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1. INTRODUCTION

The ECB has still not decided which monetary policy strategy to pursue from 1999. However, the preparatory work has reduced the possible alternatives to two: a strategy of intermediate objectives fixed in terms of the quantity of money and a direct inflation targeting strategy. It would be also possible to apply a strategy combining elements of both.

In accordance with the basic documents drawn up by the EMI to analyze the single monetary policy, the effectiveness of a strategy based on an intermediate target depends greatly, first, on whether there is a stable (or at least predictable) relationship between the chosen monetary aggregate and the final objective; and second, **"on whether the targeted monetary aggregate is controllable by the central bank through the use of monetary policy instruments"**[(1)].

Most of the studies conducted on these matters in the EMI have focused on examining the stability of a monetary aggregate at the European level[(2)]. On the contrary, the question of the controllability of the intermediate objective by means of monetary policy instruments has received less attention[(3)].

Evidently, however, if finally a strategy is chosen where a monetary aggregate is set as the intermediate objective, it is necessary that the ECB should have the capacity to influence the money stock. Faced with deviations by the demand for money in respect of the target set, the ECB shall assess the possible causes behind such differences and decide whether they can be accommodated or,

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[(1)] See European Monetary Institute 1993 and 1997.

[(2)] See, in this respect, Fagan and Henry, 1996, 1997a and 1997b.

[(3)] Other studies addressing the issue of the controllability of a monetary aggregate in Stage Three are Browne, Fagan and Henry (1996) and more recently Viaar and Schubert (1998). These papers yield contrasting results regarding this issue.

on the contrary, whether they should be corrected. In this second case, the use of monetary policy instruments should allow the deviations recorded to be reduced in a relatively short period. In this sense, controllability requires that the ECB should be able effectively to influence the monetary aggregate in the **short term**. It does not suffice, therefore, for the ECB to have means for steering the money stock in the medium and long term; control must be exerted in a relatively **immediate** fashion.

The absence of appropriate controllability of the intermediate objective by the ECB would detract from the consideration of a monetary aggregate as an objective of monetary policy. Also, monetary management would become more confused, as agents would not know whether the deviations between the actual course of the monetary aggregate and its target path were the result of an accommodating policy by the ECB or of the impossibility of controlling the aggregate in the short term. Finally, this would all harm the credibility of the ECB and of the common monetary policy, because the formally announced objectives could fail to be met without the ECB being able to do anything to avoid it[4].

This paper analyses the possibilities for the ECB effectively to control the course of a monetary aggregate representative of liquidity in EMU. Such controllability is especially necessary if the ECB decides to apply a strategy monitoring an objective in terms of a monetary aggregate. Section 2 revises the mechanisms through which monetary policy can control the money stock. Section 3 examines the empirical properties of the demand for money in EMU and in a country, such as Germany, which continues to set objectives in terms of a monetary aggregate. Section 4 shows the differential effects arising from implementing a common monetary policy in EMU11 compared with those that would ensue were there a degree of control of the monetary magnitudes such as that in Germany. The conclusions of the paper are drawn in section 5. At the end of the document, two annexes are presented explaining some of the methodological, technical and econometric aspects used in the paper.

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[4] In this sense, the ECB's evident lack of a track record implies that agents might not be as benign as they are towards other NCBs that have pursued successful anti-inflationary policies if, early into EMU, the monetary objectives set are not met.

2. CONTROLLABILITY IN THE OPERATIONAL AND FINANCIAL FRAMEWORK OF EMU

The controllability of an intermediate monetary objective consists of the capacity that a central bank has to influence its course. A variable would be controllable if the central bank could know with reasonable **certainty** how to use the instruments within its reach to achieve a change in such a variable in the direction and of the intensity desired.

The instruments available to the central bank are closely linked to the design of the monetary policy operational framework. Under arrangements such as those for EMU, where the common monetary policy operational objective is a very short-term interest rate, modifying short-term financial conditions will be the main instrument the ECB could use to control the money stock[5]. Hence the influence monetary policy exerts on the demand for money will be channelled through the transmission from short-term interest rates in the money markets to the interest rates on financial instruments with other terms and in other markets. This transmission will alter the remuneration on the financial instruments included in the definition of the targeted monetary aggregate and that on those not included therein. Insofar as liquid assets are not remunerated or are less sensitive than other assets to changes in money market interest rates, the effect of monetary policy measures will induce shifts in liquid assets toward other assets, thereby contracting the demand for money.

Evidently, there are other mechanisms through which changes in short-term interest rates can influence in the money stock. Thus, changes in interest rates affect agents' incentives to save and to spend, the demand for credit and, in sum, nominal expenditure in the economy, whereby they also change the demand for liquid assets to finance transactions. Changes in interest rates can also generate income and wealth effects which ultimately result in changes in the demand for money.

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[5] Under a traditional monetary policy framework, based on the control of the supply of bank reserves, the central bank would analyze how the monetary multiplier influences changes in the money stock.

However, this second channel is much slower than the first one, since its effects are more indirect and also more complex. Accordingly, it is very difficult to analyze it empirically[6]. Contrary to the monetary policy effect on the demand for financial assets, which can be relatively quick, the magnitude and the speed of adjustment with which changes in short-term interest rates affect expenditure in the economy will depend on the characteristics of their financial structure (volume and term of credit granted to households and firms, adaptability of interest rates, indebtedness of non-financial sectors, volume and financing of the public deficit) and on price and wage-setting mechanisms. In short, there is a combination of structural and institutional factors of the economy which, as different studies show, mean that the transmission of monetary policy impulses to the final variables of the economy differs as much in speed as in power[7].

Compared with this combined analysis of the different links between interest rates and money, this paper will focus on analysing the controllability of the money stock in terms of a demand equation. Here the main channel of transmission of interest rates to the monetary aggregate is well defined and controllability is clearer, in the sense that the central bank can know with reasonable certainty what the impact of its decisions will be on the money stock in the short term[8]. Therefore, an examination is made of the capacity the ECB will have to control a monetary aggregate in terms of how monetary policy will affect the interest rates on liquid and illiquid assets[9].

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[6] An attempt to perform a general analysis of the transmission mechanism between interest rates and the money stock is made in Browne, Fagan and Henry (1996) and Viaar and Schubert (1998) via a VAR methodology.

[7] See Gerlach and Smets (1994 and 1995) and Kennedy (1996).

[8] Admittedly, this type of analysis has also become more complex as a result of intense liberalisation and financial innovation in recent years. The return offered on certain liquid assets has increased and, on occasions, said return is linked to the course of money market interest rates. In terms of the analysis of the demand for money, this new financial context means that the transmission of interest rates to money demand may manifest some perverse effect, boosting the demand for money in the face of monetary policy tightening.

[9] The analysis to be carried out will, it is true, be a partial equilibrium analysis in which the medium-term interaction between interest rates and nominal expenditure will not be taken into account. However, since controllability

The capacity of a central bank to control a specific monetary aggregate may be limited by other factors mentioned below, but which are not the subject of this paper. Firstly, it seems that the basis underpinning the choice of a target monetary aggregate is, essentially, that it should show an appropriate degree of stability in relation to final variables, such as nominal expenditure. However, that stability relationship may require the target aggregate to be relatively broad and to include assets that are not fully liquid or are remunerated at market rates. In this sense, as mentioned in the MPSC document cited in the introduction, it may well be that the "closer the link between the final target and the intermediate variable, the less that variable may turn out to be controllable by monetary instruments." Secondly, controllability is affected by Goodhart's law according to which "as soon as the authorities try to exploit an economic relationship to achieve their objectives, agents tend to modify their behaviour so as to circumvent the implications of the authorities' actions, thereby undermining the stability of the relationship."

At a time when the monetary policy strategy to be applied by the ECB from 1999 is under discussion, it is highly relevant to analyze in detail the extent to which a targeted monetary aggregate may be effectively controlled by the ECB. To do this, an analysis follows of the properties of the money demand equations that may be considered for the group of countries that will form EMU.

3. SPECIFICATION OF THE DEMAND FOR MONEY: COMPARISON OF THE RESULTS FOR THE EMU AREA AND GERMANY

This paper sets out to analyze the controllability of the money stock, examining how the central bank can directly affect the demand for money by means of the use of short-term interest rates as instruments. In fact, among the traditional determinants of the demand for money are, besides prices and nominal income, the level of interest rates, either broadly speaking or distinguishing between short-term and long-term rates. Specifically, a money demand equation for EMU11 and for Germany will be specified, with the aim of

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requires that monetary policy should influence money in the short term and, where appropriate, correct deviations by the monetary aggregate from its target path, this shortcoming may not be so relevant.

analysing the possible differences between the degree of controllability in the respective areas. The reason for using Germany as a reference in this analysis lies in the fact that the Bundesbank is one of the few central banks that continues to pursue a monetary policy framework based on an intermediate monetary target, and in that the relationship between the demand for money and the final targets in Germany is the one that has been cited to defend a similar framework in EMU11.

As discussed in the previous section, there is broad consensus that a central bank can only make a monetary aggregate an intermediate target of monetary policy if it shows sufficient stability and controllability. The stability of the relationship between the monetary aggregate and nominal expenditure is necessary so that the central bank may be convinced that the course of money is actually anticipating what the cyclical situation of the economy so that the monitoring and control of the money stock is a sound mechanism for stabilising economic activity. The positive results obtained in former analyses of the stability of the money demand equation have served to advocate a strategy of intermediate targets in EMU11.

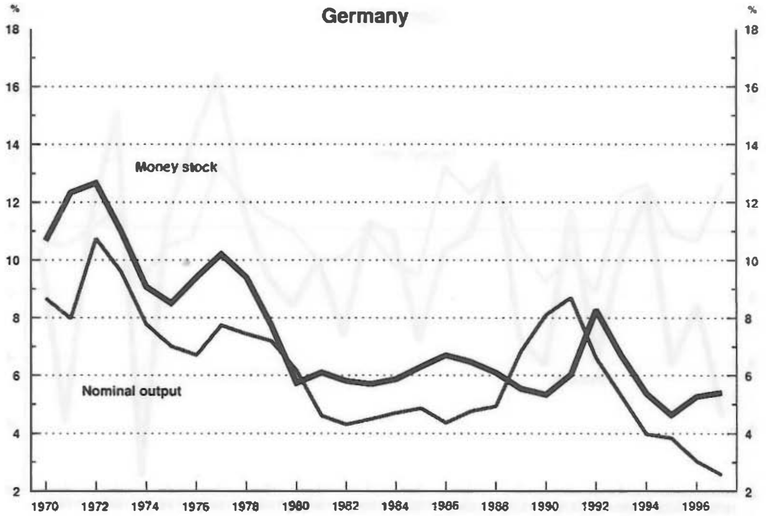
In EMU11, the analyses performed point to the fact that the demand for money remains significantly stable in its relationship to nominal expenditure. A simple graphical analysis may illustrate this result. In Chart 1, developments are presented in terms of the annual growth of nominal expenditure and money, represented by the definition of a broad aggregate (M3) both for Germany and for EMU11 as a whole. Over an extensive time perspective, the relatively close course followed by the monetary variables and nominal output over the past thirty years is apparent. The course of these two variables is particularly striking in the case of EMU11. The relationship shown by the charts is confirmed by means of statistical tests both for EMU11 and for Germany that highlight the existence of a cointegration relationship between both variables and unit elasticity between nominal income and the money stock (see annex 1).

Yet a differentiating aspect between both areas is how interest rates affect the demand for money in each case. Chart 2 plots long-term interest rates along with the annual growth of the velocity of circulation for Germany and for EMU11. It can be seen that the path of long-term rates is very similar in both areas. However, it seems that interest-rate upward or downward movements are

Chart 1

MONEY STOCK AND NOMINAL OUTPUT

Annual growth rate. Three-year moving average



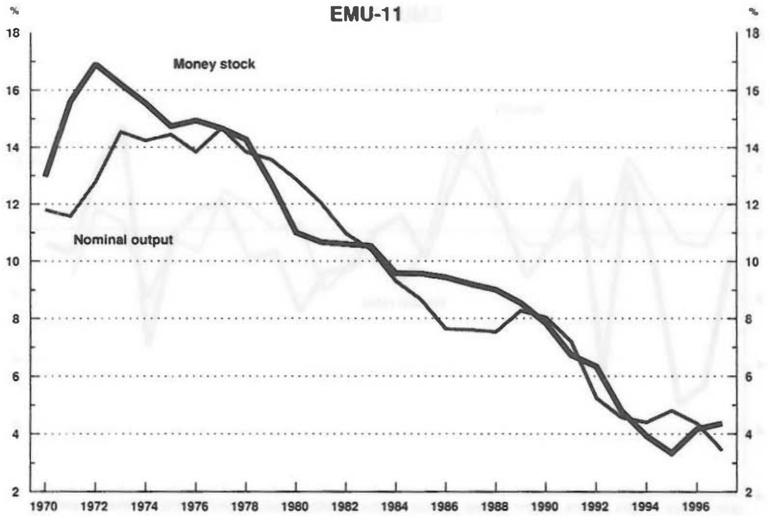
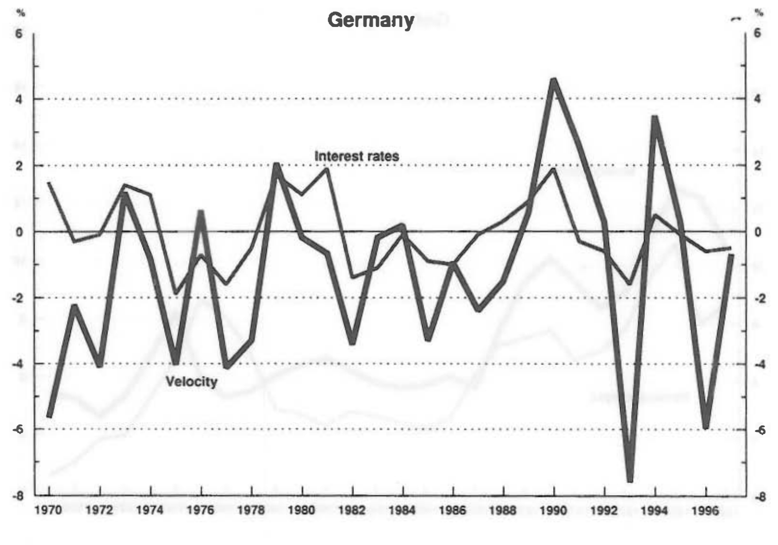
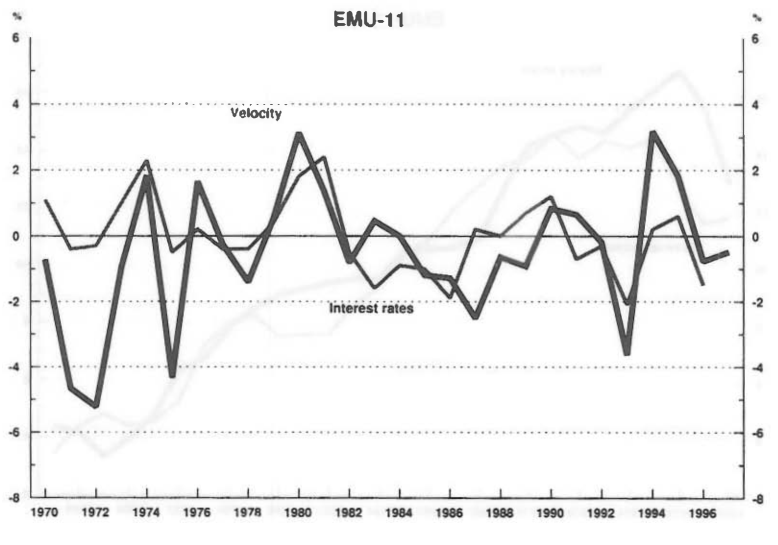


Chart 2

VELOCITY OF CIRCULATION AND INTEREST RATES

Annual growth rate





associated with wider-ranging movements in the velocity of circulation in Germany than in EMU11, i.e. with more abrupt changes and of the opposite sign in the demand for money.

The reason for this might be that in Germany there is a wide spread between interest rates on liquid assets (very low or zero) and those on non-monetary assets. In this respect, the potential perverse effect arising because greater monetary tightness may encourage the demand for remunerated liquid assets is not very significant in the German case. On the contrary, in most of the other EU countries, financial innovation in the late seventies prompted considerable changes in their financial systems that affected most particularly the traditional considerations of profitability, risk and liquidity that marked the dividing line between monetary and other assets. In these countries, a significant portion of liquid assets has a remuneration linked to that of short-term interest rates, which tends to generate a short-term perverse effect on the demand for money following a change in the monetary policy stance.

One may argue that the existence of not fully remunerated minimum reserves in Germany during most of the period analyzed might explain the higher sensitivity of money demand in Germany to changes in interest rates. In this respect, it should be highlighted that, whereas the difference between the own return on the broad money stock and money market rates (the so-called "wedge") actually has a significant impact on the growth of the money stock, it is observed that the tax imposed by the reserve requirement system exerts little influence on the pattern of the wedge itself. Even non-remunerated minimum reserves of a certain magnitude only affect the growth of money demand very modestly. Moreover, some of the countries in EMU11, such as Italy or Spain, have actually implemented during the last two decades minimum reserve systems more exacting for credit institutions than the one established in Germany. Therefore, it seems that other features of the structure of the financial system are more likely to be at the core of the different relationship between money and interest rates in Germany and EMU11.

3.1 Specification of the money demand equations

After testing that a cointegration relationship and unit elasticity between M3 and nominal GDP holds, annex 1 estimates several specifications of money demand equations expressed in terms of the inverse of the velocity of circulation, where the alternative interest rate is included as an endogenous variable in the determination of the long-term relationship[10][11]. In this regard, the specification showing the best statistical properties is that only including the long-term interest rate. However, the latter, in turn, is a function of the short-term rate[12]. Consequently, the effect of the long-term rate on the money demand equation is implicitly including the effect of the short-term rate, which is that on which the monetary authority directly acts.

The results of the estimates of the demand equations highlight that both areas show very similar behaviour in the long run as regards their relationship to nominal expenditure. However, the differentiating effect between both equations is determined by the **sensitivity of the velocity of circulation to interest rates**. In connection with this latter point, it is estimated that the semi-elasticity of M3 to the long-term interest rate for Germany is 5.3 compared with the estimated elasticity for EMU11 of 0.9. That is to say, the response of the interest rate to the demand for money is, in Germany, around five times higher than in EMU11. This ratifies the observations put forward in the light of Chart 2.

In relation to the dynamics of the adjustment process, Chart 3a depicts the accumulated response function of the money stock to changes in interest rates, in terms of semi-elasticities, obtained directly from the estimation of the velocity equation. In EMU11, the dominant effect in the whole adjustment process is basically contemporaneous while, in Germany the overall impact of interest rates on M3 tends to distribute over time. The difference between both response

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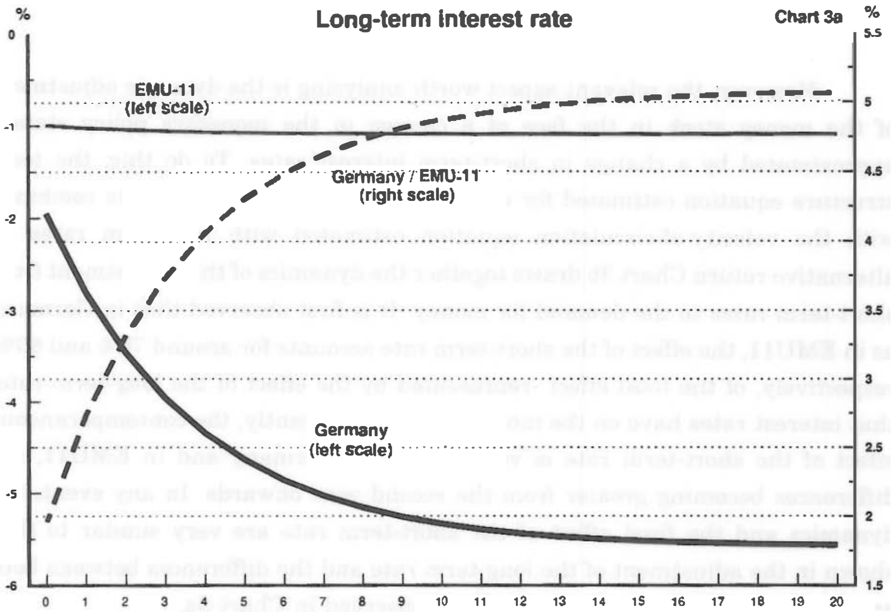
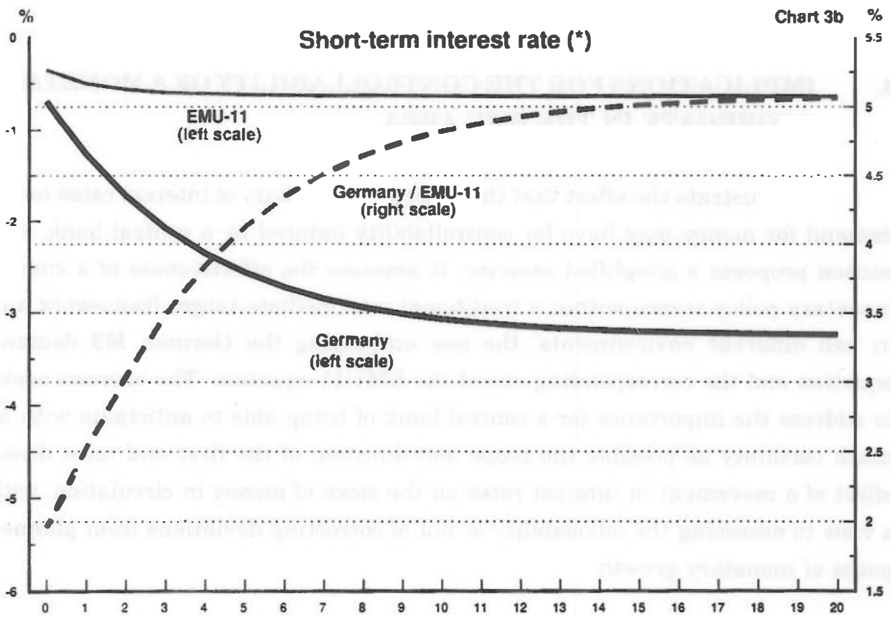
(10) A more complex specification including the own return on liquid assets, together with the long-term interest rate, has not been considered due to the lack of reliable information.

(11) The sample period spans the period from 1970 to 1997 with annual frequency.

(12) The reason for this choice is justified in annex 1, while annex 2 estimates an interest-rate equation in which the structure of the pass-through from the short- to the long-term rate prevailing in both areas is determined. These results are later used to estimate the dynamics of the response of the short-term rate to the demand for money and in the controllability simulation exercise proposed in paragraph 4.

MONEY DEMAND
CUMULATIVE RESPONSE FUNCTION





(*) Calculated on the basis of equations modeled on structure of long-term interest rates as a function of short-term rates.

functions shows that, in the short run, the elasticity of the long-term interest rate in Germany is twice that in EMU11, while in the long run, the effect is ultimately five times greater.

However, the relevant aspect worth analysing is the dynamic adjustment of the money stock in the face of a change in the monetary policy stance, approximated by a change in short-term interest rates. To do this, the term structure equation estimated for each area (presented in annex 2) is combined with the velocity-of-circulation equation estimated with long-term rates as alternative return Chart 3b draws together the dynamics of this adjustment from short-term rates to the demand for money. It is first observed that in Germany as in EMU11, the effect of the short-term rate accounts for around 70% and 60%, respectively, of the total effect -represented by the effect of the long-term rate- that interest rates have on the money stock. Significantly, the contemporaneous effect of the short-term rate is very similar in Germany and in EMU11, the differences becoming greater from the second year onwards. In any event, the dynamics and the final effect of the short-term rate are very similar to that shown in the adjustment of the long-term rate and the differences between both areas maintain the same relationship as observed in Chart 3a.

4. IMPLICATIONS FOR THE CONTROLLABILITY OF A MONETARY AGGREGATE IN THE EMU AREA

To illustrate the effect that the different sensitivity of interest rates to the demand for money may have for controllability induced by a central bank, this section proposes a simplified exercise. It assesses the effectiveness of a change monetary policy stance within a traditional intermediate-target framework and in two different environments: the one underlying the German M3 demand equation and the corresponding one of the EMU11 equation. The exercise seeks to address the importance for a central bank of being able to anticipate with as much certainty as possible the scope and duration of the first and most direct effect of a movement in interest rates on the stock of money in circulation, with a view to assessing the advisability or not of correcting deviations from planned paths of monetary growth.

Two kinds of exercise are performed, on the basis of the estimated velocity and interest-rate equations. The first compares the monetary expansion paths for the two areas, Germany and EMU11, implementing a common interest rate scenario. The second attempts to assess the speed of return and change in interest rates there must be to resume a planned path of monetary expansion in the medium term, in the presence of a positive liquidity shock. Both simulations are post-sample, on a period running from 1999 until the year 2008.

The main results of the exercise can be summarised as follows:

- As expected, the projected monetary expansion path, given a common interest-rate scenario, shows a greater range of movements in Germany than in EMU11, with a gap of over one point opening up between both paths in terms of annual growth during the simulation period.

- In the face of a monetary shock of the same magnitude in both areas and implementing identical monetary policy tightness, the projected monetary growth path would resume in two years in Germany. In the case of EMU11 it would be necessary to prolong a restrictive rates path up to four years to recover the projected level.

- In terms of magnitude, if in EMU11 it were wished to return to the projected monetary growth path in the some time span as in Germany (two years), it would be necessary to double the degree of tightness of monetary policy.

4.1 Establishing the interest rate path

Prior to determining these simulation exercises, it is needed to establish the interest-rate scenario most attuned to the economic cycle. This means establishing a short-term interest-rate scenario that passes its structure through to long-term rates. The projection of this short- and long-term rate path running from 1999 to the year 2008 is common to the two areas, and is underpinned by the convergence in interest rates in the euro area that will take place at the end of 1998.

In this respect, Chart 4a shows short-term interest rates in Germany from 1968 to 1997. A fairly regular cyclical pattern is observed; the average length of a complete interest-rate cycle in Germany is around 10 years. The width of the cycles oscillates between 6 and 8 points. In the light of the chart, it can be assumed that between 1997 and 1998 the latest cycle of short-term interest rates concludes and that, starting from 1998, a new cycle begins, extending over ten years. This extrapolation of the short-term interest-rate cycle is also applied to the EMU11 area.

Specifically, for 1998, considering an economic scenario with real GDP growth of 2.5%, price growth of 1.5% and monetary growth of 4%, short-term interest rates stand at 3.3%. As from this year, a period of rising interest rates begins that runs for 4 years, with rises of the order of 1.5 points per year, until peaking (9.3%) in the year 2002. Thereafter, there is a progressive reduction, of 1 point per year, until resuming a level of 3.3% in the year 2008 (once again, see Chart 4a)[13].

To obtain the long-term path of interest rates derived from the cycle of short-term rates, two alternative methodologies (discussed in detail in annex 2) are considered. First, there is the estimation, as mentioned previously, of a term-structure equation establishing the link between the short- and long-term rate (the "backward looking" method)[14]. This method places most emphasis on the historical course of long- and short-term interest rates. The alternative is a "forward-looking" method, which makes long-term rates dependent on expected

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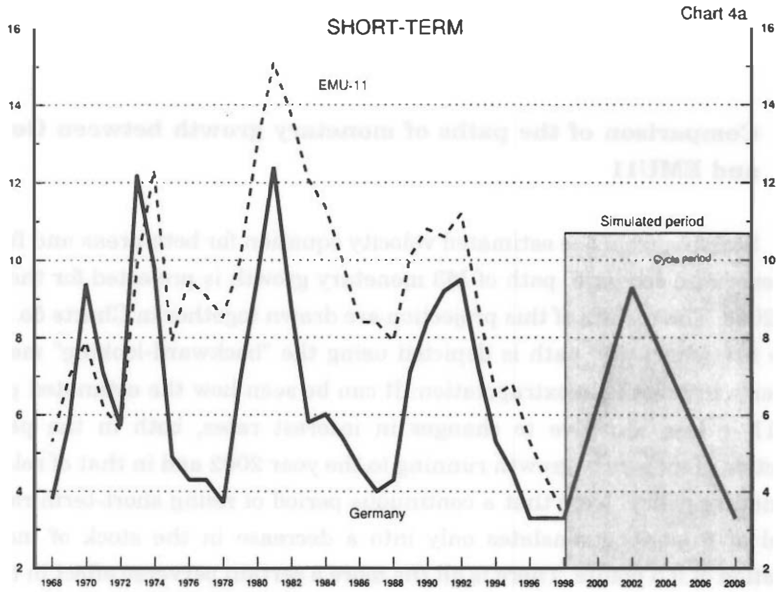
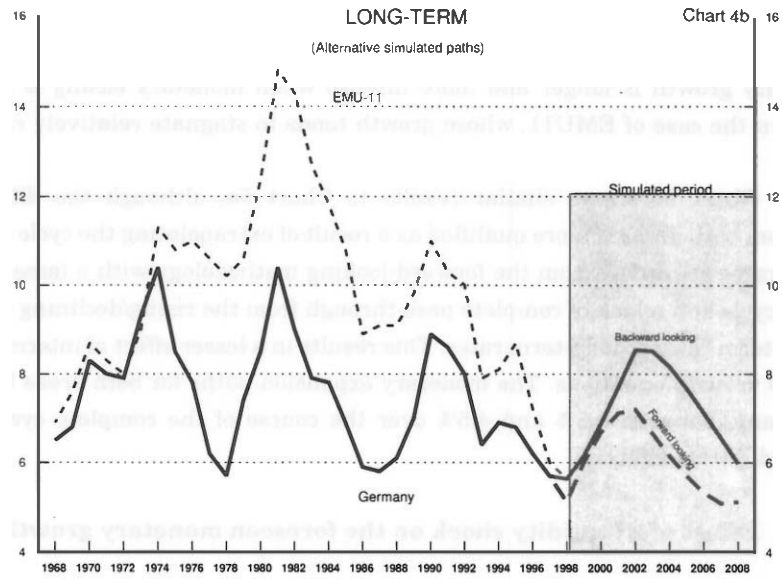
[13] The interest-rate cycle estimated for the initial years of EMU might seem to be too ample if non-inflationary growth persist and the Stability Pact actually contributes to a more balanced policy-mix. However, it is very difficult to envisage a scenario of ECB's interest rates other than that reflecting the past Bundesbank behaviour.

[14] Estimated equations of term-structure of interest rates for both, Germany and EMU11, can be found in the mentioned annex 2. As it is apparent from chart 4, the pattern of EMU11 interest-rates tends to converge over time towards the German one. This fact, together with the expectation that the behaviour of long-term interest-rates in EMU will be closer to the German pattern, rather than to the historical behaviour of EMU11 interest-rates, justify the choice of estimates for Germany to extrapolate the EMU11 path of interest-rates after 1999 based on a "backward-looking method".

INTEREST RATES





future short-term rates. The shaded area of Charts 4a and 4b shows the projected paths of rates for the simulation period in question.

4.2 Comparison of the paths of monetary growth between Germany and EMU11

Starting from the estimated velocity equation for both areas and from the long-term rate scenario, path of M3 monetary growth is projected for the period 1999-2008. The results of this projection are drawn together in Charts 5a and 5b. In the first chart, the path is depicted using the "backward-looking" method of long-term interest-rate extrapolation. It can be seen how the estimated path for EMU11 is less sensitive to changes in interest rates, both in the period of restriction of monetary growth running to the year 2002 and in that of relaxation of monetary policy. Note that a continuous period of rising short-term rates, for a total of 6 points, translates only into a decrease in the stock of money in circulation of 0.5 points. There is all the more a certain perverse effect in the first year following the monetary tightening. The response of the demand for liquidity in Germany to the same structure of rates is much more marked, decreasing the money stock by 1.5 points. Likewise, in Germany, the process of recovery of liquidity growth is longer and more intense when monetary easing is applied than in the case of EMU11, whose growth tends to stagnate relatively rapidly.

Chart 5b shows similar results to Chart 5a, although the difference between both areas is more qualified as a result of extrapolating the cycle of long-term rates stemming from the forward-looking methodology with a lesser width of its cycle and a lack of complete pass-through from the rising/declining cycle of short-term rates to long-term rates. This results in a lesser effect of interest rates on the velocity equations. The monetary expansion paths for both areas hold, in Germany, between 3.5% and 4.5% over the course of the complete cycle, and around 4% for EMU11.

4.3 Effect of a liquidity shock on the foreseen monetary growth path.

The second simulation exercise aims at assessing the differences in the response of monetary growth to interest rates given an undesired monetary surprise. An analysis has thus been made of what the intensity and the speed of

SIMULATION OF MONEY DEMAND PATH: 1999 - 2008

Chart 5a

Annual rate of growth

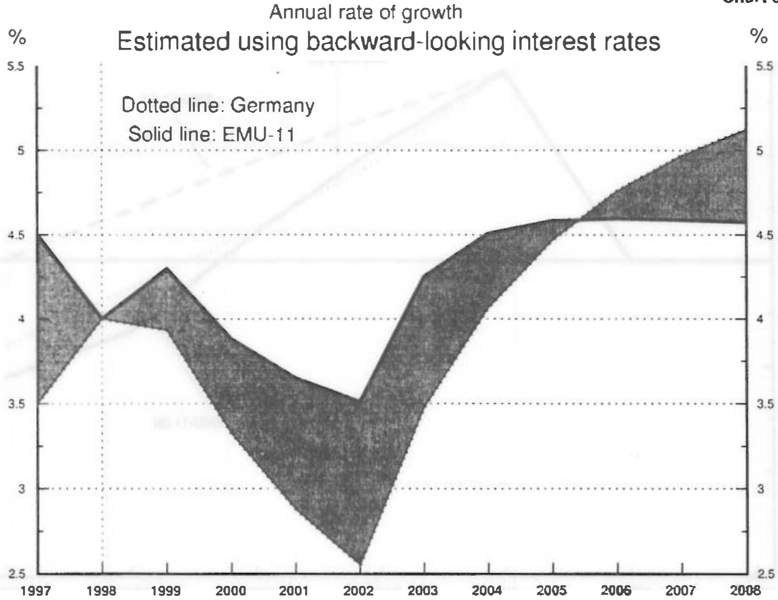


Chart 5b

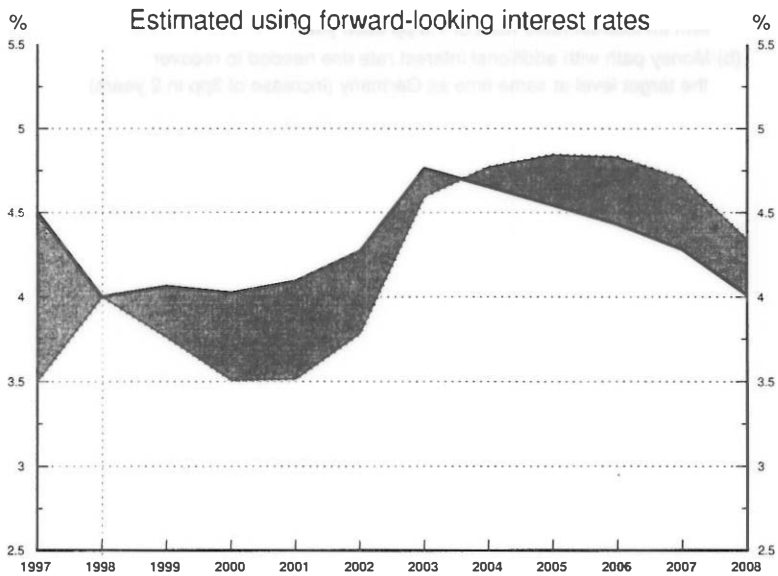
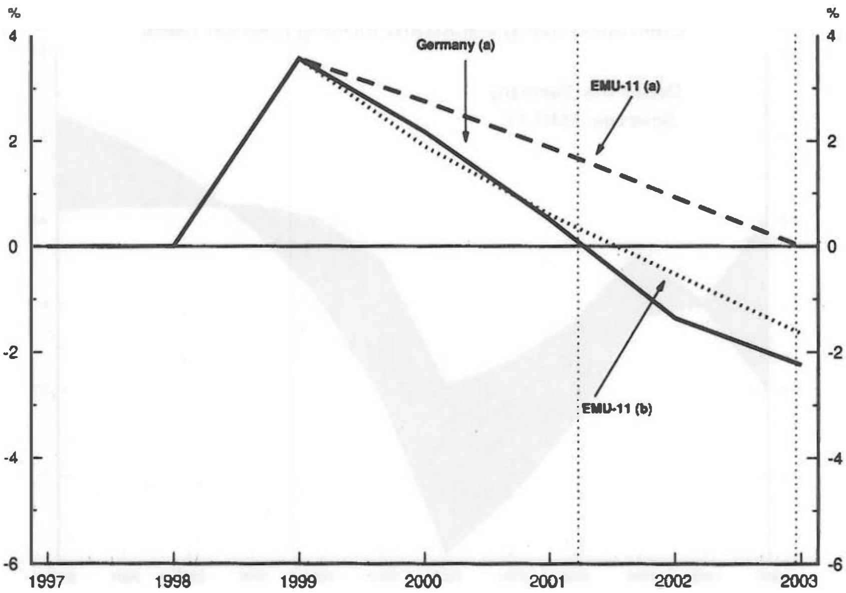


Chart 6

Deviations by monetary target level after monetary shock in 1999 (*)



(*) Assumed monetary growth target around period is 4%. 1999 money growth is 8%

(a) Years needed to recover level of monetary target with an interest rates rises of 1.5 pp each year

(b) Money path with additional interest rate rise needed to recover the target level at same time as Germany (increase of 3pp in 2 years) return to a path of sustained M3 growth of 4% would be if, at the beginning of the period of simulation, for example 1999, a positive monetary shock placed liquidity growth at 8%[15]. Further, the responses by the German and EMU11 equations are compared when faced with an identical monetary policy restriction to resume the aforementioned sustained path of 4%[16]. Concretely, to counter the effect of the expansionary liquidity shock, a restrictive monetary policy is implemented. This involves increasing interest rates by 1.5 points per year from 1999 until neutralising the unwanted effect.

Chart 6 shows the various estimated paths of return. It can be seen how in Germany the application of interest rate rises offsets in two years the deviation of 4 points caused by the 1999 shock. However, in the case of EMU11, this restrictive monetary policy has to be prolonged until the year 2003, with a rise in short-term rates of 6 points having to be applied. If the monetary authority of EMU11 decided to neutralise this effect in two years, it would have to double the intensity of its restrictive monetary policy, applying an increase of 3 points in each year (6 points in total), compared with the 1.5 point rise in each of the two years needed by the German monetary authority.

5. CONCLUSIONS

This paper shows that it is very likely that the controllability of the money stock in EMU be poorer than that prevailing in Germany, so that the ECB, if finally decides to pursue a monetary strategy based on an intermediate monetary aggregate, may face severe problems to counter liquidity shocks bringing money outside the targeted band.

The type of partial-equilibrium quantitative exercise supporting this argument has shown, over an extensive sample period, that stability in the

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(15) As equations are defined in terms of velocity both for Germany and EMU11 and dynamics do not differ significantly, hypothesis regarding nominal growth of GDP are not relevant for the outcome of this exercise.

(16) The annual average monetary growth rate of 4% is considered compatible with the interest-rate scenario proposed in this paper, and with the scenario, common to both areas, of the nominal expenditure growth projected for 1998 and extrapolated for the whole of the simulation period: price growth of 1.5% and real GDP growth of 2.5%.

relationship between the money stock and the economy's final variables are a necessary but insufficient condition for ensuring the controllability of an aggregate. The composition of a monetary aggregate must be such that its return and liquidity conditions provide a rapid, intense channel of transmission from the monetary control instrument to the intermediate target. In this respect, it has been seen how, defining money demand for the EMU11 area, the intensity and time of response to changes in interest rates are appreciably less and more extensive over time than those arising in the case of Germany, which has traditionally pursued an intermediate-target strategy.

The German minimum reserve system does not seem to be at the basis of the different sensitivity of money to interest rate changes as compared to EMU11. It is the different structure of the German financial system as compared to that of other European countries what seems to be the best explanation for the stronger ability of the Bundesbank to exert a certain control on monetary targets. However, the ECB will have to cope with a financial structure which unfortunately will probably not allow it to control money demand with the same effectiveness.

Annex 1. Econometric specification and results on money demand

This annex discusses econometric aspects of the money demand equations specified for Germany and for the EMU11 group and presents the results of the estimates.

a.1.1 Variables used in the analysis

The source of statistical information used in the econometric exercise is the April 20 1998 edition of **Statistical Annex of European Economy** (SAEE). The frequency of the data used in the analysis is yearly. The definition of the variables is as follows.

m: Log of nominal stock of money (M3). Approximated as an index number with base 1961=100. Transformation of annual growth rates (year-end). (Table 50 of SAEE)

p: Log of deflator of gross domestic product at market prices. Approximated as an index number with base 1961=100. Transformation of annual growth rates. (Table 24 of SAEE)

yn: Log of nominal GDP approximated by an index number with base 1961=100. Transformation of annual growth rates (year-end). (Table 7 of SAEE)

y: Real GDP (**yn** - **p**).

rs: Nominal short-term interest rate (table 51 of SAEE)

rl: Nominal long-term interest rate (table 52 of SAEE)

sp: Interest rate spread (**rl** - **rs**)

A.1.2 Justification of the methodology

The methodological approach involved the estimation by non-linear OLS using Hendry's methodology. The reason for this approach as opposed to other alternatives such as, for example, the estimation of a VAR-ECM model where joint consideration is made of all (direct and indirect) transmission channels between the money stock and interest rates, is determined by the very motivation of the paper.

Estimating a single behaviour equation allows for a focus on the phenomenon of controllability, placing the emphasis on the estimation of the direct channel of transmission from interest rates to the money stock[(1)]. This effect is defended in the main text as the main way of evaluating controllability by a central bank. In relation to quantitative aspects, this channel is characterised by the fact that it is estimated and analysed with greater certainty than other indirect channels with potential feedback effects and which, therefore, may be estimated with a greater degree of uncertainty.

A.1.3 Cointegration test between nominal expenditure and the money stock

The close relationship seen in Chart 1 of the main text between nominal expenditure and the nominal stock of money, both for Germany and EMU11, leads, in an initial stage of the exercise, to a test of cointegration between both variables. The procedure used is the error-correction mechanism (ECM), testing significance according to the approach of Banerjee et al (1993).

Table a.1 presents the results of the test made for the sample period 1970-1997. Moreover, the test does not reject the existence of a cointegration vector [1 -1], i.e. the existence of unit elasticity of nominal expenditure, both in Germany and EMU11, cannot be rejected.

[(1)] Other estimates of demand for money for EMU countries can be found for example in Monticelli and Strauss-Kahn (1992). Fase (1998) presents a number of specifications and estimates of money-demand equations for various aggregations of European countries. A vast bibliography on this issue can also be found in this book.

table a1.1

Cointegration test of nominal expenditure $\Delta(m)_t = c_t + \alpha(m - \beta yn)_{t-1} + \gamma\Delta m_{t-1} + \delta\Delta yn_t$ **Sample period: 1970 1997 (27 observations)** **Estimation: non-linear least squares**(1)		
	GERMANY	**EMU-11**
β	1.07 (21.7)	0.94 (13.04)
SSR	0.57	0.92
F	10.5	97
σ*100	1.9	1.1
DW	1.9	2.3
ECM(1)(2)	5.2**	5.3**
ECM(1)(2) **with β=1**	4.95**	4.6**

(1) In brackets: t-student statistic.

(2) ECM: t-ratio test of the coefficient of the error-correction mechanism. (Critical value: tables of Banerjee et al. pg 43).

** H_0 rejected at 1% significance level (cointegration accepted).

* H_0 rejected at 5% significance level (cointegration accepted)

These results allow to estimate the money demand equation in terms of velocity of circulation. Thus, the endogenous variable is the inverse of the velocity of circulation of money, with the interest rate being the determining argument in the long-run equation.

A.1.4 Specification and estimation of the velocity-of-circulation equation

Specification of the money demand equation for Germany and EMU11 is as follows:

$$\Delta(m-p-y)_t = c_t + \alpha((m-p-y) - \beta r)_{t-1} + \gamma_t \Delta y_t + \delta \Delta r_t + \rho sp_t \quad (1.1)$$

In connection with this specification, the consideration of interest rates in the velocity equation is briefly discussed below.

In the description of equation 1.1, only one interest rate is made explicit. Specifically, the alternative rate is considered as the sole argument. The reason for obviating any consideration of an own rate is because of the particular features of this rate in each country, depending on the assets making up its definition of money. In this respect, in Germany, the incidence these assets may have on the demand for money would be very limited as the return on monetary assets is very low. However, in EMU11 the own rate mirrors the fact that a significant portion of assets yielding a remuneration close to market rates is included in the definition of M3. However, the consideration of this effect, with its own dynamics, might exert some perverse effect on the estimation. In any event, a technical impossibility exists, as there is no statistical information to elaborate a synthetic interest rate for the EMU area that would reflect the effect of own dynamics in determining the money stock. Finally, a strict definition of the own rate should be weighted by the zero-rate remunerated currency stock. In the case of Germany, for example, this accounts for a significant percentage of its total monetary assets.

The aim of the econometric exercise is to establish a specification of the long-run relationship in terms of the alternative rate. Table A.2 presents the results of the estimations on three approaches: long-term interest rates, short-term rates and, finally, long-term rates with the slope of the yield curve (defined as long-term minus short-term).

The results with the long-term rate are appreciably better than those with the short-term rate. In this regard, it should be pointed out that, although in determining the degree of controllability the relevant channel is that leading from the short-term rate -on which the monetary authority can exert a direct influence- to the monetary aggregate, the most appropriate transmission tool in this channel is the long-term rate, which approximates the return on most of the non-monetary assets[2].

Also, the term structure of short-term interest rates determines the level of the long-term rate. This implicit relationship implies a functional relationship as follows:

$$r_a \approx r_l = f(r_s) \qquad \textbf{(1.2)}$$

where r_a represents the alternative rate, r_l is the long-term rate and r_s the short-term rate.

This functional relationship allows the rates structure to be estimated independently of the money demand equation, in whose specification only the long-term rate would enter as an argument (see table a1.2)[3] [4].

Concretely, the most satisfactory specification is that which considers the long-term rate as an alternative rate. This specification is the basis for the various simulation exercises presented in this paper to evaluate controllability. In this respect, it should be pointed out that the long-term semi-elasticity of the interest rate in the equation that includes the long-term rate is 5.3 in the case of Germany, compared with 0.9 in the case of EMU11. This result highlights the differential aspects regarding controllability that EMU11 may exert in relation to a country such as Germany.

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[2] The ten-year public debt bond would be an approximation to this interest rate.

[3] In fact, the combined estimation of the short-term and long-term rate in the money demand equation does not entail significant improvements on the results compared with the simplest specification considering only the long-term rate. Even if the spread (long-term rate minus short-term rate) is considered in the dynamics of the equation, the improvement is only marginally significant in the case of Germany and not significant in the case of EMU11.

[4] In annex 2, a term-structure equation is specified and estimated.

table a1.2

ECM DEMAND EQUATION FOR M3

(Sample = 1970-1997)

Estimation method: non-linear least squares[1]

$$\Delta(m-p-y)_t = c_t + \alpha((m-p-y) - \beta r)_{t-1} + \gamma_t \Delta y_t + \delta \Delta r_t + \rho sp_t$$

	GERMANY			EMU-11		
	Long rate	**Short rate**	**Long rate + sp**	**Long rate**	**Short rate**	**Long rate + sp**
C_t	0.19 (6.03)	0.11 (4.3)	0.21 (6.5)	0.1 (4.1)	0.08 (3.9)	0.088 (3.8)
α	-0.24 (-6.3)	-0.20 (-4)	-0.24 (-6.7)	-0.27 (-3.9)	-0.25 (-3.4)	-0.27 (-3.6)
β	-5.3 (-5)	-2.7 (-2.8)	-5.9 (-5.5)	-0.88 (-1.6)	-0.81 (-1.4)	-0.87 (-1.6)
γ	-0.65 (-4.88)	-0.59 (-3.1)	-0.65 (-5.1)	-	-	-
δ	-1.91 (-6.5)	-0.57 (2.98)	-2.3 (-6.5)	-0.99 (-3.6)	-0.56 (-3.3)	-0.91 (-3.2)
ρ	-	-	-0.38 (-1.8)	-	-	-0.07 (-0.18)
$\overline{R}^2$	0.77	0.54	0.80	0.55	0.51	0.55
σ_{x100}	1.5	2.1	1.4	1.5	1.5	1.5
DW	2.2	2.1	2.4	1.8	1.8	1.80
SSR	0.005	0.01	0.0045	0.0055	0.0059	0.0055
F	19.2	6.8	17.5	9.87	4.5	7
LM(4)	2.4	1.55	3.3	0.47	0.11	0.42
B-J	0.4	0.68	1.41	0.31	0.1	0.97
ARCH(4)	1.6	0.62	0.32	0.17	1.3	0.9
Q(4)	6.5	5.91	7.63	2.07	0.6	2.1
CH[2]	0.77	10.44	0.52	5.7	2.28	1.5
ECM(1)[3]	5.6**	3.4*	6.5**	5.2**	4.7**	3.4*

(1) In brackets: t-student statistic.
(2) CH: Chow stability test, in the period 1977-1997.
(3) ECM: t-ratio test of the coefficient of the error-correction mechanism. (Critical value: tables of Banerjee et al. pg 43).
** H_0 rejected at 1% significance level (cointegration accepted). * H_0 rejected at 5% significance level (cointegration accepted)

Annex 2. "Backward-looking" and "forward-looking" estimates of long-term interest rates

Under a monetary policy strategy such as that considered in this paper, the monetary policy operational tool is the short-term interest rate. However, as shown in annex 1, the specification of the money demand equation offering the best statistical conditions is that specified in terms of the long-term interest rate.

$$\Delta(m - p - y)_t = h\ (r_l) \qquad \textbf{(2.1)}$$

This implies that, in order to analyze the sensitivity of the monetary aggregate to a change in the expected path of short-term rates, it is necessary to establish a functional relationship between both kinds of interest rate (long-term and short-term), $r_l = f\ (r_s)$. Accordingly, the money stock equation can be specified in terms of the short-term interest rate:

$$\Delta(m - p - y)_t = h\ [f(r_s)] \qquad \textbf{(2.2)}$$

The aim of this annex is twofold. First, the estimation of a term-structure equation is presented in order to determine, in combination with the money demand equation, the degree of response of this variable to changes in short-term interest rates. And further, this same equation is used for simulation purposes, as an approximation to extrapolating the long-term interest-rate cycle, departing from the short-term rates scenario used in the simulation exercise presented in the main text.

Specifically, there are two methodological approaches for the estimation of the long-term path of rates in the simulation period considered (1999-2008).

- **"Backward-looking" methodology**, using equations of the long-term interest-rate structure as a function of the short-term one, in terms of an error correction mechanism model, both for Germany and for EMU-11.

$$r_l = f_{back}\ (r_s)$$

Therefore, the specification of the equation of velocity of circulation as a function of short-term rates could be expressed as

$$\Delta(m - p - y)_t = h\ [f_{backward}(r_s)] \qquad \textbf{(2.3)}$$

That allows to examine the response of the monetary aggregate to changes in short-term interest rates. Results of the equation linking short- and long-term rates are presented in table A.2.1.

"Forward-looking" methodology. In this case the extrapolation of long-term rates is made calculating the geometric average of short-term rates for the next n years, according to the following expression:

$$(1+r_{l_t}) = \sqrt[n]{(1+r_{s_t})*(1+r_{s_{t+1}})*...*\ (1+r_{s_{t+n}})} \tag{2.4}$$

This means that the relationship between short-term and long-term rates will vary in terms of time short-term interest rates are expected to remain at a certain level. Specifically, for a geometric average of ten years, a short-term rate change of 1 point will translate into an increase in the long-term rate of 1 pp too if it is expected to hold for ten years or more; into an increase of, approximately, 0.5 pp if it is expected to hold for 5 years; or into a change of 0.1 pp if the change in the short-term rate is maintained during 1 year.

The value r_l obtained from the foregoing expression may thus be interpreted as the average short-term interest rate which, were it to hold constant for n years, would allow us to obtain the final return arrived at with the short-term rate sequence: $r_{s_t}, r_{s_{t+1}}, \dots, r_{s_{t+n}}$:

$$(1+r_{l_t})^n = (1+r_{s_t})*(1+r_{s_{t+1}})*...*(1+r_{s_{t+n}})$$

$$(1+r_{l_t})*(1+r_{l_t})*...*(1+r_{l_t}) =$$

$$(1+r_{s_t})*(1+r_{s_{t+1}})*...*(1+r_{s_{t+9}})$$

When calculating r_l as a simple geometric average, we are considering that, in the estimation of the long-term rate in a certain year, the estimation of the short rate for that year and that within 9 years, will have an equal influence (same weighting). However, the estimates of the closest short rates are subject to less uncertainty and, therefore, should have a bigger weighting than those calculated for periods at a more distant horizon.

According to this, we could consider the calculation of long- term interest rates in terms of "forward-looking" expectations, on the basis of a weighted geometric average of the short-term rate for the next 10 years, where the weightings are inversely proportionate to the distance in years of each of the short-term rates in relation to the moment at which the long-term rate is estimated (e.g. the short-term rate expected in two years time should be given half the weighting than the short-term rate expected for next year):

$$(1+r_{l_t}) = \sqrt[10]{(1+r_{s_t})^{p1} * (1+r_{s_{t+1}})^{p2} * \ldots * (1+r_{s_{t+9}})^{p10}} \tag{2.5}$$

where $p1 + p2 + \ldots + p10 = 10$

$$p2 = \frac{p1}{2};\ p3 = \frac{p1}{3};\ p4 = \frac{p1}{4};\ \ldots\ p10 = \frac{p1}{10}$$

$$p1 + \frac{p1}{2} + \frac{p1}{3} + \ldots + \frac{p1}{10} = 10$$
$$p1\ (1 + \frac{1}{2} + \frac{1}{3} + \ldots + \frac{1}{10}) = 10$$

Clearing $p1$ gives:

$p1 = 3{,}4142$; $p2 = 1{,}7071$; $p3 = 1{,}1381$; $p4 = 0{,}8535$
$p5 = 0{,}6828$; $p6 = 0{,}5690$; $p7 = 0{,}4877$; $p8 = 0{,}4268$
$p9 = 0{,}3794$; $p10 = 0{,}3414$

Having obtained the path of long-term interest rates departing from the short rates scenario $r_{l_t} = f_{forward}(r_{s_t})$, the response of the monetary aggregate can be calculated in terms of the velocity equation (2.1):

$$\Delta(m - p - y)_t = h\ [f_{forward}(r_{s_t})] \tag{2.6}$$

Table A2.2 presents the cyclical scenario of short-term rates considered in the document and the long-term paths estimated with the aforementioned backward-looking and forward-looking methods.

Table a2.1

INTEREST RATES STRUCTURE				
Estimation method: non-linear least squares[1] $\Delta r_{l_t} = c_t + \alpha(r_l - \beta r_s)_{t-1} + \rho \Delta r_{s_t}$				
	Germany		**EMU-11**	
Sample:	**1970-1997**	**1976-1997**	**1970-1997**	**1976-1997**
C	0.022 (2.6)	0.02 (2.4)	0.013 (1.8)	0.01 (1.4)
α	-0.6 (-3.8)	-0.55 (3.2)	-0.53 (-3.4)	-0.44 (-2.7)
β	0.6 (6.1)	0.5(5.1)	0.81 (7.8)	0.81 (6.4)
ρ	0.38 (6.8)	0.44 (6.2)	0.53 (7.3)	0.7 (7.7)
R^2	0.75	0.77	0.72	0.77
σ **x 100**	0.6	0.6	0.7	0.6
Dw	1.8	1.9	1.4	1.8
F	23.6	19.8	19.7	20.5
SSR	0.00085	0.0006	0.001	0.0006
LM(4)	0.73	0.98	1.6	0.47
B-J	1.27	0.51	1.6	0.35
ARCH(4)	0.5	0.45	0.4	2.5
Q(4)	3.93	3.7	3.6	3.2
CH[2]	1.6[a]	1.6[b]	9.1[a]	3.7[b]

(1) In brackets: t-student statistic.

(2) CH: Chow stability test, (a) period 1977-1997
(b) period (85-97)

table a2.2

CYCLICAL SIMULATION OF SHORT-TERM RATES AND ESTIMATES OF LONG-TERM RATES			
year	Short-term interest rates Cyclical simulation r_s	Long-term interest rates	
		Backward-looking estimate $r_l = f_{back}(r_s)$	Forward-looking estimate $r_l = f_{forw}(r_s)$
1998	3.3%	5.64%	5.12%
1999	4.8%	6.15%	6.00%
2000	6.3%	6.88%	6.69%
2001	7.8%	7.69%	7.11%
2002	9.3%	8.54%	7.20%
2003	8.3%	8.52%	6.66%
2004	7.3%	8.16%	6.15%
2005	6.3%	7.67%	5.70%
2006	5.3%	7.12%	5.33%
2007	4.3%	6.55%	5.09%
2008	3.3%	5.97%	5.12%

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