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Money Demand in the Euro Area: Where Do We Stand (Today)?

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Money Demand in the Euro Area: Where Do We Stand (Today)?

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Abstract

The paper reviews the stability of long-run money demand in the euro area in the light of recent revisions to M3 data. The analysis confirms the existence of a stable long-run money demand, although the estimated equation implies a smaller equilibrium M3 growth than the European Central Bank's reference value of 4½ percent. The stability of long-run money demand does not imply that the market is always in equilibrium. Indeed, it is argued that periods of disequilibrium can be long and adjustment slow. The paper shows that the difference between the low estimated equilibrium growth rate and the actual growth rate for M3 can be explained by a velocity shock, identified here as the sharp fall in equity prices in the last two years. These characteristics of the money market—summarized in the events of the last two years—would call for an alternative approach in the communication of monetary policy developments, essentially putting less emphasis on month-to-month developments in M3.

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I. Introduction

In October 1998 the European Central Bank (ECB) announced the Eurosystem's "stability-oriented monetary policy strategy," which would guide its monetary policy decisions in Stage 3 of European Monetary Union (EMU). Instead of announcing a money growth or inflation target, as had been widely anticipated, the ECB chose instead to follow a strategy consisting of three main elements: a quantitative definition of the primary objective of monetary policy, namely price stability, and two pillars that would guide policy so as to achieve this objective.[2] While the adoption of an inflation target was considered problematic by the ECB, owing to the inconclusive empirical evidence concerning the transmission of monetary policy in the euro area, the reluctance to announce a monetary growth target was explained by the uncertainty stemming from the adoption of a single currency and the possible instability of an aggregate money demand function. Given all these uncertainties, the ECB opted instead for a more "conservative" approach.[3]

Under the first pillar, the ECB announces a reference value for the growth of M3, which is used as a guidepost for developments in the monetary sector. Similarly, the second pillar entails a "broadly based assessment of the outlook for future price developments...in the euro area as a whole."[4] Both are used as separate sources for evaluating the risks to price stability in the euro area.[5]

Nonetheless, the stability of a long-run money demand function for the euro area is an important element of this two-pillar framework since the calculation of the reference value, or long-run growth rate, for M3 rests on the assumption of a stable long-run money demand relationship. Otherwise, disorderly and repeated velocity shocks are likely to lead to persistent deviations of M3 growth from this reference value and create communication headaches for the ECB. In addition, to the extent that the ECB uses information from the first pillar to conduct policy, any uncertainties regarding the trend for M3 growth may also lead to errors in the formulation of monetary policy.

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[2]Angeloni, Gaspar, and Tristani (1999) provide a useful theoretical justification for the framework.

[3] ECB (1999) and Angeloni, Gaspar, and Tristani (1999), p.11, for example.

[4] See ECB (1999), p. 46.

[5] The main objective of the ECB as spelled out in its constitution is to maintain price stability. The *Protocol (No. 18) (ex No. 3) on the Statute of the European System of Central Banks and of the European Central Bank* (see, www.ecb.int) states that "In accordance with Article 105(1) (ex Article 105(1)) of this Treaty, the primary objective of the ESCB shall be to maintain price stability… ."

Interestingly, since January 1999 the announced growth rates for M3 have exceeded the ECB's reference in almost every public announcement. Furthermore, although the growth rate of M3 never lingered below the 4½ percent level for an extended period (ever since the introduction of the euro), the ECB alluded to the information contained in the first pillar—and in particular to M3 growth trends—as having influenced its assessment of risks to price stability in the euro area (see Kontolemis, 2001, for example). What's more, M3 growth rates have accelerated significantly since the third quarter of 2001 during a time of high volatility in the world financial markets. This volatility, according to the ECB, has contributed to the retrenching of funds from equities into the various components of M3. Against this background the ECB also announced major revisions in the M3 data, which were necessary to correct for foreign holdings of money market funds and marketable instruments that were included inadvertently in the measurement of M3.

This study re-evaluates the evidence concerning the stability of the long-run money demand function for the euro area in light of these recent developments, including the data revisions.[6] In doing so, it also examines the appropriateness of the current level of the reference value for M3 growth and also discusses whether a monitoring range, instead of the reference value, may be more suitable as a guidepost for judging risks to price stability within the first pillar. The paper does not, however, judge the appropriateness of the two-pillar framework in comparison with inflation or pure monetary targeting.[7]

Certainly, the stability of long-run money demand for the euro area is a prerequisite for designing monetary policy in this framework. Nevertheless, the stability of long-run money demand does not guarantee that the money market remains continuously in this equilibrium. Instead, long and possibly protracted disequilibrium periods are possible, if not very likely. Hence, it is important to ascertain whether such disequilibria are due to exogenous money supply shocks that may trigger inflation in the medium- or long-run, or, some unanticipated velocity shift that should in principle be accommodated by the monetary authorities (e.g., increased demand for euros from abroad or financial market volatility). For this reason this paper examines in some detail the stability of short-run money demand.

Two possible weaknesses of the analysis, which are not addressed in this study, but which apply equally to the majority of studies analyzing aggregate euro-area data include (i) the aggregation issue of euro-area data, (ii) the interpretation problems from modeling an aggregate policy reaction function based on data from the different euro-area countries. It is recognized that no aggregation method is free from criticism and therefore these results should be treated with

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[6] A number of studies have confirmed the existence of stable money demand equations for the euro area (for example, Coenen and Vega, 1999; Brand and Cassola, 2000; Kontolemis, 2001; and Calza, Gerdesmeier, and Levy, 2001).

[7] On this debate see Svensson (2000), Artis, Mizen and Kontolemis (1998) and references therein, for example.

caution when making projections or policy simulations, at least until the informational content of these series is proven over time. Furthermore, one justification for the modeling of an aggregate euro-area reaction function is based on the asymmetric nature of monetary policy decision making during the pre-EMU period.[8] The Exchange Rate Mechanism (ERM) of the European Monetary System, which dominated the pre-EMU period, was considered asymmetric, given that policy decisions affecting all ERM countries were being determined in Germany in response to domestic monetary conditions. This was especially true after 1983, or, during the "new-EMS" period (Giavazzi and Spaventa, 1990).

II. Modeling Issues

Modeling the demand for money for the euro area is not a straightforward task. First, the stability and existence of such a relationship has to be established. Second, the model has to capture adequately the declining M3 velocity trend observed over the last two decades in the euro area. Consider a standard specification for a money demand equation written in logs,

$$m^d - p = \alpha_0 y - \alpha_1 R,$$

where p is the (log) GDP deflator, y is (log) GDP, and R is a measure for the opportunity cost of holding money.

One possible explanation behind the declining velocity trend in the euro area over the last 15 years is the finding reported in Brand and Cassola (2000) of an income "elasticity" greater than unity.[9] This may account for the negative velocity trend and can be seen by noticing that velocity can, by definition, be written as:

$$v \equiv p + y - m = (1 - \alpha_0) y + \alpha_1 R,$$

and in growth rates this is expressed as a function of potential GDP growth and the steady-state change in the interest rate:

$$\dot{v} = (1 - \alpha_0)\dot{y} - \alpha_1 \dot{R}.$$

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[8] Clements, Kontolemis, and Levy (2001), in a different exercise, attempt to control for different reaction functions in measuring the effects of monetary policy on GDP and inflation.

[9] This has been discussed also in a more recent survey paper prepared by the ECB (see Brand, Gerdesmeier, and Roffia, 2002).

Assuming that interest rates remain unchanged, velocity will change proportionally to potential (or long-run) GDP growth if $\alpha_0 \neq 1$. The reasons behind this "endogenous" trend could be the existence of wealth effects (i.e., money demand increasing faster than one would expect, based on GDP growth). If that is the case, then in the absence of a proxy for wealth in the money demand equation, the scale variable also accounts for this "missing variable."

Of course, the negative velocity trend in the euro area could be the result of declining inflation over the last 20 years. If that is the case, inflation could also be included in the money demand equation, although the trend in nominal interest rates should explain part of the long disinflation process over the 1980s and 1990s and may be sufficient.

Another reason behind the declining velocity trend could be the demand for euros by foreigners.[10] Although the magnitude of this could be limited, it may nevertheless contribute to an accelerating, relative to euro-area GDP growth, increase in the demand for euro notes and coins, which is translated into a declining velocity for euro-area M3. Certainly, the introduction of euro notes and coins may—combined perhaps with the adoption of the euro as a reserve currency—contribute toward an amplification of this trend.[11]

Equally, there are also good reasons to expect a reversal in this trend, for example, as a result of improvements in payment technologies and/or the disintermediation process taking place in the euro area.

Finally, asset prices may also explain unexpected shifts in velocity. For example, to the extent that a productivity shock raises the (real) rate of return on equity—above the real, or steady-state interest rate—there is a likelihood of a portfolio shift away from money holdings into stocks. Although that should not be expected to persist, either because of a higher long-run real interest rate or (eventually) lower equity prices, such a situation could arise and a model that accounts for the effect of alternative asset prices (such as equity prices) is more likely to explain large swings in velocity. However, it should be recognized that although asset prices should not be expected to affect significantly the long-run velocity trend, they could lead to dramatic shifts in velocity in the short and medium term.

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[10] According to estimates by the Deutsche Bundesbank, in the mid-1990s, 30-40 percent of all the DM banknotes were held abroad. Although estimates for other currencies are not available, it is certain that smaller quantities of other currencies may also be circulating outside the euro area (see Box 1, *ECB Monthly Bulletin*, September 2001, for a discussion).

[11] A deterministic trend is not ideal for capturing the "true" data generating process, given that demand for euros outside the euro area may fluctuate considerably. However, it can be used as a good proxy for world GDP, for example, and may provide a more reliable estimate for M3 demand in the event of an idiosyncratic downturn in the euro area.

III. Econometric Analysis

The methodology used in this paper allows us to identify stationary combinations among (a subset of) the variables included in the econometric system (this is outlined in detail in the Appendix.) These can be given economic interpretation in terms of long-run (static) equations that represent the steady-state equilibrium properties of the system. Hence, the basic question of interest is whether a stable long-run money demand function exists. Furthermore, given the recent data revisions, it is important to evaluate how the existing long-run money demand equations compare with new estimates; more details about the results and the procedure for identification of these equations are presented in the Appendix. This section first tackles the issue of the long-run stability of euro-area money demand functions. It then presents estimates of the monetary overhang for the euro area, and finally discusses the dynamic (and forecasting) properties of the estimated models.

The variables used in the estimation are the following euro-area aggregates: the log of real money (M3), the log of real GDP, the short-term interest rate (s), the long-term interest rate (l), and inflation defined as the (year-on-year) change in the log of the GDP deflator. The data are essentially the same as in Brand and Cassola (2000) but they have been extended to cover the period up to 2001Q3 (Figure 1) and reflect the revisions of M3 announced by the ECB. A constant is included in each system, allowing therefore, for a trend in the levels of these variables.

A. Explaining the Trend in Income Velocity

A bivariate vector autoregressive (VAR) model, that includes real money and GDP, is estimated and used to examine the properties of velocity in the euro area. If income velocity is stationary then we should expect to find one long-run relationship between these variables, as follows:

$$p + y - m = c_1,$$

where c_1 is a stationary variable.[12] In other words we should expect to find one cointegrating vector with the coefficient on GDP set equal to unity.[13] Estimation yields the following equation:

$$p + 1.33y - m = c_1,$$

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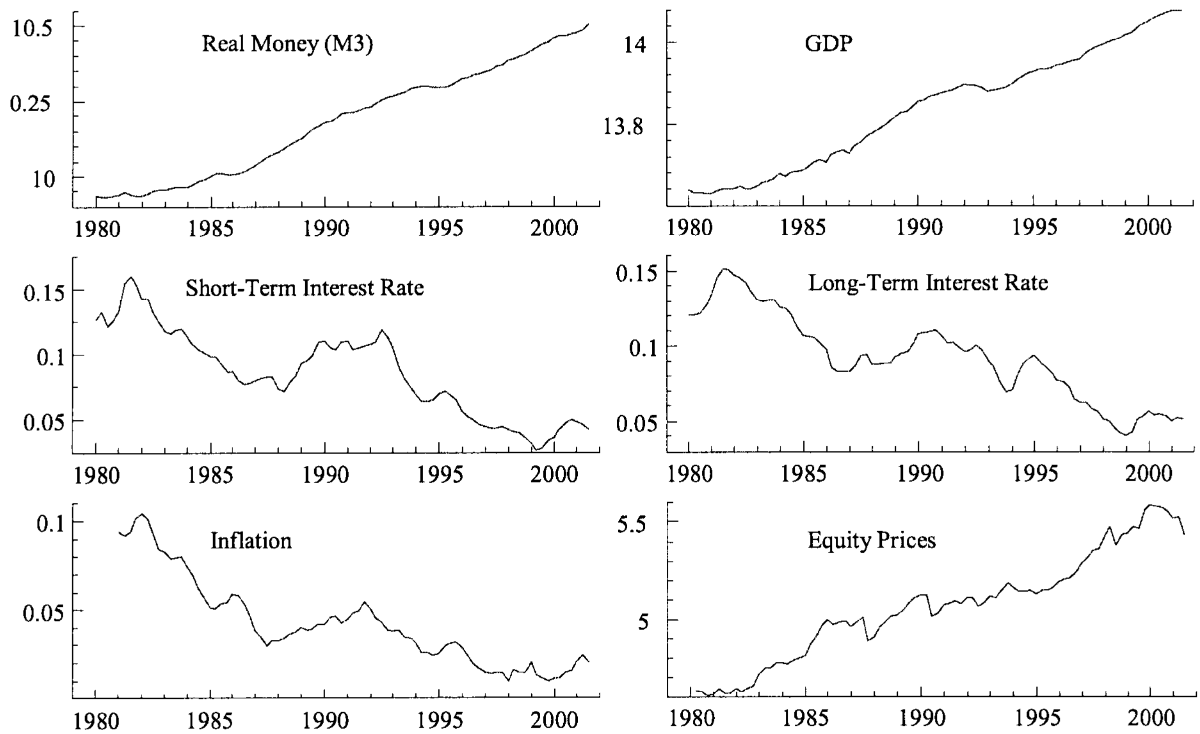
[12] For expositional purposes we rearrange the estimated equation, which is based on a model that uses real money balances *(m-p)*.

[13] In this paper we avoid using the term "elasticity" since it has argued recently that in these VAR systems it is hard to interpret the coefficients of the long-run equation as "standard" elasticities (see in particular Johansen, 2002, and references therein.)

Figure 1. Euro Area: Money, GDP, Interest Rates, Inflation, and Stock Prices, 1980Q1-2001Q3



and the restriction that the coefficient on GDP unity is strongly rejected (p-value is 0.000). Based on this result we may conclude that the trend in velocity is driven by the trend in GDP, as explained earlier.

Nevertheless, no variable that could possibly account for this trend in velocity is included into the VAR system. Therefore, as a first step we add a deterministic trend into the system and restrict it to lie in the cointegrating space (i.e., to enter the long-run equation). The test for cointegration allows us to conclude, at the 95 percent significance level, that there exists one cointegrating vector between these variables. Normalizing relative to real money yields,

$$p + 1.09y - m + 0.0013t = c_2,$$

and therefore a smaller coefficient on GDP, as one would expect, since the addition of the deterministic trend captures (at least) part of the decline in velocity. The restriction that the coefficient on GDP is unity is not rejected (p-value 0.64) and a re-estimated model yields,

$$p + y - m + 0.0019t = c_2,$$

implies a constant velocity decline of about –¾ percent per annum. Hence, although in the absence of another explanatory variable, income seems to account for the velocity trend, the addition of the trend shows that neither of these explanations can be accepted with certainty.

The question whether to allow the trend in the cointegrating space can also be examined using the procedure discussed in Doornik, Hendry, and Nielsen (1998). This involves testing sequentially the (nested) hypotheses of: (i) both a trend and constant included unrestricted in the system (i.e., inducing a quadratic trend in levels), (ii) a trend in the cointegrating space with a constant unrestricted in the system (i.e., inducing a trend in levels), and (iii) only a constant unrestricted in the system (i.e., implying a trend in the level but not in the cointegrating space). Application of this procedure reveals that the second hypothesis is accepted, and we therefore conclude that within this bivariate VAR model a trend should be restricted in the long-run space, thus rejecting the specification with the income coefficient greater than unity.[14]

[14] Using the trace statistic to test these hypotheses we find for (i) 26.7**, (ii) 27.62* for rank=0; and for (i) 6.55**, (ii) 6.55 for p<=1, and we therefore cannot reject the latter.

B. The VAR Model

Nevertheless, it is likely that other variables account for the negative (long-run) velocity trend in the euro area. First and foremost, a variable that captures the opportunity cost of holding money balances should be an important addition to the analysis. Hence, we proceed with the estimation of a more general VAR model that includes, in addition to real money and GDP, the short- and long-term interest rates, and annual inflation.

The formal test for cointegration reveals two long-run (stationary) equilibrium relationships between these variables. The identification restrictions imposed here—including a unit coefficient on income, a zero coefficient on the long-term interest rate and inflation—are not rejected (the p-value for the standard Johansen test is 0.51) and imply a long-run money demand function for the euro area that links real money balances to GDP and the interest rate only (or the inverse velocity as a function of the short-term interest rate):[15]

$$m - p - y = -1.45s. \qquad (1)$$

Therefore (the inverse of) income velocity, in the long run, is explained by the (stochastic) trend of the interest rate alone, and the proposition that it is linked to developments in real GDP is rejected.

Table 1 compares the parameters of different long-run money demand equations.[16] Equation (1) is comparable to one of the specifications provided by Coenen and Vega (1999)—estimated with the unadjusted M3 data—which, however, does not impose a unit coefficient of income. It is also similar to an equation reported by Kontolemis (2000), also estimated using the unadjusted M3 series, albeit with a slightly smaller coefficient on the interest rate. Consequently, these results provide tangible evidence that the estimates provided earlier are broadly appropriate even when the recently revised data are used for estimation; a battery of stability tests confirmed that these estimated coefficients have remained broadly unchanged throughout the sample period.[17] Note that the analysis in this section rejects overwhelmingly the

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[15] The long-term interest rate does not enter the long-run money demand function, suggesting perhaps that the inclusion of the short rate suffices as a measure of the opportunity cost of holding real money balances. A more detailed analysis of the measurement of the correct opportunity cost of holding money was presented in a recent paper by Calza, Gerdesmeier, and Levy (2001), which shows that a correctly measured proxy for this opportunity cost of M3 is highly correlated with the short-term interest rate.

[16] The paper by Brand, Gerdesmeier, and Roffia (2002) provides a review of the existing money demand models published by the ECB.

[17] Our reexamination of the model of Brand and Casola (2000) using the revised data revealed that this model did not perform well in terms of forecasting and stability of the estimated parameters. In particular, our statistical analysis rejects the specification proposed in that paper and finds that the coefficients in that model are not constant over time. This in fact is also

hypothesis that the coefficient on the GDP is greater than unity. This is in sharp contrast to the claim by Brand and Casola (2000), and Brand, Gerdesmeier, and Roffia (2002) who argue that their finding of such evidence explains the observed velocity trend in the euro area. Calza and others (2001) calculate the own rate for M3 but report a slightly smaller interest rate parameter. In addition they find an income coefficient of 1.33 but do not test formally whether this is statistically different from unity.

Table 1: Comparing Different Long-Run Parameters for Real Money Equations

Long-run model *(m-p)*	*y*	*s*	*l*	s_{own}	*trend*
Coenen, Vega (1999)	1.17	-1.26			
Kontolemis (2000)	1.00	-1.89			
Brand, Casola (2000)	1.33		-1.61		
Calza and others (2001)	1.34			-0.86	
Kontolemis (2001)	1.04	0.06	-0.5		-0.001875
This Paper	1.00	-1.45			

In an earlier paper Kontolemis (2001) compared a number of alternative long-run money demand equations including ones that incorporate both the short- and long-term interest rate as well as a deterministic trend. Adding a trend in these equations, as was also discussed earlier, results in an income coefficient close to unity and implies a constant (described by the deterministic trend) decline in income velocity by some ¾ percent per annum. Application of the test procedure discussed in Doornik, Hendry, and Nielsen (1998), however, reveals that only the model that includes an unrestricted constant is acceptable and we therefore drop the trend from the cointegrating space.[18] Hence, the (inverse) velocity trend is explained by developments in the interest rates and not by the trend in GDP.[19]

confirmed in the recent paper by Brand, Gerdesmeier, and Roffia (2002) which reports a newly estimated version of their equation $m - p = 1.32y - 2.4l$, which is significantly different from their original equation given by, $m - p = 1.32y - 0.6l$. Brand, Gerdesmeier, and Roffia (2002) conclude that "*Considering the uncertainty underlying these estimates, they can be considered to lie well within the range of estimates of this relationship provided in BC(2000).*"

[18] Using the trace statistic to test these hypotheses we find for (i) 145.4**, (ii) 151.2**, and (iii) 96.42** for rank=0; (i) 84.03**, (ii) 88.86**, and (iii) 63.29** for rank<=1; (i) 52.27**, (ii) 57.05**, and (iii) 33.97 for rank<=2; and we therefore cannot reject the latter.

[19] Notice, that the trending behavior in the variables is captured by the unrestricted constant term that enters theVAR; this, as was explained earlier, induces a deterministic trend in levels.

The econometric analysis reveals that two long-run (cointegrating) relationships exist between these variables. Although we are more interested in the long-run money demand equation it may be useful, purely from a modeling viewpoint, to try to identify a second equation with some economic interpretation. Equation (1) was obtained using a very naïve identification procedure for the second cointegrating vector; essentially excluding money from the second cointegrating vector and normalizing to one the coefficient on GDP. Alternative identification assumptions were imposed to the second cointegrating vector but did not change the results.[20]

One important conclusion that can be drawn from this analysis is that—according to the estimated equation—the equilibrium growth rate for M3 should be somewhat lower than the ECB's assumed rate of 4½ percent. This is simply because, unlike the research carried out at the ECB, this study fails to confirm an "endogenous" velocity trend which could contribute to a higher rate of growth of M3. Instead it concludes that the constant velocity decline observed during the last twenty years is explained by movements in the interest rates and is also attributed to the trend in inflation during the same period (picked up in this model by the unrestricted constant—i.e., trend in levels—in the VAR). That in turn suggests that the strong growth of M3 observed during the last two years could be the result of a "normal" but sizeable deviation from equilibrium (e.g., related to a supply shock that affects prices or a demand shock that would have an impact on GDP), or, of a velocity shock.

Asset prices

Asset prices may also affect the decision to hold money. Higher stock prices, for example, increase the opportunity cost of holding money (either in the form of cash or time deposits) and influence the overall money market equilibrium. In recent months the declining stock market and the overall uncertainty in the financial markets have, according to the ECB, contributed to a faster-than-expected increase in the stock of M3. What appears to be a random velocity shock, within the framework underlying equation (1), may therefore be a case of a missing variable in the money demand equation. In other words, the fast increase in M3 growth over the second half of 2001 may be related to the sharp fall in equity prices during this period, and what appears to be an unexplained velocity shock may in fact be a portfolio shift. If this is simply a measurement issue for the true opportunity cost of holding M3 then it could be argued that this is indeed a problem of a "missing" variable and not a velocity shock.[21]

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[20] For example, an alternative identification scheme for the second cointegrating relationship which assumed the GDP to be a function of the spread and inflation in the long-run, still produced a very similar money demand specification, or, $(m-p) = y - 1.43s$ (more details are available upon request from the author).

[21] The role of asset prices in the monetary transmission mechanism in the euro area is discussed at length in a recent paper by Cassola and Morana (2002). The important question whether monetary policy should respond to asset prices has been debated extensively recently, but it

A variable that tries to capture the level of asset prices is introduced into the system. The variable, denoted by *Ps*, is an average of the DAX and CAC50 stock market indices and enters into the VAR in (log) levels ; this is plotted in Figure 1.[22] Adding this variable into the system still produces two long-run relationships between the variables. Nevertheless, the addition of asset prices results in a much higher coefficient on the interest rate:[23]

$$m - p - y = -4.61s - 0.40Ps. \qquad (2)$$

The significantly higher interest rate coefficient is explained by the fact that the very sharp fall in equity prices since 2000Q1 (of about 16 percent), which led to a higher demand for money, was accompanied by a rather steep increase in interest rates between 1999Q3 and 2000Q4, which would have had the opposite effect on money demand. Thus, a much higher interest rate coefficient would be necessary to explain the rapid growth of M3 over this period. The identification restrictions are not rejected (the p-value equal to 0.54, is still very high), while the exclusion of the equity price index from this equation is strongly rejected.[24]

All these findings suggest that, although there appears to be a stable (and stationary) linear combination between these variables, there is some uncertainty about the correct, or true, functional form. This problem, which is not addressed in the other ECB studies, seems to be rather acute and it is made worse by the fact that over this period all variables, and hence velocity, all display a strong negative trend (except for the GDP of course). Thus it becomes very difficult to disentangle what is an autonomous trend in velocity and what is merely due to a trend in the other variables, in particular inflation and interest rates.

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remains highly controversial (for example, Cecchetti and others, 2001, Bryan and others, 2002, and references therein.)

[22] This is essentially the German DAX index through 1997 and an average of the DAX and CAC 50 subsequently. The correlation between these two series, and the wider euro area index, is rather high although such an index is not available for the entire period under consideration.

[23] An alternative version of this, with asset prices treated as an exogenous variable, is discussed later on.

[24] Notice that asset prices could also be a proxy for wealth in the euro area, and in that case the coefficient on that variable could be positive. However, stock ownership is not the biggest component of total wealth in the euro area (e.g., relative to real estate,) and the prices of the two series are not always highly correlated. Some cursory analysis shows that the response of money growth, to a shock in asset prices, is negative and appears to be statistically significant, thus corroborating with the assessment that this variable is negatively related to M3 growth.

Measuring the monetary overhang

The long-run (real) money demand model for the euro area is used to measure the "desired" money demand stock—at given levels of real GDP, and the interest rate—and to construct a measure of excess money holdings for the euro area. This is a useful measure for policy analysis purposes since it provides an indication as to whether the money market is close to, or out of, equilibrium.

Equations (1)–(2) are used to construct estimates of the excess money supply, or monetary overhang, which are plotted in Figure 2 (top panel).[25] Interestingly, taking into account equity prices implies a closing of the monetary overhang in recent quarters as a result of the significant increase in the money demand following the sharp decline in equity prices over this period. Although the magnitude (amplitude) of this gap appears to be somewhat large, this indicator seems to provide useful information and food for thought for policymakers: to the extent that the acceleration of M3 growth reflects portfolio adjustments, which may be reversed once the economy picks up and asset prices start rising again, such an increase in the stock of M3 may not prove to be inflationary.[26]

The bottom panel of Figure 2 compares these monetary overhang measures with ones obtained using the Coenen and Vega (1999), and Brand and Cassola (2000) models. Clearly, none of these two alternatives seems to provide a useful summary of conditions in the money market: both seem to give false signals pointing to a large negative overhang as a result, in large part, of the large income coefficients in their equations which results in stronger money demand over this period.

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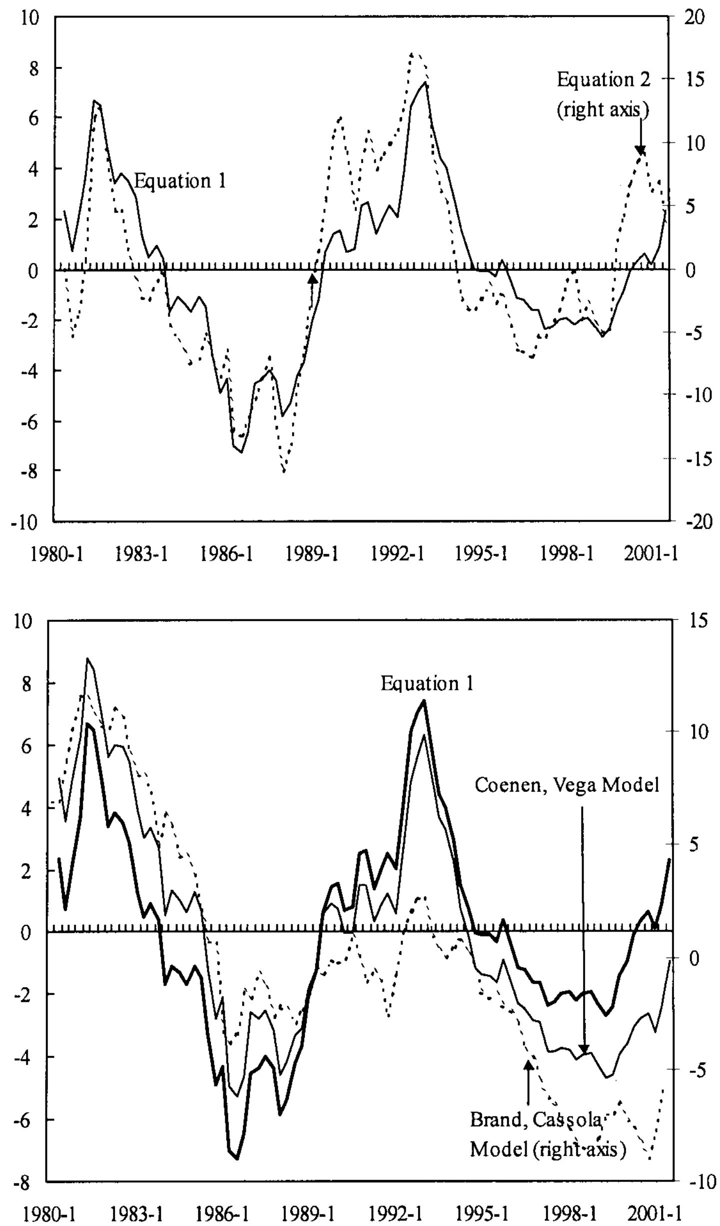
[25] These variables, which are simply estimated as the difference between the level of M3 and estimated money demand, are adjusted so that their mean is zero over the sample period.

[26] It is also important to bear in mind that the large size of some of these monetary overhang measures, or error correction terms, does not necessarily translate to faster adjustment of M3 growth rates. The speed of adjustment to these disequilibria, which is very important for the overall dynamic adjustment of the system, could vary in these four systems.

Figure 2. Euro Area: Alternative Monetary Overhang Measures, 1980Q2-2001Q3



Source: IMF staff estimates

C. The Dynamic (Error Correction) Model

Once the cointegration between the variables has been established, and unique and meaningful relationships have been identified, the next task is to rearrange the model into an error correction representation. The different models presented in the previous section provide the steady-state solutions for the full-blown dynamic models that can be used for forecasting. In this section we conduct stability analysis for these models and compare their forecasting performance.

This exercise entails transforming the variables in first differences and including, in addition to other terms expressed in growth rates (or first differences), the lagged adjustment terms, or error correction terms in levels. The transformed (dynamic) system is written as follows:

$$\begin{pmatrix} \Delta m \\ \Delta y \\ \Delta s \\ \Delta l \\ \Delta \pi \\ \Delta Ps \end{pmatrix}_t = \sum_{i=1}^{m-1} \pi_i^* \begin{pmatrix} \Delta m \\ \Delta y \\ \Delta s \\ \Delta l \\ \Delta \pi \\ \Delta Ps \end{pmatrix}_{t-i} + \begin{pmatrix} \alpha_{11}\alpha_{21} \\ \alpha_{21}\alpha_{22} \\ \alpha_{31}\alpha_{32} \\ \alpha_{41}\alpha_{42} \\ \alpha_{51}\alpha_{52} \\ \alpha_{61}\alpha_{62} \end{pmatrix} \begin{pmatrix} (m-p) - y + \beta_{13}s + \beta_{16}Ps \\ y + \beta_{23}s + +\beta_{24}l + \beta_{25}\Delta 4p + \beta_{26}Ps \end{pmatrix}_{t-1},$$

where Δ is the first difference operator (i.e., expresses variables in quarter-on-quarter growth rates). The matrix with the α_{ij}'s represents the short-run feedback of each variable to long-run disequilibria, as reflected in the deviations of real money and interest rates from their long-run equilibrium values. For example, α_{11} corresponds to the feedback of (real) M3 growth to deviations from money market equilibrium as expressed by the first cointegrating vector. The dynamic model can be reduced, by eliminating insignificant lagged terms. The reduction into a parsimonious VAR—or PVAR— model is tested to ensure that no information is lost during this process. Once the systems are set up according to these different long-run structures, they are estimated by maximum likelihood (see Doornik and Hendry, 1997, for example).

For the purposes of this exercise we have estimated alternative models through the end of 1998 and used the 11 quarters during 1999Q1–2001Q3 for a post-sample forecast evaluation period. Figures 3–4 show the (in-sample) forecasts for the variables in each system, using the two alternative long-run structures implied by equations (1)–(2). In these two specifications a "naïve" identification method is adopted, as described earlier in the paper. The top panel shows the forecasts and the actual values over this post-sample period as well as forecast error bands. The lower panel of each figure shows the recursive chow test for the overall stability of the system with the dotted line representing the 5 percent critical level (i.e., when the test value is above this line, the test suggests that the system is unstable).

Figure 3. Model 1: Post-Sample Forecast Performance and Stability Test

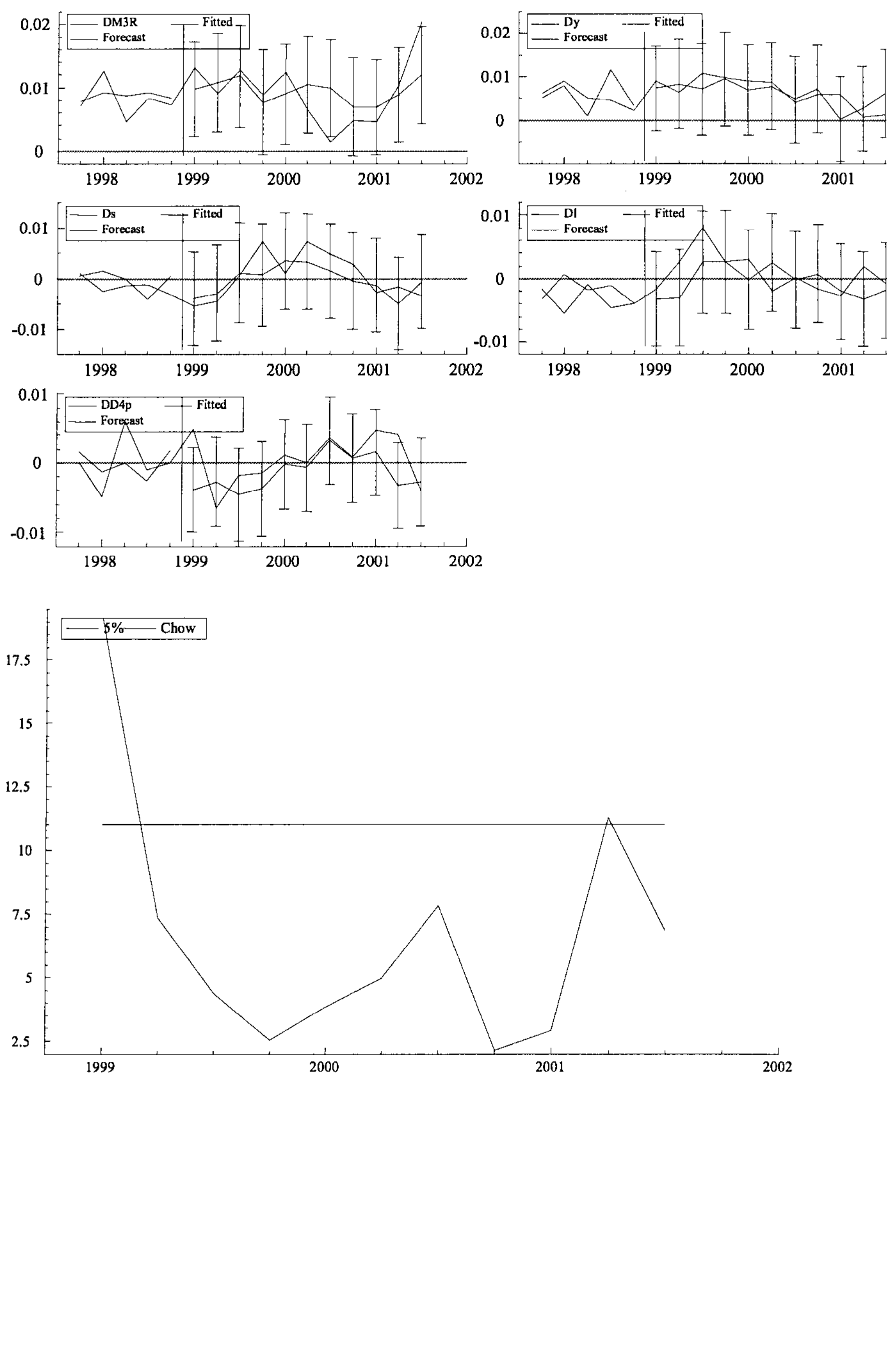
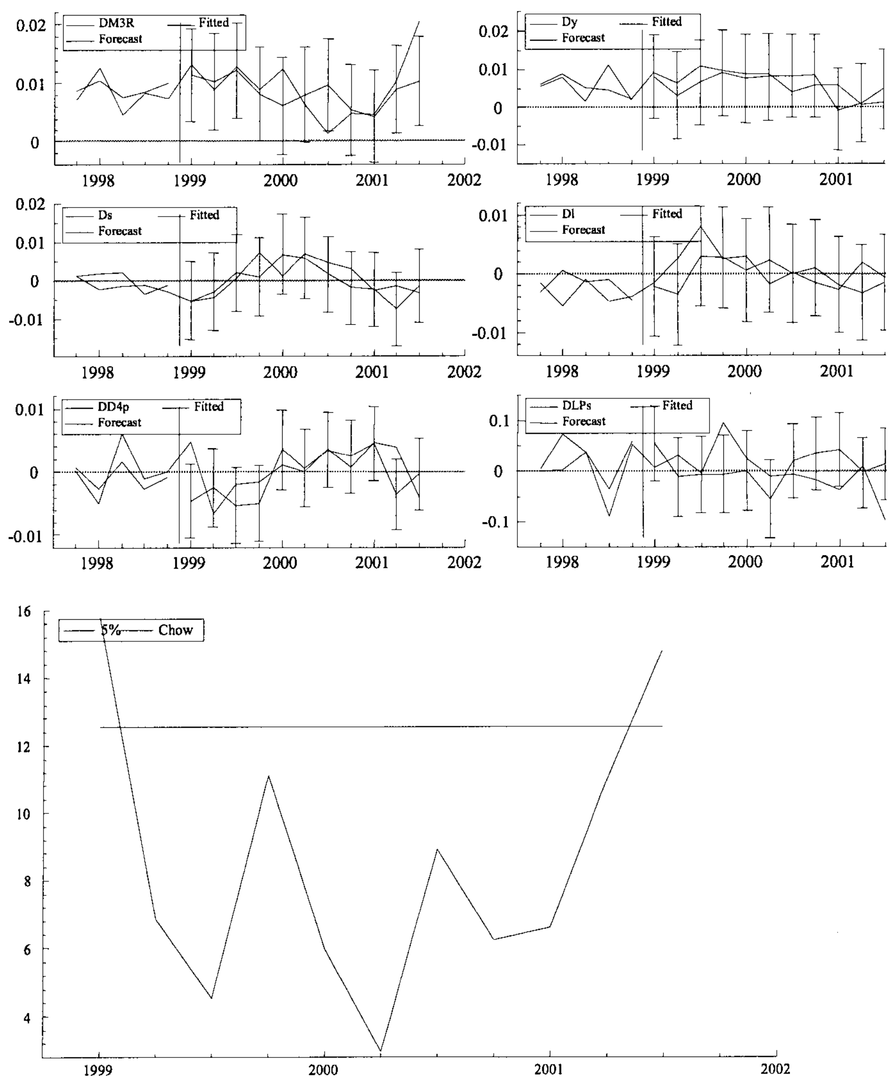


Figure 4. Model 2: Post-Sample Forecast Performance and Stability Test



Based on these figures, one can make the following interesting observations. Both models have trouble forecasting the sharp acceleration in M3 growth in the third quarter of 2001 and the standard errors appear to be particularly large. In addition, both models fail to predict the turning point in inflation in 1999 associated with the sharp increase in oil prices that year. Second, both models seem to suffer from structural instability as evidenced by the recursive Chow tests shown in the lower panel of each figure. In addition, the model that includes asset prices also fails to forecast the sharp decline in equity prices in the third quarter of 2001, which of course was the result of the unexpected events during September 2001 (Figure 4).

Does the inability of any of these models to predict correctly (some) upturn in M3 growth stem from the negative shock in equity prices in 2001Q3? To answer this question we re-estimate the model with assets prices, treating this variable as exogenous. First, the results for the long-run relationships reveal a money demand relationship given by,

$$m - p - y = -1.70s - 0.08Ps\,, \qquad (2')$$

with the identification restrictions not rejected (p-value is 0.57). Using this equilibrium relationship we re-estimate the VAR in first differences by including in each equation, in addition to the other lagged terms, equation (2′) as well as the first difference of equity prices as an exogenous variable.[27] The results from using this system are shown in Figure 5. Interestingly, the chow tests reveal no sign of instability and the growth rate of M3 falls within the (rather wide) forecast error bands of the VAR model. However, the coefficient of asset prices in equation (2′) is not statistically significant suggesting that, although asset prices are important in explaining short-run movements in M3, they are not important for the long-run determination of money demand.

This exercise reveals the important role that asset prices play in influencing developments in the money market. One tentative conclusion based on this empirical work is that the increase in asset prices propagated an unexpected portfolio shift that had a strong impact on money demand in the euro area. This is seen by the fact that asset prices appear to have had a strong short-run impact on the money demand for the euro area and explain part of the deviation from equilibrium. On the contrary, the significance of asset prices in the long-run determination of money demand is debatable. The econometric analysis also suggests that the acceleration of inflation in 1999, above the ECB's acceptable upper bound, also explains part of the deviation of money demand from equilibrium.[28] Hence, these developments suggest that the build-up of a monetary overhand should not be expected to be inflationary.

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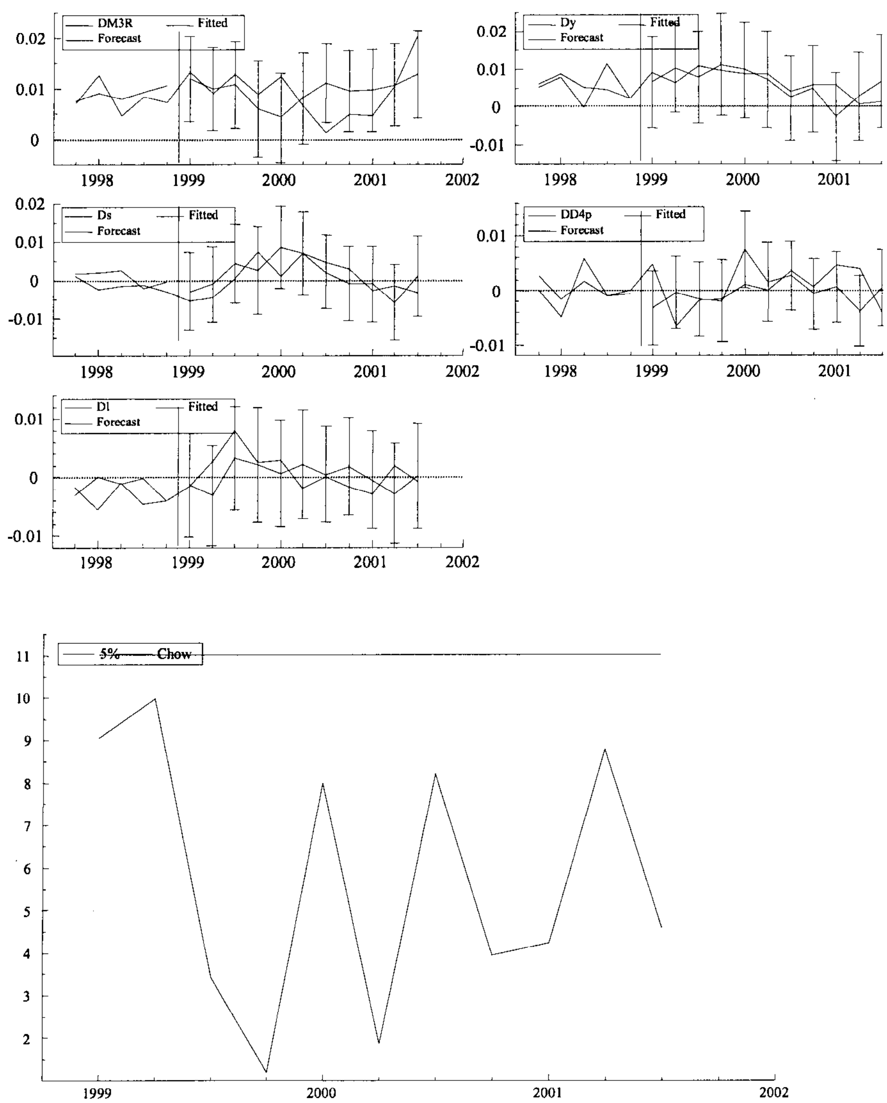
[27] The contemporaneous growth rate of *Ps* and two lags are included in each equation as well as the second cointegrated vector.

[28] Adding oil prices does not correct for the under-prediction of the inflation rate in early 1999. This is due to the fact that the GDP deflator used in the empirical analysis, is less correlated with the price of oil, or the exchange rate, but related to (the core inflation rate) and hence other variables not included in this system (e.g., wages.)

Figure 5. Model 2 ′: Post-Sample Forecast Performance and Stability Test



Speed of Adjustment

The exercise revealed that asset prices and inflation both contributed to a prolonged period of disequilibrium in the money market. Thus, although a money demand relationship seems to hold in a long-run sense, such equilibrium takes time to be reestablished once it has been disturbed. Figure 2, for example, shows that once a money gap is opened, it takes about two years to return to equilibrium, with the full cycle lasting approximately four to five years.

Table 2. Speed of Adjustment Back to Money Market Equilibrium

	Model 1	Model 2	Model 2'	CV 1/	BC 2/
Speed of adjustment	-0.12	-0.09	-0.07	-0.14	-0.14
Half-life (quarters)	6	8	10	5	5

Sources: Staff estimates; Coenen and Vega (1999); Brand and Casola (2000).
1/ CV refers to the model of Coenen and Vega (1999).
2/ BC refers to the model of Brand and Casola (2000).

The empirical results confirm this finding. Table 2 shows the speed of adjustment coefficients and the implied half-life (in quarters) corresponding to these estimated coefficients.[29] The average half-life, across these different models, is 7 quarters, which indicates that once the money market equilibrium is disturbed it takes more than 2 years to reestablish. Undoubtedly, given the slow pace of adjustment of the money market, focusing on month-on-month monetary developments—relative to some equilibrium norm—becomes a trivial exercise.

IV. Conclusions

The stability of the money demand function in Europe has been debated even before the introduction of the single currency. Several studies had argued that, owing to increasing currency substitution in Europe during the process of monetary unification, an aggregate euro-area money demand function appeared to be more stable than any of the individual country money demand functions (Kremers and Lane, 1990; Artis, Bladen-Hovell, and Zhang, 1993; and Monticelli and Strauss-Kahn, 1993, among others).[30] This finding was confirmed recently, using aggregate euro-area data that covered the years through, and after, the introduction of the

[29] This is defined as the number of quarters it takes to close half of the monetary overhang Obviously, the adjustment is faster in the beginning and slows down (in percentage terms) as the gap is closed.

[30] Owing to currency substitution, individual country money demand equations could appear to be unstable and the residuals of these equations to be negatively correlated across countries.

single currency (for example see Coenen and Vega, 1999; Brand and Cassola, 2000; Kontolemis, 2001; Calza, Gerdesmeier, and Levy, 2001.) According to the ECB these findings have provided justification for the two-pillar framework.

However, since the second half of 2001 M3 has grown at a brisk pace, defying the ECB's reference value for M3. This pick-up in M3 growth, which has been unexpected in magnitude, is however only an escalation of a state of affairs that has characterized monetary developments in the euro area since the introduction of the single currency in January 1999. Consequently, these recent developments have, naturally, renewed (old) concerns regarding the stability of money demand in the euro area and hence the appropriateness of the two-pillar monetary policy strategy of the ECB.

In this paper we tested, and confirmed, the stability of long-run money demand for the euro area. This finding merely suggests that a stable relationship between the stock of real money balances, GDP, and interest rates exists over a long horizon, although some uncertainty exists regarding the size and particularly the source of the observed velocity trend in the euro area (also documented in Kontolemis, 2001, for example). However, the results imply that the equilibrium growth rate for M3 could be somewhat lower than the ECB's assumed rate of 4½ percent, and adjustment to back to equilibrium can be particularly slow.

Consequently, the strong growth of M3 observed during the last two years could be the result of a "normal" but sizeable deviation from equilibrium (e.g., related to a supply shock that affects prices or a demand shock that would have an impact on GDP), or, of a velocity shock. In terms of policy, the Central Bank must ascertain whether the deviations from long-run equilibrium are related to velocity shifts which may simply require a more accommodative stance, or, money shocks that may pose risks to price stability. Thus, although the existence of a long-run relationship is significant, a rigorous analysis of the short-run money demand and its properties are also important.

The slow speed of adjustment back to equilibrium also raises important questions for the policy makers. An analogy with exchange rate determination may be instructive. Although the overwhelming evidence is in favor of purchasing power parity in the long run, this model is hardly used for prediction of exchange rates. Similarly, the long-run money market equilibrium, as determined by the demand for money, may be a useful concept in judging the stance of monetary policy, only once it is established that money market disequilibria are corrected reasonably quickly. Otherwise, although long-run trends of M3 growth may contain useful information for the conduct of monetary policy, short-run movements should be discarded, or at least, be given considerably lower weight during month-to-month monetary policy deliberations.

The analysis presented in this paper revealed an important role of asset prices in the determination of M3 growth, and in particular in explaining deviations of the stock of M3 from a long-run norm. Dynamic M3 equations that do not take into account the evolution of asset prices are unstable and have a poorer forecasting record compared with alternative specifications that are estimated conditional on asset prices. Hence, it can be inferred that part of the protracted increase in M3 is explained by the unexpectedly high volatility in the equity markets. Consequently, although the analysis cannot reject the stability of the money demand in the long run, questions do arise regarding the stability of the dynamic M3 equations. It is shown that asset prices can correct for this—in all likelihood—"missing variable problem," but further work is needed on this topic. In addition, the shock to prices and the persistence of inflation since 1999 also seem to have contributed to the faster-than-expected growth in M3. Clements, Kontolemis and Levy (2001) show that while euro-area GDP reacts quickly to a (unanticipated) monetary shock, prices appear to be sticky in the short-run. Hence a supply shock that affects prices is unlikely to be reversed quickly through monetary policy tightening and consequently it should also have a prolonged impact on the demand for money.

Overall, it is safe to say that although there appears to be a stable (and stationary) linear combination that can be interpreted as a long-run money demand, there is considerable uncertainty about the correct, or true, functional form. The fact that the analysis is carried out during the period of disinflation in the 1980s and 1990s makes it very difficult to disentangle what is an autonomous trend in velocity and what is purely the result of the trend in the other variables, in particular inflation and interest rates. Thus there exists considerable uncertainty regarding the size of the assumed velocity trend in the calculation of the reference value.

All these issues raise questions about the usefulness of a reference value for M3 growth and call for a more pragmatic approach to the determination, and communication, of the reference value for M3 growth, especially given the high probability that a shock may again push long-run money demand away from equilibrium for a considerable period.[31] Imposing a point reference value cannot deal effectively with the amplitude of velocity shocks that hit the euro area and which, at least based on recent history, can be rather persistent. Under these circumstances, identification of velocity shocks is crucial for the conduct of monetary policy since deviations of money growth from the reference value, even though may not affect the balance of risks to price stability in the medium-term, could create communication problems to the central bank. Hence, a reference range may be a more pragmatic alternative to the current status quo—especially given the slow adjustment back to equilibrium, and the likelihood of unexpected velocity shocks—although such a system may also be misinterpreted as establishing a target range for M3 growth. Overall, these findings call for a less prominent role regarding communication of month-on-month aggregate M3 developments relative to the reference value, and more emphasis on the long-run link between monetary developments and inflation.

[31] Note first that this model also suggests that the speed of adjustment back to equilibrium is proportional to the size of the disequilibria. Hence, it is natural to observe fast (positive or negative) growth rates following a shock. These, however, do not call for a change in the monetary policy stance.

Econometric Methodology

The econometric methodology is based on the concept of cointegration or the existence of long-run relationships between variables.[32] These long-run economic relationships—for example, between money, income, and interest rates—, by defining the steady state equilibrium, also determine short-run dynamics. For example, for a given long-run money demand relationship—with a unit income elasticity and a negative interest rate semi-elasticity— excess money demand implies that interest rates will have to rise. Thus, every period the variables adjust and the disequilibrium is eventually closed. This very intuitive economic structure allows for a clearer understanding of the dynamics of these models.

Denoting by z_t the vector that includes all the variables of interest, the vector autoregressive (VAR) system takes the form:

$$z_t = \sum_{i=1}^{m} \pi_i z_{t-i} + cD_t + v_t$$

where D_t is a vector of deterministic terms.[33] This can be written in the error correction form as:

$$\Delta z_t = c_1 + \sum_{i=1}^{m-1} \pi_i^* \Delta z_{t-i} + \alpha(\beta' z_{t-1} + \gamma' t) + v_t$$

if $\alpha(\beta' z_{t-1} + \gamma' t)$is I(0), that is, if there exists at least one cointegrating vector between the variables in z_t. The term in parentheses represents the error correction mechanism, with β the cointegrating vector and α measuring responsiveness to error correction (or to the extent of long-term disequilibrium in the system). In the system above the trend is restricted to lie in the cointegrating space while the constant term is entered unrestricted. This is to avoid inducing a quadratic trend in the levels of these variables—not evident in these series—while still allowing for a drift in the equations in first differences (see also Doornik and Hendry, 1997, for example). Once the model is estimated and the number of cointegrating relationships established, the task is to identify unique cointegrating relationships that are consistent with economic theory.

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[32] Davidson et al. (1978) is the classic reference on error correction models, and more recently, in a multivariate context, Johansen (1988a,b and 1995), Hendry (1995), Doornik and Hendry (1997), and references therein.

[33] The matrix $c=[\, c_1 \; c_2]'$ and $D_t=[1 \; t]$.

Identification of unique cointegrating vectors

Appendix Table 3 shows the cointegration tests for models 1–4. Each panel presents the eigenvalues (μ) and the corresponding maximum eigenvalue (Max) and trace (Tr) statistics, on the left-hand side of the table, and the normalized β vector on the right. The test statistics are adjusted for degrees of freedom, as suggested by Reimers (1992), and the critical values from Osterwald-Lenum (1992) are reported automatically by PC-FIML.

In all cases there are two relatively large eigenvalues and the trace statistic suggests two stationary cointegrating vectors. The unrestricted cointegrating vectors that result from the estimation are long-run combinations that span the cointegrating space and do not identify any uniquely meaningful economic relationship.

Naïve Identification

Under this identification scheme, restrictions needed to identify a long-run money demand were imposed on the first cointegrating vector. These included a normalization relative to real money balances and a unit coefficient on GDP, which was not rejected in any specification. In addition, as the standard error on the long-term interest rate and inflation, were high these were also excluded from the cointegrating vector and the relevant tests conducted did not reject these zero restrictions. In addition, real money was simply excluded from the second cointegrating vector and the coefficient on GDP was normalized to one. For models 3-4 the asset price variable was also excluded from the second cointegrating vector. These restrictions were sufficient to identify the two cointegrating vectors and the *p*-value for the tests are reported in the text.

Appendix Table 3. Cointegration Test and Unrestricted (Normalized) Cointegrating Vectors

Model 1	Cointegration Test			β matrix (models just identified)					
r	μ	Max	*Tr*	*M*	*y*	*s*	l	p_s	$\Delta 4p$
0									
1	0.34	96.42**	72.01*	1.00	1.13	0.80	-	-	-
2	0.31	63.29**	47.27*	-	1.00	3.88	-3.52		5.10
3	0.21	33.97	25.37						
4	0.17	15.32	11.44						
5	0.00	0.422	0.31						
			Restrictions, $\chi^2(1)$=0.53[0.46]						

Model 2	Cointegration Test			β matrix (models just identified)					
r	μ	Max	*Tr*	*M*	*y*	*s*	l	p_s	$\Delta 4p$
0									
1	0.43	142.24**	99.14*	1	-1.28	0.73	-	0.06	-
2	0.36	97.71**	67.75	-	1	2.31	4.73	-6.09	-0.48
3	0.33	61.01**	42.47						
4	0.19	28.72	19.99						
5	0.13	11.62	8.09						
6	0.00	0.07	0.04						
			Restrictions, $\chi^2(1)$=0.35 [0.55]						

References

Angeloni, I., V. Gaspar, and O. Tristani, 1999, "The Monetary Strategy of the ECB," in *From EMS to EMU: 1979-1999 and Beyond*, ed. by D. Cobham and G. Zis, (New York: St. Martin's Press).

Artis, M. J., R. Bladen-Hovell, and W. Zhang, 1993, "A European Money Demand Function," in *Policy Issues in the Operation of Currency Unions*, ed. by P. Masson and M.P Taylor, (Cambridge: Cambridge University Press).

———, P. Mizen, and Z. Kontolemis, 1998, "Inflation Targeting: What Can the ECB Learn From the Recent Experience of the Bank of England," *The Economic Journal*, Vol. 108, pp.1810-1825.

Brand, C., and N. Cassola, 2000, "A Money Demand System for the Euro Area," ECB Working Paper, No. 39 (Frankfurt: European Central Bank).

———, D. Gerdesmeier, and B. Roffia, 2002, "Estimating the Trend of M3 Income Elasticity Underlying the Reference Value for Monetary Growth," ECB Occasional Paper No. 3 (Frankfurt: European Central Bank).

Bryan, M. F., S.G. Cecchetti, and R. O'Sullivan, 2002, "Asset Prices in the Measurement of Inflation", NBER Working Paper 8700.

Calza, A., D. Gerdesmeier, and J. Levy, 2001, "Euro Area Money Demand: Measuring the Opportunity Costs Appropriately," IMF Working Paper 01/179 (Washington: International Monetary Fund).

Casola, N., and C. Morana, 2002, "Monetary Policy and the Stock Market in the Euro Area," ECB Working Paper No. 119 (Frankfurt: European Central Bank).

Cecchetti, S., and others, , 2000, *Asset Prices and Central Bank Policy*, Geneva Reports on the World Economy 2, CEPR: (London).

Clements, B., Z. Kontolemis, and J. Levy, 2001, "Monetary Policy Under EMU: Differences in the Transmission Mechanism?," IMF Working Paper, 01/102 (Washington: International Monetary Fund).

Coenen, G., and J.-L. Vega, 1999, "The Demand for M3 in the Euro Area," ECB Working Paper No. 6 (Frankfurt: European Central Bank).

Davidson, J.D., and others, 1978, "Econometric Modeling of the Aggregate Time-Series Relationship between Consumers' Expenditure and Income in the United Kingdom," *Economic Journal*, Vol. 88, pp. 661–92.

Doornik, J.A., and D.F. Hendry, 1997, *Modeling Dynamic Systems using PC Fiml 9.0 for Windows*, (London: International Thompson Publishers).

———, and B. Nielsen, 1998, "Inference in Cointegrating Models: UK M1 Revisited," *Journal of Economic Surveys*, Vol.12, No. 5, pp. 533–72.

European Central Bank, 1999, "The Stability-Oriented Monetary Policy Strategy of the Eurosystem," ECB Monthly Bulletin, January, pp.39–50 (Frankfurt: European Central Bank).

Gerlach, S., and G. Schnabel, 1999, "The Taylor Rule and Interest Rates in the EMU Area," unpublished paper, BIS, Switzerland.

Giavazzi, F., and L. Spaventa, 1990, "The 'New' EMS," in *The European Monetary System in the 1990s*, ed. by P. De Grauwe, and L. Papademos (London: Longman).

Hendry, D.F., 1995, *Dynamic Econometrics* (Oxford: Oxford University Press).

Johansen, S., 1988a, "Statistical Analysis of Cointegrating Vectors," *Journal of Economic Dynamics and Control* Vol. 12, pp. 231-54.

———, 1988b, "Maximum Likelihood Estimation and Inference on Cointegration—With Applications to the Demand for Money," *Oxford Bulletin of Economics and Statistics* Vol. 52, pp. 169-210.

———, 1995, *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models* (Oxford:Oxford University Press).

———, 2002), "The Interpretation of Cointegrating Coefficients in the Cointegrated Vector Autoregressive Model," mimeo, (Copenhagen: University of Copenhagen).

Kontolemis, Z.G. 2000, "Interest Rates in the Euro Area: Modeling the ECB's Reaction Function," unpublished mimeo.

———, 2001, "The ECB's Monetary Stance: First-Pillar Considerations", in "Monetary and Exchange Rate Policies of the Euro Area—Selected Issues," SM/01/297 (Washington: International Monetary Fund).

Kremers, J.M., and T.D. Lane, 1990, " Economic and Monetary Integration and the Aggregate Demand for Money in the EMS," IMF Staff Papers, Vol. 37 No. 4, pp. 777-805 (Washington: International Monetary Fund).

Monticelli, C., and M.O. Strauss-Kahn, 1993, "European Integration and the Demand for Broad Money," *The Manchester School*, Vol. 61, pp. 345-66.

Osterwald-Lenum, M., 1992, “A Note with Quantiles of the Asymptotic Distribution of the ML Cointegration Rank Test Statistics,” *Oxford Bulletin of Economics and Statistics*, Vol. 54, pp. 461-72.

Reimers, H.-E., 1992, “Comparisons of Tests for Multivariate Cointegration,” *Statistical Papers*, Vol. 22, pp. 335-59.

Svensson, L., 2000, “The First Year of the Eurosystem: Inflation Targeting or Not?," *American Economic Review: Papers and Proceedings*, Vol. 90, pp. 95-99.