: structural analysis of the financial system; support of econometric modelling of money and credit; and analysis of wealth developments.

4.1 STRUCTURAL ANALYSIS OF THE FINANCIAL SYSTEM

The analysis of the integrated euro area accounts data can provide insights into the structure of the euro area financial system. It may also support the derivation of stylised facts, with respect to the relative magnitude and timing of developments or the variability in financing and financial investment. For instance, the relative importance of monetary financial intermediaries and non-monetary financial intermediaries as well as markets for the financing of the non-financial sector may be seen as such a fact. This information may then be integrated into the current assessment of credit developments. At a more conjunctural level, information on the recent "pecking order" and substitution processes between bank and market-based funding sources in the external financing of non-financial firms (see Chart A1.2) can also be extracted from the integrated accounts data. Together, these facts provide background information when analysing recent bank loan developments, an important element of monetary analysis in recent years. A major challenge in deriving the information is the need to differentiate between fundamental/structural relationships ("facts") and developments, which are the result of circumstances, such as the financial turmoil since August 2007.

Chart A1.2 Financing of non-financial corporations

(annual flows; EUR billions)



Source: ECB.

4.2 SUPPORT OF ECONOMETRIC MODELLING OF MONEY AND CREDIT

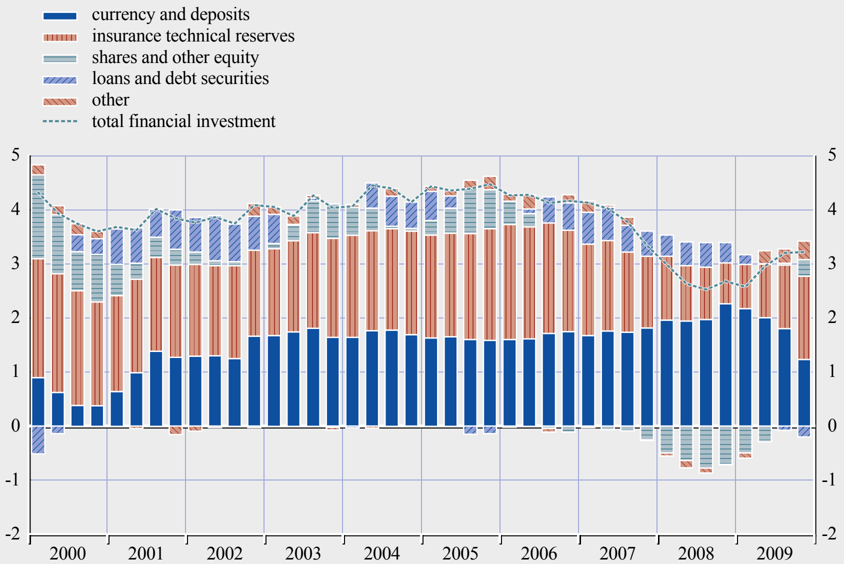
While the limited length of euro area flow-of-funds time series proves a severe impediment for the application of econometric methods, the data nonetheless provide insights valuable for the construction of econometric models for monetary analysis (e.g. equity is the second most important form of financing and thus the return on equity may be the relevant alternative cost of financing in an NFC loan equation). Given the sectoral orientation of the flow-of-funds data, the information is particularly valuable for modelling sectoral money and credit aggregates. The data, for instance, provide helpful indications when trying to construct opportunity cost measures for these sectors.

4.3 ANALYSIS OF WEALTH DEVELOPMENTS

The integrated euro area accounts data allow for the derivation of measures of financial wealth and (net) total wealth for individual sectors. Owing to the integration of the financial and the non-financial accounts, it is possible to quantify the relative importance of non-financial and financial asset accumulation in the gross wealth formation of the individual sectors. Chart A1.3, which illustrates the investment behaviour of households, puts into perspective the relative importance of "safe" investments, such as "currency and deposits" and "insurance technical reserves", vis-à-vis "riskier" investments in equity assets.

Chart A1.3 Households' financial investment

(four-quarter percentage changes; percentage point contributions)



Source: ECB.

Overall, the three uses described above are regularly made of the flow-of-funds data. While the first use – structural analysis of the financial system – may directly provide useful information on the longer-term dynamics of money, the latter two uses mainly pertain to the analysis of financial conditions in the euro area. The benefit of flow-of-funds analysis thus mainly stems from improving the assessment of the transitory component of monetary developments, which is needed in order to isolate the underlying monetary trend from overall monetary dynamics.

5 CAN MONETARY ANALYSIS CONTRIBUTE TO THE FLOW-OF-FUNDS ANALYSIS?

Monetary analysis can contribute to the development of the flow-of-funds analysis, in particular by improving the understanding of money demand of the financial and non-financial sectors both at a conceptual and at a technical level. Evidence generated in the context of the analysis of longer-term monetary trends with respect to the driving forces for money and credit demand can be used to improve the analytical foundations in modelling the demand for other assets, both for the explanation of currency and deposit holdings as well as for the other instrument holdings. Owing to the interconnected nature of the system, improvements to the understanding of money and credit demand must also be reflected in the demand for some or all the other assets/liabilities. For instance, if money demand is positively affected by the return on housing assets, then a negative reaction should be seen in another asset class or a positive impact should be detected in loans, in order to match the overall impact on wealth.

Additionally, progress made by monetary analysis in understanding the link between developments in money and credit, on the one hand, and developments in asset prices, on the other hand, can improve the understanding of the role of financial flows in asset price formation more generally.

REFERENCES

Bê Duc, L. and Le Breton, G. (2009), "Flow-of-funds analysis at the ECB: framework and applications", *Occasional Paper Series*, No 105, August, ECB.

Brainard, W. and Tobin, J. (1969), "Pitfalls in Financial Model Building", *American Economic Review*, Vol. 58, No 2, pp. 99-122.

Brunnermeier, M. and Pedersen, L. (2005), "Market Liquidity and Funding Liquidity", NBER Summer Institute on Asset Pricing, 14-15 July.

Clarida, R., Galí, J. and Gertler, M. (1999), "The Science of Monetary Policy: A New Keynesian Perspective", *Journal of Economic Literature*, Vol. 37, December, pp. 1661-1707.

ECB (2007), "The introduction of quarterly sectoral accounts statistics for the euro area", *Monthly Bulletin*, November, pp. 75-87.

Fase, M., Kramer, P. and Boeschoten, W. (1992), "MORKMON II: De Nederlandsche Bank's quarterly model of the Netherlands economy", *Economic Modelling*, April, pp. 146-204.

Friedman, B. (1978), "Financial Flow Variables in the Short-run Determination of Long-Term Interest Rates", *Journal of Political Economy*, Vol. 85, August, pp. 661-689.

Godley, W. and Lavoie, M. (2007), *Monetary Economics – An Integrated Approach to Credit, Money, Income, Production and Wealth*, Palgrave.

Goodhart, C.A.E (1989), *Money, Information and Uncertainty*, Oxford University.

Green, C. and Kiernan, E. (1989), "Multicollinearity and measurement error in econometric financial modelling", *Manchester School*, Vol. 57, No 4, December, pp. 357-369.

Green, C. and Murinde, V. (2000), "Flow of funds: implications for research on financial sector development and the real economy", Economic Research Paper No 00/6, Loughborough University.

Kiyotaki, N. and Moore, J. (1997), "Credit cycles", *Journal of Political Economy*, Vol. 105, No 2, pp. 211-248.

MEFISTO Team (1992), "A model of the French financial system at the Bank of France: MEFISTO I", *Economic Modelling*, Vol. 9, No 3, July, pp. 211-252.

Ramb, F. and Scharnagl, M. (2010), "Households' portfolio structure in Germany – Analysis of financial accounts data 1959-2009", mimeo.

Roley, V.V. (1983), "Symmetry Restriction in a System of Financial Asset Demands: Theoretical and Empirical Results", *Review of Economics and Statistics*, Vol. 65, No 1, pp. 124-130.

Teplin, A. (2001), "The U.S. Flow of Funds Accounts and Their Uses", *Federal Reserve Bulletin*, July, pp. 431-441.

Tödter, K.H. and Wewel, M. (1991), "Ein ökonometrisches Portfoliomodell für den Privaten Sektor in Bundesrepublik Deutschland", *Kredit und Kapital*, Vol. 24, pp. 235-253.

ANNEX 2

USING FLOW-OF-FUNDS STATISTICS TO ASSESS BALANCE SHEET CONTAGION AND THE TRANSMISSION OF RISK IN THE EURO AREA FINANCIAL SYSTEM

1 INTRODUCTION [18]

This annex illustrates the usefulness of flow-of-funds statistics for financial stability and macro-prudential policy analysis, an area in which central banks are becoming increasingly involved in addition to their responsibilities in the field of monetary policy. It shows how a flow-of-funds approach can offer a suitable framework to analyse the interconnectedness of different institutional sectors from a macro-financial perspective, also underlining the role of sectoral balance sheets, including broader measures of liquidity, in the propagation of financial shocks and real-financial linkages in the economy.

Assessing financial stability involves identifying risks and vulnerabilities in the various parts of the financial system. It also calls for the recognition of potential trigger events which could, if they materialised, flip the state of the financial system from stability to instability. Financial stability analysis should also aim to identify the channels through which shocks may spread more widely across the financial system, possibly affecting parts of the system that might not have been considered particularly vulnerable to the initial shock, but may nevertheless be adversely affected owing to their close interconnection with sectors that are directly confronted by the unforeseen events.

For financial stability analysis, the financial crisis that erupted in August 2007 has highlighted the particular need for a framework that can capture the interlinkages between sectors. Indeed, recent policy advice issued by international committees, which includes recommendations for European financial supervision, has suggested that systemic risk indicators be developed (see, for example, Issing et al. (2009)). In order to conceptualise such a framework, measures are needed that can capture the accumulation of imbalances and the transmission of local balance sheet dislocations. This annex uses data on the euro area financial accounts (flow of funds) to construct a network of balance sheet exposures that connects the main sectors of the euro area financial system. The analysis focuses on measures of leverage, which is a key indicator of balance sheet vulnerability owing to its ability to increase the sensitivity of economic agents' net financial wealth positions to changes in cash flows and asset prices. The annex goes on to

18 Prepared by O. Castrén and I. Kavonius.

show how shocks to some parts of the financial system can affect net financial wealth positions in other parts of the network. Finally, it illustrates how the network of leveraged exposures can be combined with data on asset returns and asset volatility to provide measures of risk exposures for individual sectors.

2 SECTOR-LEVEL BALANCE SHEETS IN THE EURO AREA FINANCIAL SYSTEM

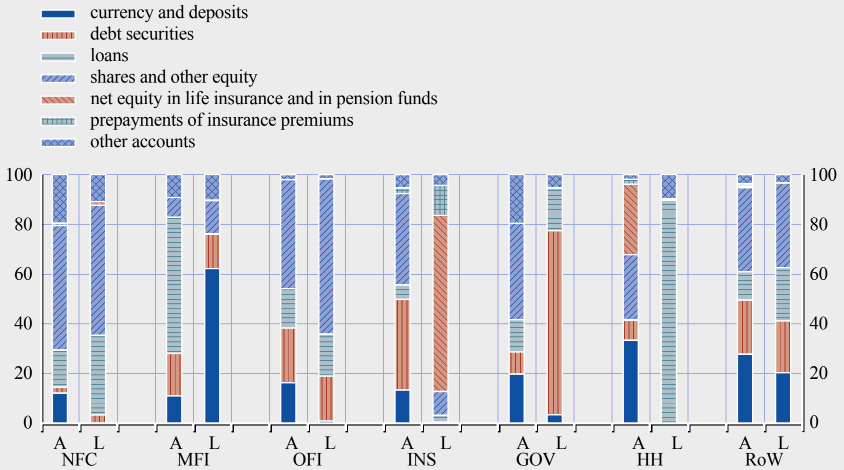
The euro area financial system is here considered as a closely intertwined group of seven distinct sectors: households, non-financial corporations (NFCs), banks and other monetary financial institutions (MFIs), insurance companies and pension funds, other financial intermediaries (OFIs), general government and the rest of the world (RoW). The data used to construct the sector-level balance sheets are from the ECB's euro area accounts. In these accounts, the analytical grouping of economic agents into institutional sectors and transactions is based on the methodological framework established in the European System of Accounts 1995 (ESA 95).[19]

Chart A2.1 illustrates the composition of the balance sheets (assets and liabilities) of the seven sectors as at the end of the third quarter of 2008. The categories of financial instruments included in the balance sheets are those used in the ESA 95 statistics, which are classified according to liquidity factors and legal characteristics.

[19] For more details, see the website at http://forum.europa.eu.int. The ESA 95 is the European application of the System of National Accounts (SNA 93).

Chart A2.1 The composition of sector-specific balance sheets in the euro area financial system

(Q3 2008; A = financial assets; L = financial liabilities; percentages)



Source: ECB.
Note: NFC stands for the non-financial corporations sector, MFI for the monetary financial institutions sector, OFI for the other financial intermediaries sector, INS for the insurance and pension fund sector, GOV for the government sector, HH for the household sector and RoW for the rest of the world.

For most sectors, the asset side of the financial account balance sheet consists of holdings, in different proportions, of cash and money market instruments, as well as debt and equity securities issued by financial and non-financial firms. Several sectors (notably MFIs, but also NFCs and OFIs) also extend large amounts of loans to the other sectors. There are also smaller asset items, such as prepayments of insurance premiums and net equity in life insurance and pension funds. Owing to the inclusion of the RoW sector, these asset holdings include instruments originated by both domestic and foreign counterparties.

In contrast to the asset holdings, the sector-specific liability positions show more distinct characteristics. The liabilities of the NFC sector consist of loans from banks and other firms, as well as equity and debt securities issued to other firms and other sectors in the financial system. For banks (MFIs), the liabilities are currency and deposits collected from other banks and from the other sectors, as well as stocks and bonds issued to investors in the other sectors. The bulk of the OFI sector's liabilities are mutual fund shares, while the largest share of the insurance and pension fund sector's liabilities is made up of net equity of households in life insurance cover and pension funds. For general government, government bonds account for the largest share of liabilities. Household sector liabilities are accounted for almost entirely by MFI loans to finance housing and consumption expenditure. Finally, for the rest of the world, both sides of the balance sheet are rather evenly split between cash, loans and investment securities.

3 LEVERAGE AS A MEASURE OF FINANCIAL FRAGILITY

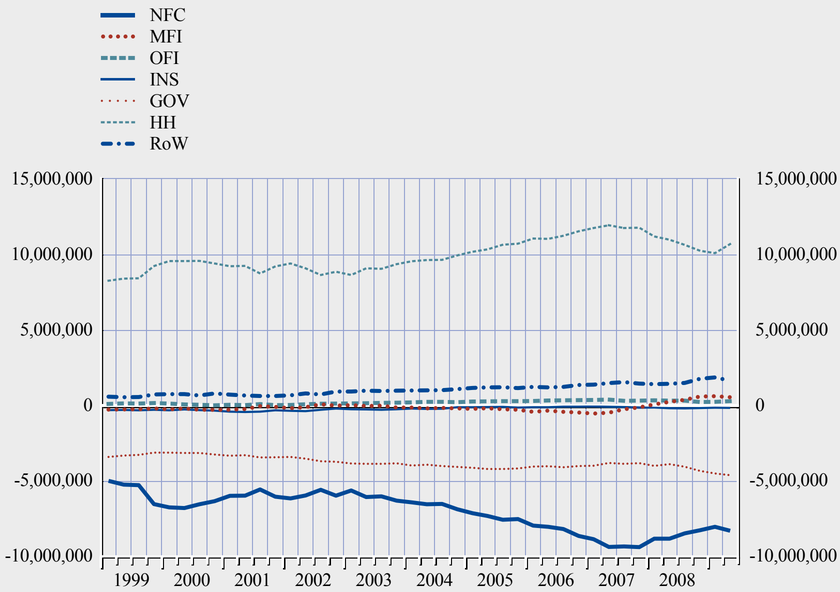
Although assets must equal liabilities at the system level in an integrated financial system like the ECB's euro area accounts, this is not necessarily the case at the sector level. Indeed, some sectors in the financial system show systematic deficits in their financial accounts, while others report systematic surpluses. The NFC and government sectors typically (although not always) belong to the former category, while households form the largest part of the latter category. Insofar as the deficits run by the borrowing sectors exceed the surpluses recorded by the lending sectors, the gap must be financed by borrowing from abroad. There is therefore a need for an RoW sector, whose financial position mirrors the current account of the balance of payments of the domestic financial system.

The difference between a sector's financial assets and liabilities equals that sector's net financial wealth. Chart A2.2 illustrates the evolution over time of the net financial wealth positions of the sectors of the euro area financial system. In the euro area, the positive net financial wealth of the surplus sectors (mainly households and the rest of the world) matches the negative net financial wealth of the deficit sectors (mainly the government sector and non-financial corporations). It is noteworthy that the net financial wealth of the financial sectors is small.This reflects the fact that, since they comprise financial intermediaries, the bulk of their assets and liabilities consist of financial instruments, and that their holdings of non-financial assets such as real estate and capital goods are relatively insignificant.

Net financial wealth and its role in attributing sectors to the borrowers or lenders in the financial system also provide a link between the financial and the real

Chart A2.2 Evolution of sector-level net financial wealth in the euro area financial system

(Q1 1999 – Q3 2008; EUR trillions)



Source: ECB.

Notes: Net financial wealth is defined as total financial assets minus total liabilities. For the explanation of the abbreviations used, see the note in Chart A2.1.

accounts. They therefore allow an analysis of the transmission of "vertical" contagion whereby shocks may spread from the real sector to the financial sector via the net lending positions of the different sectors.[20]

Constructing a comparable measure of leverage for different sectors is complicated somewhat by the above-mentioned differences in the composition of the liability sides of the balance sheets. Chart A2.3 provides a measure of debt-to-asset ratios for the individual sectors, where debt is defined as total liabilities minus shareholder equity and net financial wealth.

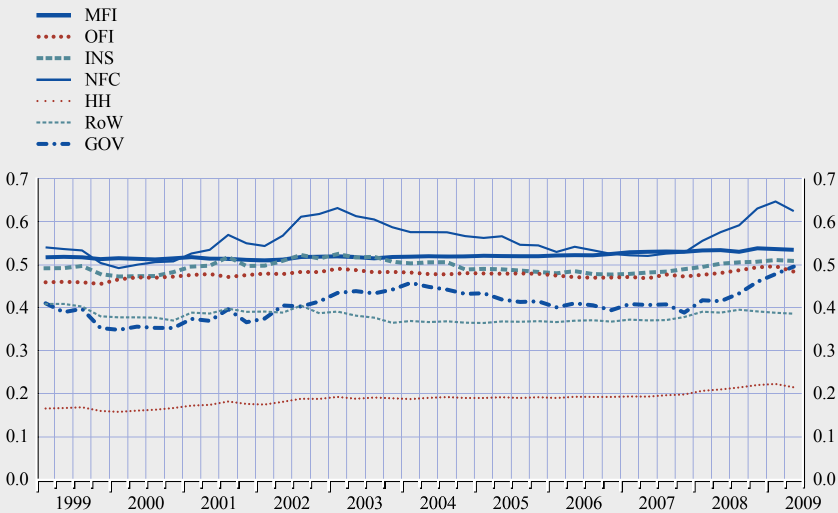
Leverage increased for euro area non-financial corporations in the run-up to the stock market crash in 2000-01 and then broadly declined, before starting to increase again from mid-2007. For the euro area household sector, financial leverage increased steadily over the period under review, although the ratio remained low, equalling around one-third of the corporate sector leverage on this particular measure.[21]

20 More specifically, net wealth (a measure of stocks) can be defined as accumulated lending or borrowing (flow measures), including changes in prices and other components. The net lending/borrowing of a sector can be decomposed into investment (gross capital formation) and saving. Therefore, shocks to savings and investment are conveyed to the financial accounts via their impact on the flows of net lending and, thus, on the net wealth position.

21 However, there are important differences across the countries of the euro area in this respect.

Chart A2.3 Sector-level measures of leverage in the euro area financial system

(Q1 1999 – Q2 2009)



Source: ECB.

Notes: Leverage is defined as debt over market value of financial assets. For the explanation of the abbreviations used, see the note in Chart A2.1.

The leverage of the banking sector remained rather stable, which is consistent with the notion that banks tend to target constant leverage ratios over time as they strive to minimise fluctuations in their regulatory capital and credit ratings (see Adrian, T. and Shin, H. (2008)[22]). Regarding insurance companies and pension funds, leverage increased in the period 2001-03, as the decline in the euro area equity markets caused a sharp drop in the market value of their financial assets. This was followed by a period of balance sheet deleveraging and, subsequently, by a gradual increase in the leverage ratio from 2007.

4 A NETWORK OF BALANCE SHEET EXPOSURES FOR THE EURO AREA FINANCIAL SYSTEM

The financial accounts in the ECB's euro area accounts do not currently provide complete information on the specific counterparties of the instruments issued by a given sector (the "who-to-whom" accounts).[23] In the absence of this information,

22 Consistent with their findings, when plotting the changes in leverage against changes in total assets for the different sectors on the basis of data from the ECB's euro area accounts, it can be noted that, in the euro area, all sectors except the MFI and OFI sectors show a negative relationship. This suggests that for the non-financial sectors and insurance companies/ pensions funds, leverage ratios adjust passively, i.e. the ratios fall when the denominator (financial assets) increases. By contrast, the MFI and OFI sectors actively manage their leverage ratios by increasing (decreasing) debt when assets increase (decrease), mainly reflecting common risk management strategies that call for constant leverage across the cycle.

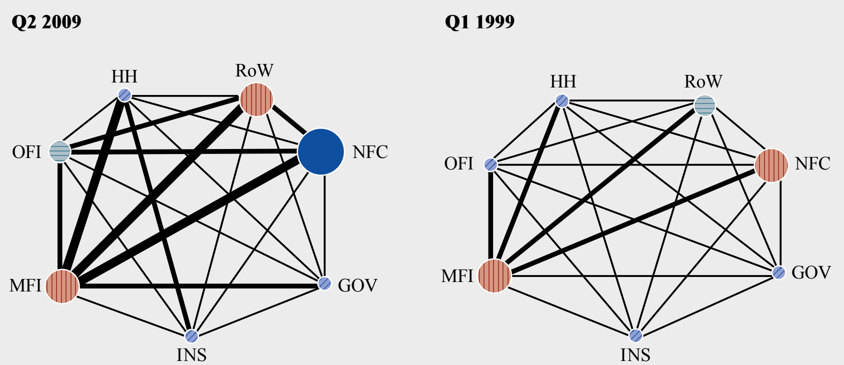
23 This situation is expected to improve with the implementation of "who-to-whom" statistics in the coming years.

the balance sheet linkages between sectors can be estimated using statistical techniques. More specifically, when the aggregate asset (liability) holdings of each sector are known on an instrument-by-instrument basis, the allocation of these aggregate holdings across the liabilities (assets) of all other sectors can be approximated using the maximum entropy technique, which exploits the relative shares of the sectoral total assets and liabilities. In other words, the who-to-whom detail is approximated to follow the distribution of assets and liabilities. The use of this assumption is standard in statistical exercises and in the literature on financial contagion (see, for example, Upper, C. and Worms, A. (2004), van Lelyveld, I. and Liedorp, F. (2006), and Wells, S. (2004)).

Once the bilateral exposures have been calculated, a network connecting all sectors in the financial system can be constructed. Chart A2.4 illustrates this network of balance sheet exposures for the euro area financial system at two distinct points in time, namely in the first quarter of 1999 and in the second quarter of 2009. The lines in the charts show the gross exposures, i.e. the sums of exposures on the asset and the liability side between two sectors. The thickness of the line connecting two sectors is commensurate with the magnitude of the gross exposure, while the sizes of the circles describe the exposures within sectors. The latter include, among other items, cross-shareholdings of firms, intercompany loans and interbank credit exposures.

Three main observations can be drawn from Chart A2.4. The first is the overall increase in the size of balance sheet exposures in the first decade of Stage Three of Economic and Monetary Union. The second is the crucial role played by the banking (MFI) sector in the euro area financial system. As a financial intermediary, it holds liabilities in the form of deposits collected from mainly the household, NFC and RoW sectors, while it holds assets in the form of loans extended predominantly to these same sectors. In addition, the MFI sector

Chart A2.4 Cross-sector balance sheet exposures of the euro area financial system



Sources: ECB and ECB calculations.

Notes: The thickness of the lines shows the size of the gross balance sheet exposure (assets plus liabilities) between two sectors. The size of the circle illustrates the amount of gross exposures within sectors. For the explanation of the abbreviations used, see the note in Chart A2.1.

also plays an important role in securities markets, as it issues equity and debt securities mainly to the household, insurance/pension fund, OFI and RoW sectors, and holds securities issued mainly by the NFC, OFI, government and RoW sectors. The third observation is the growing role played by the OFI sector over the past ten years. While the bulk of the sector in the euro area consists of money market funds, its growth also reflects the expansion of securitisation transactions and off-balance sheet structures.

Overall, it is evident from the above that potential stresses in the MFI sector have substantial negative spillover effects into virtually all other sectors in the euro area financial system, while the MFI sector is vulnerable to contagion especially from the household, NFC, RoW and OFI sectors, as well from the interbank credit market within the MFI sector itself.

5 TRANSMISSION OF SHOCKS IN THE NETWORK VIA BALANCE SHEET EXPOSURES

From the financial stability perspective, the network of financial exposures outlined in Chart A2.4 can be used to analyse how shocks to some sectors may cause a "horizontal" chain reaction in the network, whereby the other sectors may also see their financial positions adversely affected. The analysis below is inspired by the literature on balance sheet contagion, which provides the theoretical underpinnings of shock transmission in the financial system (see Allen, F. and Gale, D. (2000) and Kiyotaki, N. and Moore, J. (1997)).

Shocks to the cash flows of the non-financial corporate sector are analysed below using the ECB's euro area accounts data. More specifically, it is assumed that the NFC sector faces a negative earnings shock that is large enough to cause a 20% drop in the value of shareholder equity. For the sake of simplicity, it is also assumed that there are no further changes in cash flows in any other sectors in any future period and that all sectors must mark their investment losses to market. These rather restrictive assumptions nevertheless help to reveal the precise transmission of the shock over time and across sectors.[24]

Table A2.1 shows the result of this simple exercise. It suggests that, overall, in terms of the negative impact on financial assets owing to the loss of value in investment in other sectors' equity, the percentage impact on individual sectors is highest within the non-financial sector itself, as well as in the OFI and government sectors. This mainly reflects the large holdings by these sectors of non-financial corporate sector shares. However, the scale of the further impact of the shock also differs across sectors over time. In particular, the fact that in the later rounds a sector may be affected by valuation losses from other sectors to which it has large exposures means that the intensity of the shock may change over time. Indeed, Table A2.1 shows that the second round of the

24 Note that since the euro area accounts are a closed system, the shock persists indefinitely unless it is assumed that future positive cash flows in some sector can offset the losses.

Table A2.1 Simulated transmission of a shock to non-financial corporations' cash flows

(Q2 2009; percentage changes in financial assets)

	20% NFC cash flow shock							
	Round							
	1		2		3		Average	
	EUR billions	% of financial assets	EUR billions	% of financial assets	EUR billions	% of financial assets	EUR billions	% of financial assets
NFC	662.65	-4.91	529.45	-3.92	455.11	-3.37	549.07	-4.07
HH	271.36	-2.62	216.81	-2.09	186.37	-1.80	224.84	-2.17
MFI	160.02	-0.68	127.85	-0.55	109.90	-0.47	132.59	-0.57
INS	98.16	-1.65	78.43	-1.32	67.42	-1.13	81.34	-1.37
OFI	334.12	-3.51	266.96	-2.81	229.48	-2.41	276.85	-2.91
GOV	120.26	-3.75	96.09	-2.99	82.60	-2.57	99.65	-3.10
RoW	280.81	-1.91	224.36	-1.52	192.86	-1.31	232.68	-1.58
Average	**275.34**	**-2.72**	**219.99**	**-2.17**	**189.10**	**-1.87**		

Sources: ECB and ECB calculations.

Note: For the explanation of the abbreviations used, see the note in Chart A2.1.

impact is greater than the first round for almost all sectors except the insurance/pension fund sector. The latter sector is relatively less affected by losses in the valuation of equity issued by sectors other than the NFC sector.[25]

6 RISK EXPOSURES AND THE TRANSMISSION OF RISK IN THE FINANCIAL SYSTEM

The identification of imbalances using flow of funds data and sector-specific balance sheets as well as the illustration of the propagation of shocks via the network of exposures are useful tools for financial stability analysis. However, since the presentation above is based on a purely deterministic framework, it is not possible to say anything about the accumulation and transmission of *risk exposures*. To incorporate such characteristics, the analysis has to be extended by using tools that also capture the volatility of the key balance sheet items, such as shareholder equity and assets. In this way, it is possible to quantify the uncertainty, or risk, involved in the leveraged positions.

Recent contributions to contingent claims analysis extend tools originally developed for assessing firm-level default risk to the macro-financial level and can provide insight into the measurement of sector-level risk exposures (see Gray, D., Merton, R. and Bodie, Z. (2006) and Gray, D. and Malone, S. (2008)). Contingent claims analysis is based on structural finance models, which use options pricing theory and include as inputs data on leverage, interest rates, the market value of assets, asset returns and asset volatility (see Merton, R. (1974)).

25 Note that the contagion impact on other sectors is in this case dependent on the size of the cross-exposure in equity holdings, which may not be in proportion to the aggregate cross-exposure between sectors as shown in Chart A2.4.

The output consists of the optimal debt-equity structure of the firm plus a number of risk indicators, such as the distance to distress, the expected loss, the probability of distress, the expected recovery rate and the credit spread over the risk-free interest rate. While some of these indicators are available for selected financial and non-financial firms from various private data sources, their availability for other sectors such as households, government and OFIs is far more limited.

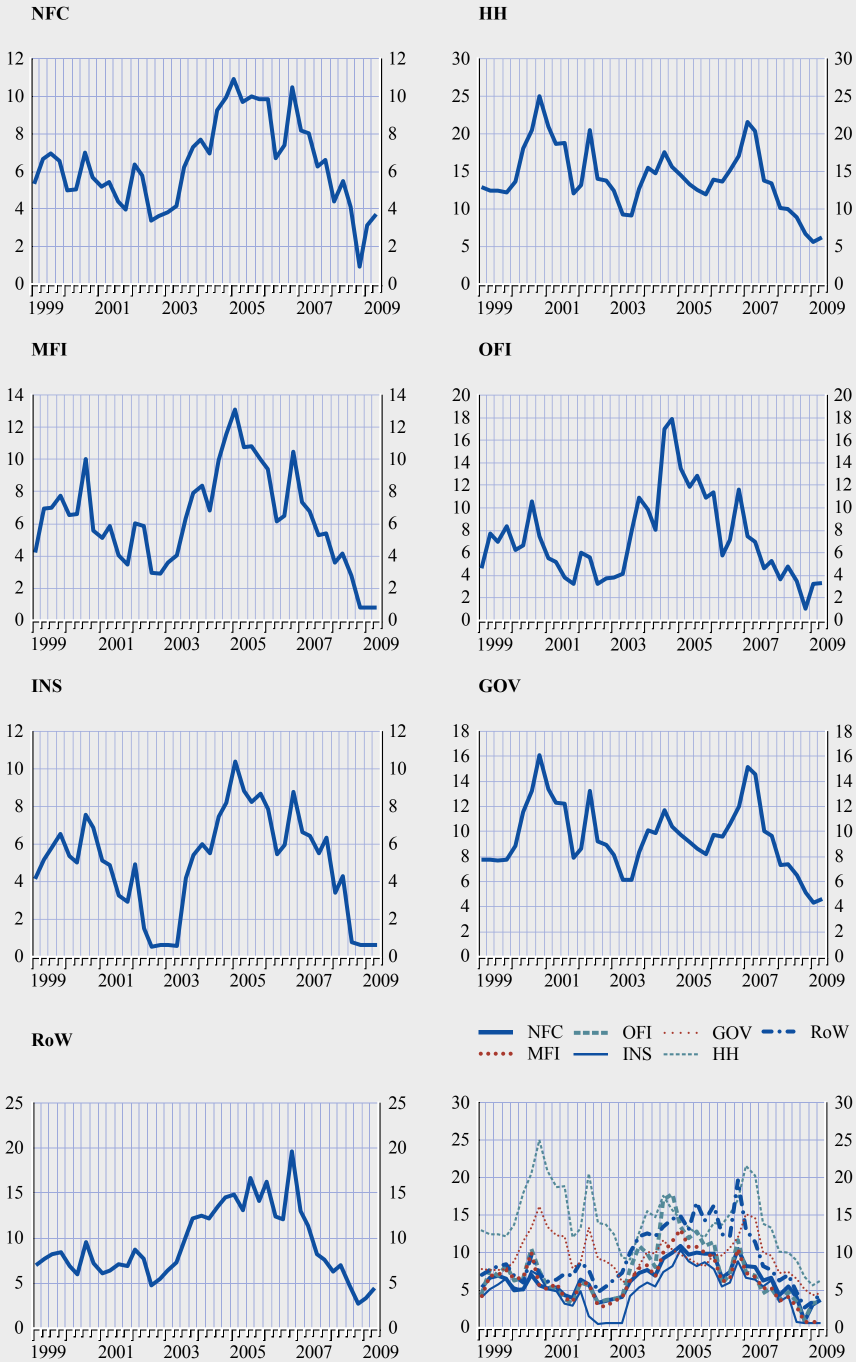
The fact that the euro area accounts provide a consistent source of leverage measures across different sectors makes it possible to construct time series for risk indicators at the sector level. It should be stressed from the outset, however, that the interpretation of these indicators is not straightforward for two reasons. First, the liability structure of many of the sectors differs from the liability structure of the firm sector for which the relevant models were originally developed. Second, the risk measures should not be understood as reflecting, for example, the probability of distress or expected loss given financial distress of an entire sector (which is likely to be very close to zero anyway) but rather the risks faced by a representative agent in that sector.[26] Bearing in mind these caveats, the dynamics of the indicators can nonetheless provide useful and timely signals on changes in individual sectors' risk exposures and how they can spread to other sectors in the financial system.

Using the sector-level balance sheet data on leveraged exposures from the euro area accounts and market data on volatilities, interest rates and the market price of risk as inputs, contingent claims analysis can be applied to calculate the risk indicators. By way of example, Chart A2.5 depicts the evolution of the distance to distress for the different sectors in the euro area financial system from the first quarter of 1999 to the second quarter of 2009. The distance to distress measures the distance of a sector's market value of assets from the value of its debt (the distress point). The impact of the financial sector turmoil that started in the second half of 2007 and intensified in the second half of 2008 and in early 2009 resulted in a marked decrease in the distance to distress in all sectors, most notably in the banking (MFI) sector and the other financial sectors. For most sectors, the distance to distress measure reached its lowest level in the sample series in late 2008. This decrease started from the high level of distances to distress (i.e. low perception of distress risk) that had prevailed throughout the years before the turmoil, mainly driven by the very moderate levels of asset volatility observed in all sectors.

Table A2.2 shows the simulated impact on the sector-level distances to distress of the first-round shock applied in the balance sheet contagion analysis above. The shock that was assumed to materialise in the third quarter of 2008 would have caused the distances to distress to decrease by between 2.5% and 7% in the OFI, insurance/pension fund and NFC sectors. The impact on the risk indicators in the

26 It should also be noted that, in general, the level of default risk among households, for example, is a tiny fraction of that among non-financial corporations, owing to the much higher leverage and asset volatility in the latter sector.

Chart A2.5 Sector-level distances to distress for the euro area financial system



Source: ECB.
Notes: High distance to distress means low risk of distress. The scales on the y-axes measure the distance, in standard deviations, between the market value of assets and the distress point. For the explanation of the abbreviations used, see the note in Chart A2.1.

Table A2.2 Simulated transmission of shocks on distances to distress

(Q2 2009; percentages)

	Decrease in distance to distress
NFC	3.70
HH	0.20
MFI	0.30
INS	7.00
OFI	2.52
GOV	0.10
RoW	0.20

Source: ECB calculations.

Notes: The shock scenario is the same as that applied in Table A2.1. For the explanation of the abbreviations used, see the note in Chart A2.1.

other sectors would have been more muted, reflecting either low leverage (in the household sector) or an already increased level of risk (in the RoW sector).[27]

7 CONCLUDING REMARKS

This annex used the data from the euro area accounts (flow-of-funds statistics) to construct a type of "systemic risk map" that illustrates how financial shocks are transmitted across sectors within the euro area financial system. The network of balance sheet exposures was then combined with a contingent claims model, which introduces an additional channel of transmission that traces the propagation of risk in the financial system. What is important is that this final step makes it possible to produce indicators for risk exposure and risk contagion at the sector level. Analysis of balance sheet and risk networks is especially useful for macro-prudential purposes, where attention should be paid to the vulnerabilities that arise from the interlinkages among agents in the financial system. In particular, these types of tool allow the early identification of risks that may not be easily recognisable when the focus of the analysis is only on measures of leverage and volatility within individual sectors.

REFERENCES

Adrian, T. and Shin, H. (2008), "Liquidity and Leverage", *Federal Reserve Bank of New York Staff Report*, No 328.

Castrén, O. and Kavonius, I. (2009), "Balance sheet interlinkages and macro-financial risk analysis in the euro area", *Working Paper Series*, No 1124, ECB.

De Larosière, J. et al. (2009), "Report", *The high-level group on financial supervision in the EU*.

27 An important mitigating factor with respect to the observed increase in risk is that, for the sake of simplicity, asset volatility of the affected sectors is assumed to remain unchanged. In practice, asset volatility typically increases quite sharply during periods of stress, which would push the distances to distress further down, possibly substantially so.

ECB (2009), Special Feature C, *Financial Stability Review*, June.

Gray, D., Merton, R. and Bodie, Z. (2006), "A New Framework for Analysing and Managing Macrofinancial Risks of an Economy", *NBER Working Paper Series,* No 12637, National Bureau of Economic Research.

Gray, D. and Malone, S., "Macrofinancial Risk Analyis", *Wiley Finance* 2008.

Issing, O. et al. (2009), "New Financial Order", *Recommendations of the Issing Committee.*

Merton, R. (1974), "On the Pricing of Corporate Debt: the Risk Structure of Interest Rates", *Journal of Finance*.

UK Financial Services Authority (2009), *The Turner Review.*

Upper, C. and Worms, A. (2004), "Estimating bilateral exposures in the German interbank market: is there a danger of contagion?" *European Economic Review.*

Van Lelyveld, I. and Liedorp, F. (2006), "Interbank contagion in the Dutch banking sector: a sensitivity analysis", *International Journal of Central Banking.*

Wells, S. (2004), "Financial interlinkages in the UK interbank market and the risk of contagion," *Working Paper Series*, No 230, Bank of England.

ANNEX 3

THE FINANCIAL CRISIS IN THE EURO AREA: A FLOW-OF-FUNDS PERSPECTIVE

1 INTRODUCTION[28]

The events that have unfolded since the summer of 2007 represent a setback of unprecedented intensity and complexity to economic development. Extraordinary changes in the value of assets, large financial flows, disorderly balance-sheet restructuring, shifts in portfolio and intertemporal expenditure decisions and adjustments to savings, financing and intermediation patterns all took place within the short period of three years. Understanding the intricate relationships between these events becomes a major challenge for the analyst, which – in principle – entails the cumbersome task of pooling diverse economic and financial data of different methodological backgrounds. Moreover, the analyst usually lacks an appropriate – comprehensive and methodologically consistent – conceptual tool to help make sense of the various messages embedded in the data.

In this paper, we make use of a relatively new analytical tool, the euro area accounts (EAA),[29] to describe the period leading up to the crisis and the crisis itself. The EAA are a set of macroeconomic sectoral accounts describing, in a comprehensive manner, economic activity in the euro area from the generation of value added to the accumulation of such value in assets. We use the tool to shed light on the events since the turn of century, following a sector-by-sector approach, starting with households as the ultimate lenders in the economy and ending with non-financial corporations as those ultimately responsible for the accumulation of a stock of productive capital. Along the path from the former to the latter, we will travel through the financial institution sector, which channels funds between and within the two sectors, and government and its role in distributing income and expenditure.

This summary provides a more horizontal, cross-sectoral view of the events. We first start with a chronological description both of the relevant factors that contributed to the build-up of vulnerabilities and of the response of the various actors to the unfolding of the crisis. We then discuss three recurrent themes that

28 Prepared by Celestino Girón with input from Philippe de Rougemont.

29 The EAA are statistics published quarterly with a delay of 120 days after the end of the reference quarter. The compilation of the EAA is the outcome of close collaboration between Eurostat, the ECB, the national statistical institutes in the euro area and Eurosystem national central banks. The data can be accessed at http://www.ecb.europa.eu/stats/acc/html/index.en.html

become apparent in the accounts: changes in intermediation patterns, leveraging behaviour and the emergence of sectoral and geographical imbalances.

2 A CHRONOLOGY

Although the events dealt with in this paper start roughly in 2007, many of the vulnerabilities, mismatches and imbalances that either contributed to the crisis or revealed their importance in the course thereof had built up in previous years. We start our description of the current balance-sheet crisis with the onset of the previous one, just after the turn of the century.

In 2001 and 2002 equity prices in the euro area were adjusted downwards in the wake of the bursting of the dot-com bubble, concerns about corporate governance and the geopolitical uncertainty in the aftermath of 11 September 2001. At the same time, capital formation by non-financial corporations reached historically high levels as firms were building up productive capacities for the New Economy environment, in particular in the telecommunications sector. Furthermore, business consolidation trends had been resulting in a progressive replacement of debt for capital, as debt-financed mergers and acquisitions soared.

All this brought euro area non-financial corporations to higher-leveraged positions that posed risks of future debt financing difficulties (see Charts A3.23 and A3.24). Moreover, further balance-sheet restructuring pressures started to unfold in some countries in the euro area that had been subject to severe losses of competitiveness over the 1990s, in particular Germany after re-unification.

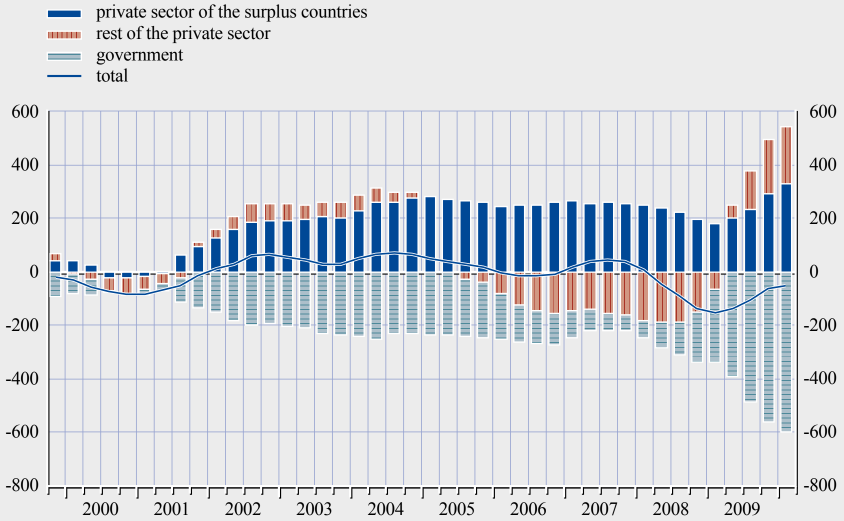
2003 and 2004 saw a slowdown in economic activity following the repair of the vulnerabilities that had previously been built up. However, heterogeneous balance-sheet and asset price stances (in particular regarding housing prices) across the euro area resulted in a mixed development of the economic and credit cycles, with robust growth starting to be resumed in some countries by 2004, while others continued to be confronted with modest activity.

The situation marked by two distinct growth speeds resulted in an overall shock to the euro area's sectoral lending imbalances. Initially, the sharp increase in lending by the private sector of the adjusting countries – following the contraction of the non-financial corporations' borrowing requirements and the rise in household savings in a context of balance-sheet repairs, low growth and uncertainty – was offset by government deficits as the automatic stabilisers and active countercyclical fiscal policies kicked in. But soon, as fiscal consolidation progressed, the private sectors of the other countries took over on the back of their relatively higher growth and expenditure. This internal imbalance in the private sector continued into the first phases of the recession (see Chart A3.1).

The value of the banking sector was similarly affected by the stock price declines of 2001 and 2002. As a result, the banks' capital ratio at market value decreased by more than 35% between early 2000 and early 2003 (Chart A3.2). In principle, one would have expected a relatively fast correction of that ratio over the subsequent years, back to its previous level, as banks undertake active

Chart A3.1 Net lending/borrowing in the euro area

(four-quarter sum of transactions; EUR billions)



Sources: ECB and Eurostat.

Notes: The group of "surplus countries" includes those running external current account surpluses for most of the period. It comprises Belgium, Germany, the Netherlands, Austria, and Finland. Net lending/borrowing is approximately the difference between income and expenditure, and the difference between assets acquired and liabilities incurred.

Chart A3.2 MFI capital ratios

(percentage points)

Sources: ECB and Eurostat.

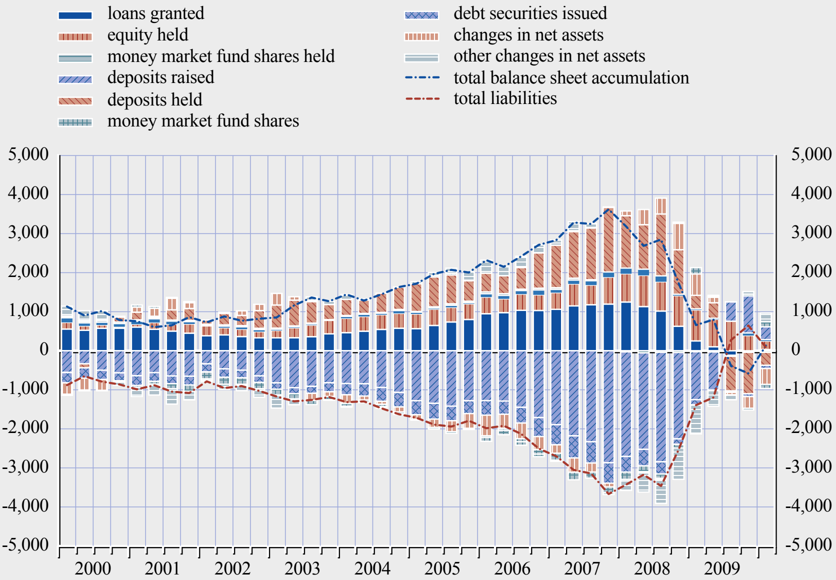
Notes: (Financial) assets and liabilities are valued at market prices. "Net assets" is the difference between financial assets and liabilities other than equity. The capital ratio calculated on net assets is equal to 1 minus the leverage ratio (liabilities other than equity to financial assets). "Notional equity" is the result of accumulating net lending/net borrowing and equity issuances on the net assets as of the end of the first quarter of 1999.

deleveraging in response to the deterioration of their capital position (by way of equity issuance, retaining more profits and/or decreasing the relative pace of increase in intermediated funds). Furthermore, passive deleveraging – through equity price increases – would also have contributed to restoring the ratio, as its then lower level, coupled with a virtually unchanged return on assets, translated into higher returns of capital thus making banking equity attractive for investors. However, none of this happened with enough intensity to restore the capital positions: as late as end-2005, the capital ratio at market value was still 20% below the levels of 2000, while the leverage ratio constantly remained above its level of 1999, even at the time of its lowest level in mid-2007. The slow growth of the capital ratio is all the more remarkable considering the overall increase in banking equity prices and the increase in banks' retained profits after 2003, which indicates how fast intermediated funds grew up to the end of 2007 (Chart A3.3).

A possible explanation of this structural change is to be found in shifts in risk appetite. A new equilibrium seems to have arisen with higher returns – measured as higher profit-to-capital ratios – and higher risk – measured as lower capital-to-assets ratios. At the same time, the increase in the return on capital was almost proportionate to the decrease in the capital ratio. In other words, the higher risk was not compensated for by higher returns on assets (which would have delivered a more than proportionate increase in the return on capital). Instead, spreads remained low and the return on assets virtually unchanged

Chart A3.3 Additions to the MFI balance sheet

(four-quarter sum of transactions; EUR billions)

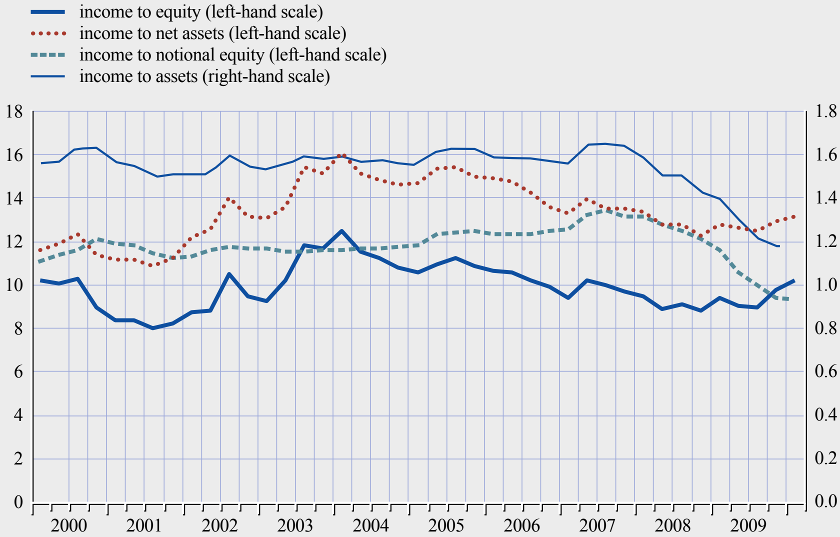


Sources: ECB and Eurostat.

Notes: Transactions in assets are given with a positive sign, while transactions in liabilities are given with a negative sign. Net assets refer to financial assets minus liabilities other than equity.

Chart A3.4 Ratios of return on capital of financial institutions

(percentage points)



Sources: ECB and Eurostat.

(Chart A3.4 illustrates this for the total financial sector[30]). This outcome is consistent with the overall under-pricing of risk that allegedly spread across global markets on the back of an excess of global savings, which materialised in the form of low interest rates and narrow spreads. In the euro area, the internal imbalances across private sectors may have contributed to the riskier stance of the banking sector.

Moreover, appetite for leveraging was even more acute than indicated by the simple analysis of balance-sheet ratios. Banks engaged in further effective leveraging[31] by moving to the business model of "originate to distribute", which allowed them to intermediate funds without affecting their balance sheets. The rise in loans granted by securitisation funds bears witness to this. Similarly, off-balance-sheet leveraging was on the rise through short positions or positions in financial derivatives, including synthetic securitisation-related derivatives. Highly leveraged products – including rating leverage[32] products, such as asset-backed securities (ABSs) and collateralised debt obligations (CDOs) – emerged throughout the financial system. Although to a lesser extent than in the United States, complex products of this kind were de facto playing a maturity

30 The return on assets started to decline as of 2007, in line with the reduction in the capital ratio.

31 Here, leveraging is understood in a broad sense as the exposure to risks (on or off the balance sheet) per unit of capital.

32 Rating leverage refers here to increases in the risk exposure relative to capital by pooling and tranching cash flows.

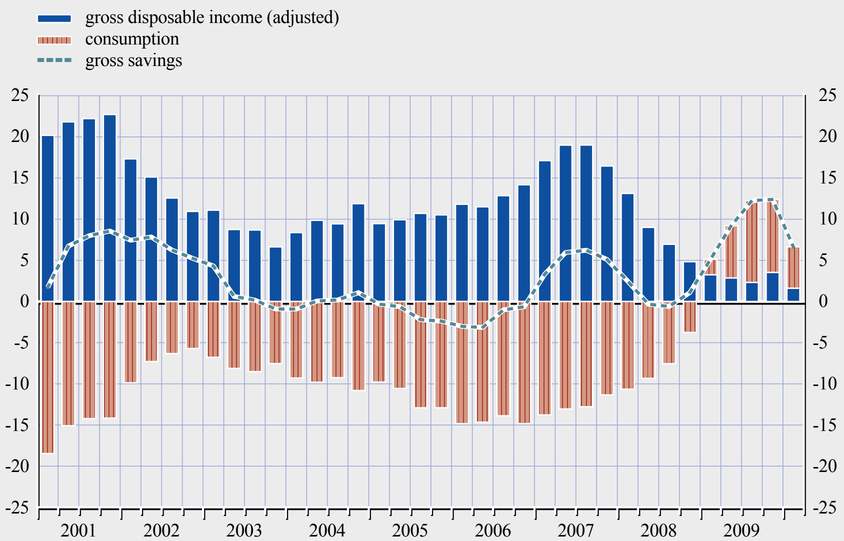
transformation role in that they led to the financing of long-term assets with short-term liabilities, as would be done by a traditional banking business, but without the appropriate capital and liquidity buffers, let alone sufficient supervision.

Arguably on the back of the easy credit times, 2005 and 2006 marked a generally highly expansionary period with quarterly real GDP growth rates averaging 0.7%. Consumption grew at a high pace, driving savings down in real terms for eight quarters in a row and reducing the savings ratio to a low of 13.5% at the end of 2006 (Charts A3.5 and A3.6). Conventional explanations for the decrease in savings are the high level of employment, the increase in future income expectations and the decrease in overall uncertainty and risk perceptions. But some other factors related to the financial conditions – such as the ready availability of consumer credit, financial wealth effects on the back of rising stock prices or debt cash flow effects on the back of low interest rates – seem to have also played a relevant role.

This paper argues, in particular, that the rise in the value of housing collateral may also have contributed notably to the consumption boom. We use the metric of "housing equity", defined as the difference between housing wealth and mortgage financing, to capture households' portfolio decisions. Households allocate and transfer wealth to and between housing equity and financial assets, or "financial equity", mainly through mortgage debt transactions. While there are mortgage instruments in place in the United States or the United Kingdom that make such transactions easier, such as reverse mortgages, these are less common in the euro area. We nevertheless take the view that wealth reallocation has taken place in the euro area through simple

Chart A3.5 Household real gross savings

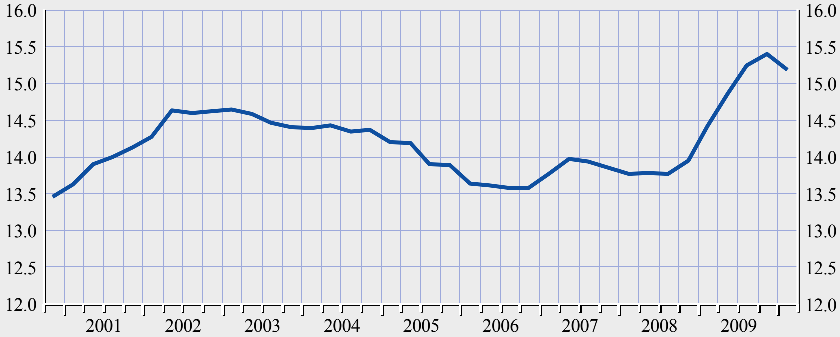
(four-quarter sums; year-on-year growth)



Sources: ECB and Eurostat.

Chart A3.6 Nominal gross savings ratio – ratio of household savings to disposable income

(four-quarter sums; percentage of gross disposable income)



Sources: ECB and Eurostat.

sales/purchases of existing dwellings financed with mortgages, which translates into higher financial equity and lower housing equity for the seller and into unchanged housing equity for the buyer. When this channel for wealth transfers is widely available thanks to easy access to loans, it results, de facto, in more liquid properties for housing equity, which can be more easily transformed into financial equity. This exerts additional pressures on consumption.[33]

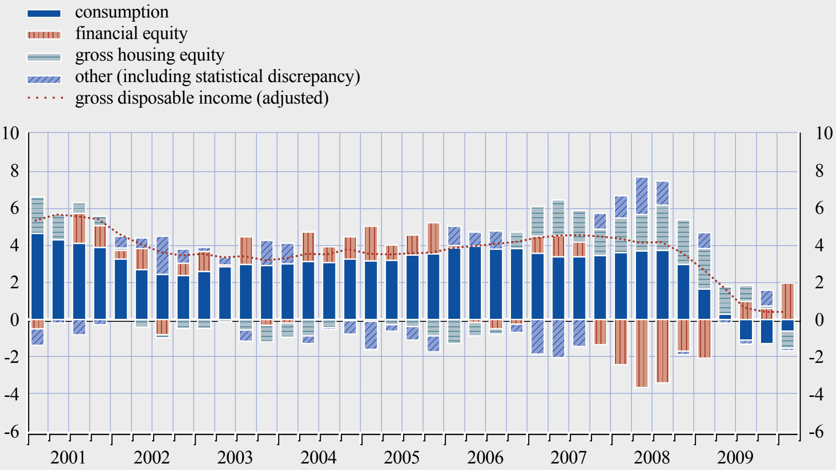
Housing equity grows organically through the repayment of past mortgages, while new mortgages on new dwellings are neutral in terms of housing equity formation: both housing wealth and debt increase. Between 2003 and 2007, however, housing equity transactions had been decreasing at a high rate that peaked at -1.3% of nominal income in the first quarter of 2006, indicating the high incurrence of mortgages on existing dwellings, i.e. the high transfers of housing equity to financial equity and, arguably, to finance consumption thereafter (Chart A3.7).[34] We postulate that the rise in housing prices, which was particularly pronounced in some countries, lies behind this development which follows a pure portfolio preference mechanism: households react to the unplanned increase in wealth owing to price increases by changing its composition and reallocating assets from housing equity to financial equity so as to restore their desired mix of financial and non-financial wealth (Chart A3.8); the associated increase in liquid wealth also potentially translates into consumption. The availability of ample credit in these years facilitated this portfolio mechanism.

33 Note that the relationship between the relative propensity to consume on wealth of the seller and the buyer (whether one is higher or not than the other) is largely immaterial to the validity of the statement that higher liquidity properties of housing equity evolve overall into a higher propensity to consume on that kind of wealth. However, it can be argued that savings of the buyer would have to rise in the future to cope with the mortgage payments – i.e. to maintain an organic accumulation of housing equity.

34 By construction, the dynamics of housing equity transactions lag the residential investment cycle depending on the maturity structure of the mortgages incurred. The slight decreases in 2003-04 are arguably the echoes of the decrease in residential investment growth over 2001 and 2002.

Chart A3.7 Household nominal income, broken down by use

(four-quarter sums; year-on-year growth)

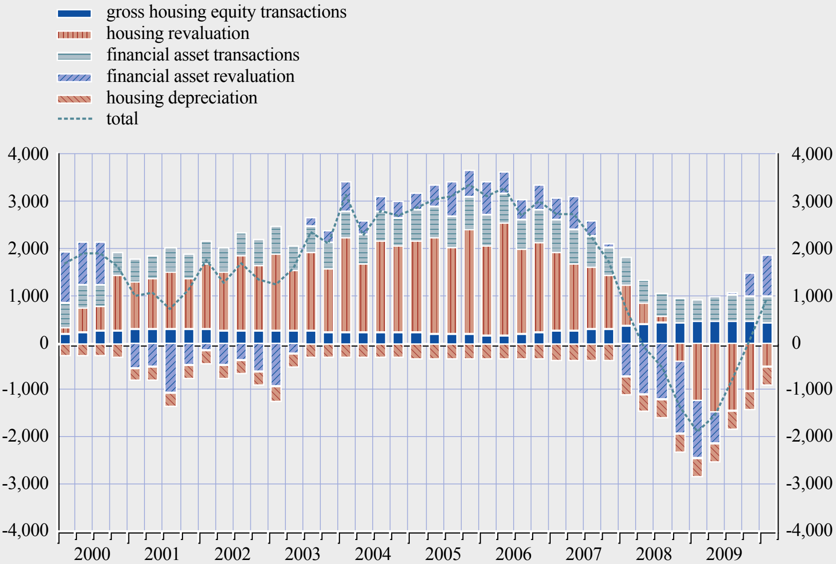


Sources: ECB and Eurostat.

Notes: Gross housing equity transactions equal gross residential investment capital formation (proxied with total household gross capital formation) less incurrence in loans for house purchase (proxied with long-term loans). "Financial equity" refers to financial investment. "Other" refers to transactions in all other liabilities plus the statistical discrepancy.

Chart A3.8 Accumulation of wealth by households

(four-quarter sum of flows; EUR billions)



Sources: ECB and Eurostat.

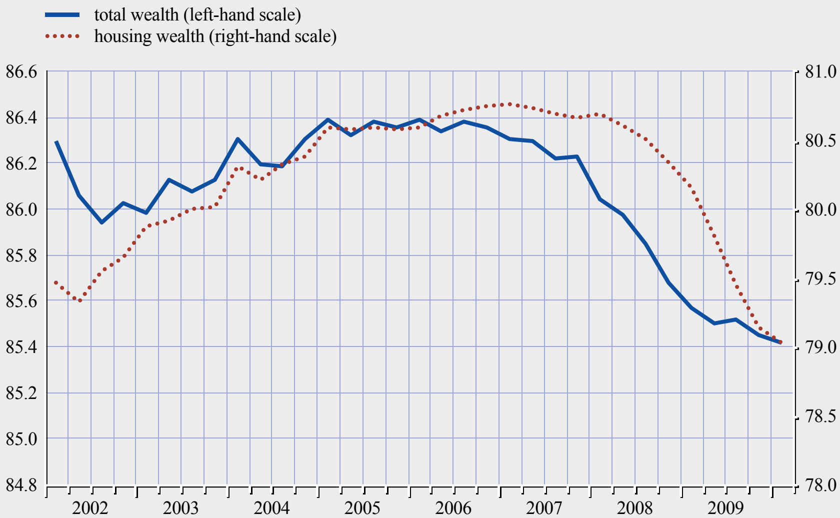
Note: Housing revaluation data are ECB estimates that have not yet been incorporated into official EAA publications.

The situation starts to change in early 2007. Before mid-2006, transactions in housing equity had been widely supported by housing market developments as attested by decreases in the housing leverage ratio at market value (ratio of debt to housing wealth) in spite of the high incurrence of debt. In the second half of 2006, however, the poorer housing market resulted in more moderate price increases that already led to rises in the leverage ratio (Chart A3.9). Households reacted by reducing transactions in the market for existing dwellings, taking out fewer loans, and thus stopping portfolio shifts between housing equity and financial equity.[35] Transactions in housing equity reversed from negative to positive growth to reach a maximum by mid-2007 (Chart A3.10). At the same time, in 2007 banks started to experience the first losses in debt securities and, to a lesser extent, loans, as the United States sub-prime mortgages crises started to unfold, revealing that euro area banks had been running too thin a capital layer (Chart A3.11). On the back of these developments, real savings moved from a moderate decline of -0.6% to robust growth of 6.2% in just three quarters (Chart A3.5).

35 As usual in this kind of relationship, it is difficult to draw precise conclusions on causality. Whether the higher appetite for housing equity transactions was the consequence of a lower availability of loans for house purchase or the other way around cannot be established from this analysis.

Chart A3.9 Household wealth ratios

(percentage of total assets)

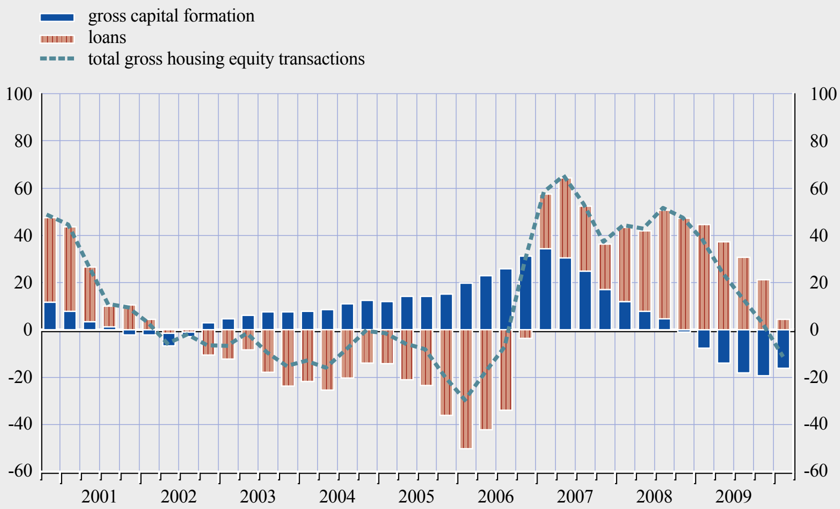


Sources: ECB and Eurostat.

Notes: The total wealth ratio is calculated as the ratio of total wealth to total assets. Total wealth is the sum of housing wealth and financial wealth, which in turn is equal to total financial assets minus liabilities. The housing wealth ratio is calculated as the ratio of housing equity to housing wealth. Housing wealth data are ECB estimates that have not yet been incorporated into official EAA publications.

Chart A3.10 Additions to housing equity

(four-quarter sum of transactions; year-on-year growth; percentage point contributions)

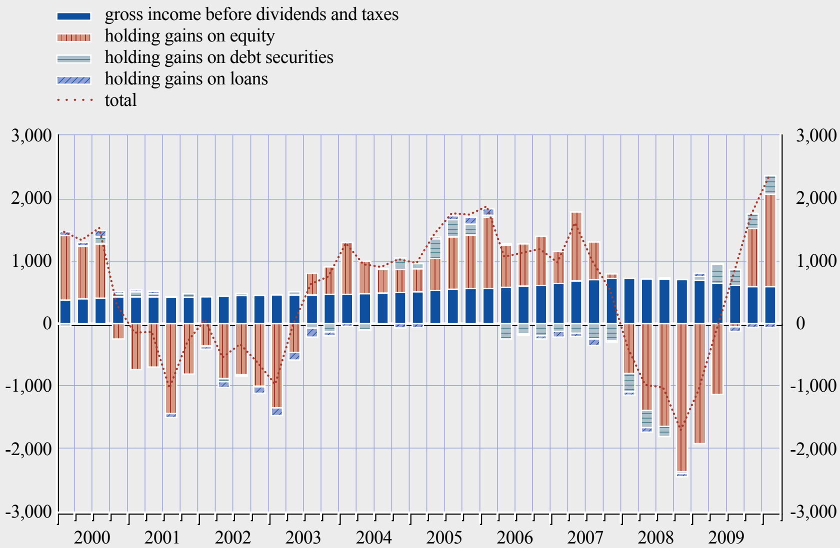


Sources: ECB and Eurostat.

Note: See notes to Chart A3.7 for a definition of gross housing equity transactions and its components.

Chart A3.11 Financial institutions' income and gains on holdings of financial assets

(four-quarter sum of flows; EUR billions)



Sources: ECB and Eurostat.

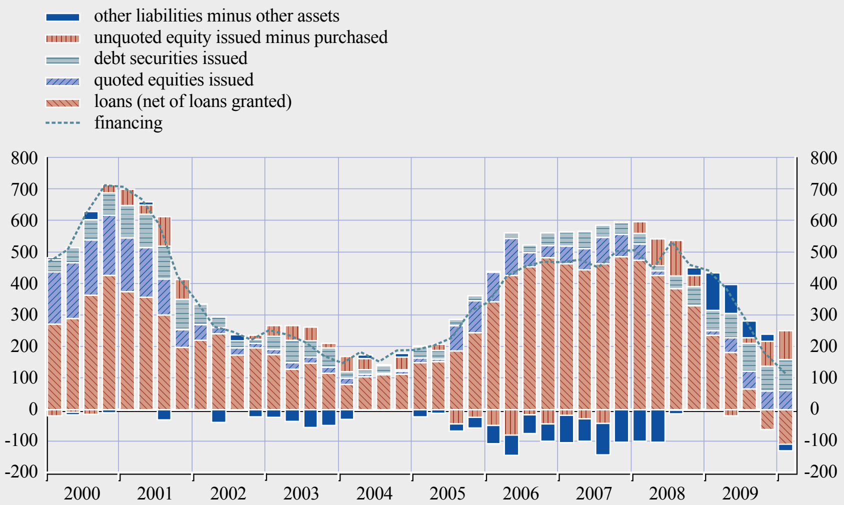
In mid-2007, however, increases in commodity prices changed these dynamics. The (previously increasing) savings growth went down as a consequence of the reduction in real income growth that resulted from inflationary pressure, in line with the historical regularity that consumption tends to withstand oil price shocks. In spite of the lower availability of savings, transactions in housing equity continued to grow robustly, but now mainly on the basis of the positive contributions of loans redemptions, while residential investment started on a downward path on the back of tighter income developments (Chart A3.10). Given the lower availability of income and savings, transactions in housing equity then came at the expense of financial equity, leading to a sharp reversal of previous portfolio shifts that have no parallel in the previous ten years (Chart A3.7).[36] The disposal of financial assets may have also contributed to sustaining consumption at relatively high levels before the end of 2008.

While households started clearly in early 2007 to show caution in response to the high leverage ratio and the inflationary shock caused by oil prices, non-financial corporations continued to remain in a generally expansionary mood, with resilient gross capital formation and debt financing (Chart A3.12). The economic slowdown of early 2008 was in fact absorbed almost completely by net entrepreneurial income, while dividends remained unchanged and net equity transactions with shareholders (issuance less acquisitions) even increased

36 Additional portfolio shifts within financial equity are also apparent in this period. Households reduced their investment fund shares to accumulate M3 in what can be considered a precautionary reaction.

Chart A3.12 External financing of non-financial corporations

(four-quarter sum of transactions; EUR billions)

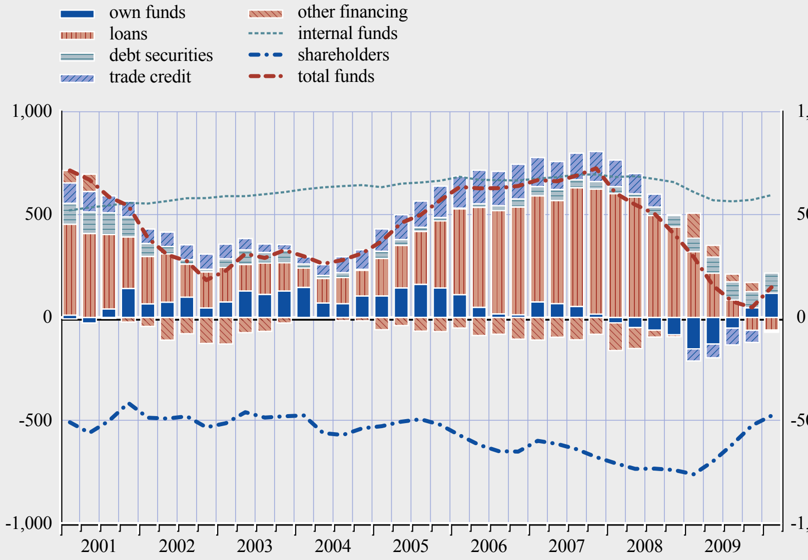


Sources: ECB and Eurostat.

Notes: For presentational purposes, some transactions in assets are netted from financing, as they are predominantly internal to the sector (loans granted by non-financial corporations, unquoted shares, other accounts receivable/payable)

Chart A3.13 Financing of non-financial corporations

(four-quarter sum of transactions; EUR billions)



Sources: ECB and Eurostat.

Notes: "Internal funds" is entrepreneurial income. "Shareholders" is equity issued less equity acquired less dividends paid. "Own funds" is "internal funds" plus "shareholders".

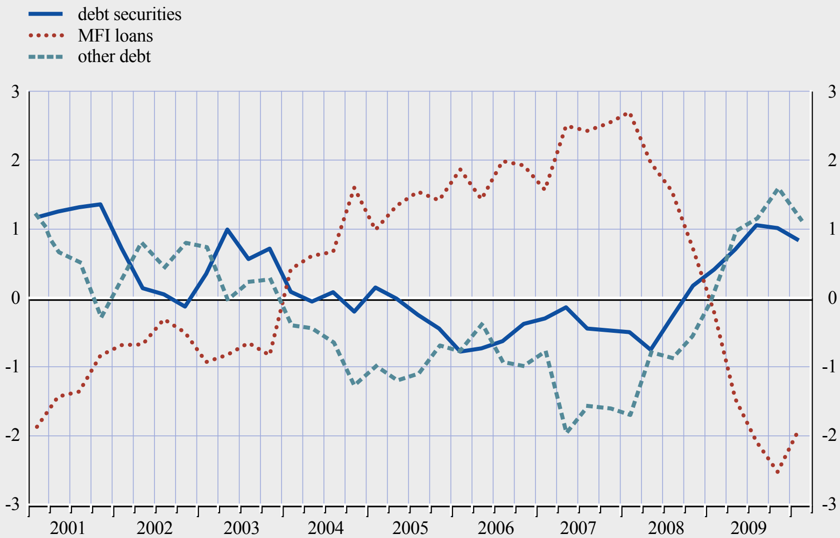
(Chart A3.13). This resulted in a net transfer of value to shareholders unparalleled in the ten preceding years, which probably reflects the more cautious stance of households who were trying to increase their cash flows. It can be argued that in the first three quarters of 2008, non-financial corporations cushioned households from the recession by providing additional cash flows.

A massive shock to non-financial corporations resulted from the bankruptcy of Lehman Brothers. Short-term credit virtually disappeared from the financial system as bank liquidity dried out and uncertainty surged. That left non-financial corporations with no means of financing their working capital and triggered a frenzied run to shorten the cash conversion cycle. Companies reduced their stock of inventories, adding to falling aggregate demand, tightened their terms and conditions for trade credits and scrambled for cash sources. Excess capacities and the lower availability of credit soon translated into falling investment and receding long-term financing.

In 2009 non-financial corporations also reacted to the new credit conditions by partially shifting their financing strategy away from bank loans. Large companies with access to the capital markets increased their issuance of debt securities to a remarkable extent, namely by 12% in annual terms in the third quarter, compared with negative growth of up to 3% in bank lending (Charts A3.12, A3.13 and A3.14). A possible explanation for this shift in financing choices is to be found in the increasing uncertainty surrounding credit risks. Uncertainty triggers a

Chart A3.14 Euro area non-financial corporations' financing and substitution effects – contributions to the annual growth of debt financing (deviation from trend)

(annual percentage changes; percentage point contributions)



Sources: ECB and Eurostat.

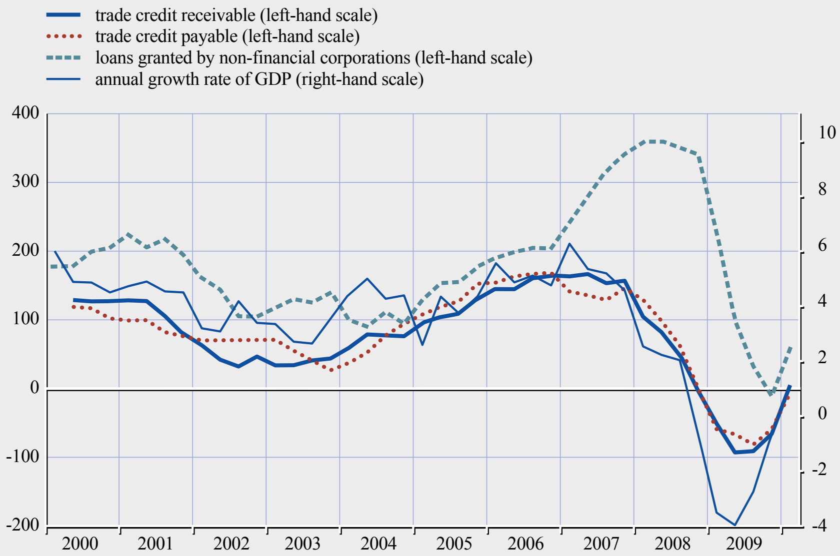
Notes: The chart shows the differences between the *actual* contributions to the growth rate of total debt financing and the *theoretical* contributions to such growth rate. Theoretical contributions are calculated by applying to the growth rate of total debt financing the proportions of the outstanding amount of each component in the total debt outstanding at the beginning of each quarter.

"flight-to-quality" mood in the markets by virtue of which the risks of companies with historically better ratings are priced even below what such ratings would imply. At the same time, banks, whose risk-pricing is by nature less discriminatory towards borrowers than the market, would tend to overprice large companies' risks in a context of overall increase in credit risk. As a result, large, high-rated companies would find it particularly advantageous to obtain financing in the market. Moreover, such companies seem to have also acted as financial "hubs" to provide small companies, especially those belonging to the same group, with access to cheaper, market financing. Such financing would have been channelled from the large companies to the small companies through intercompany loans and trade credits, the weight of which increased (relative to the value added in the case of the latter) in the balance sheets of non-financial corporations (Charts A3.15 and A3.16).

By mid-2009 households were showing the stylised flow-of-funds pattern of a deep recession. Net lending surged upwards on the back of low residential investment and consumption. Low income growth was sustained by transfers from the government sector, which was running high deficits and had clearly taken over the initial compensatory role of non-financial corporations. In fact, similar to what had occurred in 2003-04, the latter had started to undertake their own adjustment efforts, reducing dividend payments, wages and capital

Chart A3.15 Trade credit and loans granted by non-financial corporations

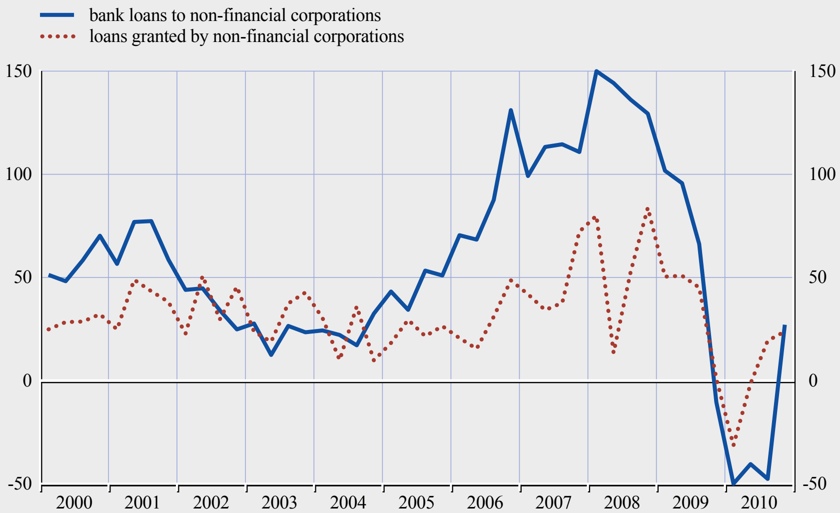
(four-quarter sum of transactions; EUR billions; year-on-year growth)



Sources: ECB and Eurostat.

Chart A3.16 Loans granted by banks to non-financial corporations and loans granted by non-financial corporations

(transactions; EUR billions; seasonally adjusted)

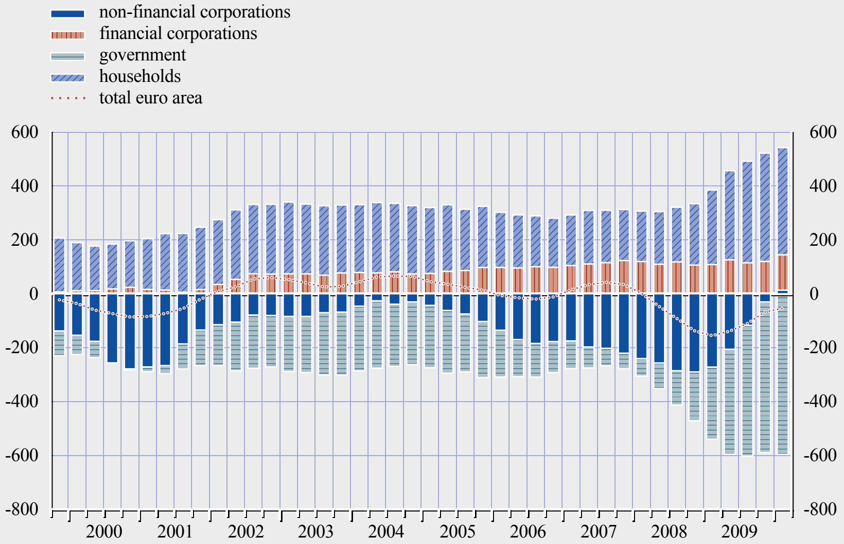


Sources: ECB and Eurostat.

Notes: Data seasonally adjusted by ECB staff and not yet incorporated into official EAA publications.

Chart A3.17 Net lending/net borrowing, broken down by sector

(four-quarter sum of transactions; EUR billions)



Sources: ECB and Eurostat.

formation and increasing their capital positions: the net increases in borrowing of 2008 had given way to decreases, and even to net lending, by the third quarter of 2009 (Chart A3.17).[37]

By the end of the period under review, the first small indications of a recovery had appeared precisely in the institutional sector that first reflected the crisis, the household sector. Up to the first quarter of 2009, in a precautionary move, households had been replacing other asset classes with M3 components, in which there were actually net increases in spite of the decline in overall financial investment. As from the second quarter of the year, however, households regained an appetite for risky, long-term assets, which resulted in stronger relative de-accumulation of money and overall increases in total financial investment. Mutual fund liabilities, the main loser of the move to housing equity, expanded strongly in the second half of 2009 and beginning of 2010 as households' appetite for riskier assets grew. Similarly, households started to accumulate insurance liabilities strongly (Chart A3.18).[38,39] At the same time, the renewed confidence was also visible in consumption which resumed a more robust growth, as indicated by a decrease in the savings ratio in the first quarter of 2010 for the first time since mid-2008 (Charts A3.5 and A3.6).

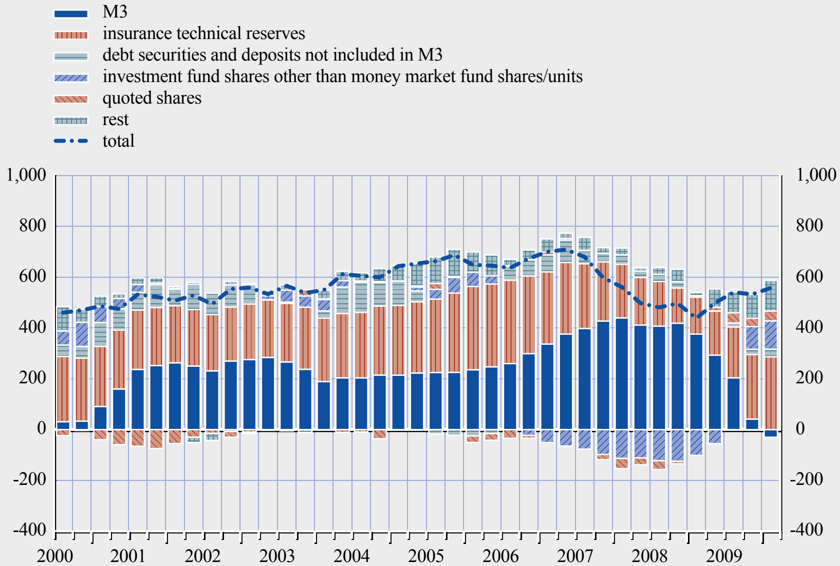
37 Although as a four-quarter sum, net lending by non-financial corporations is only apparent in the first quarter of 2010.

38 The large supply of public debt is also behind this development as households were indirectly acquiring government securities through institutional investors.

39 In addition, the interest rate configuration also triggered portfolio shifts within monetary assets, away from money in its broader definition and into M1.

Chart A3.18 Acquisitions of financial assets by households

(four-quarter sum of transactions; EUR billions)



Sources: ECB and Eurostat.

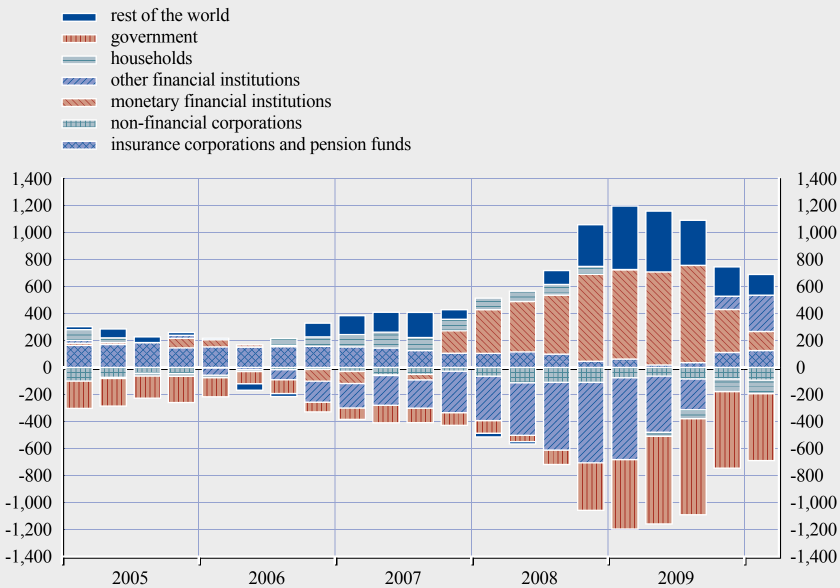
3 INTERMEDIATION

Partially in response to the crisis, but possibly also as a more structural change, economic agents have been modifying their funding patterns and have noticeably changed the way intermediation is conducted. The basic outcome of these changes has been a loss of importance for the traditional bank deposit-loan intermediation channel.

Since the turn of the century, euro area banks have been developing an off-balance-sheet leveraging strategy that entailed a transfer of loan portfolios from their balance sheets. The funds thus obtained and available for new lending were raised in the form of debt securities issued by special investment vehicles and channelled back to the originators in return for the loans transferred. Moreover, loans were also securitised and "retained by the originator" (acquired by the originator itself) with the purpose of being used in repurchase agreements in the wholesale repo market. On the back of such securitisation schemes, usually referred to as the "originate-to-distribute" banking model, loans granted and debt securities issued by "other financial institutions" grew at an annual rate of more than 20% in 2006 and 2007. Although the collapse of credit in the course of 2008 was a heavy blow to such operations, with markets virtually closing up, they still paradoxically showed resilient amounts owing to the absence of other sources for funding intermediation activity: banks securitised sizeable parts of their loan portfolios, with the securities not being placed in the market, but rather retained in full by the originator. The securities thus created were thereafter used as collateral for main refinancing operations at the ECB.

Chart A3.19 Net transactions in debt securities, broken down by sector

(four-quarter sum of transactions; EUR billions)



Sources: ECB and Eurostat.

Note: Net transactions are calculated as net acquisitions of assets less net issuance of liabilities.

This form of retained securitisation progressively gave way back to market-based securitisation in the course of 2009 as loans for house purchase began modestly to recover (Chart A3.19). Securitisation operations have been identified by some as a factor that contributed to the development of the credit boom and risk under-pricing since they allowed highly leveraged loan growth outside the banking system and its stringent capital and liquidity requirements and other regulatory controls.

Market debt financing by non-financial corporations picked up significantly over 2009 and the beginning of 2010 (from 0.2% in the second quarter of 2008 to 1.1% in the first quarter of 2010 in terms of the contribution to the annual growth rate of total debt financing), while bank financing collapsed (its contribution falling from 6.4% to -1.3%). This presumably reflected the tightened credit conditions of banks, as well as the successful attempts by large or creditworthy borrowers to circumvent banking constraints by funding themselves directly via the market. A similar pattern was also observed in past periods of slowdown, with episodes of low financing accompanied by robust levels of debt securities issuance, as in the period 2003-04 for instance.[40] Conversely, episodes of high bank credit seem to be associated with low debt securities issuance. A similar pattern can also be observed over the long run for the United States.

40 The high proportion in total debt financing at the turn of the century was mainly due to large debt-financed mergers and acquisitions.

US flow-of-funds data show bank lending to non-financial businesses to be pro-cyclical, while debt securities financing has a tendency to partially offset bank lending developments.[41] This suggests that the booms and busts in bank lending may reflect some cyclicality in credit conditions through which banks crowd out market financing during booms, but crowd it in during busts. Going forward, it remains to be seen whether such dynamics will continue in the euro area, possibly signalling a structural shift towards disintermediated financing in the wake of the financial crisis – converging to the financing structure of US firms, which is less bank-related than that of European businesses – or whether they will be reversed as bank credit conditions improve.

As argued above, part of the funds raised by large companies in the market, as well as part of the traditional bank loans obtained by them, has been channelled to small companies that were facing greater difficulties in gaining access to bank lending. Intercompany lending would have served as a bridge for such funds to reach the target companies in the case of inter-related firms. Increases in the maturities of trade credits extended by high-rated firms to lower-rated firms would have played the same role for unrelated companies (Charts A3.15 and A3.16).

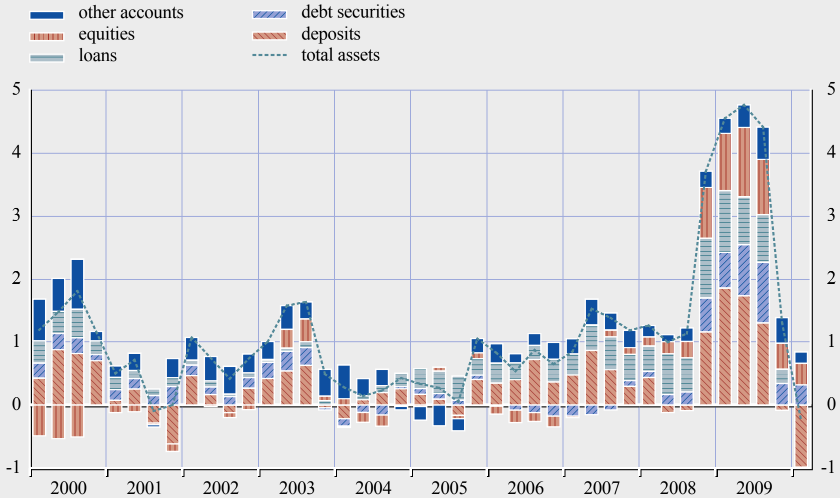
Presumably, this financial intermediation role played by highly rated companies is only cyclical in character and will fade away as financial conditions recover. Similarly, even the public sector engaged in temporal, subsidiary financial intermediation activities as private credit disappeared. Some governments established exceptional discount windows for financial institutions in order to add liquidity to the balance sheets of banks and other financial institutions. More notably, several governments injected capital into the banking sector to help restore their capital positions (the annual growth rate of equity acquired by government reached 8% in the second quarter of 2009) (Chart A3.20).

The thinner bank deposit-loan channel for meeting financing and investment needs is clearly reflected in the financial portfolios of households (Chart A3.18). After the period of high-volume transactions with money-related instruments in 2008, arguably owing to extreme risk aversion, households started to accumulate the new liabilities that had arisen in the wake of the crisis. Direct acquisitions of debt securities, in particular in the growing segment of public sector debt securities, increased, but more remarkably, indirect acquisitions through purchases of institutional investors' liabilities rose sharply (Chart A3.19) to lead the overall recovery in financial investment. At the same time, M3 holdings, i.e. traditional bank liabilities, contracted sharply. Moreover, a larger proportion of the funds

41 Long time series for the non-financial corporations in the United States show a remarkable degree of stability in debt securities financing over the long run, which generally fluctuates between 1% and 3% of GDP, with an average of 1.4% of GDP in the period from the first quarter of 1952 to the second quarter of 2009. By contrast, loan dynamics (all loans incurred) appear to be extremely volatile, subject to boom and bust, oscillating between -2% of GDP and 6% of GDP, with a 47-year average of 2.6% of GDP. The differential between debt securities and loans financing has never been as large as it was in 2009. The last time the differential was particularly large was in 1992-93, in the wake of the Savings and Loans crisis.

Chart A3.20 Acquisitions of financial assets by government

(four-quarter sum of transactions; EUR billions)



Sources: ECB and Eurostat.

raised by banks were in 2009 used not for loans but rather for investment in debt securities, again primarily in public sector debt securities (Chart A3.3).

A great number of these developments, in particular those in banks' portfolio allocation, are allegedly also only cyclical in nature and due to the specific risk and maturity pricing conditions and high borrowing needs of the government sector. However, a more structural change might be underway if the recourse to market financing by non-financial corporations consolidates and progressively replaces government debt in the portfolios of banks and institutional investors.

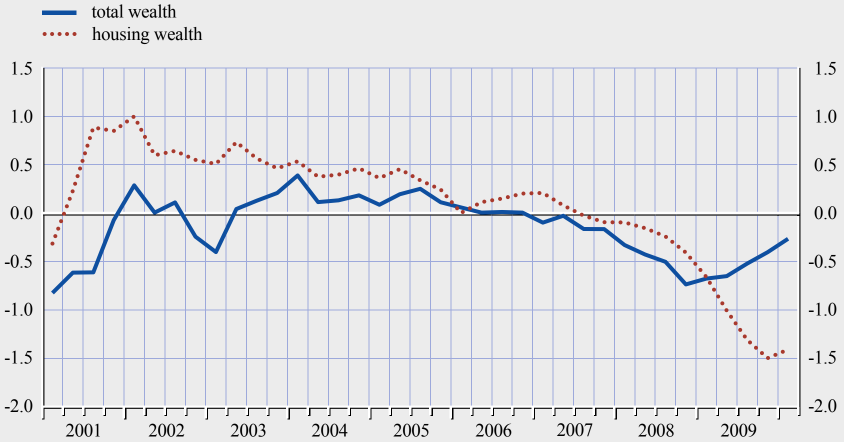
4 LEVERAGE

An overall trend in the run up to the crisis was a general increase in leverage. We have discussed the developments in banks' balance sheets above and have outlined how they led to low capital buffers that threatened them with bankruptcy as risk exposures unwound into losses at the end of 2008 and beginning of 2009. We have also seen how rises in the non-financial leverage ratio of households seem to be associated with the slowdown in lending for house purchase in 2007.

Although the total wealth ratio of households (ratio of net wealth to total assets, i.e. one minus the total leverage ratio – the ratio of debt to total assets) is basically driven by the housing wealth ratio (the ratio of housing equity to housing wealth), 2009 saw a sharp divergence of the two (Chart A3.21). The former showed a more positive development on account of the relatively high volume of transactions in financial assets and the mix of asset prices: while house prices continued to decline, stock prices were on the rise, making up for

Chart A3.21 Household wealth ratios

(percentage of total assets; year-on-year changes)



Sources: ECB and Eurostat.
Note: See notes to Chart A3.9.

the losses of 2008.[42] In the medium term, such divergence, which is no more than a pronounced change in the structure of households' portfolios towards more financial equity, might trigger a period of compensating portfolio shifts similar to what occurred in the period from mid-2007 to mid-2008.

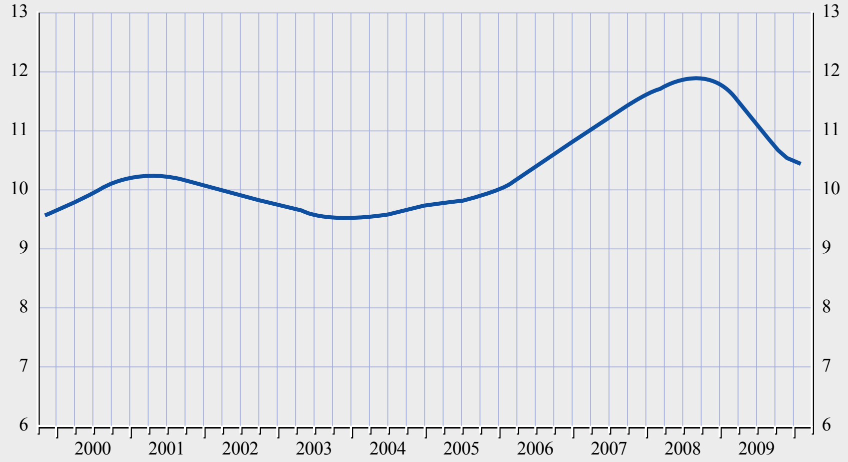
Also of interest with respect to explaining the impact of leveraging in household loans dynamics is the development of the debt servicing burden (Chart A3.22). Similar to the leverage ratio itself (Charts A3.9 and A3.21), the ratio of the debt servicing burden to disposable income did not start to rise before 2006, and actually declined in 2005. Thereafter, it is linked to the boom-burst cycle in the same manner as the leverage ratio, showing high increases in 2007 that coincided with the high volume of transactions in housing equity and the de-accumulation of debt. Since mid-2008, however, it has shown a distinct pattern, with values decreasing on the back of lower interest rates and lesser debt accumulation, in contrast to the behaviour of the leverage ratio that continued to rise on the back of declining residential property prices.

One recurrent question is whether non-financial corporations were building up vulnerabilities in terms of indebtedness in the run-up to the crisis, as was the situation immediately after 2002. In terms of the capital position, Chart A3.23 shows that, for the years following 2002, the messages are mixed, depending on whether equity price developments are considered or not. While the peak in leveraging at market value after the market downturn

42 Another episode of divergence between the two ratios happened in 2001-02, when the lower share of housing wealth in total wealth, as compared with the current situation, caused the rates of change in the two ratios to diverge markedly. However, the directional changes were the same, as opposed to what occurred in the 2009 episode.

Chart A3.22 Ratio of households' debt servicing burden to their gross disposable income

(four-quarter sums; percentage of gross disposable income)

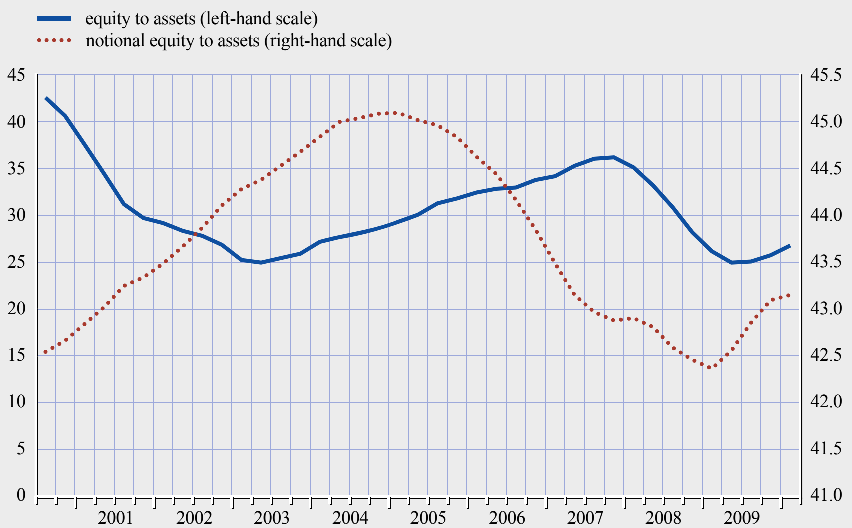


Sources: ECB and Eurostat.

Note: Debt repayments estimated by the authors.

Chart A3.23 Capital ratios of non-financial corporations

(percentage points)

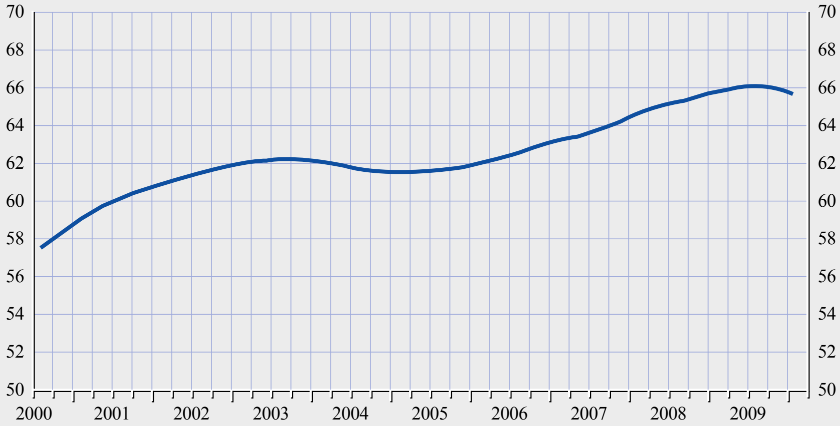


Sources: ECB and Eurostat.

Notes: Notional equity is the accumulated retained profits and equity issuance on net assets as of the first quarter of 1999. Non-financial assets are ECB staff estimates that have not yet been incorporated into official EAA publications.

Chart A3.24 Leverage ratio of non-financial corporations

(percentage of total assets)



Sources: ECB and Eurostat.
Notes: The leverage ratio is calculated as the ratio of total liabilities other than equity to total assets. Non-financial assets are ECB staff estimates that have not yet been incorporated into official EAA publications.

of 2001 and 2002 is deep and the subsequent recovery relatively slow, the ratio that excludes the effects of equity prices shows rapid balance-sheet repairs in 2003-04, followed by a correction downwards in 2005.[43] However both show deterioration after 2007.

A clearer picture arises from the leverage ratio itself. In particular, Chart A3.25 shows the balance-sheet-repair period of 2003-04, which was followed by moderate growth of the ratio in the course of 2005 and subsequent robust increases up to the beginning of 2008. However, the growth rates at these peak times are not comparable with those of the first part of the century, which indicates a certain moderation in debt financing by comparison.

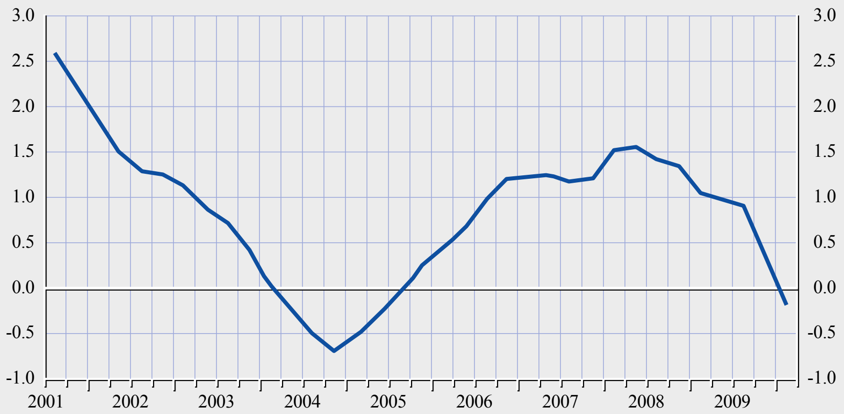
Another relevant question is whether or not a process of some deleveraging started in the non-financial corporation sector in 2009. While measures of leveraging based on ratios vis-à-vis value added or operating surplus do not seem to indicate an ongoing process of deleveraging (Chart A3.26), the metrics based on ratios expressed in terms of assets (Charts A3.23 to A3.25) do show a reversal of the ratio.[44] In comparison with developments

43 While the non-market ratios capture "active" leverage/deleveraging, i.e. transactional additions to own funds, the market ratios also capture "passive" results through stock price changes that might mask a firm's "active" strategies. On the other hand, the market ratios better capture the actual leverage stance and the relative cost of alternative sources of financing. The analysis of leveraging trends must combine both kinds of ratios.

44 Such conflicting messages on leverage are due to the effect of the subdued value added and net operating surplus on the ratios calculated on them. The robust increase in net operating surplus recorded in the first quarter of 2010 has a depressing effect on the ratio already as can be seen in Chart A3.26.

Chart A3.25 Leverage ratio of non-financial corporations (annual changes)

(percentage of total assets; year-on-year changes)



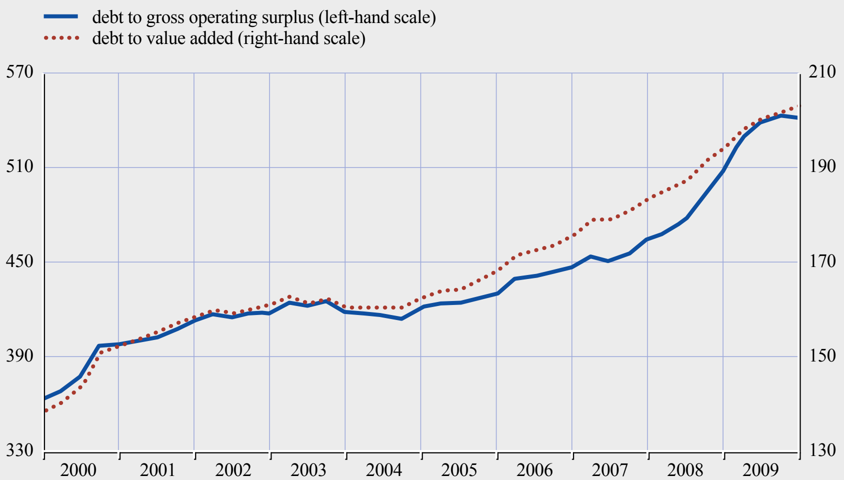
Sources: ECB and Eurostat.

Notes: The leverage ratio is calculated as the ratio of total liabilities other than equity to total assets. Non-financial assets are ECB staff estimates that have not yet been incorporated into official EAA publications.

in the household sector, this again indicates the differences in the timing of the response of the non-financial sectors to the various stages of the crisis: while households started deleveraging earlier, and seem already to be effecting a certain reversal in the last quarters of 2009 and beginning of 2010, non-financial corporations may only now be starting to restructure their balance-sheets.

Chart A3.26 Debt ratios of non-financial corporations

(percentage of gross operating surplus or value added)



Sources: ECB and Eurostat.

Note: The debt ratio is calculated as the ratio of all liabilities other than equity and other payables to gross operating surplus or value added.

Chart A3.17 shows the sectoral imbalances of the institutional sectors in the euro area over the last ten years.[45] 2000 and 2001 present a classic picture of imbalances, with households as net lenders who provide funds to non-financial corporations with high borrowing requirements as a consequence of productive capital formation. The borrowing requirements of non-financial corporations were larger than the lending capabilities of households, thus resulting in borrowing from the rest of the world, i.e. a current account deficit for the euro area.

The economic slowdown in subsequent years resulted in a progressive shift from borrowing by non-financial corporations to borrowing by the government sector.[46] As the euro area economy recovered in the course of 2005 and 2006, the net borrowing of non-financial corporations crowded out government deficits. In 2007 and 2008, cautious behaviour on the part of households and their use of non-financial corporations as an extra source of cash-flows accentuated the net borrowing of the latter, but then the commodity price shock brought overall net borrowing down. 2009 saw the return of a recession-like configuration with huge public deficits, high net lending by households and low borrowing on the part of firms.

Of particular interest is the geographical distribution of such imbalances. As discussed above, the recovery phase after the slowdown in 2003 took place at different speeds across euro area countries. The sharp increase in the lending capacity of the private sector (households and non-financial corporations) in those countries that embarked on a process of deeper balance-sheet repairs was initially met by government deficits as automatic stabilisers and active countercyclical fiscal policies unfolded. But soon, as fiscal consolidation progressed, the private sectors of the other countries, which had already started to grow robustly by 2004, took over as the recipients of the excess savings of adjusting countries. By the end of 2004, the euro area has turned into a two-track economy in terms of imbalances, divided into countries running an external surplus (those that had undertaken the adjustment in the previous years) and those running external deficits (largely those that had recovered first, which were broadly also those that undertook less far-reaching adjustments). The process was underpinned by constant gains in the competitiveness of the former vis-à-vis the latter, on the back of the stronger adjustment that delivered wage increases that were lower than the productivity gains.

45 By imbalance, we mean the difference between savings and capital formation, i.e., the difference between the acquisition of financial assets and the incurrence of liabilities. An excess of savings results in net lending (indicated with a positive sign in Chart A3.17), while an excess of capital formation results in net borrowing (indicated with a negative sign in Chart A3.17). For the euro area as a whole, net lending/net borrowing corresponds to the external current account surplus/deficit.

46 While expansions are associated with high capital formation by non-financial corporations and high incomes of households, slowdowns are linked to low capital formation and consumption, as well as high transfers from government to households.

Chart A3.1 shows this by focusing on the interaction of the private sectors in the two groups of euro area countries. It becomes apparent that the net lending position of the countries with surpluses – which were high enough to even entail net lending by non-financial corporations – has been met by the net borrowing position of the countries running deficits since 2004. Since 2008, as the crisis changed the sign of the private sector imbalance of the deficit countries, governments – in particular those of the deficit countries – have been accommodating the resilient net lending of the surplus countries. Unless a new two-track configuration of private sector imbalances arises, future government debt consolidation will result in a lower surplus of the private sector as a whole, in particular in those countries that currently run external surpluses, or in a higher external surplus for the euro area as a whole.

ANNEX 4

THE EFFECTS OF MONETARY POLICY IN THE EURO AREA: AN ANALYSIS BASED ON THE FLOW OF FUNDS

1 INTRODUCTION[47]

The vast literature which has attempted to assess the effect of monetary policy shocks on the economy employing vector auto-regression (VAR) models has dealt only marginally with the borrowing and lending activities of the different economic sectors, with the possible exceptions of those transactions running through the banking system, such as loans. In order to understand the functioning of an economic system, it is very important to be able to answer questions such as: does monetary policy affect households' decisions on their portfolio allocation? How? And how quickly? What about firms? Do they cut back on new debt issuance when they experience an unexpected interest rate hike? Does any sign of rigidity or market imperfection appear? What happens to the public deficit?

This annex, which summarises Bonci (2010), focuses on monetary transmission in the euro area, extending the well-known VAR methodology to variables whose behaviour in response to a policy shock has not been investigated so far, i.e. the flow of funds. Following Christiano et al. (1996) for the United States, and Bonci and Columba (2008) for Italy,[48] we aim to provide a new set of stylised facts on the impact of an unexpected monetary tightening on the financing (borrowing) and financial investment (lending) decisions of households, firms, the government sector and the foreign sector.

We proceed in two steps. First, we estimate a VAR model for the euro area economy which allows us to identify movements in the short-term interest rate (our chosen policy instrument), which can be labelled as monetary policy shocks. Our model includes real GDP, a price index (HICP), a nominal short-term interest rate (three-month EURIBOR, chosen as the policy instrument) and a monetary aggregate (M1).

As regards the VAR identification, in line with a number of existing studies in the VAR literature, we assume recursiveness, thus allowing monetary policy shocks to have contemporaneous effects on money, but only a lagged impact on output and prices; these latter variables, on the other hand, are known to the policy-maker when setting the policy variable.

[47] This annex was prepared by Riccardo Bonci.
[48] In a recent paper, Gameiro and Sousa analysed the same issue for Portugal.

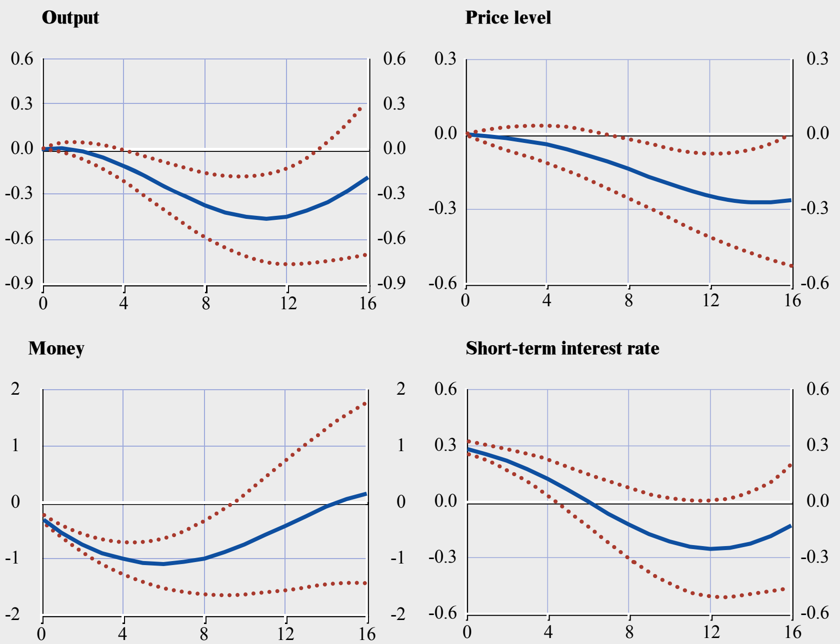
The sample period is from Q1 1999 to Q2 2009, in light of the quarterly availability of the flow-of-funds series. Supported by standard likelihood ratio tests, one lag was included in the VAR; this result significantly contributes to the feasibility/robustness of the exercise, given the relatively short sample available, which makes the degrees-of-freedom issue potentially problematic.

The qualitative impact of a monetary policy shock on output, prices and money is in line with theoretical priors and with much of the existing empirical evidence available, also on the euro area. Impulse response functions of the VAR endogenous variables to a one standard deviation increase in the short-term interest rate (corresponding to 25 basis points) are plotted in Chart A4.1. The same holds for a set of additional macro variables (e.g. consumption, investment and asset prices) included in the model to further support the identification achieved. All in all, our results for the main macroeconomic aggregates included in the benchmark model are consistent with the VAR literature on the impact of monetary policy shocks (both in the United States and in the euro area) and are not affected by the empirical puzzles which can be found in part of it.

As a second step, we analyse the response of some of the flow-of-funds variables to an unexpected monetary policy tightening. This is achieved via the so-called "marginal strategy", that is, adding one variable at a time to the benchmark VAR specification, placing it in the last position (i.e. considering it as the most

Chart A4.1 The effect of a contractionary monetary policy shock: VAR variables

(percentages)



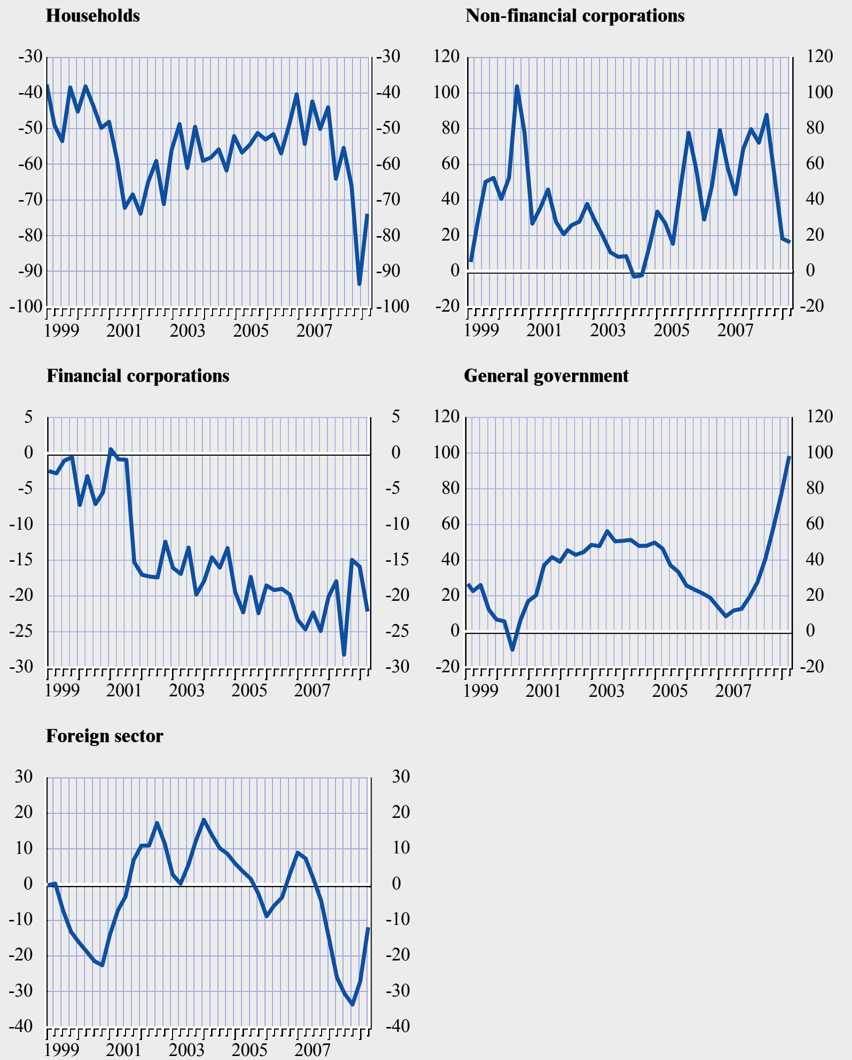
Source: Author's calculations.
Notes: Deviation from baseline at various quarters following an exogenous one standard deviation (i.e. 25 basis points) increase in the short-term interest rate. Dotted lines are ±1 standard error bands from 1,000 Monte Carlo replications.

endogenous variable). Following Christiano et al. (1996), we consider the net funds raised by each sector, i.e. new debt issued net of new financial assets acquired (plotted in Chart A4.2), plus some assets and liabilities depending on the specific sector analysed. We also analyse the impact of monetary policy on credit granted to the private sector (households and firms), in light of the importance of this variable for the functioning of the economic system and of its prominent role in the context of the ECB's monetary analysis.

The flow-of-funds data can provide some useful insights into the empirical evaluation of the effects of monetary policy in the euro area. The main results on the impact of a monetary policy shock, defined as a 25 basis point increase in the

Chart A4.2 Flow of funds: net funds raised by the economic sectors

(quarterly flows, seasonally adjusted; 1995 EUR billions)



Source: Author's calculations.

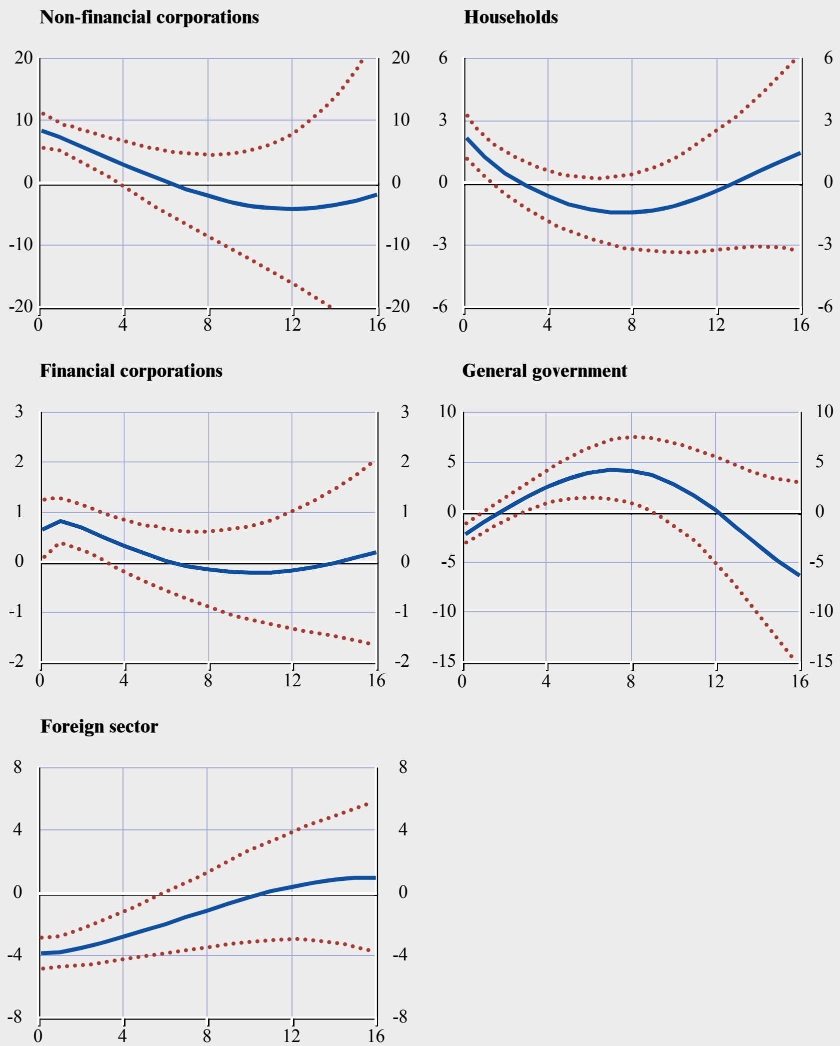
short-term interest rate, on the borrowing and lending activities of the economic sectors are summarised in the following paragraphs.

2 FIRMS

Following the interest rate hike, firms' net borrowing increases in the first year after the shock (Chart A4.3) and then declines below the baseline. Looking at the asset and liability components of their net borrowing, firms seem to require more

Chart A4.3 Impact of a contractionary monetary policy shock on net funds raised by the economic sectors

(deviation from baseline; 1995 EUR billions)



Source: Author's calculations.

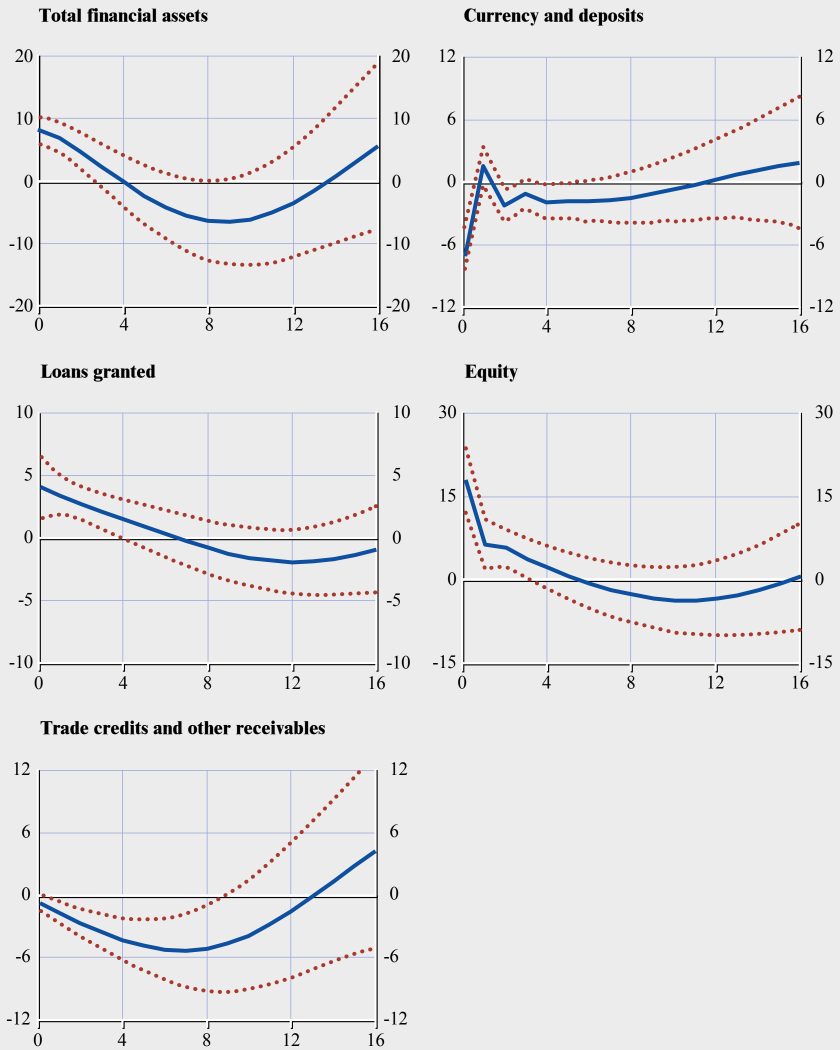
Notes: Percentage deviation from the baseline following an exogenous one standard deviation (i.e. 25 basis points) increase in the short-term interest rate. Dotted lines are ±1 standard error bands taken from 1,000 Monte Carlo replications. Each impulse response function shown has been estimated from a five-variable VAR, in which each macro variable was added in turn to the benchmark model, placed in the last position.

funds both for financing capital formation (real assets) and for buying financial assets. In particular, firms grant more loans in the short run, while they reduce, to a lesser extent, the accumulation of currency and deposits (Chart A4.4). The increase in loans granted (mainly inter-company loans) might be a direct consequence of

Chart A4.4 Impact of a contractionary monetary policy shock on firms' assets and liabilities

(deviation from baseline; 1995 EUR billions)

a) Firms' financial assets



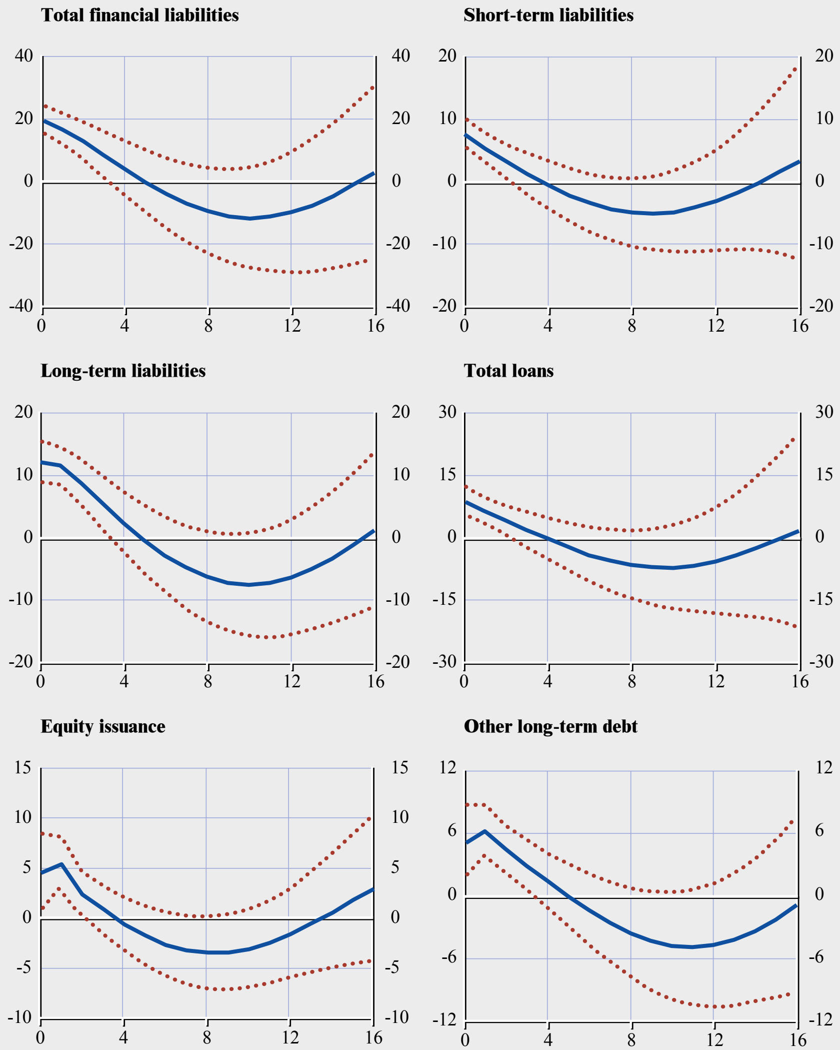
Source: Author's calculations.

Notes: Percentage deviation from the baseline following an exogenous one standard deviation (i.e. 25 basis points) increase in the short-term interest rate. Dotted lines are ± 1 standard error bands taken from 1,000 Monte Carlo replications. Each impulse response function shown has been estimated from a five-variable VAR, in which each macro variable was added in turn to the benchmark model, placed in the last position. Long-term liabilities are the sum of "equity" and "other long-term debt"; the latter comprises securities and loans both with a maturity of over one year.

Chart A4.4 Impact of a contractionary monetary policy shock on firms' assets and liabilities (cont'd)

(deviation from baseline; 1995 EUR billions)

b) Firms' liabilities



Source: Author's calculations.

Notes: Percentage deviation from the baseline following an exogenous one standard deviation (i.e. 25 basis points) increase in the short-term interest rate. Dotted lines are ± 1 standard error bands taken from 1,000 Monte Carlo replications. Each impulse response function shown has been estimated from a five-variable VAR, in which each macro variable was added in turn to the benchmark model, placed in the last position. Long-term liabilities are the sum of "equity" and "other long-term debt"; the latter comprises securities and loans both with a maturity of over one year.

the higher cost of bank financing for firms so that they tend to avoid new bank credit as much as possible, also reducing their deposit holdings.

The observed pattern of the response of funds raised (in net terms) by firms is in line with what Christiano et al. (1996) found for the US economy, also quantitatively, i.e. as a percentage of the average of the quarterly flows. Moreover, both in the United States and in the euro area the response of firms' net borrowing is mainly accounted for by the positive response of short-term liabilities; Christiano et al. (1996) found that it is especially those liabilities issued by corporations and large manufacturing firms that rise after the tightening. To explain this outcome, they point to the existence of financial frictions owing to contracts in force, which would prevent firms from adjusting immediately their level of inventories to the new (lower) level of demand, as standard monetary business cycle models would predict. On the other hand, no significant impact of a short-term interest rate increase on net funds raised by firms was detected in the case of Italy (Bonci and Columba (2008)). This ranking in the presence of cost inertia faced by firms (smaller in Italy than in the euro area and the United States) might be related to the average firm size in these areas which, in turn, might affect the possibility for firms to alter promptly their investment and current expenditures.

There is also widespread evidence supporting the view that large firms are less subject to the risks of a credit crunch than small ones, because they are less prone to asymmetric information problems (see Christiano et al. (1996), Gertler and Gilchrist (1993 and 1994) and Ehrmann (2000)). For this reason, larger firms might be able to smooth the impact of reduced sales via higher debt issuance, much more so than small enterprises. In other words, banks might be more willing to grant loans to larger firms, which in turn need them to finance the (too) high level of inventories against the background of reduced cash flow.

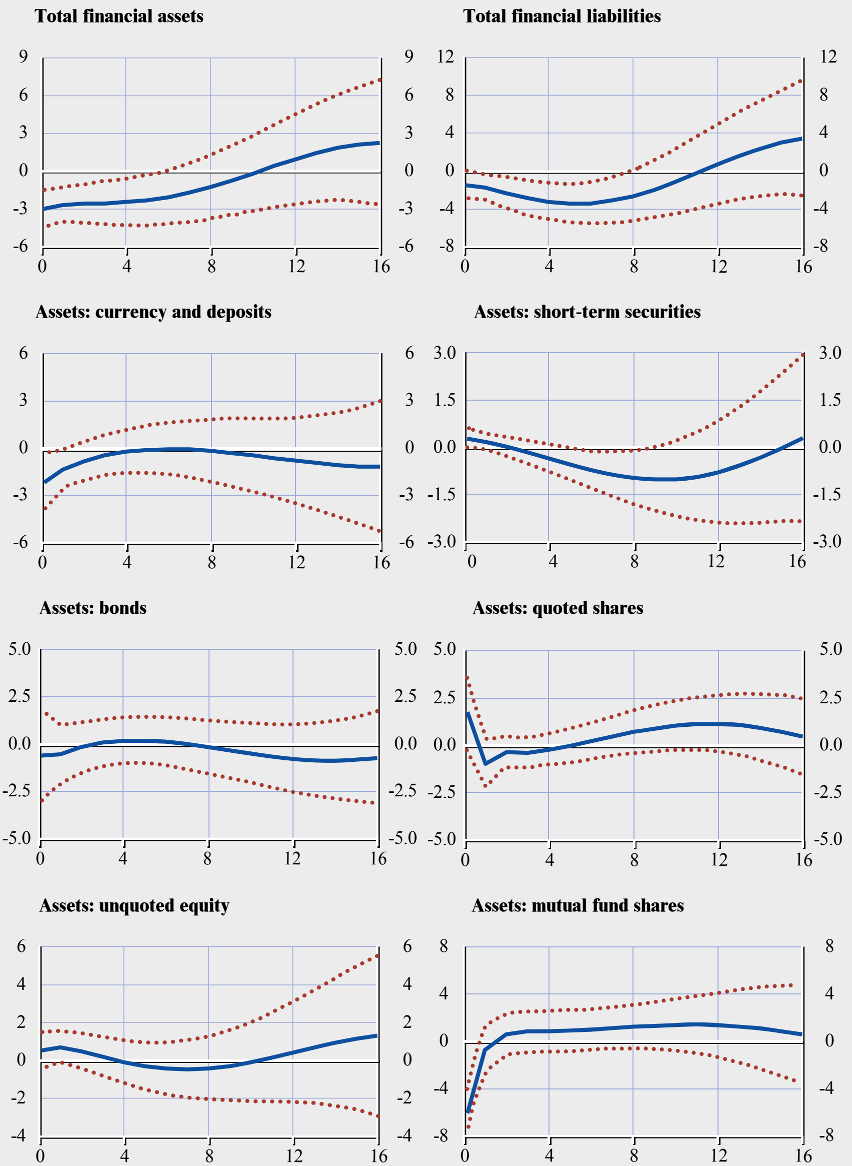
3 HOUSEHOLDS

Following a restrictive policy shock, households initially borrow more funds (in net terms) compared with the baseline scenario (Chart A4.3). In the following quarters, their net financial position improves and net funds raised by the household sector fall below the baseline. Looking at the different components (Chart A4.5), the short-run increase in households' net borrowing is mainly accounted for by the fall in the acquisition of deposits and mutual fund shares; on the other hand, following the unexpected increase in the short-term rate, households buy more securities, especially short-term ones.

While the fall in the acquisition of mutual fund shares might be explained by the worsening in the expected future profitability perceived after the restrictive shock, the decrease in the accumulation of currency and deposits might be due to an increase in their opportunity cost. This would induce households to replace them with other (higher) interest-bearing assets, like government short-term securities, as long as the deposit rate follows (possibly even only partially) the increase in interest rates only with a certain delay.

Chart A4.5 Impact of a contractionary monetary policy shock on households' assets and liabilities

(deviation from baseline; 1995 EUR billions)



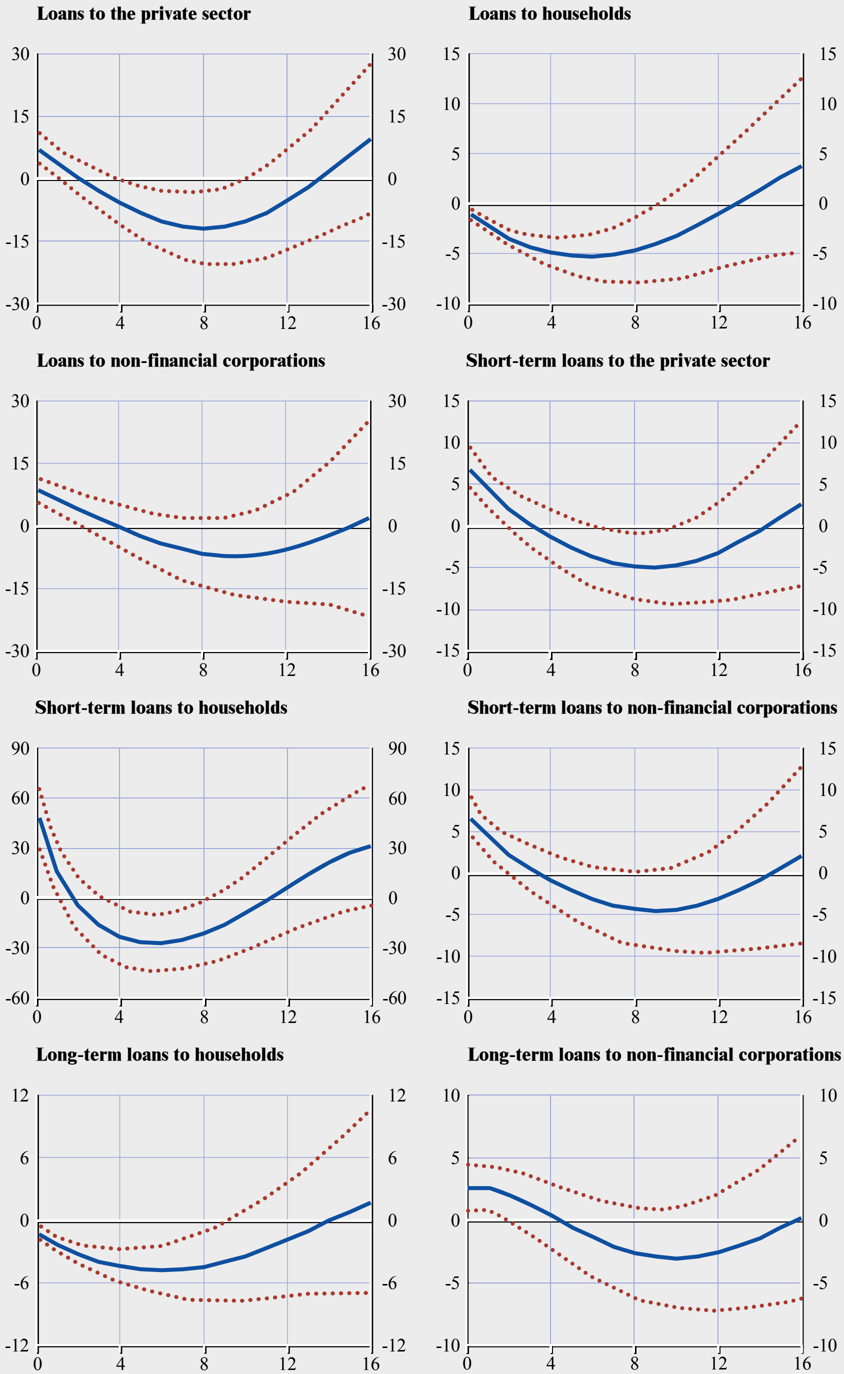
Source: Author's calculations.

Notes: Percentage deviation from the baseline following an exogenous one standard deviation (i.e. 25 basis points) increase in the short-term interest rate. Dotted lines are ±1 standard error bands taken from 1,000 Monte Carlo replications. Each impulse response function shown has been estimated from a five-variable VAR, in which each macro variable was added in turn to the benchmark model, placed in the last position.

All in all, we find evidence that households react to the monetary policy restriction by reducing their accumulation of financial assets rather quickly; in doing so, they also adjust their portfolio, switching from deposits and (mutual fund) shares towards securities.

Chart A4.6 Impact of a contractionary monetary policy shock on total loans to the private sector

(deviation from baseline; 1995 EUR billions)



Source: Author's calculations.

Notes: Percentage deviation from the baseline following an exogenous one standard deviation (i.e. 25 basis points) increase in the short-term interest rate. Dotted lines are ± 1 standard error bands taken from 1,000 Monte Carlo replications. Each impulse response function shown has been estimated from a five-variable VAR, in which each macro variable was added in turn to the benchmark model, placed in the last position.

4 THE OTHER SECTORS OF THE ECONOMY

The increase in net funds raised by firms and households in the immediate aftermath of a policy restriction coincides with a decline in net funds raised by the foreign sector and, to a smaller extent, by the general government.

Net funds raised by the foreign sector decrease after the shock (Chart A4.3). In other words, the net external position of the euro area deteriorates after the interest rate hike, meaning that the resident sectors as a whole borrow more funds, in net terms, from abroad. This might happen because the demand for funds by the foreign sector falls or because the acquisition of foreign assets by the euro area residents decelerates (or a combination of both). As suggested by Christiano et al. (1996), this result might hint at foreign economies beginning their recession later, reflecting the delayed reaction of foreign central banks to a (in our case) euro area contractionary monetary policy shock.

Finally, the pattern of net funds raised by the general government sector, i.e. a higher deficit in the medium term after a small decrease on impact (Chart A4.3), is quite consistent with the budget worsening that the theory would predict, with lower tax receipts following the slowdown in economic activity induced by the interest rate hike and with the cost of automatic stabilisers.

5 LOANS

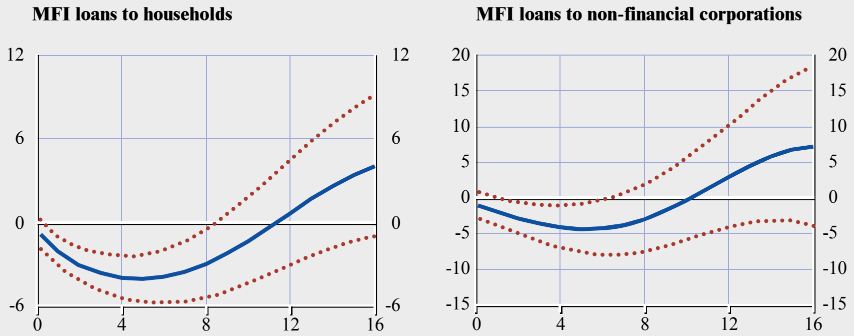
Switching from a sector to an instrument perspective, we find that total loans granted (net of amounts repaid) to households and firms, after a very short-run positive response, decline below the baseline following the monetary policy contraction (Chart A4.6). The positive response of loans to the private sector is the result of two opposite effects which do not completely offset each other: while loans to households decrease, business loans increase in the immediate aftermath of the shock.

Starting with households, the negative response of loans to this sector is mainly driven by the long-term component (mainly real estate loans). This is consistent with the US evidence provided, for example, by Gertler and Gilchrist (1993), who find that mortgage loans decrease after a monetary tightening. The fall in mortgage loans in response to a monetary tightening in the euro area has also been documented by Giannone et al. (2009).

On the other hand, the short-run increase in loans granted to non-financial corporations might be considered as a counter-intuitive result, as one could regard a decline in loans as the most natural consequence of an interest rate increase; a decrease in financing is also what the bank lending channel of the monetary transmission mechanism would predict after an interest rate hike. As argued by Bernanke and Gertler (1995), the observed increase can still be consistent with a reduction in loan supply if the increase in loan demand is even higher (for example driven by the build-up of inventories), so that the observed pattern results from a demand for new loans being met by banks only partially.

Chart A4.7 Impact of a contractionary monetary policy shock on MFI loans to the private sector

(deviation from baseline; 1995 EUR billions)



Source: Author's calculations.
Notes: Percentage deviation from the baseline following an exogenous one standard deviation (i.e. 25 basis points) increase in the short-term interest rate. Dotted lines are ±1 standard error bands taken from 1,000 Monte Carlo replications. Each impulse response function shown has been estimated from a five-variable VAR, in which each macro variable was added in turn to the benchmark model, placed in the last position.

The positive response of business loans after a monetary tightening, also found by Giannone et al. (2009), is similar to what was observed for the US economy by Christiano et al. (1996), Bernanke and Gertler (1995) and den Haan et al. (2007).

A number of alternative explanations have been put forward in the literature to explain the short-run increase in loans taken out by firms after a policy contraction. On the *demand* side, one reason could be that during the downturn induced by the interest rate hike, conditions on the trade credit market deteriorate and firms need more time to cash their sales (especially of those goods and services provided to other businesses); in other words, firms need more funds to finance their working capital. But there are also arguments supporting the view that loan *supply* might not fall in the immediate aftermath of the policy tightening. Den Haan et al. (2007) point to banks' willingness to invest in short-term (less risky) assets (like short-term loans) which earn a high return, given that short-term interest rates are relatively high. The "frontloading" argument has also been suggested by Giannone et al. (2009); according to these authors, loans might increase in response to a monetary contraction because firms draw heavily on pre-committed credit lines locked in at the pre-shock (thus lower) interest rate. Frontloading might also be reinforced if banks, after the monetary tightening, adjust their lending rates with some delay, so that firms could be tempted to lend as much as they can in view of the expected increase in the cost of financing in the next quarters.

Loans analysed so far are those granted by all the other sectors of the economy. Focusing on loans granted to firms and households only by monetary financial institutions, the above (possibly) puzzling result vanishes: after a monetary policy tightening, in fact, bank loans to the non-financial private sector fall below the baseline (Chart A4.7), confirming the importance of the bank lending channel in the transmission of monetary policy shocks in the euro area.

REFERENCES

Bernanke, B.S. and Gertler, M. (1995), "Inside the Black Box: The Credit Channel of Monetary Policy Transmission", *Journal of Economic Perspectives*, 9(4), pp. 27-48.

Bonci, R. (2010), "The effects of monetary policy in the euro area: first results from the flow of funds", mimeo, paper presented at the NCB Expert Meeting on *Flow of funds analysis after the financial crisis: challenges, tools and applications*, ECB, Frankfurt am Main, 22 February.

Bonci, R. and Columba, F. (2008), "Monetary policy effects: new evidence from the Italian flow of funds", *Applied Economics*, Vol. 40, No 21, pp. 2803-2818.

Christiano, L., Eichenbaum, M. and Evans, C. (1996), "The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds", *Review of Economics and Statistics*, 78, pp. 16-34.

Den Haan, W., Sumner, S. and Yamashiro, G. (2007), "Bank loan portfolios and the monetary transmission mechanism", *Journal of Monetary Economics*, Vol. 54, No 3, pp. 904-924.

Ehrmann, M. (2000), "Firm size and monetary policy transmission: evidence from German business survey data", *Working Paper Series*, No 21, ECB, Frankfurt am Main, May.

Gameiro, I.M. and Sousa, J. (2010), "Monetary Policy Effects: evidence from the Portuguese flow of funds", *Working Papers*, Banco de Portugal, No 14.

Gertler, M. and Gilchrist, S. (1993), "The Role of Credit Market Imperfections in the Monetary Transmission Mechanism: Arguments and Evidence", *Scandanavian Journal of Economics*, Vol. 95, No 1, pp. 43-64.

Gertler, M. and Gilchrist, S. (1994), "Monetary Policy, Business Cycles and the Behavior of Small Manufacturing Firms", *Quarterly Journal of Economics*, Vol. 109, No 2, pp. 309-340.

Giannone, D., Lenza, M. and Reichlin, L. (2009), "Money, credit, monetary policy and the business cycle in the euro area", paper presented at the conference *The monetary policy transmission mechanism in the euro area in its first ten years*, mimeo, Frankfurt am Main, 28-29 September.

ANNEX 5

EURO AREA FLOW OF FUNDS: EVIDENCE ON MONETARY TRANSMISSION AND OUT-OF-SAMPLE FORECASTS

1 INTRODUCTION [49]

The financial crisis and the preliminary events leading up to it, in particular the build-up of financial imbalances in the United States, which were at least in part linked to exceptionally loose monetary conditions (Eickmeier and Hofmann (2010)), reinvigorated interest in flow of funds (FoF) analysis among academics and monetary policy-makers. This annex outlines the methodology and preliminary results obtained from the analysis of euro area FoF aggregates using a factor-augmented vector autoregressive (FAVAR) model. The scope of the analysis is twofold. First, the FAVAR is used to perform an impulse response analysis in order to establish stylised facts relating to the dynamic effects of monetary policy shocks on euro area FoF aggregates as well as on other macro variables. Second, FAVAR-based forecasting models are used to construct forecasts of FoF aggregates and to assess the role of FoF aggregates in forecasting key macro variables and hence the implications of financial developments for the macroeconomic outlook.

2 DATA

The analysis covers notional stocks of assets and liabilities of the euro area private sector, i.e. households, non-financial corporations (NFCs), monetary financial institutions (MFIs), other financial institutions (OFIs), insurance corporations and pension funds (ICPFs), as well as financial corporations as the aggregate of the three financial sectors. The data series for notional stocks of the FoF aggregates were constructed using flows and stocks from the euro area financial accounts and pre-1999 backdata constructed on the basis of data for the four largest euro area economies (Germany, France, Italy and Spain). The sample period of the analysis is from Q1 1991 to Q3 2009. In all, the factor model comprises 93 FoF data series. Besides the FoF data, the factor model also includes 13 euro area loan and monetary aggregates from BSI statistics, 129 euro area macro data series covering inter alia HICP and PPI series, national accounts series, asset prices, exchange rates, interest rates, industrial production indices and economic survey data retrieved from the AWM and CMR databases and other ECB or external databases.

[49] This annex has been prepared by Boris Hofmann. The results are based on an ongoing research project with Sandra Eickmeier.

3 THE FACTOR MODEL

As the first step, the data are transformed in the usual manner for factor analysis, i.e. they are standardised to have a zero mean and a unit variance. Stationarity of the variables is ensured through differencing if necessary. The FoF notional stocks are entered in log differences. Outliers are removed in a standard, automated manner.

For the estimation of the common factors F_t driving the $N\times 1$ vector X_t which summarises the 235 (=N) variables, it is assumed that X_t follows an approximate dynamic factor model (e.g. Bai and Ng (2002), Stock and Watson (2002)):

$$X_t=\Lambda' F_t+\Xi_t, \tag{1}$$

where F_t are the first r principal components of X_t. $\Xi_t=[\xi_{1t} \; \dots \; \xi_{Nt}]'$ denotes an $N\times 1$ vector of idiosyncratic components. The matrix of factor loadings $\Lambda=[\lambda_1 \dots \lambda_N]$ has the dimension $r\times N$ and $\lambda_i, i=1,\dots,N$ are of dimension $r\times 1$. Based on the IC_{P2} criterion proposed by Bai and Ng (2002), the number of factors is determined to be six, explaining 58% of the overall variation of the dataset.

4 A FAVAR MODEL FOR THE ANALYSIS OF MONETARY TRANSMISSION

The estimation of the FAVAR model for monetary policy analysis closely follows Bernanke et al. (2005). The key advantage of the FAVAR approach in this context is that it allows the analysis of monetary transmission via a large number of variables within a single, unified analytical framework. We estimate a FAVAR of the form:

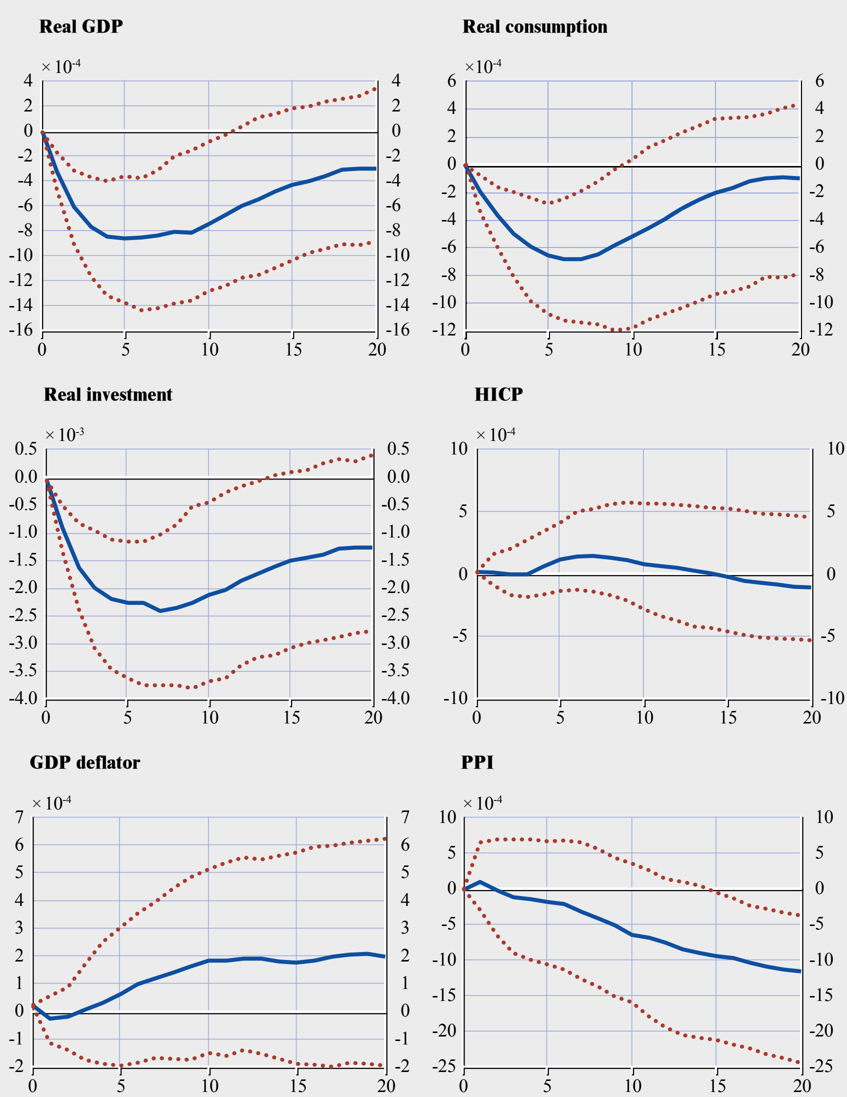
$$G_t=A(L)G_{t-1}+Qw_t, \tag{2}$$

where $G_t=[H_t \;\; i_t]'$. Here, i_t is the overnight interest rate, representing the main monetary policy instrument, and H_t is the vector of latent factors spanning the space covered by F_t after the removal of the observable factor (the overnight interest rate). H_t is estimated by means of the iterative procedure suggested by Boivin and Giannoni (2010). We start with an initial estimate of H_t denoted by $\hat{H}_t^{(0)}$ and obtained as the first $r-1=5$ principal components of X_t. We then regress X_t on $\hat{H}_t^{(0)}$ and G_t to obtain $\hat{\Lambda}_G^{(0)}$, the loadings associated with G_t. We compute $\tilde{X}_t^{(0)}=X_t-\hat{\Lambda}_G^{(0)}G_t$ and estimate $\hat{H}_t^{(1)}$ as the first $r-1$ principal components of $\tilde{X}_t^{(0)}$. This procedure is repeated until convergence, and we are left with final estimates of H_t and the loadings matrix Λ. The lag order of the FAVAR is determined to be two, based on the Schwarz-Bayes information criterion.

w_t is a vector of structural shocks which can be recovered by imposing restrictions on Q. Following Boivin et al. (2008), identification of the monetary policy shock is achieved via a standard Cholesky decomposition of the covariance matrix of the reduced-form VAR residuals. The overnight interest rate is ordered below the latent factors, thereby assuming that the short-term interest rate reacts contemporaneously with shocks to the factors, while the factors are assumed not to react contemporaneously with the interest rate. Finally, confidence bands of the impulse response functions are constructed using the bootstrap-after-bootstrap technique proposed by Kilian (1998). This technique allows us to remove a possible bias in the VAR coefficients which can arise due to the small sample size. The number of bootstrap replications equals 1,000. Notice that, since $N > T$, we neglect the uncertainty involved with the factor estimation, as also suggested by Bernanke et al. (2005).

Charts A5.1-A5.5 illustrate a few results of the impulse response analysis. Chart A5.1 reports impulse responses for a number of real activity indicators

Chart A5.1 Impulse responses of real activity variables and prices



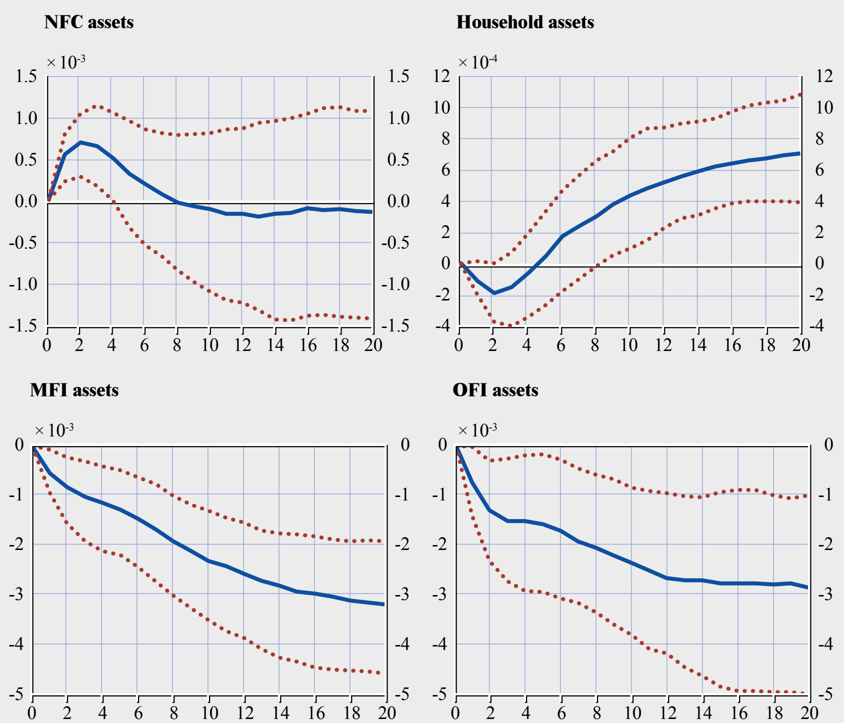
Source: ECB.
Note: Median and 90% confidence bands.

(real GDP, real consumption and real investment) and a number of price indices (HICP, GDP deflator and PPI). The results suggest that a monetary policy shock has a temporary negative effect on real activity, with the strongest effect being on real investment – a finding that is in line with earlier evidence on monetary transmission in the euro area. Also in line with earlier research, we find that it is hard to establish a significantly negative effect on price levels on the basis of a recursive identification scheme. Only the producer price index displays a persistent and significant decline after a contractionary monetary policy shock.

Charts A5.2 and A5.3 report impulse responses for total assets and total liabilities of NFCs, households, MFIs and OFIs. The charts reveal a rather dispersed pattern of responses across the different sectors. NFC assets temporarily increase following a monetary shock, while household total assets temporarily decrease. Total assets of MFIs and OFIs, in contrast, both decrease persistently. A similar picture is obtained on the liability side. NFC liabilities temporarily increase and household liabilities temporarily decrease. MFI and OFI liabilities both decrease persistently.

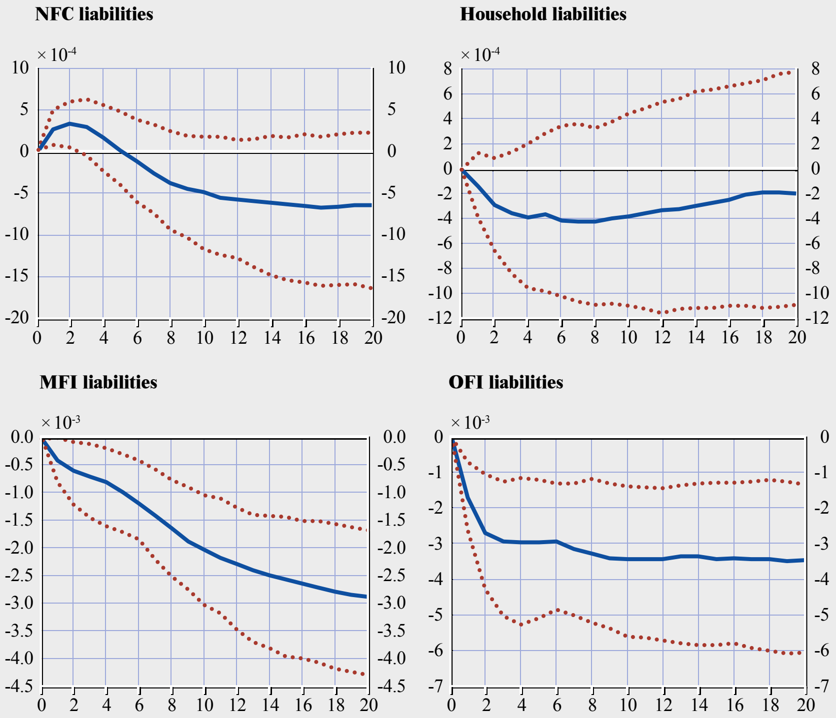
In order to understand the dispersed response of the different sectors' assets and liabilities, a more disaggregated analysis of the reaction patterns of the various components of the sectors' assets and liabilities is required. Performing such an

Chart A5.2 Impulse responses of private sector total assets (breakdown by sector)



Source: ECB.
Note: Median and 90% confidence bands.

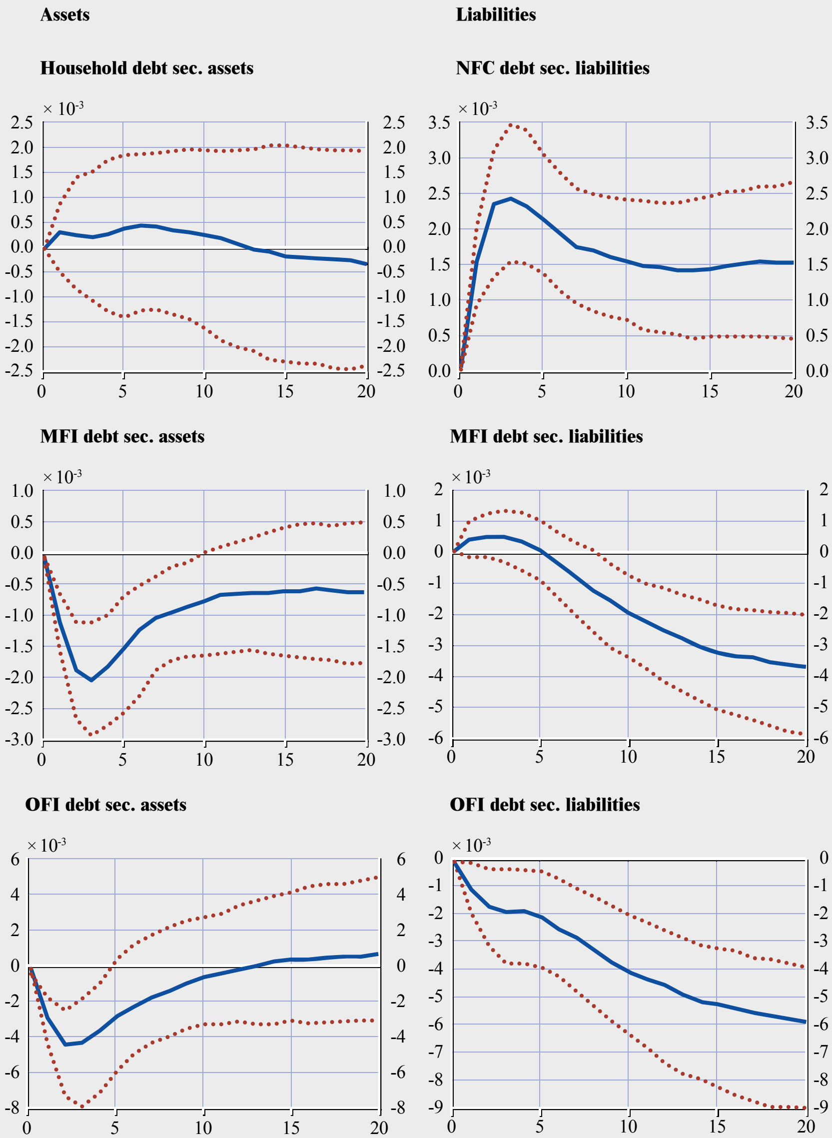
Chart A5.3 Impulse responses of private sector total liabilities (breakdown by sector)



Source: ECB.
Note: Median and 90% confidence bands.

analysis in great detail is beyond the scope of this annex. Instead, we will focus on the reaction patterns of two particularly important asset and liability categories, namely debt securities and loans, displayed in Charts A5.4 and A5.5. Chart A5.4 reveals that household holdings of debt securities barely respond to a monetary policy shock, while the other two main debt security-holding sectors, MFIs and OFIs, reduce their debt security holdings significantly. On the liability side, NFCs increase their debt security liabilities significantly, suggesting that they are able to partly smooth out the contractionary effects of a monetary tightening by increasing debt security issuance. This result is in line with evidence for the United States (Eickmeier and Hofmann (2010)). In contrast to this, MFI and in particular OFI debt security liabilities decrease persistently after a monetary policy shock, suggesting that, with regard to the ability to issue debt securities, the financial sector is more negatively affected by a monetary policy shock than the non-financial sector. The reaction patterns of loans reveal that loan assets of NFCs increase after a monetary contraction, reflecting an expansion in inter-company loans, while loan assets of both MFIs and OFIs decrease persistently. Loan liabilities of NFCs and OFIs decrease persistently after a temporary increase, with OFI loan liabilities decreasing more than twice as strongly. Household loan liabilities barely respond to a monetary policy shock, which in turn explains the reaction pattern found for total household liabilities.

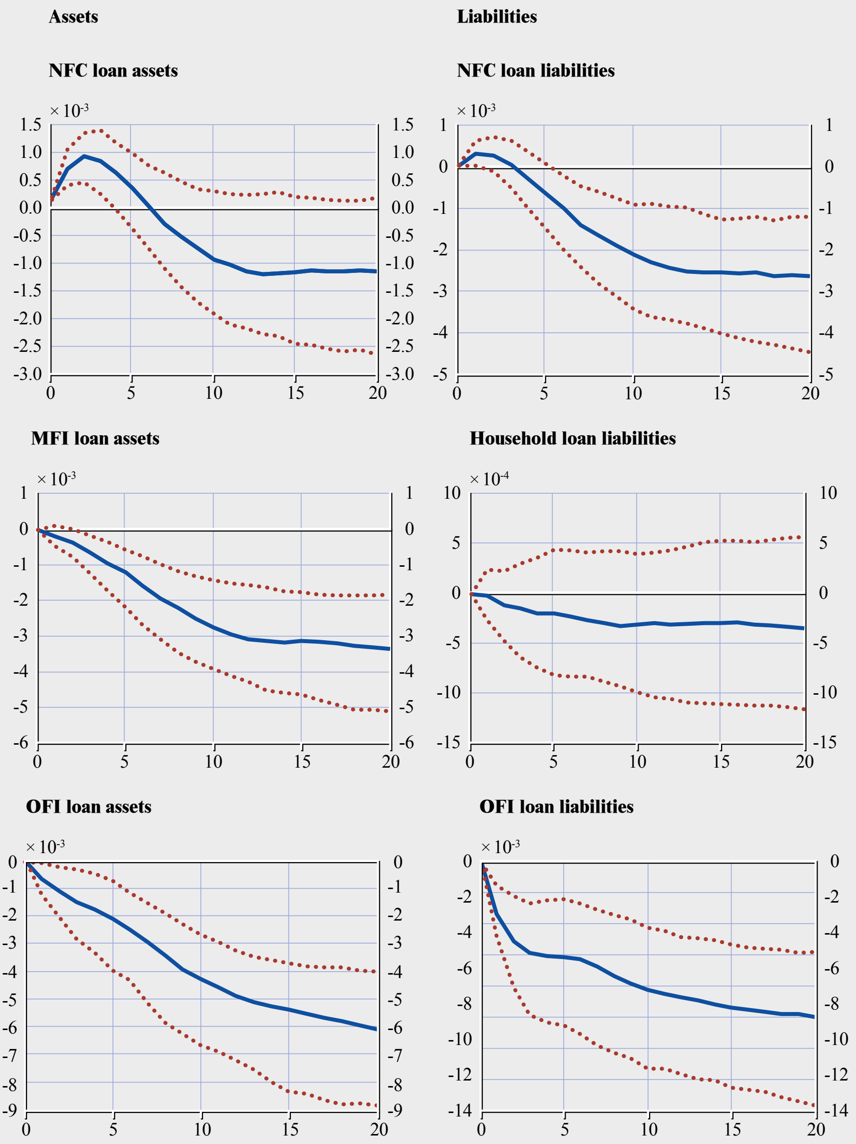
Chart A5.4 Impulse responses of private sector debt security assets and liabilities (breakdown by sector)



Source: ECB.

Note: Median and 90% confidence bands.

Chart A5.5 Impulse responses of private sector loan assets and liabilities (breakdown by sector)



Source: ECB.
Note: Median and 90% confidence bands.

5 FAVAR-BASED FORECASTS OF THE FLOW-OF-FUNDS AGGREGATES

For each variable to be forecast, we estimate a FAVAR of the form:

$$G_t = A(L)G_{t-1} + \varepsilon_t, \tag{3}$$

where $G_t = [x_t \quad F_t]'$. x_t is the variable to be projected and F_t is the set of six latent factors. We perform a pseudo out-of-sample forecast evaluation exercise over the period from Q1 2000 to Q3 2009. To this end, we construct out-of-sample forecasts on the basis of recursively estimated forecasting models and construct forecasts from one to four quarters ahead. The forecast performance of the FAVAR forecasting models is assessed on the basis of the relative root mean squared error (relative RMSE), i.e. the root mean squared error produced by the FAVAR forecasting model relative to the root mean squared error produced by a simple autoregressive forecasting model over the forecast evaluation sample. In Tables A5.1 and A5.2 we report, as examples of the results produced by this exercise, the relative RMSEs for NFC and household loan liabilities (Table A5.1) and for MFI loan and debt security assets (Table A5.2). We report results for r = 1, 2, 3, 6 factors. The lag order of the FAVAR and of the autoregressive benchmark models was determined on the basis of the Schwarz-Bayes information criterion. The results suggest that the forecast performance of the FAVARs with regard to the simple autoregressive benchmark model is mixed. For NFC and household loan liabilities, the RMSEs produced by the best-performing FAVAR are respectively about 30% and 20% lower than those produced by the benchmark model at the four-quarter forecast horizon. In contrast to this, for MFI loan and debt security assets, the FAVARs do not outperform the autoregressive benchmark model.

Table A5.1 Relative RMSEs for NFC and household loan liabilities

(forecast sample Q1 2000 – Q3 2009)

	h=1	h=2	h=3	h=4
Δ NFC loan liabilities				
AR (RMSE)	0.0069	0.0082	0.0093	0.0109
FAVAR, r=1	0.9000	0.8400	0.8400	0.8400
FAVAR, r=2	0.9300	0.8700	0.7800	0.7700
FAVAR, r=3	0.9900	0.9200	0.8400	0.7900
FAVAR, r=6	0.9900	0.8000	0.7000	0.7100
Δ Household loan liabilities				
AR (RMSE)	0.0035	0.0040	0.0046	0.0053
FAVAR, r=1	1.0400	1.0300	1.0400	1.0300
FAVAR, r=2	1.0400	0.8900	0.8400	0.8200
FAVAR, r=3	1.1100	1.1800	1.2300	1.0600
FAVAR, r=6	1.3200	1.3500	1.4800	1.1600

Source: ECB.

Note: The table displays the root mean squared error (RMSE) of the benchmark autoregressive model and the relative RMSEs of the FAVAR forecasting models with r=1, 2, 3, 6 factors respectively.

Table A5.2 Relative RMSEs for MFI loan and debt security assets

(forecast sample Q1 2000 – Q3 2009)

	h=1	h=2	h=3	h=4
Δ MFI loan assets				
AR (RMSE)	0.0062	0.0067	0.0083	0.0091
FAVAR, r=1	1.1200	1.0700	0.9700	1.0200
FAVAR, r=2	1.2500	1.1400	0.9600	0.9400
FAVAR, r=3	1.2300	1.0800	0.9700	0.9900
FAVAR, r=6	1.3300	1.0600	1.1100	1.2100
Δ MFI debt sec. assets				
AR (RMSE)	0.0112	0.0111	0.0107	0.0107
FAVAR, r=1	1.2200	1.0700	1.0500	1.0400
FAVAR, r=2	1.3700	1.3500	1.3900	1.3700
FAVAR, r=3	1.4800	1.3700	1.3900	1.3900
FAVAR, r=6	1.8300	1.6400	1.4200	1.3000

Source: ECB.

Note: The table displays the root mean squared error (RMSE) of the benchmark autoregressive model and the relative RMSEs of the FAVAR forecasting models with r=1, 2, 3, 6 factors respectively.

6 THE ROLE OF FOF VARIABLES FOR MACROECONOMIC FORECASTS

In order to assess the role of FoF variables for forecasts of key macro variables, we perform two pseudo out-of-sample forecast exercises for real GDP growth and HICP inflation over the same sample as above: once using FAVARs with factors estimated on the basis of the complete dataset including FoF variables and once using FAVARs with factors estimated on the basis of a dataset excluding the 93 FoF variables. If FoF variables contain useful additional information for the two key macro variables, the relative RMSEs of the former model should be lower than the relative RMSEs from the latter models. The results of this exercise are presented in Table A5.3. As before, the exercise was performed for r = 1, 2, 3, 6 factors and the lag order of the FAVARs and of the benchmark autoregressive models was determined on the basis of the Schwarz-Bayes information criterion. The results suggest that the RMSEs produced by the factor models including FoF variables are only marginally lower than those produced by the FAVAR model excluding FoF variables. However, just as good forecast performance in the past is no guarantee of good performance in the future, the same holds true the other way around, meaning that the information content of FoF variables for forecasting macro variables should not be prematurely discarded. In order to assess what the recent dynamics of FoF variables imply for the macroeconomic outlook, we take, as a final exercise, the best-performing FAVARs including and excluding FoF variables estimated up to Q3 2009 and compute one to nine steps ahead out-of-sample forecasts for the period from Q4 2009 to Q4 2011. The results of this exercise, which are displayed in Chart A5.6, reveal that the forecasts of the FAVARs including FoF variables are less benign than those from the FAVAR excluding FoF variables, in particular for real GDP growth, which suggests that there are measurable feedback effects of financial factors on economic activity.

Table A5.3 Relative RMSEs for real GDP growth and HICP inflation

(forecast sample Q1 2000 – Q3 2009)

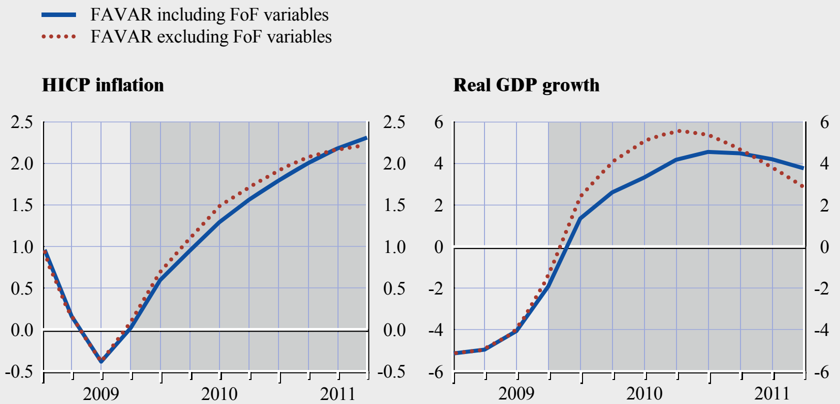
	h=1	h=2	h=3	h=4
Real GDP growth				
AR (RMSE)	0.0059	0.0075	0.0072	0.0073
FAVAR, excluding FoF, r=1	0.8500	0.9900	1.0700	1.0600
FAVAR, excluding FoF, r=2	0.8200	0.8400	0.8700	0.9200
FAVAR, excluding FoF, r=3	0.8200	0.8500	0.8300	0.8400
FAVAR, excluding FoF, r=6	0.9100	0.9000	0.9100	0.8900
FAVAR, including FoF, r=1	0.9500	1.0300	1.0700	1.1000
FAVAR, including FoF, r=2	0.9400	0.9100	0.8400	0.8800
FAVAR, including FoF, r=3	0.8100	0.8200	0.8200	0.8500
FAVAR, including FoF, r=6	0.8200	0.8700	0.8200	0.8600
HICP inflation				
AR (RMSE)	0.0030	0.0032	0.0032	0.0034
FAVAR, including FoF, r=1	1.0300	1.0400	1.0700	1.0500
FAVAR, including FoF, r=2	1.0100	1.1000	1.1700	1.2100
FAVAR, including FoF, r=3	1.0600	1.0800	1.1500	1.1500
FAVAR, including FoF, r=6	1.0400	1.1400	1.2500	1.2000
FAVAR, including FoF, r=1	1.0200	1.0200	1.0600	1.0500
FAVAR, including FoF, r=2	1.0600	1.1400	1.1800	1.2000
FAVAR, including FoF, r=3	1.0500	1.0800	1.1100	1.1200
FAVAR, including FoF, r=6	1.0300	1.1300	1.1600	1.1500

Source: ECB.

Notes: The table displays the root mean squared error (RMSE) of the benchmark autoregressive model and the relative RMSEs of the FAVAR forecasting models with r=1, 2, 3, 6 factors respectively. Two FAVAR forecasting models are considered, one excluding FoF variables from the factor dataset and one including them.

Chart A5.6 FAVAR-based out-of-sample macro forecasts

(annual growth rates in %)



Source: ECB.

REFERENCES

Bai, J. and Ng, S. (2002), "Determining the number of factors in approximate factor models", *Econometrica*, 70(1), pp. 191-221.

Bernanke, B., Boivin, J. and Eliasz, P. (2005), "Measuring the effects of monetary policy: a factor-augmented vector autoregressive (FAVAR) approach", *Quarterly Journal of Economics*, 120(1), pp. 387-422.

Boivin, J. and Giannoni, M. (2010), "Global forces and monetary policy effectiveness", in Gali, J. and Gertler, M. (eds.), *International dimensions of monetary policy*, University of Chicago Press, Chap. 8, pp. 429-478.

Boivin, J., Giannoni, M. and Mojon, B. (2008), "Has the euro changed the monetary transmission?", in Acemoglu, D., Rogoff, K. and Woodford, M. (eds.), *NBER Macroeconomic Annual 2008*.

Eickmeier, S. and Hofmann, B. (2010), "Monetary policy, housing booms and financial (im)balances", *Working Paper Series,* No 1178, ECB.

Kilian, L. (1998), "Confidence intervals for impulse responses under departures from normality", *Econometric Reviews*, 17, pp. 1-29.

Stock, J. and Watson, M. (2002), "Macroeconomic forecasting using diffusion indexes", *Journal of Business and Economic Statistics*, 20(2), pp. 147-162.

ANNEX 6

THE FLOW-OF-FUNDS PROJECTIONS AT THE ECB

I INTRODUCTION[50]

The flow-of-funds matrix contains a large amount of quantitative information and offers a coherent accounting framework and inter-linkages between the financial and non-financial accounts as well as the various institutional sectors. Consequently, the financial projections can serve many objectives and be used in several different ways within the forecasting exercises.[51] It should be recognised, however, that the flow-of-funds projections are not produced in a general equilibrium framework based on a theoretically-sound micro-founded model that includes optimising and utility-maximising agents, rational expectations and learning. Although these factors are not taken directly into account, forecast data and information which are derived from models incorporating, at least partly, such considerations are nevertheless used as input for financial projections.

The flow-of-funds projections have been part of the Eurosystem staff quarterly macroeconomic projection exercises since mid-2003, replacing the previous financial consistency exercise.[52] However, during the recent financial crisis, which has coincided with the deterioration of the balance sheets of households, non-financial corporations and banks, they have gained in importance at the ECB. This partly reflects the fact that the financial sides of the models used to project real and price developments are not yet that developed or sufficiently detailed, implying that the information available from the flow-of-funds forecasts can be of great benefit to the macroeconomic projections and especially the risk and scenario analysis. Since the macroeconomic projection exercise for September 2008, the financial projections at the ECB have been based on a new "enhanced" framework.[53] This annex presents the main features of this extended flow-of-funds projection matrix, describes how the financial forecasts are produced technically, and explains how the information retrieved from the system is used in the projection exercises.

50 Prepared by Mika Tujula. Comments and input from Elena Angelini, Riccardo Bonci, Véronique Genre and Silvia Scopel are gratefully acknowledged.

51 For the purposes of this annex, the terms "forecast" and "projection" are used interchangeably, although in the context of the Eurosystem macroeconomic projection exercises, the official term is "projection".

52 For more details about the Eurosystem projection exercises, see ECB (2001).

53 The new framework was developed jointly by Mika Tujula, Elena Angelini, Riccardo Bonci and Massimiliano Loi.

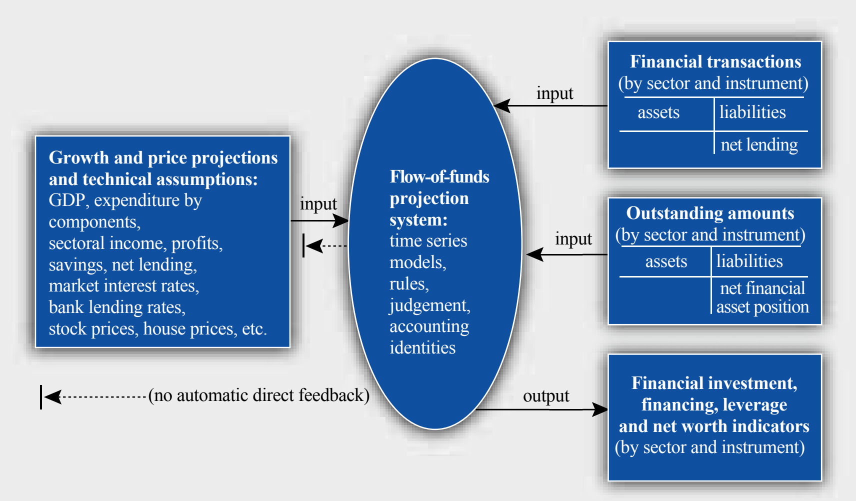
2 COVERAGE

The flow-of-funds projections have always been derived post-recursively as part of the Eurosystem forecasting exercises, and are based on growth and price projections – which are produced with other models and tools – and the technical assumptions underlying the macroeconomic forecasts published in the quarterly issues of the ECB's Monthly Bulletin (see Chart A6.1). This approach ensures, in principle, full (accounting) consistency between the financial projections and all the other projections, including the budgetary and current account forecasts. But it also implies that there is no direct feedback from the wider set of financial projections to the other parts of the forecast.

The current set of financial variables projected covers all the new transactions (net) occurring between the different institutional sectors of the economy (euro area domestic sectors and the rest of the world) and the balance sheet positions of the various sectors for each instrument for which data exist in the euro area accounts (see Table A6.1). The domestic sectors for which the projections are prepared include: households (HHs), non-financial corporations (NFCs), monetary financial institutions (MFIs), other financial intermediaries (OFIs), insurance corporations and pension funds (ICPFs) and general government (GG) (i.e. every individual sector for which such data exist).

In the new framework the total number of financial variables for which forecasts are produced is 715 (taking into account the availability of who-to-whom

Chart A6.1 The Eurosystem macroeconomic projection exercises: post-recursive flow-of-funds block



Source: Author.

Table A6.1 Financial projections: sectors and instruments covered

Financial transactions and outstanding amounts	HH	NFC	MFI	ICPF	OFI	GG	ROW
Total financial assets/total liabilities							
Monetary gold and special drawing rights							
Currency and deposits							
Debt securities, excluding financial derivatives							
Original maturity up to 1 year							
Original maturity above 1 year							
Loans							
Original maturity up to 1 year							
Original maturity above 1 year							
Shares and other equity							
Shares and other equity, excluding mutual fund shares							
Quoted shares							
Unquoted shares and other equity							
Mutual funds shares							
Insurance technical reserves							
Net equity of households in life insurance and pension fund reserves							
Prepayments of insurance premiums and reserves for outstanding amounts							
Other accounts receivable/other accounts payable							
Financial derivatives							
Net lending/net borrowing from financial accounts							
Net financial asset position							

Source: ECB.
Note: The more detailed breakdown of currency and deposits and loans into different maturities and who-to-whom information for which projections are prepared is not shown here.

information for some instruments).[54] A full range of financial projections is only prepared for the euro area as a whole. Nevertheless, the national central banks provide individual country forecasts on total MFI loans granted to private money-holding sectors as part of the Eurosystem June and December projection exercises. Their aggregation and consistency is always cross-checked against the respective aggregate loan projections produced by ECB staff for the euro area.

The projections for all series in the enhanced flow-of-funds system are based on a quarterly frequency, benefiting greatly from the availability of the quarterly (EAA) sectoral accounts since June 2007. Indeed, these data allow the use of a single data source with one frequency and ensure a fully internally-consistent dataset and framework. Previously the forecasts relied on both annual and quarterly series, as well as multiple data sources, which made it more difficult to maintain the system and update the projections.

Currency and deposits on the liabilities side of MFIs have been further disaggregated into currency, short and long-term deposits, as well as into

54 The chart excludes the aggregated projections on different instruments (both the financial transactions and balance sheet positions on the assets and the liabilities sides) for financial corporations (MFIs+OFIs+ICPFs), private money-holding sectors (HHs+NFCs+OFIs+ICPFs) and domestic sectors (HHs+NFCs+MFIs+OFIs+ICPFs+GG). They are calculated for reporting and other purposes outside the main projection framework based on the detailed forecasts on the individual sectors and would add 210 to the number of variables that can be retrieved from the whole system.

liabilities vis-à-vis the euro area money-holding sectors, the rest of the world and interbank deposits in the matrix. Loans on the assets and liabilities sides of the individual domestic sectors and the rest of the world have in turn been separated into loans granted by and received from different sectors. The further disaggregation of deposits and loans into different maturities and who-to-whom data in the system reflects the selected modelling strategies for these instruments and ensures their consistent treatment on the assets and liabilities sides without having to resort to any mechanical adjustments. At the same time, this splitting significantly increases the number of variables in the matrix.[55]

The meeting documents and internal reports prepared over the course of the Eurosystem projection exercises contain forecasts for most of the flow-of-funds variables for which projections exist. These also include the key leverage ratios and computed balance sheet indicators based on the more detailed financial and non-financial forecasts (see Table A6.2). Nonetheless, the projections for some financial corporation sub-sectors, as well as instrument and maturity splits, which are less important for the growth and price forecasts, are typically left out.

55 This more detailed information on deposits and loans was initially derived from the Money and Banking Statistics (MBS) and the Balance of Payments Statistics (BOP) and using some assumptions, but since May 2010 it can also be retrieved from the EAA.

Table A6.2 Flow-of-funds projections: level of detail in reporting

(as a percentage of GDP; annual percentage changes)

	Percentage share in total[1)]	2003	2004	2005	2006	2007	2008	2009
Net lending/net borrowing of euro area[2)]		**0.4**	**0.8**	**0.2**	**-0.1**	**0.4**	**-1.5**	**-0.8**
Households		3.3	3.3	3.3	2.5	2.4	3.1	4.3
Non-financial corporations		-0.8	-0.5	-1.7	-2.4	-2.7	-3.8	-0.2
General government		-3.1	-3.0	-2.6	-1.3	-0.6	-2.0	-6.2
Financial corporations		1.0	0.9	1.2	1.2	1.4	1.2	1.3
Households								
Assets		4.0	4.2	4.6	4.1	3.4	2.7	3.1
- Deposits	35.0	4.9	5.2	4.9	5.5	5.8	6.9	3.5
- Debt securities	7.6	-0.6	5.7	-1.5	5.5	6.3	4.2	-6.3
- Shares and other equity	23.6	2.3	0.2	2.5	-0.4	-0.8	-2.1	2.7
- Insurance technical reserves	30.6	6.9	7.1	7.5	6.7	4.7	2.7	5.0
- Other	2.8	-0.6	2.6	11.4	6.9	0.8	1.8	9.3
Liabilities		6.8	7.4	8.6	8.6	6.6	3.4	2.3
- Loans	89.4	7.0	7.5	9.0	8.3	6.8	3.8	1.7
of which: MFI loans	74.9	6.4	7.8	9.4	8.5	6.2	1.7	1.3
- Other	10.6	5.2	6.1	4.8	11.4	4.8	0.2	7.8
Leverage ratios								
Debt to GDP		60.5	62.7	65.8	68.0	68.8	69.4	73.3
Debt to disposable income		90.2	93.8	98.8	103.6	106.0	105.8	108.3
Net worth to disposable income		558.0	581.6	613.3	639.4	639.0	594.2	602.0
Debt to financial assets		32.4	32.7	32.9	33.3	34.1	37.5	36.2
Debt to housing assets		24.4	24.1	24.0	24.0	24.4	25.3	26.3

1) Percentage share in outstanding amounts of total assets and liabilities at the end of 2009.
2) Based on financial accounts in euro area sectoral accounts.

Table A6.2 Flow-of-funds projections: level of detail in reporting (cont'd)

(as a percentage of GDP; annual percentage changes)

	Percentage share in total[1)]	2003	2004	2005	2006	2007	2008	2009
Gross interest payments to disposable income		2.5	2.5	2.4	3.0	3.6	3.9	2.5
Net interest receipts to disposable income		2.3	2.1	1.8	1.7	1.6	1.7	1.6
Debt reimbursements to disposable income		7.0	7.2	7.5	7.7	7.9	8.0	8.1
Non-financial corporations								
Assets		4.8	4.2	6.2	7.2	7.9	4.3	1.1
- Deposits	11.0	9.5	9.2	12.8	13.1	9.4	2.6	6.2
- Loans	18.3	9.0	5.4	9.7	10.2	15.4	14.0	0.1
- Debt securities	2.4	-5.9	-12.0	-6.7	6.9	2.2	-12.6	-2.2
- Shares and other equity	46.4	4.2	4.6	4.1	4.2	5.7	4.5	2.2
- Other	21.9	3.7	3.7	7.4	9.2	8.1	-0.5	-2.0
Liabilities		3.4	2.8	4.6	5.5	6.0	4.0	0.8
- Loans	32.8	4.7	3.6	7.3	11.1	12.0	8.8	-0.9
of which: MFI loans	18.7	2.8	5.2	8.6	13.0	13.7	8.7	-3.1
- Debt securities	3.5	10.7	0.8	2.4	5.9	5.4	8.7	10.5
- Shares and other equity	49.8	2.5	2.1	2.7	2.0	3.1	2.1	2.0
of which: quoted shares	13.9	0.8	0.4	3.4	1.0	1.6	0.1	2.1
- Other	13.9	1.7	4.0	6.1	7.2	4.9	0.4	-1.0
Leverage ratios								
Debt to GDP		63.8	62.8	63.8	66.2	67.9	70.1	72.3
Debt to gross operating surplus		344.2	336.7	340.6	351.5	356.7	369.4	390.9
Debt to financial assets		68.3	64.5	60.2	56.8	56.9	73.6	65.2
Debt to equity		174.8	163.7	140.1	125.8	122.5	228.5	190.6
Gross interest payments to operating surplus		15.8	14.9	15.0	17.0	19.7	22.1	16.9
Net interest payments to operating surplus		6.7	6.3	5.7	6.5	7.9	9.6	7.8
Debt reimbursements to operating surplus		37.0	36.5	36.9	38.2	38.9	41.5	46.4
Financial corporations								
Assets		6.6	7.4	10.0	11.2	12.2	6.7	0.4
- Deposits	23.3	8.1	9.7	9.1	13.5	20.9	11.9	-8.1
- Loans	31.2	5.3	6.5	10.3	12.7	12.5	6.7	0.1
- Debt securities	22.9	9.2	8.5	9.8	8.0	9.8	6.2	7.6
- Shares and other equity	18.6	5.6	5.9	9.7	10.1	5.9	-0.2	6.2
- Other	3.9	-2.0	0.0	15.2	9.5	7.5	15.3	-1.6
Liabilities		6.4	7.1	9.7	11.0	12.0	6.6	0.2
- Deposits	42.7	6.3	7.8	8.8	10.5	15.8	10.7	-4.2
- Loans	6.1	7.3	9.9	21.6	25.7	24.8	10.2	-2.6
- Debt securities	15.6	8.2	10.3	11.1	14.6	15.5	7.6	3.9
- Shares and other equity	21.0	5.8	4.5	8.0	8.7	5.0	-0.8	6.9
of which: quoted shares	1.8	2.1	3.0	2.4	3.6	0.9	2.4	9.4
- Insurance technical reserves	11.2	6.7	7.0	8.3	6.7	5.0	2.8	5.3
- Other	3.4	1.2	-0.7	20.2	14.7	6.5	7.9	-3.1
Balance sheet indicators								
Equity to total assets		10.6	10.3	10.9	11.5	10.6	7.8	8.8
Net financial assets to GDP		0.4	2.3	3.0	2.9	5.8	7.1	8.8

1) Percentage share in outstanding amounts of total assets and liabilities at the end of 2009.

Table A6.2 Flow-of-funds projections: level of detail in reporting (cont'd)

(as a percentage of GDP; annual percentage changes)

	Percentage share in total[1]	2003	2004	2005	2006	2007	2008	2009
Loans to deposits		74.2	73.4	73.8	75.5	74.1	71.0	74.0
Net interest receipts to GDP		2.2	2.2	2.2	2.3	2.6	2.6	2.0
Monetary financial institutions								
Assets		6.0	8.0	8.8	10.4	14.0	9.0	-2.2
- Deposits	29.0	6.9	9.6	8.1	12.8	21.1	12.2	-10.1
- Loans	39.0	5.3	6.8	8.9	10.4	11.0	5.2	-0.1
of which: loans to euro area private sectors	32.9	5.2	7.0	9.3	10.9	10.9	5.5	-0.6
- Debt securities	21.5	9.7	9.8	9.3	8.2	13.5	13.8	6.1
- Shares and other equity	6.3	1.5	7.0	4.3	9.1	5.7	-0.3	2.0
- Other	4.1	-3.8	-0.6	22.3	5.9	12.0	21.2	-5.6
Liabilities		6.0	7.6	8.2	10.2	13.7	8.9	-2.6
- Deposits	69.6	6.2	7.7	8.7	10.5	16.0	10.7	-4.1
of which: deposit holdings of euro area money-holding sectors	28.9	6.1	6.2	7.7	9.7	11.4	8.5	3.3
- Debt securities	16.8	7.3	11.2	8.8	11.9	11.7	2.8	1.4
- Shares and other equity	9.1	4.5	3.4	2.4	5.1	5.8	4.3	2.1
of which: quoted shares	1.7	1.2	3.4	1.6	3.0	1.7	2.6	12.5
- Other	4.5	-1.1	2.1	17.3	13.9	9.9	17.4	-1.8
Balance sheet indicators								
Equity to total assets		11.4	11.5	12.1	12.7	11.2	8.0	9.0
Net financial assets to GDP		3.7	3.0	3.3	2.5	5.0	7.6	8.5
Loans to deposits		104.9	104.8	106.2	107.4	107.3	104.0	99.3
Euro area vis-a-vis rest of the world								
Net external transactions of domestic sectors		0.4	0.8	0.2	-0.1	0.4	-1.5	-0.8
Balance of external transactions on deposits		0.6	-0.5	-2.3	-0.6	-2.9	-2.6	2.2
Balance of external transactions on loans		0.3	1.3	1.9	2.0	3.2	2.2	0.6
Balance of external transactions on shares and other equity		-0.1	0.9	1.0	0.1	0.1	1.2	-0.7
Balance of external transactions on debt securities		-0.6	-0.7	-0.2	-1.2	-0.8	-3.4	-2.5
Balance of external transactions on other instruments		0.1	-0.1	-0.2	-0.5	0.9	1.1	-0.3
Net external asset positions of domestic sectors		-11.6	-11.6	-10.7	-12.8	-14.0	-16.9	-16.9
Net external asset position on deposits		-8.8	-8.7	-11.0	-10.7	-11.9	-14.3	-12.7
Net external asset position on loans		4.1	5.0	7.9	8.8	11.3	12.0	12.6
Net external asset position on shares and other equity		-3.5	-4.0	-3.7	-6.6	-8.0	-3.7	-4.4
Net external asset position on debt securities		-5.0	-5.3	-4.3	-4.3	-4.8	-10.2	-11.4
Net external asset position on other instruments		1.6	1.3	0.6	-0.1	-0.6	-0.7	-1.1

Source: ECB.

1) Percentage share in outstanding amounts of total assets and liabilities at the end of 2009.

The flow-of-funds projections at the ECB combine forecasts based on both time series model techniques and non-model approaches.[56] More specifically, projections for the key financial variables on the liability side of the individual euro area private domestic sectors, which are considered most important from the point of view of growth and price forecasts, are based on partial equations. Such econometric models have been estimated on a quarterly basis for currency and short-term deposits (including repos) and for long-term deposits held by euro area money-holding sectors within MFIs, for loans granted by MFIs to households and NFCs, for debt securities and quoted shares issued by NFCs, MFIs and non-MFIs and for insurance technical reserves (see Table A6.3).

[56] The ECB's enhanced flow-of-funds projection system consists of a number of EViews programmes and Excel files. The former are used to produce the actual forecasts and the latter to update the input data needed for the projections and report the obtained results.

Table A6.3 Forecasting tools: time series models for selected financial instruments

Dependent variable	Explanatory variables				Model type
ST deposits within MFIs	rGDP (+)	deflGDP (+)	own rate (+)	STIR (-)	VECM
LT deposits within MFIs	rGDP (+)	deflGDP (+)	LTIR-STIR (+)		VECM
MFI loans to HHs	rGDP (+)	deflGDP (+)	real house prices (+)	composite MIR (-)	VECM
MFI loans to NFCs	nINV (+)	profits (+)	BLR (-)	CoASoF (+)	VECM
DSec issued by NFCs	nGDP (+)	RCoBF (-)	M & A (+)		ECM
QE issued by NFCs	nGDP (+)	RCoQEF (-)	M & A (-)		ECM
Insurance technical reserves	nGDP (+)	LTIR (-)			ECM
Interest received by HHs	deposits held (+)	other IBA (+)	STIR (+)	LTIR (+)	OLS
Interest paid by HHs	stock of debt (+)	STIR (+)	LTIR (+)		OLS
Interest received by NFCs	deposits held (+)	STIR (+)			OLS
Interest paid by NFCs	stock of debt (+)	STIR (+)	LTIR (+)		OLS

Source: Author's compilation based on the models used to produce flow-of-funds projections at the ECB.
Notes: own rate = own rate of M2 deposits plus repurchase agreements; STIR = short-term market interest rate; LTIR = long-term market interest rate; composite MIR = composite market interest rate; BLR = bank lending rate; CoASoF = cost of alternative sources of financing; RCoBF = relative cost of bond issuance; M&A = intra-euro area mergers and acquisitions of NFCs; RCoQEF = relative cost of equity issuance; other IBA = loans granted and direct holdings of debt securities plus indirectly held interest-bearing assets.

The choice of estimating models primarily for individual liabilities instead of assets reflects mainly two factors. First, a key interest of the Eurosystem projection exercises is to assess the implications of the projected macroeconomic developments and forecast technical assumptions on sectoral financing needs and balance sheet positions over the forecast horizon rather than the portfolio behaviour of various institutional sectors. Second, data limitations posed restrictions for the asset-side model at the time it was decided that financial projections should become a standard part of the forecasts.

Currency and short-term deposits, long-term deposits, loans to households and loans to NFCs are modelled by vector error correction models, whereas debt securities and quoted shares issued by NFCs, MFIs and non-MFIs as well as insurance technical reserves rely on single equation error correction models estimated in two steps. The main determinants of these variables are GDP, inflation, business investment, the gross operating surplus, the costs of financing (short and long-term market interest rates, composite market interest rates and bank lending rates, corporate bond yields, and the cost of equity), house prices, oil prices and M&A activity.[57,58]

The partial equations for these instruments and for the interest received and paid by households and NFCs discussed below are always re-estimated as part of projection exercises when new data become available. This ensures that the model parameters reflect the latest data and possible changes in the relationships between the macroeconomic and financial variables. For deposits, loans and security issuance, preliminary estimates for the current quarter are derived from the available monthly data, relying on univariate models, or simply fixed on the basis of the data for the first two months of the quarter, to ensure that the most recent data are somehow incorporated into the projections.

The equations on loans to households and NFCs, as well as on debt securities and quoted shares issued by NFCs, MFIs and non-MFIs, should be interpreted as demand-side models (see Charts A6.2 and A6.3). This means that they do not directly capture possible restrictions in credit supply originating from banks' capital and funding constraints or higher government debts crowding out loans granted by MFIs to households and NFCs and demand for securities issued by private sectors. Such events would eventually show up – together with other unexplained developments – in the model residuals of these instruments, insofar as these factors have not previously influenced GDP or its components, prices and costs of financing.

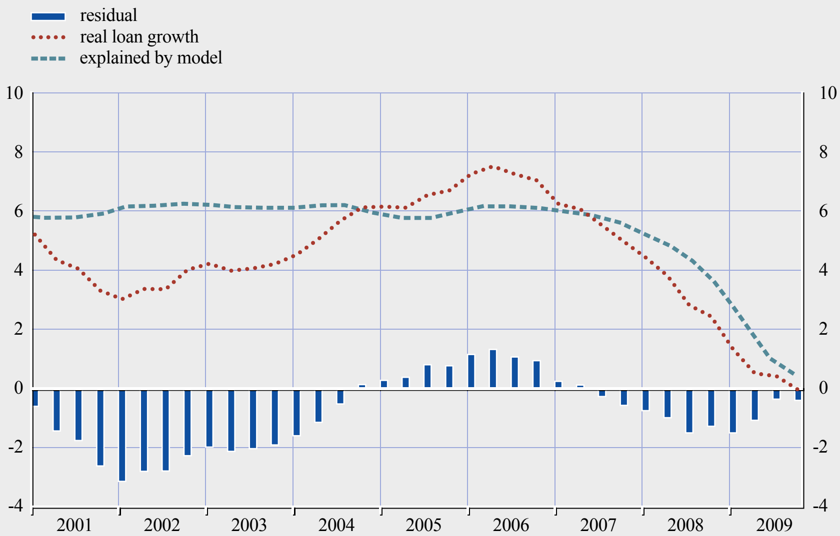
Projections for unquoted shares and other equity issued, mutual fund shares issued by euro area domestic private sectors, MFI loans to OFIs and ICPFs, non-MFI loans to households and NFCs, inter-company loans and other accounts payable, general government and rest of the world net transactions for most instruments

57 For more information on the technical details of the models used to produce the projections for the key financial variables see Calza, Manrique and Sousa (2003), Kok Sørensen, Marqués-Ibáñez and Rossi (2009), Calza, Gerdesmeier and Levy (2001), and Bondt de (2002).

58 See also ECB (2007).

Chart A6.2 Actual developments in MFI loans to households and model fitted values

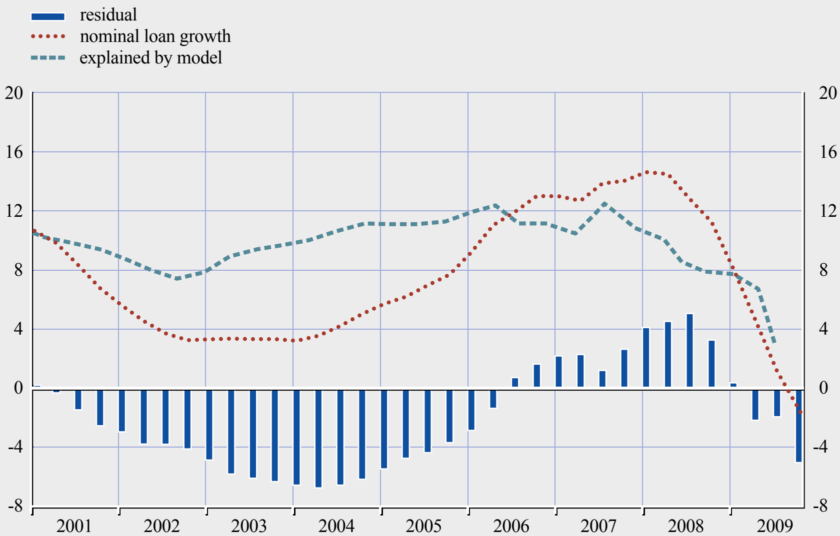
(annual rates of growth; percentage point contributions)



Sources: ECB and ECB calculations.
Note: The loan data have been corrected for the impact of securitisation.

Chart A6.3 Actual developments in MFI loans to NFCs and model fitted values

(annual rates of growth; percentage point contributions)



Sources: ECB and ECB calculations.

Table A6.4 Forecasting tools: non-model approaches

Variable	Assumption/rule
Fiscal and external net transactions	Convergence to average past quarterly flows
MFI loans to OFIs and ICPFs	Convergence to average past quarterly flows
Non-MFI loans to HHs and NFCs	Convergence to average past quarterly flows
Inter-company loans	Convergence to average past quarterly flows
Unquoted and other equity	Grow in line with gross operating surplus
Mutual fund shares	Grow in line with nominal GDP
Other accounts payable	Grow in line with nominal GDP
Financial investment	Based on past shares in total transactions or outstanding amounts
Interest received and paid by financial corporations	Computed based on interest received and paid by other sectors

Source: Author's compilation based on information from the flow-of-funds projection framework used at the ECB.

on the liabilities and asset sides are rule or judgement-based (see Table A6.4). In the case of euro area domestic sectors, the flows are assumed either to converge to their past average levels over the forecast horizon or to follow developments in GDP and gross operating surplus, whereas the external transactions take judgementally on board potential differences in the projected GDP growth, expected stock market returns and interest rate assumptions between the euro area and other economies.

Debt securities issued by general government and other accounts payable by the rest of the world deviate, however, from these principles. Indeed, these variables are used to accommodate possible initial differences emerging between the non-financial account and the financial account net lending/borrowing numbers for these sectors. This implies that they are computed as residuals in the flow-of-funds projection framework to ensure that the fiscal and external forecasts are ultimately fully consistent internally.

More recently, the plausibility of the projections for currency and short-term deposits (including repos), money market fund shares and short-term debt securities issued by MFIs has also been double-checked with the forecasts produced directly for the broad monetary aggregate (M3), based on the most recent money demand models used at the ECB for monetary analysis purposes.[59] These models not only consider the relative returns across the monetary and interest-bearing non-monetary financial assets in the euro area, but also incorporate the expected returns on housing investment within the euro area, differences in bond yields and stock prices between the euro area and the rest of the world, as well as movements in exchange rates.

The check is done after the projections, including the accounting adjustments, have been produced by, first, decomposing the projection for M3 to forecasts on currency and overnight deposits (M1), other short-term time deposits (M2-M1) and marketable instruments (M3-M2) in a satellite framework, assuming their shares in annual flows to money converge gradually towards previous average levels during the forecast period. In addition, this mechanical decomposition is still adjusted judgementally to take on board potential shifts within money

[59] See Beyer (2009), De Santis, Favero and Roffia (2008).

reflecting the shape of the yield curve. The final outcomes based on this top-down approach are then compared with the flow-of-funds bottom-up results, which enables M2 and M3-M2 forecasts to be derived using simplified assumptions. Finally, if there are large discrepancies between the two sets of projections, the reasons for this will be analysed in detail and, if necessary, the flow of funds-based forecasts will be modified.

While the projections of all liabilities and of assets for general government and the rest of the world follow a bottom-up approach by sectoral instrument, the forecasts of assets for the individual euro area private sectors – for which there is no direct counterpart available on the liabilities side – follow a top-down approach by instrument. In this approach, the financial investment of domestic private sectors to individual asset classes are derived on the basis of each sector's past shares in total outstanding amounts or transactions in a particular instrument conditional on the projected developments in sectoral liabilities and the forecasts on general government and rest of the world assets for each instrument.

More specifically, total assets for each instrument i (euro area domestic sectors + rest of the world) are calculated by adding up sectoral liabilities in the individual respective instruments vis-à-vis all sectors (also including possible intra-sectoral transactions):

$$asset_i\_earow\_na_t = liability_i\_hh\_na_t + liability_i\_nfc\_na_t + liability_i\_mfi\_na_t + liability_i\_icpf\_na_t + liability_i\_ofi\_na_t + liability_i\_gg\_na_t + liability_i\_row\_na_t. \quad (1)$$

This approach ensures that, for all instruments, total assets always equal total liabilities, thus implying that there is no need to adjust euro area or rest of the world total assets, total liabilities and net lending/borrowing over the forecast horizon.

In the next step, total euro area private sector asset holdings for each instrument are computed by subtracting from the total assets obtained above judgemental projections for general government and the rest of the world by instrument:

$$asset_i\_eap\_na_t = asset_i\_earow\_na_t - asset_i\_gg\_na_t - asset_i\_row\_na_t. \quad (2)$$

Projections for the asset holdings of single euro area private sectors are then derived by instrument, based on their past shares in total euro area private sector transactions or outstanding amounts in each instrument:

$$asset_i\_xxx_j\_na_t = asset_i\_eap\_na_t * asset_i\_xxx_j\_na_{t-1} / asset_i\_eap\_na_{t-1}, \quad (3)$$

where xxx_j denotes households, NFCs, ICPFs and OFIs respectively.

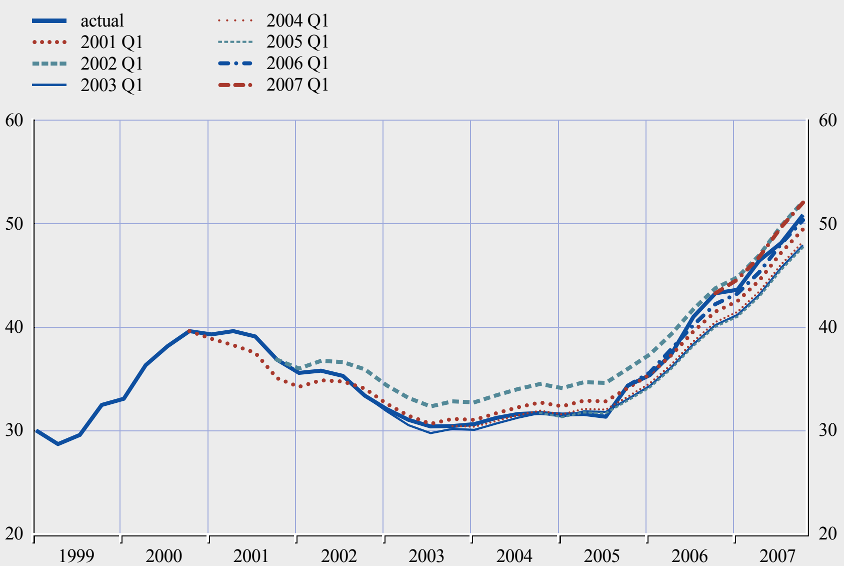
The outstanding amounts of different instruments, both on the assets and liabilities sides by sector, are calculated in the system by adding the forecasted net transactions for each instrument in a particular quarter to their actual or projected stocks at the end of the previous quarter. Only in the case of quoted shares are revaluation effects stemming from share price movements taken into account in computing stocks.

The framework also comprises difference equations for the gross interest revenue and expenditure of households and NFCs, based on quarterly data, which are run after the financial projections have been produced (see Charts A6.4 and A6.5). Households' interest revenue and expenditure are modelled by relating them to short and long-term market interest rates and, respectively, to the stocks of their interest-bearing asset holdings (both directly-held deposits, debt securities and money-market fund shares/units and those held indirectly through OFIs and ICPFs), and to the outstanding amounts of loans taken. Similarly, NFCs' interest revenue and expenditure are related to short and long-term market interest rates, to the stock of their direct deposit holdings, and to the level of debt (including all loans taken and debt securities issued).

For financial corporations, the projections for net interest revenue are computed as a residual based on the expected changes in the net interest revenue of other sectors (households, NFCs, general government and the rest of the world). This approach ensures that the interest revenue and expenditure forecasts are consistent across sectors (i.e. the sum of sectoral interest revenue equals the sum of interest expenditure by sector). It should be noted that both the sectoral interest revenue and expenditure are calculated and reported net of FISIM (financial

Chart A6.4 Interest paid by households: dynamic simulations

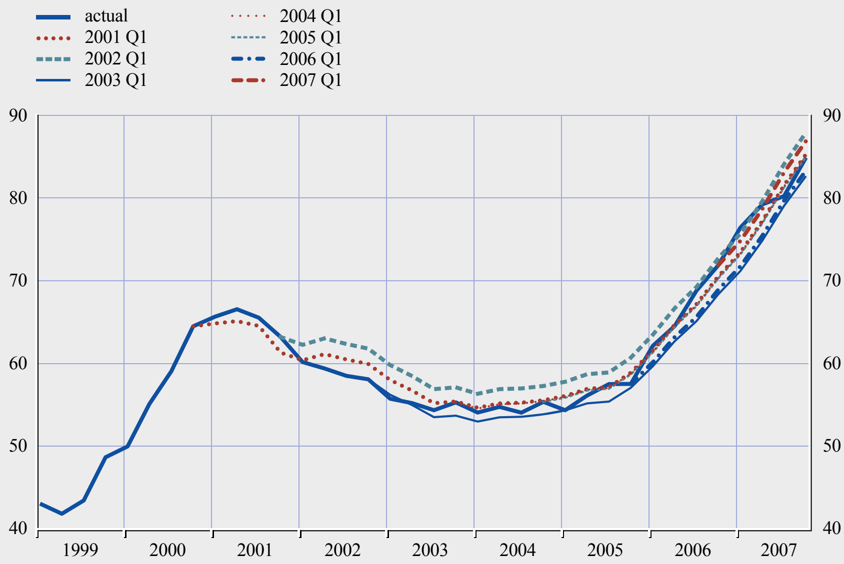
(quarterly flows; EUR billions)



Sources: ECB, Eurostat and ECB calculations.
Notes: The simulation results are based on the model used to project interest paid by households conditional on the actual developments in the underlying determinants of the model. The time period in the legend indicates the starting point from which the simulations were conducted.

Chart A6.5 Interest paid by NFCs: dynamic simulations

(quarterly flows; EUR billions)



Sources: ECB, Eurostat and ECB calculations.
Notes: The simulation results are based on the model used to project interest paid by NFCs conditional on the actual developments in the underlying determinants of the model. The time period in the legend indicates the starting point from which the simulations were conducted.

intermediation services indirectly measured) in the EAA. This means that the numbers overestimate and underestimate the actual total amounts of interest received and paid by different sectors respectively.

The system also makes it possible to derive quarterly projections and estimates for the net worth and debt repayments of households and NFCs after the growth and price and financial projections have been updated. The former are based on the forecasts on non-financial assets, which are obtained from so-called capital accumulation equations and the projections on financial assets and liabilities, whereas the latter are estimated with the help of information regarding the maturity structure of household and NFCs' liabilities.[60, 61]

60 $NCS_t = (1-\gamma)NCS_{t-1} \times (1+\beta_t) + GFCF_t$, where NCS_t and NCS_{t-1} is net capital stock at current replacement cost/market value in time t and t-1 respectively, γ is the retirement and depreciation rate of capital per quarter, β_t is the revaluation of existing capital stock (e.g. quarterly change in the property price index in the case of housing wealth), and $GFCF_t$ is gross fixed capital formation. See also ECB (2006a) and (2006b).

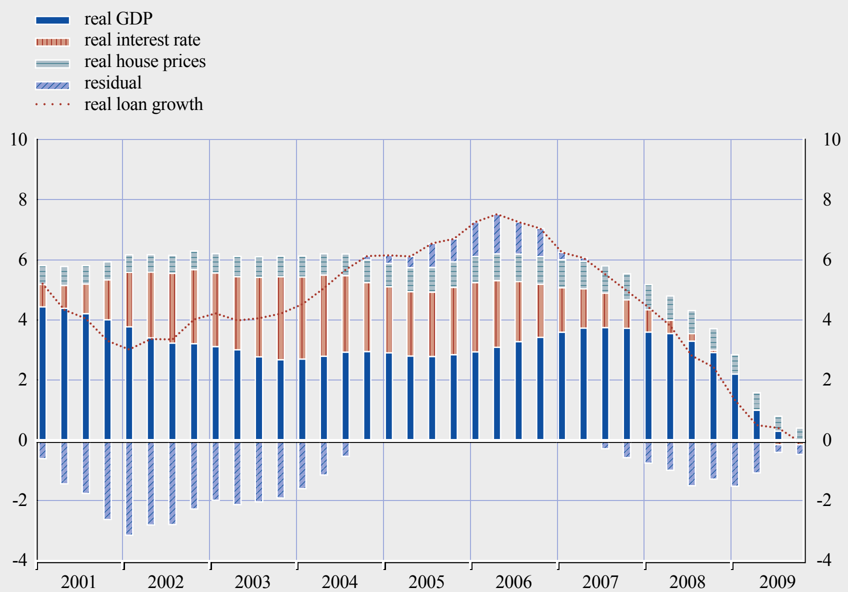
61 For the assumptions underlying the estimation of household and NFCs' debt repayments in more detail, see the annex to Bê Duc and Le Breton (2009).

The enhanced system for producing the flow-of-funds projections at the ECB follows a three-step approach. First, initial pure model-based forecasts with zero residuals are derived and their implications for the projection profiles of different financial instruments are analysed on both the assets and liabilities sides. At this point, the contributions of individual determinants and past shocks and their changes to the projected developments and forecast revisions in financial variables are also calculated and reported (see Charts A6.6 and A6.7). This concerns only those instruments on the liabilities side for which econometric time series models are currently available. At this stage, the judgemental forecasts for the assets and liabilities of the general government sector and the rest of the world are finalised as well.

In the next step, judgemental projections are prepared to account for the past forecast errors of the equations and possible special factors affecting the projected variables (see Charts A6.8 and A6.9). This is done by setting the model add-ons to appropriate levels and incorporating them into the forecasts. Special factors cover, for instance, the estimated or assumed effects from potential limitations in credit availability, higher loan securitisations and increased government bond issuance on MFIs loans granted to households and NFCs, as well as on demand for securities issued by NFCs and financial corporations during the projection period.

Chart A6.6 Growth of MFI loans to households: decomposition to its determinants

(annual rate of growth; percentage point contributions)

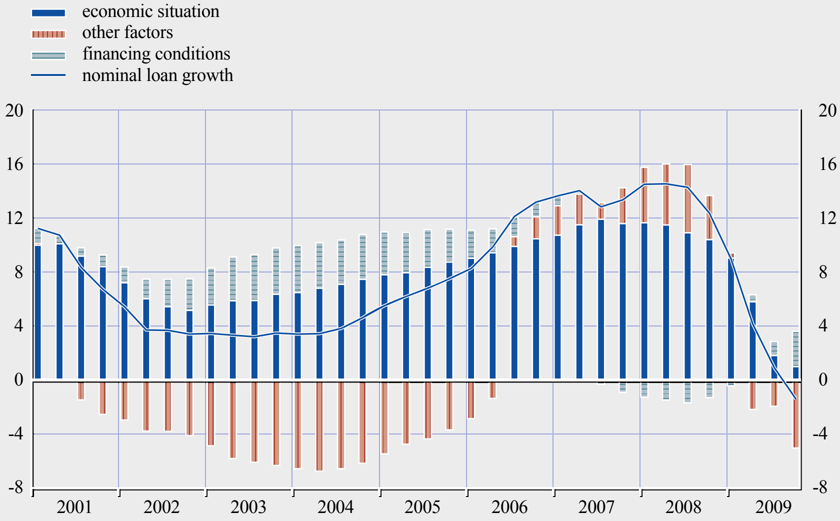


Sources: ECB and ECB calculations.

Note: The loan data have been corrected for the impact of securitisation.

Chart A6.7 Growth of MFI loans to NFCs: decomposition to its determinants

(annual rate of growth; percentage point contributions)

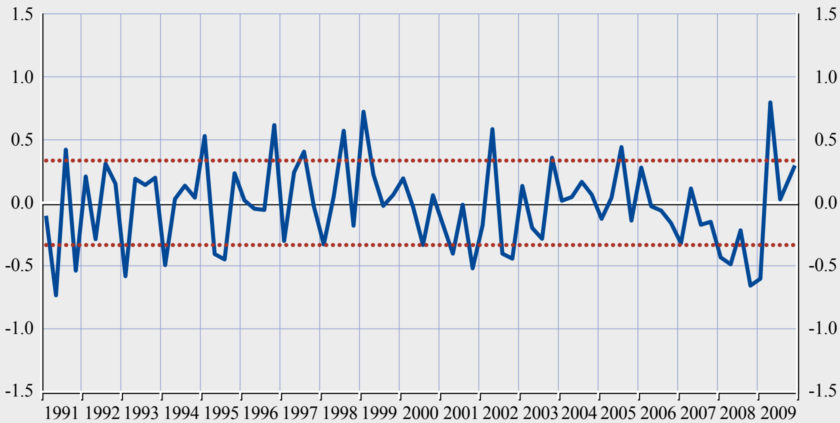


Sources: ECB and ECB calculations.

The add-ons may also be incorporated into the projections for those financial instruments for which models do not exist. For instance, the effects from potential government bank asset purchase programmes or capital support measures would be taken into account in the forecasts by adjusting the baseline projections of the general government sector, by lowering the shares of MFIs in various asset holdings and by modifying the residual paths of MFI liabilities. To avoid

Chart A6.8 MFI loans to households: residuals of dynamic model

(percentage points of loan stock)

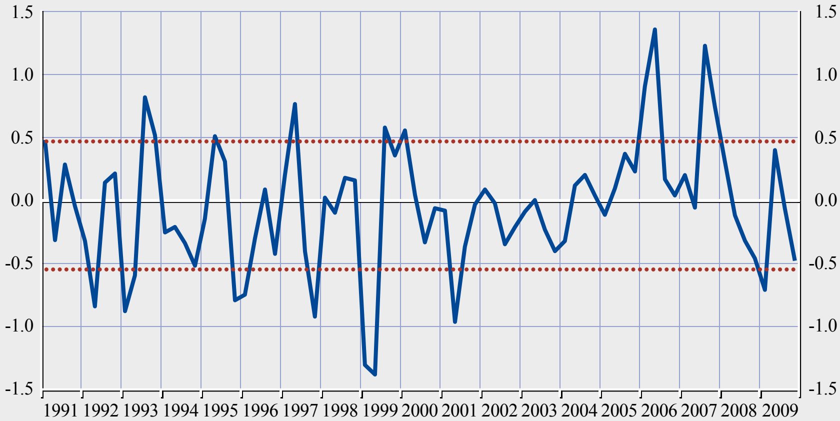


Source: ECB calculations.

Note: The loan data have not been corrected for the impact of securitisation.

Chart A6.9 MFI loans to NFCs: residuals of dynamic model

(percentage points of loan stock)



Source: ECB calculations.

potential double-counting, the impacts of special factors are incorporated into the forecasts via the residuals only insofar as they have not been taken indirectly on board in the projections through the growth and price forecasts or technical assumptions.

In the final step, after the judgemental add-ons have been incorporated into the projections, an assurance is still needed that the accounting identity holds across the non-financial and financial account net lending/borrowing numbers for all institutional sectors. This is eventually achieved with so-called accounting adjustments, whereby financial assets belonging to specific categories are reallocated between financial corporations, households and NFCs to ensure full consistency with the sectoral non-financial account net lending numbers, which are taken as reference points. Only debt securities, quoted shares, unquoted shares and other equity, mutual fund shares and other accounts receivable holdings are adjusted in the process, whereas deposits, loans and insurance technical reserves are left unchanged.

Regarding this last step in more detail, initial financial accounts-based net lending numbers are calculated for each institutional sector in the system by subtracting total liabilities incurred (net transactions) from total assets purchased:

$$fa\_net\_xxx_j\_na_t = assets\_xxx_j\_na_t - liabilities\_na\_xxx_{jt}, \quad (4)$$

where xxx_j denotes households, NFCs and financial corporations.

Next, differences between the financial accounts and non-financial accounts net lending numbers are computed for all sectors:

$$diff\_xxx_j\_na_t = fa\_net\_xxx_j\_na_t - nfa\_net\_xxx_j\_na_t. \quad (5)$$

The existing discrepancies in the net lending numbers are then removed for financial corporations by shifting the above-mentioned individual assets from the MFIs, ICPFs and OFIs to the non-financial private sectors, based on the past sectoral and instrumental shares in the total transactions or outstanding amounts of assets to be adjusted:

$$adj_{i}\_xxx_{j}\_nfp_{t} = -diff\_fin\_na_{t} * asset_{i}\_xxx_{j}\_na_{t-1} / assets_{adj}\_fin\_na_{t-1}, \quad (6)$$

where $adj_{i}\_xxx_{j}\_nfp_{t}$ is the size of adjustment by instrument and financial sub-sector (MFIs, ICPFs and OFIs) to be shifted to the non-financial private sectors.

Next, the adjustments made to the individual assets of financial corporations are distributed to households and NFCs based on their relative weights in each instrument that has been adjusted (based again on either transactions or outstanding amounts):

$$adj_{i}\_yyy_{k}\_fin_{t} = -adj_{i}\_fin\_nfp_{t} * asset_{i}\_yyy_{k}\_na_{t-1} / (asset_{i}\_hh\_na_{t-1} + asset_{i}\_nfc\_na_{t-1}), \quad (7)$$

where yyy_{k} denotes households or NFCs.

Then the adjusted new asset values are calculated for the MFIs, ICPFs, OFIs, households and NFCs by adding the quarterly adjustments to the unadjusted transactions and the cumulative sums of quarterly adjustments to the unadjusted stocks for those individual assets affected by these adjustments.

The assets moved from the financial corporations to the non-financial private sectors are then reallocated across households and NFCs following the above principles, so that the final discrepancy between the financial and non-financial accounts net lending numbers for these two sectors taken individually is equal to the average observed over the last four quarters. Next, the final adjusted values are computed for the assets of households and NFCs by adding the second adjustments to the first adjustment of individual assets (both transactions and outstanding amounts).

Finally, it should be noted that the final adjustments of quoted share holdings of MFIs, ICPFs, OFIs, households and NFCs are also corrected for the impact of revaluation effects in this procedure. This is done by adding to or subtracting from the adjusted stocks amounts which correspond to the difference between the adjusted and initial holdings in these instruments multiplied by the changes in stock prices.

Given that rest of the world and general government accounts and the liabilities of individual euro area private sectors are not considered at this stage, the euro area domestic and private sector assets and liabilities by instrument remain unchanged after all these adjustments.

One purpose of the flow-of-funds projections is to assess the overall plausibility of the resulting projected financial developments, to cross-check the real and nominal sides with the financial developments during the forecast period and to provide feedback to baseline projections on different domestic demand components, sectoral savings and net lending/borrowing, as well as asset prices (see Chart A6.10).[62] Indeed, the financing data of households and NFCs are available much earlier than data on GDP and its sub-components as well as on house prices; and these are not revised afterwards. This means that, for example, the latest data on MFI loans granted to households and NFCs, the implied model residuals (on equations used to project these items) for the most recent quarter and the short-term forecasts for these items could be used to motivate an adjustment – up or down in time t-1, t and t+1 – of the baseline projections on private consumption, business and residential investment, profits, and house prices, together with other available short-term forecasting models for the latter variables.

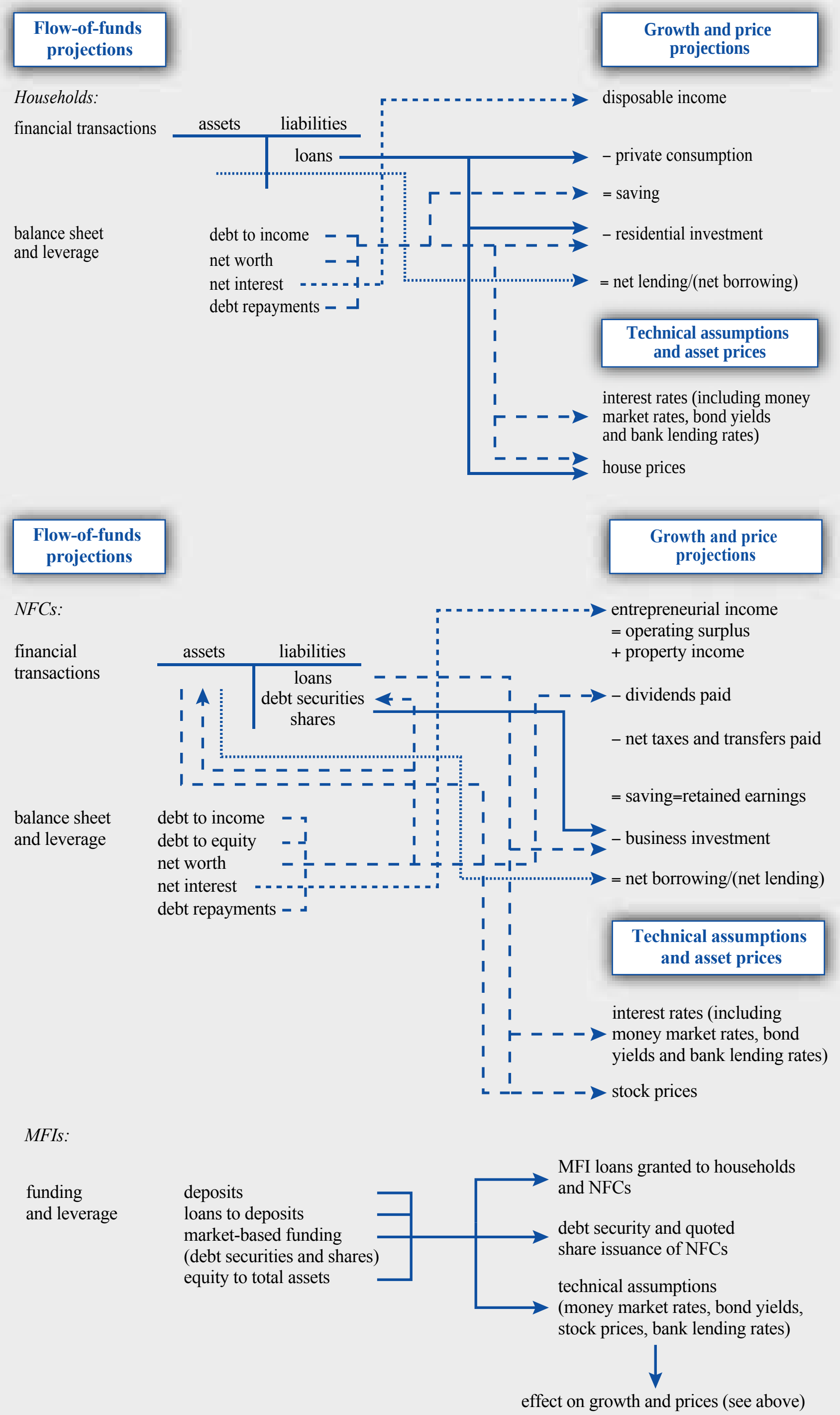
Equally, the projections for interest received and paid by households and NFCs, which are derived from the flow-of-funds framework, help to ascertain whether the projections for households' non-wage and non-transfer income and for NFCs' entrepreneurial income and gross savings are reasonable. The forecast paths on the net financial investment of households, NFCs and financial corporations in the system are in turn conditional on the projected sectoral financing and non-financial account net lending/borrowing numbers. Hence, the implausible profiles on net financial investment by sector compared with past developments might indicate revision needs to the baseline non-financial account net lending/borrowing forecasts – which is the balance between sectoral savings and investment – and ultimately to the income and spending projections of different institutional sectors.

Another purpose of the flow-of-funds projections is to identify and quantify possible risks stemming from the projected financial developments to the key macroeconomic variables and technical assumptions underlying the forecasts over the projection horizon, even if this information is not used to adjust the actual baseline. The forecast profiles on the debt-servicing burden and indebtedness of households and NFCs may, for instance, give an indication of possible required changes in their saving behaviour and deleveraging needs to ensure that debt repayment obligations are met from available income and to prevent a build-up of imbalances in their balance sheet positions.

In the absence of a commonly accepted "equilibrium" level of households' and NFCs' indebtedness, establishing benchmarks for their sustainable debt developments can draw on the information from the loan demand models used

62 The financial projections can also be used to enrich the analysis and "story-telling" in the projection reports when growth and price forecasts are discussed (e.g. how changes in net interest receipts affect sectoral income or how different components of household net worth influence private consumption).

Chart A6.10 Flow-of-funds projections: feedback to real and nominal projections and risk and scenario analysis



Source: Author.

to derive financial projections during the forecasting exercises. These models include a long-run relationship between the sectoral debt and its fundamental determinants, thus allowing quantitative loan gap and debt overhang/shortfall estimates to be derived.

The loan gaps denote the deviation of actual MFI loans to households and NFCs from the levels that would have resulted from reference paths for loan growth (see Charts A6.11 and A6.12), which are calculated on the basis of assumptions for "trend" developments in the scale and cost of financing variables included in these models, weighed together with the respective long-run loan demand elasticities estimated in the models as follows:

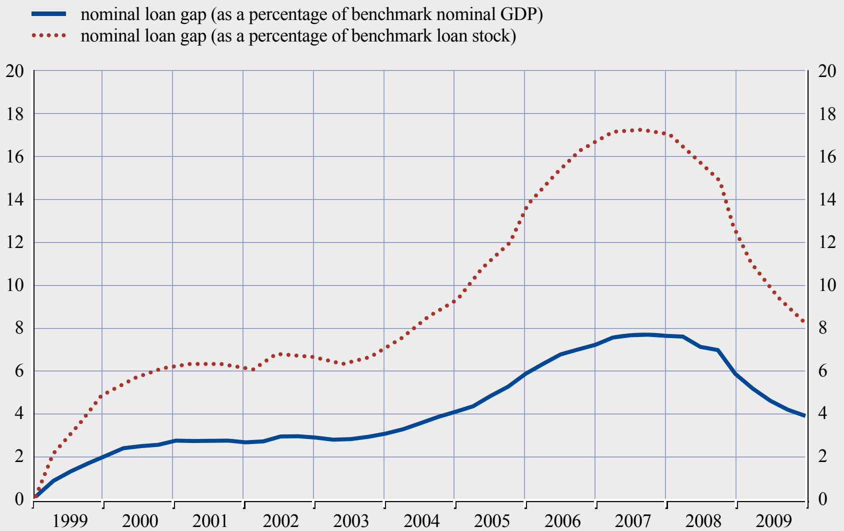
$$hhgap_t = hhloans_t - hhloans^*_t; \quad (8)$$

where $hhgap_t$ is the household loan gap, $hhloans_t$ is the level of actual nominal MFI loans granted to households and $hhloans^*_t$ is the reference level of nominal MFI loans to households in time t;

$$hhloans^*_t = hhloans^*_{t-1} * (1 + d(1.25 * realgdp^*_t + 0.36 * realhp^*_t - 5.00 * realcmr^*_t/100 + 1 * infl^*_t); \quad (9)$$

Chart A6.11 Household loan gap

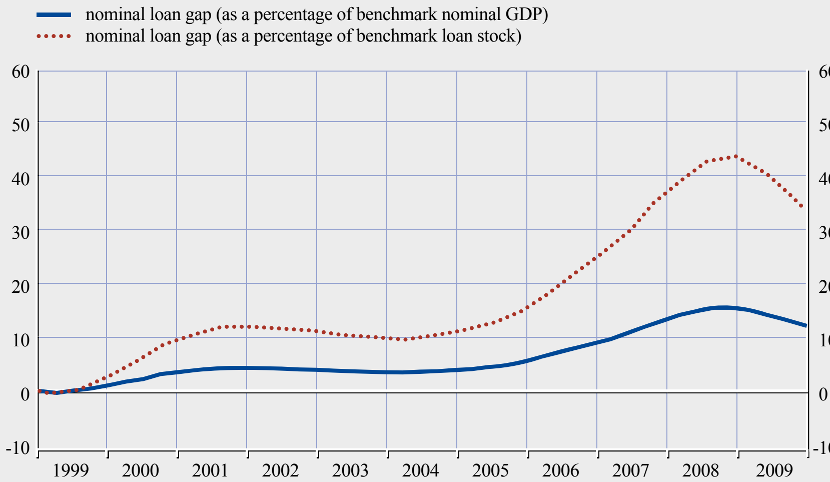
(percentages)



Source: ECB calculations.
Notes: The computations assume that nominal MFI loans to households, real GDP and real house prices would have been at their "equilibrium" levels in the fourth quarter of 1998. The trend real GDP growth and sustainable real house price increases are assumed to be 2% and 2.5% per annum from the fourth quarter of 1998 onwards respectively. For the same period, the natural real rate of interest is assumed to be 2.5% and the annual change in consumer prices is set at 2%.

Chart A6.12 NFC loan gap

(percentages)



Source: ECB calculations.

Notes: The computations assume that nominal MFI loans to NFCs and real GDP would have been at their "equilibrium" levels in the fourth quarter of 1998. The trend nominal GDP growth is assumed to be 4% per annum from the fourth quarter of 1998 onwards, while the relative nominal cost of bank lending and the annual change in consumer prices are set at -1.5% and 2% respectively.

where $realgdp^*_t$ is the log of trend real GDP, realhp*t is the log of real house prices, $realcmr^*_t$ is the natural real rate of interest and $infl^*_t$ is the annual change in consumer prices in time t;

$$nfcgap_t = nfcloans_t - nfcloans^*_t; \quad (10)$$

where $nfcgap_t$ is the NFC loan gap, $nfcloans_t$ is the level of actual nominal MFI loans granted to NFCs and $nfcloans^*_t$ is the reference level of nominal MFI loans to NFCs in time t;

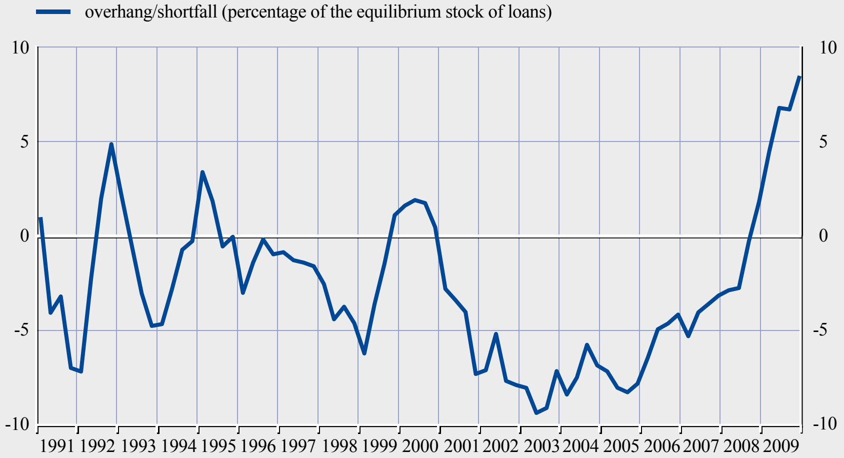
$$nfcloans^*_t = nfcloans^*_{t-1} * (1 + d(1.00 * nomgdp^*_t - 3.80 * rcbl^*_t/100); \quad (11)$$

where $nomgdp^*_t$ is the log of trend nominal GDP and $rcbl^*_t$ is the relative nominal cost of bank lending to NFCs, which is calculated as the difference between the nominal bank lending rate and the nominal cost of debt security and quoted share issuance to NFCs in time t.

The debt overhangs/shortfalls show, in turn, the deviation of actual MFI loans to households and NFCs from the paths implied by the weighted (with long-run coefficients) averages of actual developments in the underlying determinants of the respective loan models (see Charts A6.13 and A6.14).

Chart A6.13 Debt overhang/shortfall of real MFI loans to households

(percentages)



Source: ECB calculations.
Note: The loan data have not been corrected for the impact of securitisation.

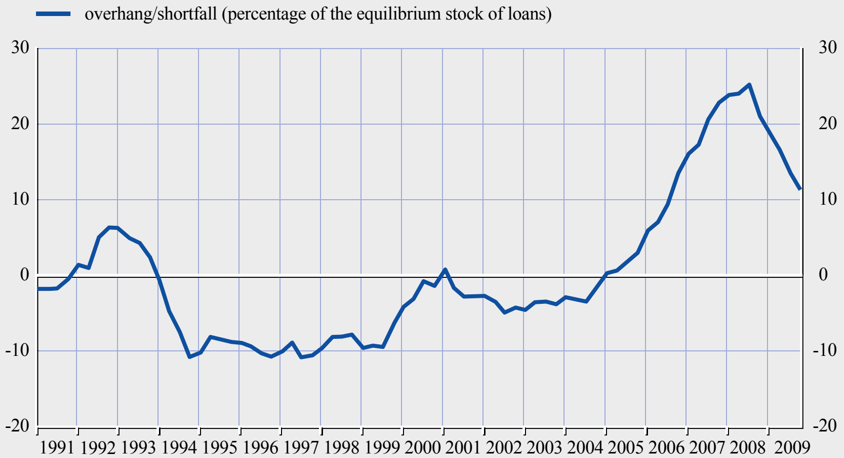
These indicators are computed in the following way:

$$hhect_t = hhloans_t + c - 1.25 * realgdp_t - 0.36 * realhp_t + 5.00 * realcmr_t /100; \quad (12)$$

where $hhect_t$ is the error correction term implied by the model estimated for MFI loans to households over the sample period, $hhloans_t$ is the log of real loans

Chart A6.14 Debt overhang/shortfall of nominal MFI loans to NFCs

(percentages)



Source: ECB calculations.

to households (deflated by the GDP deflator), $realgdp_t$ is the log of real GDP, $realhp_t$ is the log of real house prices and $realcmr_t$ is the real composite market interest rate on loans to households in time t;

$$nfcect_t = nfcloans_t + c - 1.00 \ * nomgdp_t \ + 3.80 \ * rcbl_t /100; \qquad (13)$$

where $nfcect_t$ is the error correction term implied by the model estimated for MFI loans to NFCs over the sample period, $nfcloans_t$ is the log of nominal loans to NFCs, $nomgdp_t$ is the log of nominal GDP and $rcbl_t$ is the relative nominal cost of bank lending in time t;

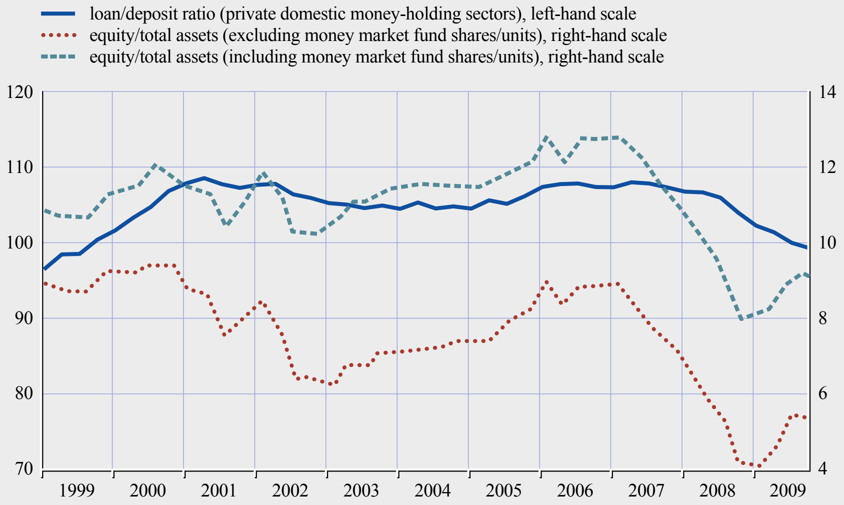
c is a constant in both cases being computed so that the deviations for MFI loans to households and NFCs from their long-run equilibrium relationships average zero over the sample period.

Likewise, the MFI loan/deposit and equity/total assets ratios can be used to check the overall consistency of flow-of-funds projections (see Chart A6.15). The former contains information on the stability of financing available to MFIs and their reliance on market-based and wholesale funding sources when providing loans to other sectors, whereas the latter may be regarded as a measure of leverage.[63] Subsequently, the implausible profiles of these indicators during the forecast period could indicate problems in the funding situation of MFIs and possible deleveraging needs, which might point to revision needs in the growth, price and non-financial sectoral net lending/borrowing projections as well as technical assumptions.

[63] The MFI equity/total assets ratio cannot be interpreted as a proxy of the capital adequacy ratio for regulatory purposes, since the assets in the EAA are not risk-weighted.

Chart A6.15 MFI loan/deposit and equity/total assets ratios

(percentages)



Sources: ECB and ECB calculations.

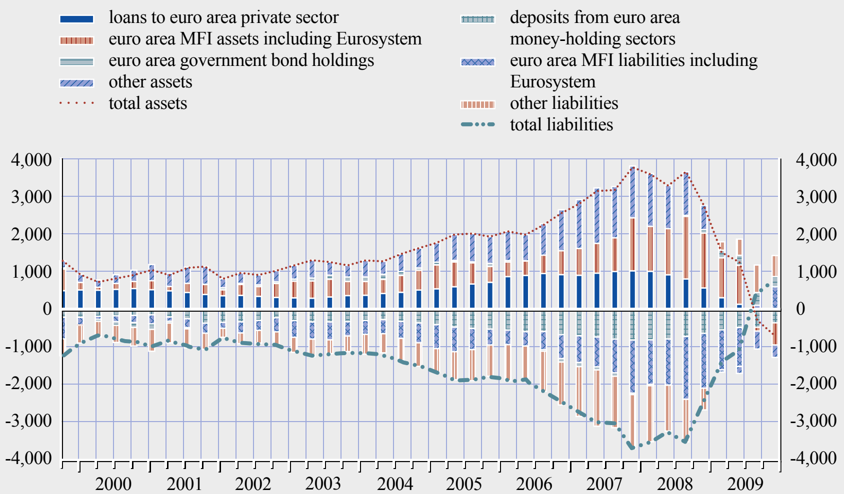
The size of total projected net financial transactions (flows) of MFIs, their breakdown into different instruments and their comparison with past developments on both the assets and liabilities sides can be used to detect changes in banks' role as regards financial intermediation and recognise possible inconsistencies in the projections in the same way as the ratios mentioned above (see Chart A6.16). At the same time, it should be recognised that the unrealistic profile for the total net financial transactions of MFIs on the assets side may also just reflect problems in the asset distribution between MFIs, OFIs and ICPFs rather than in the other parts of the forecasts, depending on how the projections for the individual financial sub-sectors are derived.

A third purpose of the flow-of-funds projections is to help motivate and specify alternative scenarios in the context of the forecasts. The loan gap and debt overhang/shortfall estimates discussed above may, for instance, be applied to calibrate the potential effects of deleveraging needs of households and NFCs on their loan demand or greater recourse to debt financing if these indicators remain or turn significantly positive or negative over the forecast horizon. This can be done, first, by deriving such paths for loans that would bring these measures to zero or more normal levels by the end of the projection period and, next, by calculating the differences vis-à-vis the baseline loan growth and debt levels.

The MFI loan/deposit and equity/total assets ratios may in turn be employed to quantify possible restrictions on loan supply stemming from their balance sheet imbalances or excess amount of funds and capital that could be used to grant more loans or purchase other types of financial assets in the event these ratios

Chart A6.16 MFI total financial investment and financing

(four quarter flows; EUR billions)



Sources: ECB and ECB calculations.
Note: Liabilities are shown with an inverted sign.

Table A6.5 The direct effects of changes in asset prices on household wealth

1 percentage point shock to asset prices: effect on household wealth in percentage points	Stock prices	Bond prices	House prices
- Financial wealth	0.235	0.078	..
- Housing wealth	..	..	1.000
- Total gross wealth	0.099	0.033	0.579
- Net worth	0.117	0.039	0.683

Source: Author's calculations.

Notes: The impacts are calculated on the basis of the shares of different asset and wealth components in households' total financial, gross and net worth. The computations do not take into account the possible effects of lower asset prices on the value of holdings in insurance technical reserves.

are markedly above and below or below and above their average historical levels respectively. The alternative paths for loans and other assets can then be computed following the same principles as in the previous case.

Similarly, the flow-of-funds matrix includes detailed information on the shares of individual asset categories in households' total financial and non-financial asset holdings. These data may be used to assess the combined or separate impacts of shocks to stock, bond and house prices on their net worth and debt/assets ratios (see Table A6.5).

Together with the estimated models for the financing of households, NFCs and financial corporations, the equations for household and NFCs' gross interest revenue and expenditure and the projection update elasticities also make it possible to quantify the effects of changes in short and long-term market interest rates on sectoral net transactions in assets and liabilities, as well as on sectoral net interest income and balance sheet positions (see Table A6.6).[64]

[64] See also Bê Duc and Le Breton (2009) for conducting this kind of scenario analysis based on the previous flow-of-funds projection framework.

Table A6.6 The direct impacts of changes in market interest rates on interest received and paid by households and NFCs

	Year 1	Year 2	Year 3
Households (percentage of gross disposable income)			
- interest received	0.5	0.5	0.5
- interest paid	0.3	0.3	0.3
- net interest received	0.2	0.3	0.3
NFCs (percentage of gross operating surplus)			
- interest received	0.6	0.6	0.6
- interest paid	1.7	1.9	1.9
- net interest paid	1.1	1.3	1.3

Source: Author's estimations.

Notes: The simulation results are based on the models used to project interest received and paid by households and NFCs. They have assumed both short and long-term market interest rates to be 100 basis points higher than in the baseline. The results do not take into account the effects of higher interest rates on household income and gross operating surplus or financial investment and financing of households and NFCs. The reported numbers are net of FISIM.

The final effects of the above-mentioned flow of funds-related scenarios on the real economy and prices as well as housing markets can be best evaluated with the DSGE and other structural macroeconometric models. Alternatively, if these kinds of tools are not available, the impacts may simply be assessed with the inverted elasticities of the loan equations and other possible models (including BVARs, FAVARs, SVARs and VARs) used in the projections.[65]

6 CONCLUSION

To sum up, this annex has presented the main features of the extended flow-of-funds projection system which has been in use at the ECB since the September 2008 macroeconomic projection exercise. It has also shown how the financial forecasts are produced technically and how their plausibility conditional on the projected macroeconomic developments and technical assumptions can be evaluated. The annex has also highlighted how the flow-of-funds projections can be used to identify and quantify possible risks stemming from the financial developments to the key macroeconomic variables and technical assumptions underlying the forecasts over the projection horizon. It has also shown how they may be employed for scenario analysis.

The development and enhancement of the new flow-of-funds projection framework is an ongoing task. Possible further refinements to the system could include replacing the currently used model for currency, short-term deposits and repos held by euro area money-holding sectors with the available sectoral money demand models used in the context of monetary analysis. One might also substitute the rule and judgemental-based approaches used to derive projections for unquoted shares and other equity issued by NFCs and financial corporations, mutual fund shares issued by financial corporations, and non-MFI loans to households and NFCs with time series models. Finally, the assets side modelling of the framework could be developed further, taking into account portfolio choice models.

REFERENCES

Altissimo, F., Georgiou, E., Sastre, T., Valderrama, M.T., Sterne, G., Stocker, M., Weth, M., Whelan, K. and Willman A. (2005), "Wealth and Asset Price Effects on Economic Activity", *Occasional Paper Series*, No 29, ECB.

Bê Duc, L. and Le Breton, G. (2009), "Flow-of-funds analysis at the ECB – framework and applications", *Occasional Paper Series*, No 105, ECB.

Beyer, A. (2009), "A stable model for euro area money demand: revisiting the role of wealth", *Working Paper Series*, No 1111, ECB.

65 See for instance Christoffel, Coenen and Warne (2008), Christiano, Motto and Rostagno (2007), Fagan, Henry and Mestre (2001), Slacalek (2009), Skudelny (2009), Altissimo et al. (2005).

Bondt, G. de (2002), “Euro area corporate debt securities market: first empirical evidence”, *Working Paper Series*, No 164, ECB.

Calza, A., Gerdesmeier, D. and Levy, J. (2001), “Euro area M3: measuring the opportunity costs appropriately”, *Working Paper Series*, No 01/179, IMF.

Calza, A., Manrique, M. and Sousa, J. (2003), “Aggregate loans to the euro area private sector”, *Working Paper Series*, No 202, ECB.

Christiano, L., Motto, R. and Rostagno, M. (2007), “Shocks, structures or monetary policies? The euro area and US after 2001”, *Working Paper Series*, No 774, ECB.

Christoffel, K., Coenen, G. and Warne, A. (2008), “The New Area-Wide Model of the euro area: a micro-founded open-economy model for forecasting and policy analysis”, *Working Paper Series*, No 944, ECB.

De Santis, R.A., Favero, C. A. and Roffia, B. (2008), “Euro area money demand and international portfolio allocation: a contribution to assessing risks to price stability”, *Working Paper Series*, No 926, ECB.

ECB (2007), “Long-term developments in MFI loans to households in the euro area: main patterns and determinants”, *Monthly Bulletin*, October, pp. 69-84.

ECB (2006a), “Estimates of the euro area capital stock”, *Monthly Bulletin*, May, pp. 45-47.

ECB (2006b), “Estimates of housing wealth for households in the euro area”, *Monthly Bulletin*, December, pp. 47-49.

ECB (2001), “A guide to Eurosystem staff macroeconomic projection exercises”, June.

Fagan, G., Henry, J. and Mestre, R. (2001), “An area-wide model (AWM) for the euro area”, *Working Paper Series*, No 42, ECB.

Kok Sørensen, K., Marqués-Ibáñez, D. and Rossi, C. (2009), “Modelling loans to non-financial corporations in the euro area”, *Working Paper Series*, No 989, ECB.

Skudelny, F. (2009), “Euro area private consumption: is there a role for housing wealth effects”, *Working Paper Series*, No 1057, ECB.

Slacalek, J. (2009), “What drives personal consumption? The role of housing and financial wealth”, *Working Paper Series*, No 1117, ECB.

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