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M3 Money Demand and Excess Liquidity in the Euro Area

Christian Dreger and Jürgen Wolters

Abstract: Recent empirical studies have found evidence of unstable long run money demand functions if recent data are used. If the link between money balances and the macroeconomy is fragile, the rationale of monetary aggregates in the ECB strategy has to be doubted. In contrast we present a "stable" long run money demand relationship for M3 for the period 1983-2006. To obtain the result, the short run homogeneity restriction between money and prices is relaxed and a break in the income elasticity of money demand after 2001 is taken into account. Measures of excess liquidity do not significant inflation pressures.

Keywords: Cointegration analysis, error correction, excess liquidity, monetary policy, money demand

JEL Classification: C22, C52, E41

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1. Introduction

The primary goal of the European Central Bank (ECB) is to maintain price stability. To achieve this objective the ECB has developed the so-called two-pillar strategy, where monetary aggregates play a crucial role. In particular, one pillar is based on the economic analysis of price risks in the short term, while the other one is built on the analysis of risks to price stability in the medium and long run. Given the complexity of the monetary transmission process, central bankers "often also take into account some simple rules of thumb to guide or cross-check their action. One such rule is based on the fact that inflation is always a monetary phenomenon in the medium to long term. This rule recommends that central bankers be generally aware of monetary developments in order to assess inflation trends" (ECB 2004a: 47). In fact, the reference value for monetary growth is taken as a benchmark for assessing monetary developments. It is based on price stability which is seen to be consistent with consumer price inflation of below 2%. Potential output growth is estimated at around 2 to 2.5%, and a negative trend in velocity leads to an increase of money growth in a range between 0.5 and 1%. Given these assumptions, the target for money growth has been set at 4.5% per annum.

Since the end of 2001, monetary conditions became abnormally loose. Actual monetary growth has continuously exceeded its target. For example, M3 increased by 9.9% in 2006, after 7.3% in 2005. Due to uncertainties in the labor and capital markets and a greater risk aversion of agents due to significant losses in asset values, liquidity preferences have increased. Together with a relatively flat term structure of interest rates agents shifted their portfolios towards safe and liquid assets. During this process, inflation did not accelerate at all, thereby questioning whether a fixed reference path is a

reliable tool to interpret the monetary evolution. If the link between money and prices turns out to be increasingly unstable, money growth is not well-designed either for predicting future inflation prospects or for supporting policy decisions.

For monitoring the inflation process, a stable money demand function is extremely important, at least as a long run reference (see ECB 2004a: 64). If this condition is met, money demand can be linked to the real side of the economy. “Tracking the evolution of actual M3 developments against the paths implied by estimated money demand models is an important component of the ECBs monetary analysis” (ECB 2004b: 49). For the relevance of monetary aggregates in performing monetary policy see, for example, von Hagen (2004), Kirchgässner and Savioz (2001) as well as Kirchgässner and Wolters (2010).

However, recent evidence has cast serious doubts on concerning the robustness of money demand functions. If data up to 2001 are used, standard money demand functions for the euro area can be firmly established (see Fagan and Henry 1998; Hayo 1999; Funke 2001; Coenen and Vega 2001; Bruggemann, Donati and Warne 2003; Gerlach and Svensson 2003; Brand and Cassola 2004; Holtemöller 2004a, b). Extending the sample to a more recent period usually destroys these findings as a stable long run relation between the variables cannot be detected anymore (see Greiber and Lemke 2005; Carstensen 2006). This has led some authors to analyse relationships between the core components of the original variables, either generated by the Hodrick-Prescott (HP) filter or moving averages (see Gerlach 2004; Neumann and Greiber 2004). In other studies, measures of uncertainty are allowed to enter the long run equation. Adopting this modification, Greiber and Lemke (2005) and Carstensen (2006) find support for a stable money demand function. Nevertheless, as proxies for uncertainty should be sta-

tionary, this approach is not really convincing. Greiber and Setzer (2007) extend the standard specification by taken account of real house prices and housing wealth and obtained a stable long run relation with data up to 2006. Boone and van den Noord (2008) also include house and share prices in the long run money demand equation. Brüggemann and Lütkepohl (2006) have reported a stable money demand equation for euro-area time series up to 2002. In contrast to the other papers, they used German instead of euro area series until the end of 1998.

Despite the results from the previous literature, this paper presents strong evidence in favor of a "stable" long run money demand relationship specified in terms of a standard set of explanatory variables. The existence of such a long run relation allows quantifying excess liquidity which is a threat to price stability. In principle, excess liquidity can be measured differently (see Masuch, Pill and Willeke 2001, for a discussion). One option is the deviation of actual money from its equilibrium value, the latter calculated on the basis of the ECB's reference value for M3 growth[1]. However, one has to choose a base period arbitrarily. The monetary overhang defined as the difference between the observed monetary aggregate and the estimated long run money demand relation is a better indicator, as it takes the actual situation of the economy into account (ECB 2001). Furthermore, a real monetary gap can be considered. In addition to the error correction term, the deviations of the explanatory variables from their equilibrium values play a vital role. In the subsequent analysis, both measures do not point to severe inflation pressures in the future.

The rest of the paper is organized as follows. Section 2 reviews the specification of the long-run money demand function. In section 3 the time series used in the empirical analysis are discussed. Specification and estimation of money demand functions in error

correction form has been the customary approach to capture the nonstationary behavior of the relevant data. Evidence regarding the cointegration properties is provided in section 4. In section 5 an error correction model for money demand is presented. Section 6 concludes.

2. Specification of money demand

In this paper, a widely used specification of money demand is chosen as the point of departure. According to Ericsson (1998), the specification of the demand for a broad monetary aggregate leads to a long run relationship of the form

$$(1) \qquad m_t - p_t = \delta_0 + \delta_1 y_t + \delta_2 R_t + \delta_3 r_t + \delta_4 \pi_t$$

where m is nominal money taken in logs, p is the log of the price level, and y is log income, representing the transaction volume in the economy. Opportunity costs of holding money are proxied by nominal long (R) and short (r) term interest rates and the annualized inflation rate, i.e. $\pi=4\Delta p$, in case of quarterly data. The index t denotes time.

Price homogeneity is assumed to be valid as a long-run condition. In fact, the money stock and the price level might be integrated of order 2, I(2). If these variables are cointegrated, real money balances could be I(1). Then, the long run homogeneity restriction is appropriate for mapping the money demand analysis into an I(1) system; see Holtemöller (2004b). According to textbook presentations, the scale variable is expected to exert a positive effect on nominal and real money balances. Typical models in the literature differ in the opportunity cost measure (see Golinelli and Pastorello 2002, for a survey). If the costs refer to earnings on alternative financial assets, possibly relative to

the own yield of money balances, their coefficients should enter with a negative sign. Inflation is usually interpreted as part of the opportunity costs as it represents the costs of holding money in spite of holding real assets (see Ericsson 1998). But its inclusion can be justified by different arguments. In the presence of adjustment costs and nominal inertia, Wolters and Lütkepohl (1997) have shown that inflation should enter the long run relation for real balances, even if it is not relevant in the equation for nominal balances. See also Wolters, Teräsvirta and Lütkepohl (1998) on this point. Thus, the variable allows us to determine whether adjustment is in nominal or real terms (Hwang 1985). Alternatively, the inflation rate provides a convenient way to generalize the short run homogeneity restriction imposed between money and prices. While the restriction is justified from a theoretical point of view, there might be a lack of support in the particular observation period.

The parameters $\delta_1>0$, $\delta_2<0$, δ_3 and δ_4 denote the income elasticity and the semi-elasticity with respect to the return of other financial assets and inflation, respectively. The parameter δ_3 is positive when r is mainly a proxy for the own rate of interest of holding money balances, but negative otherwise. Due to the ambuigity in the interpretation of the inflation variable, the sign of its impact cannot be specified on theoretical grounds.

3. Data and preliminary analysis

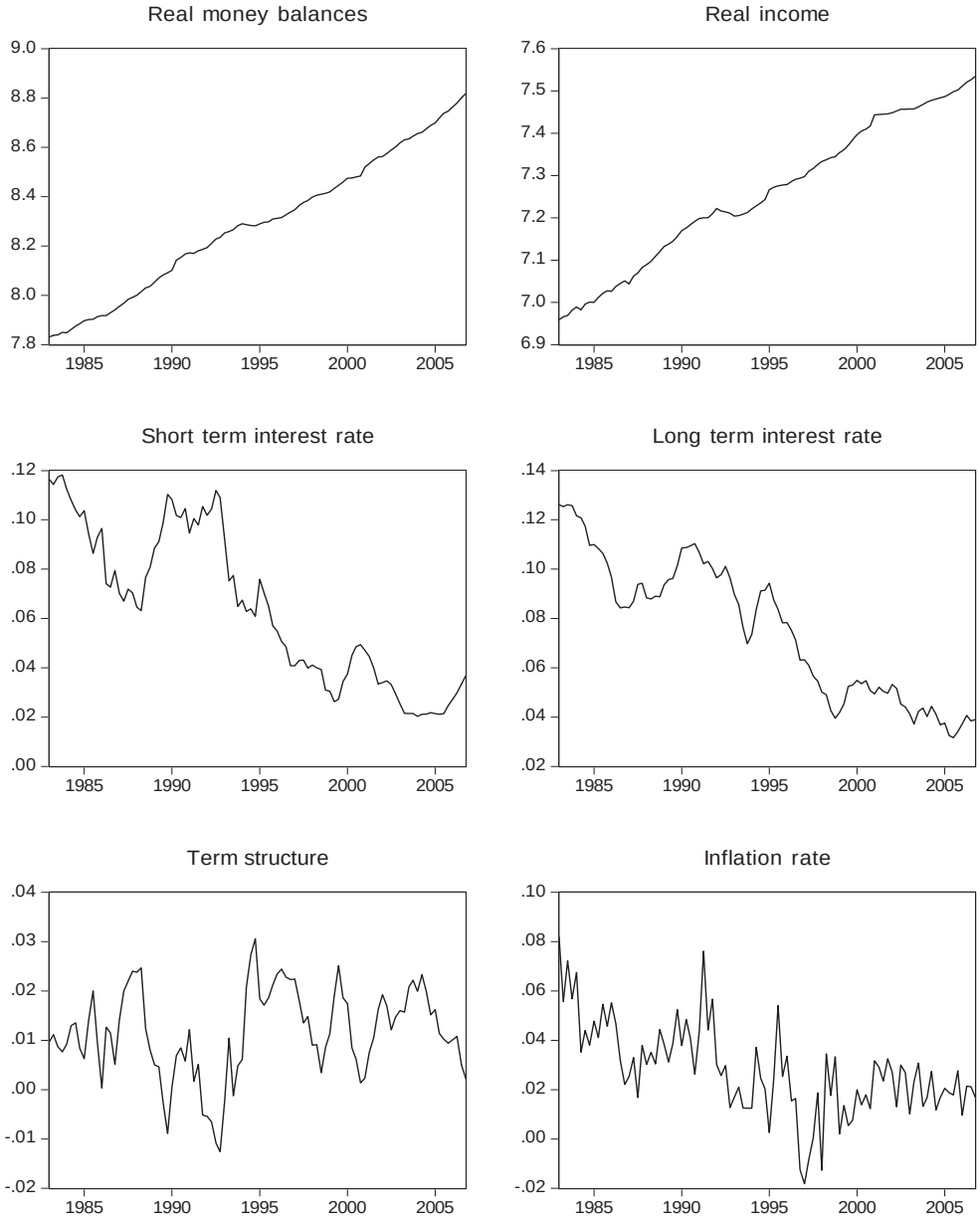
Since the introduction of the euro on January 1, 1999, the ECB is responsible for the implementation and conduct of monetary policy in the euro area. As the time series under the new institutional framework are too short to draw robust conclusions, they have to be extented by artificial data. Usually, euro area series prior to 1999 are obtained by

aggregating national time series (see for example Artis and Beyer 2004). Different aggregation methods are available and can lead to different results. By comparing aggregation based on methods using variable or fixed period exchange rates, Bosker (2006) has emphasized that the differences are substantial prior to 1983, in particular for interest and inflation rates. However, they are almost negligible for money demand variables from 1983 onwards. The European Monetary System started working in 1983, and the financial markets of the member countries have become much more integrated since then. Therefore, the observation period in this study is 1983.1-2006.4, where quarterly seasonally adjusted series are used.

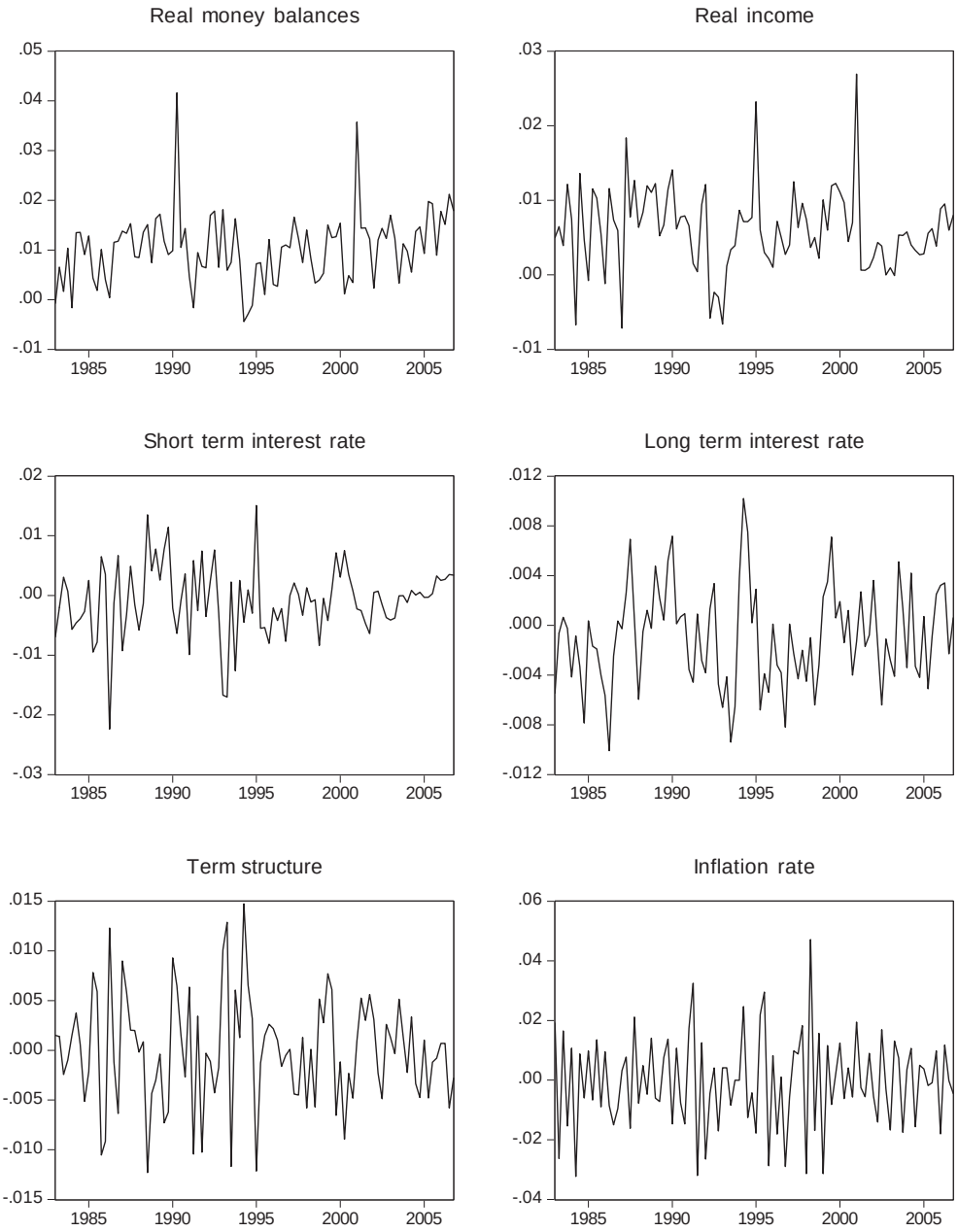
Nominal money balances are taken from the ECB monthly bulletin database and refer to M3 and end-of-period values. The short and long term interest rates r and R are also obtained from this source and defined by the end-of-period 3-month Euribor and ten-year government bond rates, respectively. Nominal and real GDP, as a proxy for income, are taken from Eurostat, the latter defined as chain-linked volumes with 2000 as the reference year. The GDP deflator (2000=100) is constructed to be the ratio of nominal to real GDP multiplied by 100. Due to evidence presented by Holtemöller (2004a), the Brand and Cassola (2004) GDP data should be used in earlier periods, as these data yield stable and economically interpretable results. Note that this choice does not affect any conclusions in this paper, as instability of money demand is a problem only in recent years. In order to obtain real money balances, the nominal money stock is deflated with the GDP deflator. Figure 1 shows the evolution of the time series in levels (A) and first differences (B) during the period.

Figure 1 Variables used in the empirical analysis

A. Levels


Real money balances
9.0
8.8
8.6
8.4
8.2
8.0
7.8
1985
1990
1995
2000
2005
Real income
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
1985
1990
1995
2000
2005
Short term interest rate
.12
.10
.08
.06
.04
.02
.00
1985
1990
1995
2000
2005
Long term interest rate
.14
.12
.10
.08
.06
.04
.02
1985
1990
1995
2000
2005
Term structure
.04
.03
.02
.01
.00
-.01
-.02
1985
1990
1995
2000
2005
Inflation rate
.10
.08
.06
.04
.02
.00
-.02
1985
1990
1995
2000
2005

B. First differences



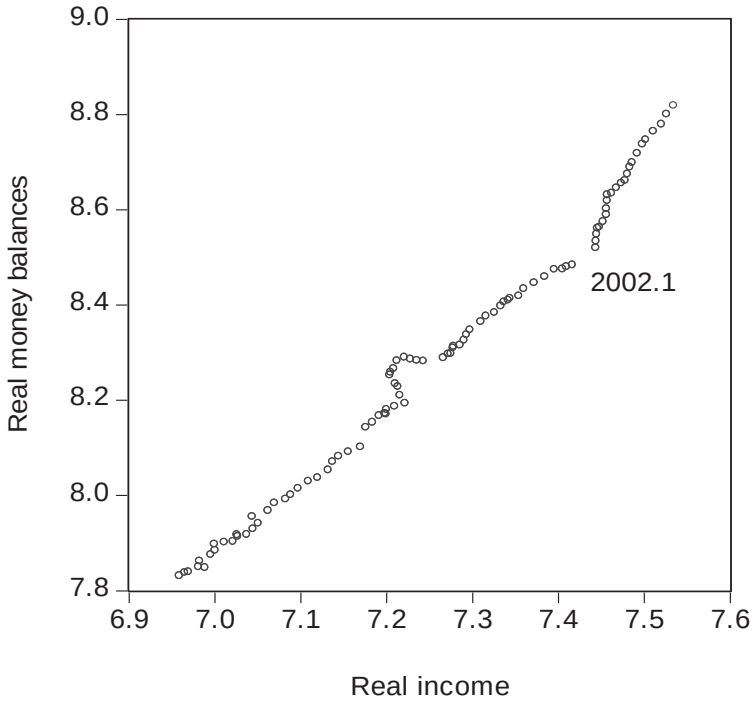
Note: Sample period 1983.1-2006.4. Panel A: Real money and real GDP are given in billions of euros and have been transformed to logs. Inflation calculated using the GDP deflator (2000=100). Inflation, the term structure and nominal interest rates are given as decimal numbers. Panel B: All variables are given in decimal numbers.

Several comments are in order. First, all variables, with the exception of the term structure, are integrated of order 1, I(1), implying that they are nonstationary in levels, but stationary in first differences.[2] The results of the integration tests are omitted here in order to save space, but can be obtained from the authors upon request. This well known result holds for different observation periods (compare the results in the aforementioned empirical studies). Second, outliers occur in real money balances; see the graph for the first differences. The first one (1990.2) is due to the German unification, while the other one (2001.1) refers to stock market turbulences; see Kontolemis (2002). In particular, the large decrease in stock market averages has raised the demand for liquid assets. In the subsequent analysis, these outliers are acknowledged by two impulse dummies, which are equal to 1 in the respective period and 0 otherwise (d902 and d011). Note that real GDP also has an outlier in 2001.1 which may compensate for the outlier in real balances during the same period.

Looking at the scatterplot of real money and real GDP reveals a clear permanent change in the income elasticity of money demand starting in 2002.1 that coincides with the introduction of euro coins and banknotes to the public (Figure 2). As such it might be explained by some kind of money illusion. However, the break although might be traced to the fact that permanent income expectations have been revised upwards in the euro area. If actual income is below its potential level, the income elasticity in the money demand function can have increased for the adjustment period. A break in the income elasticity has also been reported by Lütkepohl, Teräsvirta and Wolters (1999) for the German M1 aggregate. According to the strategy outlined in that paper, the break is captured by an additional income variable y^*, defined as the product of y and a step dummy s021 equal to 1 from 2002.1 until the end of the sample and 0 in the period be-

fore.[3] The transitory change in the income elasticity between 1992 and 1994 occurs just after the fall of the iron curtain, when a negative growth rate in real income and a positive change in real money balances can be observed.

Figure 2 Structural break in income elasticity



Note: Sample period 1983.1-2006.4. Increase in income elasticity from 2002.1 onwards.

4. Cointegration analysis

In systems including real money balances, real income, nominal interest rates and inflation, at least one cointegrating relationship should represent a long run money demand function in the style of (1). To explore the cointegration properties of different sets of variables, the Johansen (1995) trace test is used as the workhorse; see Table 1 for the results.[4] To correct for finite samples, the trace statistic is multiplied by the scale factor

(*T-pk*)/*T*, where *T* denotes the number of the observations, *k* the number of the variables and *p* the lag order of the underlying vector autoregression model in levels (Reimers 1992). The lag length of the vectorautoregressive (VAR) model in levels is determined by the Schwarz criterion and is equal to one throughout the analysis. All models are estimated with an unrestricted constant term and the two impulse dummies.[5]

Table 1 Cointegration tests for sample period 1983.1-2006.4

Variables	Rank null hypothesis	Johansen trace test	Finite sample correction
m-p, y	0	8.76	
	1	3.84	
*m-p, y, y**	0	21.33	
	1	4.83	
	2	0.21	
m-p, y, π	0	47.97**	46.47**
	1	8.10	
	2	0.20	
m-p, y, R	0	29.80	
	1	15.49	
	2	3.84	
m-p, y, r	0	22.02	
	1	9.03	
	2	1.38	
m-p, y, y, π*	0	76.19**	73.02**
	1	18.44	
	2	4.37	
	3	0.08	
m-p, y, y, R*	0	29.70	
	1	11.91	
	2	5.17	
	3	0.05	
m-p, y, y, r*	0	35.58	
	1	15.15	
	2	5.77	
	3	0.83	

Note: All models estimated with unrestricted constant terms and impulse dummies for 1990.2 and 2001.1. The finite sample correction is due to Reimers (1992). A (*), *, ** denotes significance at the 0.1, 0.05

and 0.01 level. Critical values are from MacKinnon, Haug and Michelis (1999), and are also valid for the finite sample correction. Lag order of 1 in underlying VAR models (level specification), according to the Schwarz criterion.

There is a strong indication of exactly one cointegrating vector in the (m-p, y, π) and (m-p, y, y^*, π) system, respectively. This evidence can be consistent with a money demand relationship in the long run, probably without the interest rates. Due to the increase in the income elasticity of money demand since 2002, the cointegration parameters in (m-p, y, π) are unstable. Therefore, the further analysis refers to the (m-p, y, y^*, π) system, which does not suffer from parameter instability. The inclusion of the variable y^* can capture the break in the income elasticity of money demand after 2001 in the cointegration space spanned by (m-p, y, π)[6]. As a drawback, replacing π with interest rates does not lead to a significant long run money demand equation. However, the economic content of the long run relation implied by the (m-p, y, y^*, π) system can be improved. In fact, the term structure R-r can be embedded, because it is a stationary variable. An augmented Dickey Fuller unit root test rejects the null hypothesis of nonstationarity with a p-value of 0.03.

As a standard procedure, the cointegration parameters are revealed using Johansen's reduced rank maximum likelihood (ML) estimator. However, the ML estimator should be applied with caution because it can produce extremely distorted and unreliable estimates in small samples. Furthermore, the usual diagnostic tests are not helpful in detecting the distorting factors. To overcome the problem, Brüggemann and Lütkepohl (2005) have recommended a two-step generalized least squares estimator, which is more robust in this regard. This so-called S2S estimator is used as a cross-check to the ML results.

The cointegrating relationships are estimated in two variants, both with and without the term structure. The results

$$ec_{1,ML} = (m-p) - \underset{(0.115)}{0.955}\, y - \underset{(0.005)}{0.031}\, y^{*} + \underset{(0.791)}{6.743}\,\pi$$

(2)

$$ec_{2,ML} = (m-p) - \underset{(0.080)}{1.096}\, y - \underset{(0.004)}{0.029}\, y^{*} + \underset{(0.566)}{5.534}\,\pi + \underset{(0.959)}{4.855}(R-r)$$

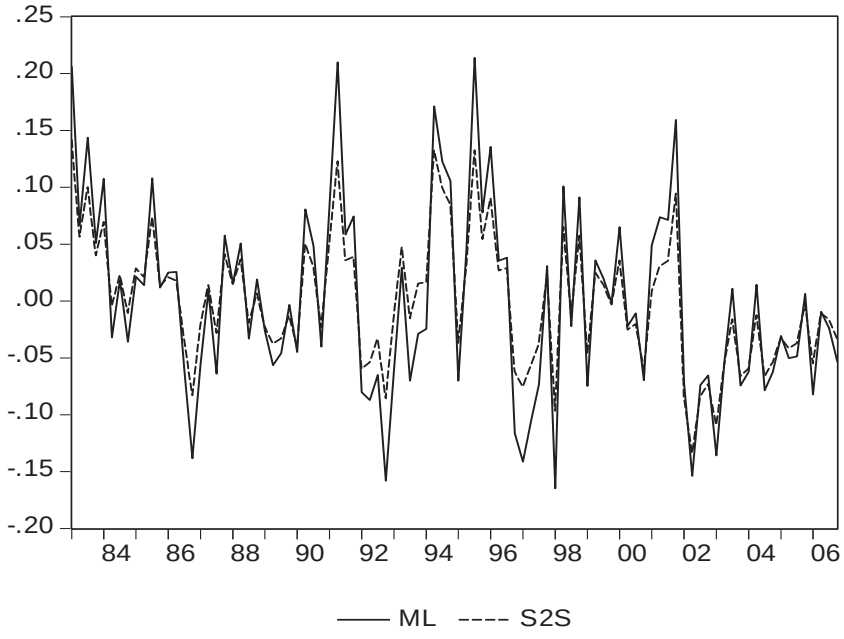
$$ec_{1,S2S} = (m-p) - \underset{(0.090)}{1.249}\, y - \underset{(0.004)}{0.025}\, y^{*} + \underset{(0.617)}{3.895}\,\pi$$

(3)

$$ec_{2,S2S} = (m-p) - \underset{(0.064)}{1.297}\, y - \underset{(0.003)}{0.023}\, y^{*} + \underset{(0.450)}{3.348}\,\pi + \underset{(0.761)}{3.233}(R-r)$$

are very similar for the different estimation methods (standard errors in parentheses). The inclusion of the term structure of interest rates contributes to slightly more precise estimates. The S2S parameters seem to be more stable than their ML counterparts. After controlling for a structural break in the income elasticity, the long run relationship appears to be stable over time.

Figure 3 Mean-adjusted deviations from the long run



Note: Sample period 1983.1-2006.4. Long run estimated according to (2) and (3), variants include term structure.

Because of its improved properties, the model including the term structure is used in the subsequent analysis. Under the assumption that *r* approximates the own rate of M3, the term structure may be interpreted as the opportunity cost of holding bonds. However, all the results remain valid when the more compact version is used. The mean-adjusted deviations from the long run relation are displayed in Figure 3 for the ML and S2S estimation methods. Overall, the equilibrium errors on the basis of the ML procedure seem to produce larger deviations from equilibrium, thereby reflecting the well-known deficits of this approach in small samples. However, no abnormal behavior can be detected over the full sample.

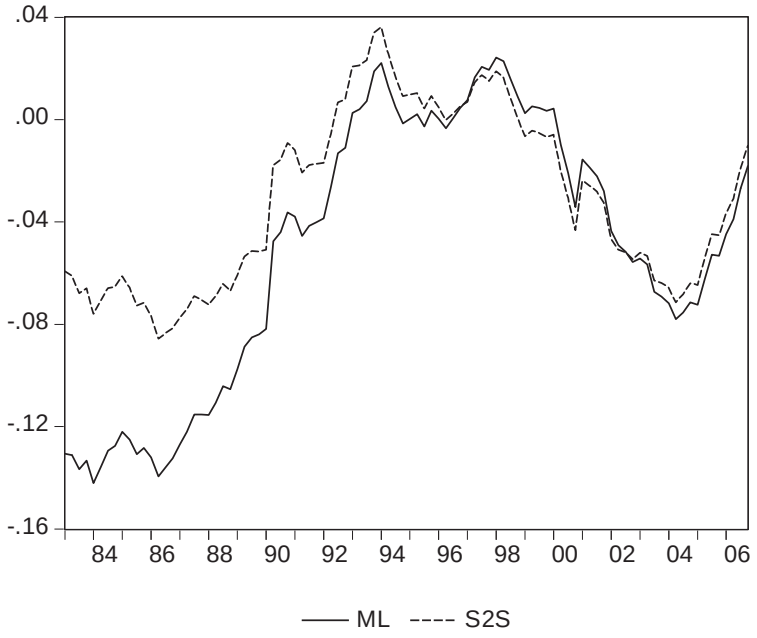
The monetary overhang coincides with the respective error correction term, as the latter shows the deviations from the long run development. The overhang falls far below 0.1% of the real money stock under both estimation methods. As an alternative, the so-called real monetary gap (*rmg*) is considered; see Hallman, Porter and Small (1991). Compared to the former measure, the deviations of the explanatory variables from their equilibrium values are also taken into account. In particular, using equation (1), the real monetary gap is defined as

$$(4) \qquad rmg_t = ec_t + \delta_1(y_t - \bar{y}_t) + \delta_2(R_t - \bar{R}_t) + \delta_3(r_t - \bar{r}_t) + \delta_4(\pi_t - \bar{\pi}_t);$$

see ECB (2004b: 65). The bar variables represent equilibrium or desired levels of the respective series. Since these measures are unobservable, they have to be estimated in advance. As different estimation methods can be involved here, the results are arbitrary to some degree.

To explore the size and development of the real monetary gap, parameter estimates from the extended versions of equations (2) and (3) are employed. The equilibrium level of income is estimated as the HP-filtered component of real GDP. The long run value for the term structure is set equal to the mean of the series (0.01), and inflation in the steady state corresponds to the ECB's inflation target of 2% (0.02). The results are displayed in Figure 4. ML and S2S methods both indicate an increase in the real monetary gap until the middle of the 1990s. Since 1999, the gap has declined. In the last years, *rmg* is on the rise again. In most recent years, it has remained negative. To sum up, no future inflation pressure can be detected from this behavior.

Figure 4 Real money gap



Note: Sample period 1983.1-2006.4. Long run gap estimated according to (2) and (3), variants include term structure of interest rates.

5. Error correction modeling

Whether or not the cointegrating relationship can be interpreted in terms of a money demand function is inferred from the error correction model. However, as we are mostly interested in the stability of a money demand equation, the analysis concentrates on conditional single-equation models. A conditional model may lead to constant coefficients even if a shift is present in the reduced form. Given the identification problems in full systems, a structural model for an individual variable might be easier to develop using the single-equation context.[7]

At the initial stage of the estimation process, the contemporaneous values and the first four lags in the changes in all variables, a constant term and the two impulse dummies are considered in addition to the error correction terms, ec_{ML} and ec_{S2S}, specified in (2) and (3). The regressions are again augmented by the term structure of interest rates. Variables with the smallest and insignificant *t*-values (0.1 level) are eliminated subsequently. The final money demand relationship is (*t*-values in parentheses)

$$\begin{aligned}\Delta(m-p)_t = {} & \underset{(7.93)}{0.028} - \underset{(6.15)}{0.039}\, ec_{ML,t-1} + \underset{(8.13)}{0.034}\, d902 + \underset{(7.25)}{0.031}\, d011 - \underset{(6.19)}{0.204}\, \Delta\pi_t \\ & + \underset{(2.61)}{0.173}\, \Delta(m-p)_{t-1} + \underset{(2.45)}{0.158}\, \Delta(m-p)_{t-3} - \underset{(2.89)}{0.193}\, \Delta(m-p)_{t-4} + \underset{(3.38)}{0.253}\, \Delta r_t + \hat{u}_t \end{aligned} \tag{5}$$

$$\begin{aligned}\Delta(m-p)_t = {} & -\underset{(5.41)}{0.048} - \underset{(6.28)}{0.055}\, ec_{S2S,t-1} + \underset{(8.13)}{0.034}\, d902 + \underset{(6.99)}{0.030}\, d011 - \underset{(5.90)}{0.185}\, \Delta\pi_t \\ & + \underset{(2.48)}{0.165}\, \Delta(m-p)_{t-1} + \underset{(2.28)}{0.146}\, \Delta(m-p)_{t-3} - \underset{(3.05)}{0.201}\, \Delta(m-p)_{t-4} + \underset{(3.15)}{0.234}\, \Delta r_t + \hat{u}_t \end{aligned} \tag{6}$$

T=96 (1983.1-2006.4).

For both variants we end up with the same specification with very similar coefficients and extremely large *t*-values for the error correction coefficients. According to their negative values, excess money lowers money growth, as one expects in a stable model. Moreover, changes in inflation are significant. The results point to substantial inertia in the adjustment of real money balances, as the adjustment to the long-run equilibrium is very low and up to four lagged changes of real money are relevant in the specifications. Finally, as the *t*-values indicate, the impulse dummies *d*902 and *d*011 should enter these equations.

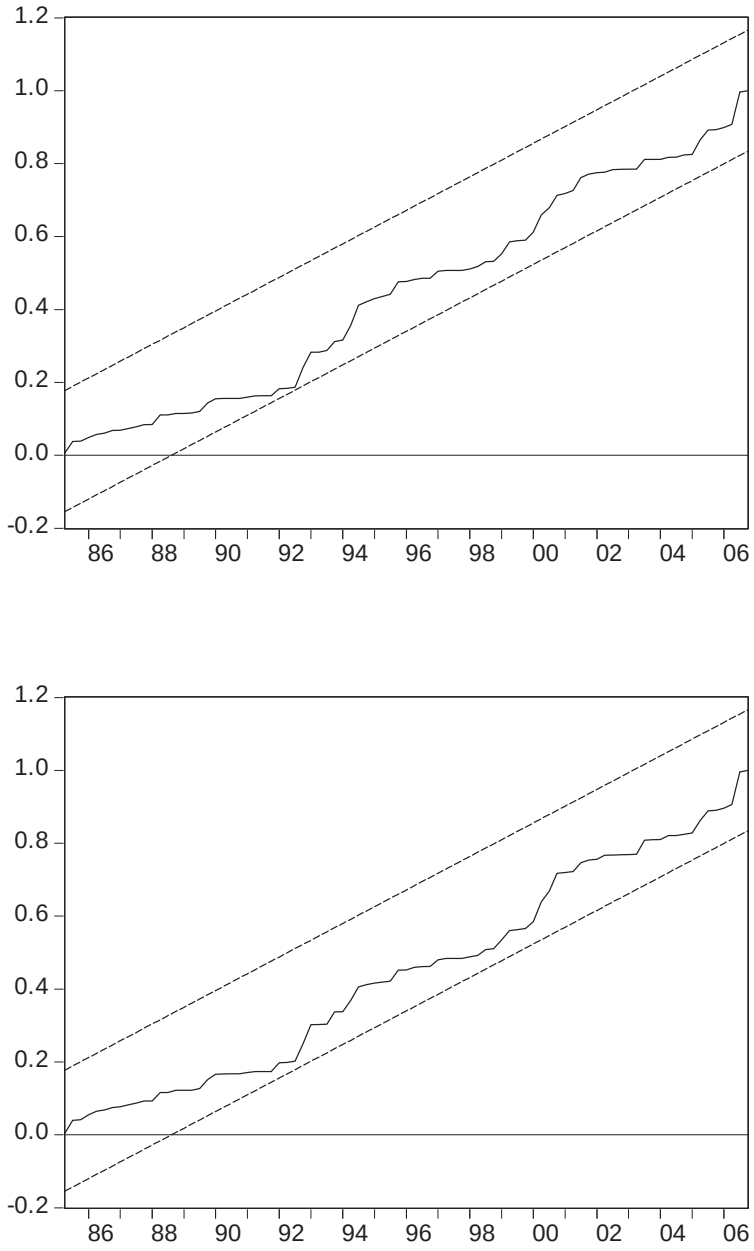
Standard specification tests are largely supportive of the model; see Table 2. *LM* is a Lagrange Multiplier test for autocorrelation in the residuals up to order 1, 4 and 8. The *p*-values show no problems with autocorrelated residuals. *ARCH* is a Lagrange multiplier test for conditional heteroscedasticity. Again, the residuals do not exhibit such behavior. Furthermore, they are distributed as normal, as indicated by the Jarque-Bera test. Moreover, the Ramsey *RESET* test does not point to misspecification. The cusum of squares test does not indicate any structural break in the regression coefficients; see Figure 5. Overall, the empirical evidence in favor of a stable money demand equation for the euro area is strongly supported by the error correction analysis.

Table 2 Standard specification tests of error correction models

	Equation (5)	Equation (6)
R2	0.66	0.66
SE	0.0042	0.0041
SC	-7.81	-7.82
JB	0.54 (0.76)	0.23 (0.89)
LM(1)	0.00 (0.99)	0.00 (0.95)
LM(4)	0.43 (0.79)	0.38 (0.82)
LM(8)	0.46 (0.88)	0.37 (0.93)
ARCH(1)	0.72 (0.40)	0.65 (0.42)
ARCH(4)	0.43 (0.79)	0.25 (0.91)
ARCH(8)	0.72 (0.68)	0.26 (0.98)
RESET(1)	0.02 (0.89)	0.15 (0.70)
RESET(2)	1.73 (0.18)	1.13 (0.33)
RESET(3)	1.19 (0.32)	1.06 (0.37)

Note: Sample period 1983.1-2006.4. R2=R squared adjusted, SE= standard error of regression, SC= Schwarz criterion, JB=Jarque-Bera test, LM=Lagrange multiplier test for no autocorrelation in the residuals, ARCH=Lagrange multiplier test against conditional heteroscedasticity, RESET=Ramsey test; *p*-values in parentheses.

Figure 5 Cusum of squares of the error correction models



Sample period 1983.1-2006.4. Dashed lines represent 0.05 significance levels. ML model (top) and S2S alternative (below).

6. Conclusion

In this paper we analyzed money demand behavior in the euro area, where special emphasis is given to the issue of stability. In fact, many researchers have detected instabilities especially when data after 2001 are included in the analysis. Such a result casts serious doubts concerning the rationale for including monetary aggregates in the monetary strategy of the ECB.

Monetary aggregates play a crucial role in the monetary strategy of the ECB. The rationale for the strategy requires a stable relationship between money and fundamental economic variables, which is re-established in the paper. In particular, we report strong evidence in favor of a stable money demand relationship for the M3 aggregate. This result can be achieved by including inflation in the cointegration vector, i.e., the short run homogeneity restriction between money and prices is not imposed. Furthermore a permanently larger income elasticity of money demand since 2002 is taken into account. This break coincides with the public introduction of euro coins and banknotes. In this setup, a stable long run money demand relationship is identified. The result is robust over different estimation methods. The corresponding error correction model survives a wide range of specification tests.

Excess liquidity refers to the difference between observed and equilibrium money balances. Different concepts have been adopted to define the equilibrium development of M3. Using the ECB's reference value of 4.5% for annual money growth rates would imply an equilibrium path which grows from an arbitrarily chosen starting value in a linear way, that is a linear trend with slope 0.045 (Masuch, Pill and Willeke 2001: 134). This strategy might be problematic as M3 develops more or less as an I(2) variable. Therefore the monetary overhang or the real monetary gap are strongly preferred as

measures of excess liquidity, as the economic situation and the statistical properties of the data are taken into account. The overhang is given by the error correction term and the real monetary gap is identified by equation (4). Applying these concepts suggest that there has been no problem with excess liquidity since 2001.

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[1] M3 refers to a broad monetary aggregate comprising currency in circulation, overnight deposits, deposits with an agreed maturity of less than or equal to two years and deposits redeemable at notice of less than or equal to 3 months plus repurchase agreements, money market fund shares and units, as well as debt securities with a maturity of less than or equal to two years.

2. For performing unit root tests see, for example, Kirchgässner and Wolters (2007, Chapter 5).

3. According to an augmented Dickey Fuller test y^* behaves like an I(1) variable.

4. For performing cointegration tests and estimating the long run parameters see, for example, Kirchgässner and Wolters (2007, Chapter 6).
5. All computations have been carried out with EViews 6 and JMulti 4.
6. Using recursive estimation methods, Dreger and Wolters (2010) have demonstrated that instability does not distort the results, if data up to 2004.4 are employed. If the observation period is taken beyond this point, the parameters become increasingly unstable in this specification. Estimating with the Johansen approach, the income elasticity for the period 1983.1 to 2001.4 in the model (m-p, y, π) gives a value 1.292, with a standard error of 0.046. Estimating in the same system with data up to 2006.4 leads to an income elasticity of 2.976, with a standard error of 0.477. This indicates a significant statistical discrepancy between the two income elasticities. Moreover, an income elasticity of 2.976 has no meaningful economic interpretation.
7. The single equation error correction model can be even justified by testing on assumptions of weak exogeneity. If the S2S estimator is used, all variables can be classified as weakly exogeneous with respect to the cointegrating relationship, apart from real money balances. Detailed results are available from the authors upon request.