Money demand in the euro area: new insights from disaggregated data

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Abstract

Conventional money demand specifications in the euro area have become unstable since 2001. We specify a money demand equation in deviations of individual euro area Member States variables from the euro area average and show that the income elasticity as well as the interest rate semi-elasticity remain stable. The corresponding deep parameters of the utility function have not changed. Aggregate money demand instability does therefore not result from altered standard factors determining the preference for holding money. Instead, other factors determine the aggregate monetary overhang. Since monetary developments cannot easily be explained by changing preferences, they should be closely monitored and might be a sign of imbalances.

JEL: E41, E51, E52

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1 Introduction

Monetary dynamics in the euro area has been exceptionally strong in recent years. The annual growth in M3 averaged 7.9% in the 2001-2008 period, reaching even two-digit growth rates from February 2007 to May 2008. At the same time, prices were comparably stable, with yearly inflation rates averaging 2.3% and never rising above 4%. The apparent divergence between money and prices has led to an intensive debate on the significance of the money stock for the Eurosystem's monetary policy strategy. Some observers are calling into question the stability of the long-run link between money and prices concluding that "the M3 aggregate ceased to display the empirical properties that supported its prominent role in the ECB monetary policy strategy" (Alves et al. 2007). Similar signs of instability occurred in other major economies (see Calza and Sousa 2003 for an overview). The assessment of a weakening link between money and prices is typically based on strong signs of instability or cointegration breakdown in money demand functions.

In this paper we specify a panel money demand equation in national deviations from euro area averages of the twelve countries which have been member of the euro area since 2001. The focus on national data instead of a euro area aggregate has the advantage that we can estimate the elasticities of the money demand equation abstracting from aggregate M3 developments and get a view of these elasticities at a disaggregate country-specific level. Our results suggest that there is no evidence that the strong money growth in the euro area in recent years has altered the long-run relationship between money and its traditional long-term determinants income and interest rates. A co-integrated money demand relationship can be established when national deviations from the euro area averages are taken during the period of aggregate money demand instability, i.e. 2001Q1 to 2008Q3. Moreover, both income and interest rate elasticities can be estimated with plausible coefficients.

Previous studies aim to fix the failing aggregate money demand specification by including additional variables in the aggregate money demand equation. The strong monetary growth is then explained by portfolio shifts due to macroeconomic uncertainty, technological innovations in the financial markets, or wealth effects related to the longstanding strong rise in asset prices in recent years. These studies provide useful extensions to the conventional money demand model. However, augmented money demand functions typically have a lower theoretical foundation and there is little direct evidence of structural changes in the euro area economy to suggest that the relative attractiveness of holding money as opposed to other financial instruments has been fundamentally altered in recent years (Fischer, Lenza, Pill, and Reichlin 2006).

Our results do not stand in contrast to these recent studies in the literature in which the conventional money demand models are augmented by additional variables. In fact, as we use national deviations from the euro average in our panel study, we leave the reasons behind the strong rise in money growth at the European aggregate unexplained. Rather, we show that these monetary dynamics in the post-2001 period cannot be attributed to a change in the adjustment of money holdings to its fundamental determinants income and interest rates. The long-run parameters have not changed and can be reliably estimated even in the recent period of aggregate money demand instability.

The rest of the paper is structured as follows: In the next section, we present a conceptual framework for our empirical model in light of recent contributions to European money demand. Section 3 outlines our empirical approach in detail. Section 4 presents the estimation results and provides robustness checks. Section 5 concludes.

2 Euro area money demand - conceptual framework

To fix ideas, consider a consumer who maximizes her lifetime utility depending on real consumption and real money balances.

$$\max E_0 \left[\sum_{t=0}^{\infty} \beta^t U \left(C_t, \frac{M_t}{P_t} \right) \right] \tag{1}$$

Each period, the consumer receives an income of Y_t and a real gross interest rate of R_t on bonds B_{t-1}. Moreover, he can transfer wealth from one period to the next by holding money. Money does not yield an interest rate. The corresponding budget constraint is

$$C_t + \frac{B_t}{P_t} + \frac{M_t}{P_t} = Y_t + R_t \frac{B_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} \tag{2}$$

Furthermore, assume that a Fisher-type equation holds such that

$$R_t = \frac{1 + i_t}{1 + \pi_{t+1}} = (1 + i_t) \frac{P_t}{P_{t+1}} \tag{3}$$

where i is the nominal interest rate and π the inflation rate.

The first order conditions of this intertemporal optimization problem imply that

$$\frac{U_{\frac{M}{P}}}{U_C} = \frac{i}{1+i} \tag{4}$$

To get an analytical solution, suppose that the actual utility function is given by a constant relative risk aversion (CRRA) type function:

$$U(C_t, \frac{M_t}{P_t}) = \frac{C_t^{1-\sigma} - 1}{1-\sigma} + b_t^{\delta} \frac{(\frac{M_t}{P_t})^{1-\gamma} - 1}{1-\gamma} \tag{5}$$

where b_t stands for shifts on the preference for money holding. Using this specific utility function and Equation 4 and solving for the real balances leads to a money demand equation:

$$\ln(\frac{M_t}{P_t}) = \frac{\sigma}{\gamma} \ln(C_t) - \frac{1}{\gamma} \ln(\frac{i_t}{1+i_t}) + \frac{\delta}{\gamma} \ln(b_t) \tag{6}$$

Money demand thus depends on real income (equal to consumption in the steady state), the opportunity cost of holding money i_t and exogenous preference shifts. The respective elasticities are a function of the deep parameters of the utility function.

The theoretical model suggests that real money balances can be modelled as a function of a transaction variable and an opportunity cost variable. In the standard model, the preference for holding money relative to consuming is held constant. The term b_t in the equation thus appears in the constant.

$$m_t - p_t = \alpha + \beta y_t + \gamma oc_t + e_t \tag{7}$$

where real money balances $m_t - p_t$ are calculated by a broad monetary aggregate (usually M3) deflated with the GDP deflator and the transaction volume y_t is typically proxied by real GDP (all in logs). No consensus exists as to which opportunity cost measure oc should be used. Typical choices include the long or the short term interest rate (Brand and Cassola (2004), Kontolemis (2002)), the difference between the long term government bond yield and the three-month money market rate (Coenen and Vega 2001), the spread between the three-month rate and the rate of return on M3 assets (Calza, Gerdesmeier, and Levy 2001), the short-term interest rate and the own rate of M3 separately (Bruggeman, Donati, and Warne 2003) or simply the inflation rate (Dreger and Wolters 2006). The econometric specification usually relies on co-integration, following Stock and Watson (1993). This has the advantage to derive the cointegrating vectors between the variables as well as the dynamic relationship in the form of an error correction model.

Regardless of the exact specification, the standard form of money demand has proven to be very stable for the euro area until 2001. A number of studies confirmed the existence of a cointegrating relationship between money, prices, real income and interest rate (spreads). Long-run income elasticity was estimated to be in a narrow range of about 1.1 to 1.4. Differences in interest rate semi-elasticities were somewhat larger depending on the choice of the opportunity cost variable, but the parameter estimates were also in plausible dimensions (see Table A-2 in the appendix for further details).

However, updating these standard money demand equations for the more recent period results in increasing instability (Carstensen (2003), Alves, Marques, and Sousa (2007)). The standard money demand equation turns out to be unstable with respect to the number of cointegrating relationships as well as to the long- and short-run parameters of the model. This seems to be the case for all alternative interest rate measures and also when considering the possibility that the longstanding historically low interest rate level may have heightened the demand for liquidity on a disproportionately large scale.[1]

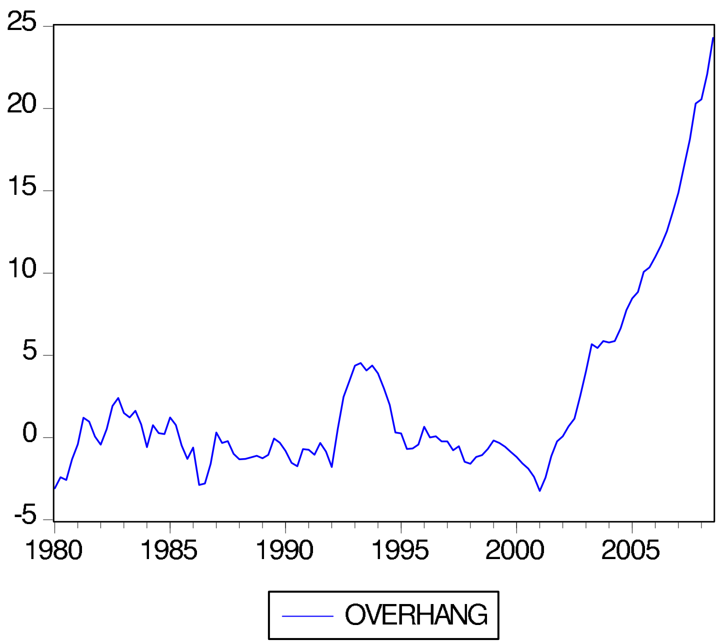

Figure 1: Monetary overhang. Residual of money demand equation

A simple re-estimation of the Calza, Gerdesmeier, and Levy (2001) money demand function illustrates the break in the relationship between money and its tradi-

[1]When specifying a money demand, this phenomenon can be taken into account by formulating a non-linear relationship between the money stock variables and the interest rate variable(s).

tional determinants. The model is based on a Vector Error Correction specification and consists of one cointegrating vector, which specifies the long-run demand for real money ($m_t - p_t$) as a semi log-linear function of real GDP (y_t) and the spread between the short-term market interest rate and the own rate of return of M3 ($rsown_t$). Using data up to 2000Q4, the long-run parameters of the original Calza et al. study can be closely replicated:

$$m_t - p_t = 6.19 + \underset{(0.05)}{1.31 y_t} - \underset{(0.32)}{0.64 rsown_t} + e_t \tag{8}$$

However, the relationship brakes down if the data-set is extended to the more recent period. A cointegration test for the period 1980Q1-2008Q3 fails to find evidence for a stable long term relationship and the parameter estimates are implausible.

$$m_t - p_t = 12.0 y_t + 72.9 rsown_t \tag{9}$$

Another possibility to illustrate the break in the relationship is to estimate the model until 2000Q4, freeze the parameters and lengthen the sample to the end of the sample (2008Q3). The underlying assumption of this procedure is that current distortions are temporary and the parameters will return to the "true values" as estimated in the specification until 2000Q4. As displayed in Figure 1, this leaves a major part of monetary growth in recent years unexplained. The monetary overhang, defined as the level between the actual level of M3 and the level of M3 implied by the specification in (8), was very small for most of the time, with the main exception of the period 1992-1993 during which a significant overhang emerged due to the inverted yield curve, which increases the attractiveness of holding short-term money. Starting from 2001, however, the monetary overhang has risen sharply, leading to a sustained accumulation of excess liquidity. In 2008Q3 the deviations of M3 growth from its benchmark have accumulated to nearly 25%.

A potential interpretation of such a break is that the fundamental link between money, income and prices has broken down because the underlying preference parameters have shifted. This would suggest that monetary developments would cede to provide useful information for monetary policy making. A new literature aims at explaining the instability of conventional money demand functions and potentially re-establishing a stable "new" money demand function.

The literature can broadly be classified in two groups. A first branch of the literature emphasizes portfolio motives, either related to the search for safe returns in times of extraordinary uncertainty (Greiber and Lemke (2005), Carstensen (2006) and Banque de France (2006)), because of structural changes in the economy due to financial innovation and changes in the management of liquidity by households and firms, which resulting in redefinitions of monetary aggregates (Ferrero, Nobili, and Passiglia 2007) or due to substitution effects in an international context (Santis, Favero, and Roffia 2008). A second branch of the literature stresses wealth effects and extends conventional money demand functions by asset prices (Greiber and Setzer (2007) and Boone and van den Noord (2008)). In terms of the model sketched above, the first branch can be thought of as time-varying shifts in the preference for holding money. The approaches intend to come up with explanations for these shifts. The second branch of the literature regards money as an asset. If the portfolio composition is assumed to be fixed, a rise in the value of other assets will also increase money holdings.

An important conclusion that can be drawn from the two branches of the literature is that monetary developments at times cannot be fully explained by real income or interest rates. Moreover, the studies show that common international developments such as asset price increases, affect the demand for money. However, it has also become apparent that the extensions to the conventional money demand model come at the expense of introducing other anomalies in the money demand behaviour at other points in the observation period (Fischer et al. 2008). In other words, it is extremely difficult to find variables that serve as a good proxy for the term b described in Equation 6. Our approach allows to abstract from different proxies for b and instead focuses on the estimation of the standard parameters of the money demand equation.

3 Empirical approach

We propose an approach, which avoids the problem of coming up with precise proxies for unexplained shifts in aggregate money balances. The approach relies on country specific developments and allows to estimate the deep parameters of money demand relating to the income and the interest rate. More specifically, the model presented above shows that money demand is a function of income of country i at time t, y_{it} , the opportunity cost of holding money, i_{it}, and the preference parameters σ, γ and b_t:

$$\ln(\frac{M_{it}}{P_{it}}) = \frac{\sigma}{\gamma}\ln(Y_{it}) - \frac{1}{\gamma}\ln(\frac{i_{it}}{1+i_{it}}) + \frac{\delta}{\gamma}\ln(b_t) \tag{10}$$

Deducting from this country specific money demand equation the average euro area money equation

$$\ln(\frac{M_t}{P_t}) = \frac{\sigma}{\gamma}\ln(Y_t) - \frac{1}{\gamma}\ln(\frac{i_t}{1+i_t}) + \frac{\delta}{\gamma}\ln(b_t) \tag{11}$$

yields a money demand equation in difference to the euro area average:[2]

$$\tilde{m}_{it} - \tilde{p}_{it} = \alpha + \beta_1\tilde{y}_{it} + \beta_2\tilde{i}_{it} + e_{it} \tag{12}$$

where $\tilde{x}_{it}$ specifies the deviation of the respective variable in country i from the euro area average. The estimated coefficients $\beta_1 = \frac{\sigma}{\gamma}$ and $\beta_2 = -\frac{1}{\gamma}$ reflect the same underlying parameters as in the aggregate money demand equation if the deep parameters of the utility function σ, γ, b are identical across countries. For σ and γ this can be reasonably assumed since aggregate money demand equation estimates of the euro area prior to 2001 provide similar figures to money demand equations of individuals countries. Moreover, we provide robustness checks with varying country compositions, which point at fairly stable estimates of the parameters. Regarding the time varying parameter of the utility function, b_t, we can also reasonably assume that it is similar across countries. First of all, to the extent that it captures shocks to risk aversion etc., empirical studies document a high degree of international correlation. For example, yield compression across asset classes has been a global phenomenon (Deutsche Bundesbank 2007, 15-33). Asset markets have seen strong increases on a global scale. Macroeconomic uncertainty is, as the current financial crisis documents, a highly correlated phenomenon across countries. Shifts in the preference for holding money should thus be globally correlated. Indeed, estimates for other regions of the world show similar signs of money demand instability as we document above for the euro area. For the US, it has been documented that a stable relationship between money, output and opportunity costs had been prevailing until the late nineties (Carlson, Hoffman, Keen, and Rasche 2000), but that for the more recent period, a stable cointegrating relationship can only be documented when additional variables are taken into account (Greiber and Lemke 2005, Greiber and Setzer 2007). Studies at the global level also suggest that the link between changes in the money supply and prices has been in recent years, at least if asset prices are neglected (Giese and Tuxen 2008).

A central advantage of estimating the money demand function in difference to the euro area average is therefore that it allows to take out global shocks to money

[2] Driscoll (2004) specifies a money demand equation in deviations of US states from the US average.

demand. This permits an easier identification of the income and interest rate elasticities without having to come up with more or less ad-hoc proxies for exogenous shifts in the preference for holding money. While the approach can thus not explain the evolution of aggregate monetary developments and does not solve the problem of monetary overhang, it is as a useful approach to testing the stability of the underlying deep parameters of the money demand equation.

The literature on money demand in the euro area has largely neglected a more disaggregated view. A notable exception is Carstensen, Hagen, Hossfeld, and Neaves (2008) who use information from individual country-level data to analyze money demand functions for the four largest EMU countries. They find sensible money demand functions for Germany, France and Spain until 2004Q4. In the case of Italy, the formal stability tests are less supportive of a stable long-run relationship, but the cointegration relationships are comparable to previous results in the literature. To our knowledge, no study on money demand in the euro area has so far estimated money demand in a panel context in deviations of the euro area average.[3]

Quarterly GDP data are in volumes and seasonally adjusted. GDP and the GDP deflator are taken from the Eurostat website. We use various measures for the opportunity cost variable. The deposit interest rate is from the MFI Interest Rate Statistics of the ECB and refers to the deposits with agreed maturity, up to two years. Long-term interest rates are country specific 10 year government bond yields averages of the quarter relative to the euro area average. In the empirical specification, we also include the spread between the long-term and the short-term interest rate (diff). The use of national interest rates as opportunity cost measures can be justified on the basis of the small degree of international integration in euro area retail banking. The share of euro area cross-border MFI loans granted to non-MFI's is minor and there are significant cross-country standard deviation of MFI interest rates on consumer credits and house purchase credits (Weber 2006). Moreover, significant home bias exist and national sovereign bonds therefore reflect a suitable proxy for the national opportunity cost of holding money. M3 are the national contributions to M3 calculated from the ECB's aggregate balance sheet of euro area monetary and financial institutions, excluding currency in circulation.[4] The M3

[3]Another example for a disaggregated view on European money demand is Von Landesberger (2007) who estimates sectoral money demand functions differentiating between the financial, the non-financial corporation and the household sector.

[4]Data are computed as 2.2-2.2.1-2.2.2-2.2.3.2.3-2.2.3.3.2+2.3+2.4-2.4.3 from the "Aggregated balance sheet of euro area monetary financial institutions, excluding the Eurosystem."

data are quarterlized and seasonally adjusted with the Census X12 methodology.

The sample ranges from 2001Q1 to 2008Q3 and thus includes the full period of dynamic monetary developments since 2001. In the case of short-term rates, however, the estimation period starts only in 2003Q1 as national data on deposit rates are not available before that date. The twelve countries with the euro as of 2001 are included, namely Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

In a further regression, we extent the sample back to 1999Q1 and therefore employ the full data set since the introduction of the euro. An extension to the period before the introduction is, however, not meaningful. Our approach involves taking deviations of national M3 contributions from the euro area average. The estimated income and interest rate coefficients indicate to what extent the national M3 contributions deviate from the average if income and opportunity costs deviate from the average. In other words, the coefficients are indicative of the distribution of euro area M3 across Member States.

To illustrate the national development of money growth since 1999, Figures 2 and 3 show real M3 (national contributions to M3 deflated with the GDP deflator) in those countries which have been member of the euro area since 2001. Money growth has been strong throughout the period, in particular after 2001 when monetary policymakers turned to a more expansionary policy in the course of the rapid downturn in stock markets and a number of further shocks such as September 11th. The unweighted average yearly growth rate of real M3 over the period 1999Q1 to 2008Q2 is 8.4%. This is substantially higher than the figure for the weighted euro area aggregate (6.2%) suggesting that smaller countries have been experiencing stronger monetary dynamics than larger countries. Ireland records by far the highest relative national contributions to real M3 with an average yearly growth rate of more than 22% since the start of EMU. By contrast, real money growth in Portugal has averaged only 2.5% since 1999. The largest euro area member countries account for yearly growth rates of real M3 of 6.6% (Germany), 7.4% (Italy), 8.4% (Spain) and 9.7% (France). Overall, the graphical inspection provides some glance for the view that there is some heterogeneity in national contributions to M3 in the euro area.

To assess the time series properties of the data, we performed panel unit root and co-integration tests of the variables included in the money demand equation. Table 1 provides the results of the Hadri (2000) stationarity test as well as the Im-Pesaran-Shin (IPS) panel unit root test. The results of the Hadri (2000) test

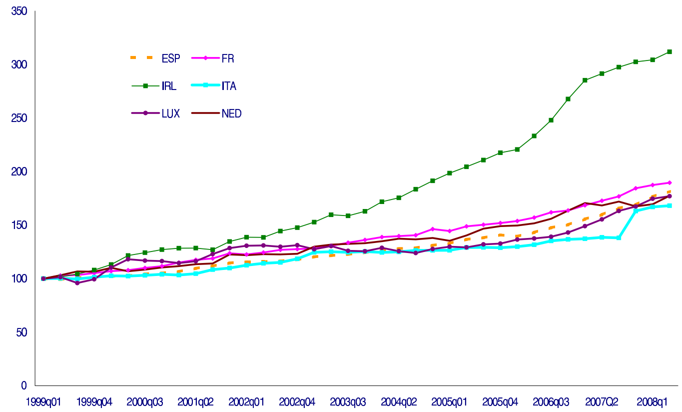

Figure 2: Real money growth in euro area countries (1999Q1=100), "Strong money growth countries"

Table 1: Results of panel unit root tests

	Hadri		IPS	
	z-statistic	p-value	tbar	p-value
real money balances	13.01	0.00	-1.47	0.46
real GDP	14.88	0.00	-1.12	0.89
deposit interest rate	9.79	0.00	-1.02	0.94
LT government yield	9.53	0.00	-1.46	0.5
Diff	8.45	0.00	-1.31	0.68

Notes: Hadri (2000) test for the null of (level) stationarity, controlling for serial dependence in errors. Controlling for heteroscedastic disturbances across units gives same results. Test results of Im Pesaran Shin (IPS) unit root test with two lags. The inclusion of four lags and trend yields comparable results.

show that for all series we reject the null hypothesis that the series is stationary. Performing the Im-Pesaran-Shin panel unit root test with the null hypothesis of a unit root confirms the result as we do not reject the null for any of the series. The results thus clearly point to the existence of a unit root for all series.

We therefore tested for panel co-integration. The Table 2 presents the statistics of the Phillips Perron group and the ADF test of co-integration. The test results point to the existence of a co-integrating relationship among the panel variables.

As a co-integration framework is appropriate, we estimate the money demand equation in a panel co-integration framework. We perform the estimation by dynamic ordinary least squares with one lead and one lag (DOLS(-1,1)). Dynamic

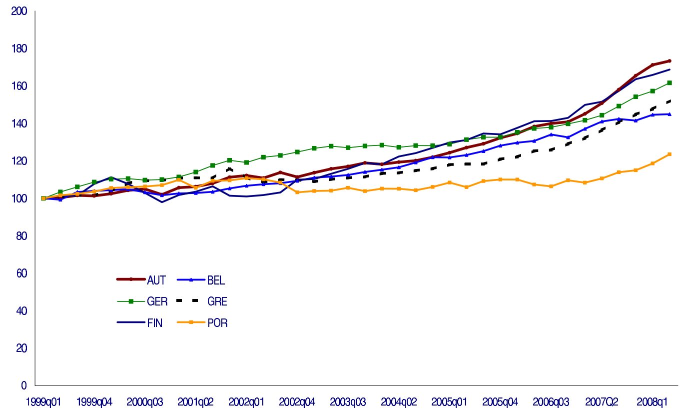

Figure 3: Real money growth in euro area countries (1999Q1=100), "Weak money growth countries"

Table 2: Results of panel co-integration tests

(M/P), (GDP/P), ST	Group PP	-4.74	0.00
	Group ADF	-3.92	0.00
(M/P), (GDP/P), LT	Group PP	-2.71	0.00
	Group ADF	-0.99	0.16
(M/P), (GDP/P), Diff	Group PP	-5.33	0.00
	Group ADF	-3.5	0.00

Notes: Pedroni (1999) group test for null of no co-integration among a multivariate vector (Group rho statistic).

OLS was originally developed by Stock and Watson (1993); Kao and Chiang (2000) analyze its properties in a panel context.[5] Our money demand equation takes the following form:

$$\begin{aligned} \ln(M_{it}/P_{it}) &= \beta_1 \ln(Y_{it}/P_{it}) + \beta_2 i_{it} + \varepsilon_{it} \\ &+ \rho_{11}\Delta\left(\ln(Y_{i,t+1}/P_{i,t+1})\right) + \rho_{12}\Delta\left(\ln(Y_{i,t-1}/P_{i,t-1})\right) + \rho_{21}\Delta\left(i_{i,t+1}\right) + \rho_{22}\Delta\left(i_{i,t-1}\right) \end{aligned} \tag{13}$$

where ε_{it} include country fixed effects and all variables are expressed as difference to the euro area average. The inclusion of leads and lags of the first difference of the regressors improves the efficiency in estimating the co-integration vector, which is given by (-1, β_1, β_2,). It is important to note that Kao and Chiang (2000) show that ε is by definition auto-correlated. When estimating equation (13), appropriate correction for the autocorrelation needs to be performed. We employ the correction

[5] See also Kao, Chiang, and Chen (1999) and Pesaran, Hashem, and Smith (1995).

of Newey and West (1994). Moreover, our standard errors are robust with respect to arbitrary heteroskedasticity. Finally, the estimation results presented constrain the short- as well as long-run dynamics to be the same across the countries. However, as a robustness check, we also allowed for different short-run dynamics for the countries. The main results were unaffected when estimating the less restrictive model. Moreover, the model includes country dummies.

4 Empirical results

4.1 Main results

Table 3 presents our central estimation results. We present dynamic OLS results, which cater for the co-integration of the series alongside with simple OLS estimation results. The estimation results reveal robust and standard estimates of money demand parameters. We find an income elasticity of real balances of roughly 1.6 for the sample 2003 to 2008, while for the sample starting in 2001, the income elasticity is at 1.2.

Regarding the semi-elasticity on the interest, we find that larger opportunity cost of money holding are connected with lower real balances. We present results of three different concepts of measuring opportunity cost. A short- and a long-run interest rate serve as the usual variable to capture the opportunity cost of holding money. Moreover, we use the difference between the long- and the short-run interest rate as a measure of the opportunity cost. All three interest rates are measures as a deviation from the euro area average. The estimated coefficients are somewhat smaller than those usually found but still in the range of standard estimates.

In regression F, we extend the sample back to the beginning of monetary union, i.e. 1999Q1. For this estimation period, only the long-run government bond yields are available as a measure of opportunity cost. The estimated income elasticity is slightly smaller at around 1, with a 95% confidence interval ranging from 0.65 to 1.34. The semi-elasticity of the interest rate is insignificant with a 95% confidence interval ranging from -0.05 to 0.20. The results are thus again within the range of normal estimates of income and interest rate elasticities. However, the results indicate that restricting the sample to more recent periods leads to somewhat higher income elasticity estimates, even though confidence intervals overlap. The values for the more recent period are, however, by no means in the range of the clearly unstable

Table 3: Results of panel co-integration estimation

	OLS				Dynamic OLS				
	A	B	C	D	E	F	G	H	I
real GDP	**1.43*****	**1.18*****	**1.53*****	**1.37*****	**1.67*****	**0.99*****	**1.2*****	**1.61*****	**1.59****
	13.3	13.5	14.8	13.2	5.9	5.55	5.6	6.8	5.85
deposit interest rate	**-0.05****				**-0.09*****				
	-1.98				-3.12				
LT interest rate		**-0.17*****	**-0.18*****			**0.1**	**-0.18*****	**-0.23*****	
		-5.16	-5.32			1.29	-3.34	-3.8	
diff				**-0.04**					**0.02**
				-1.6					0.74
sample	03Q1-08Q3	01Q1-08Q3	03Q1-08Q3	03Q1-08Q3	03Q1-08Q3	99Q1-08Q3	01Q1-08Q3	03Q1-08Q3	03Q1-08
N	264	336	264	264	228	416	324	252	228
R2	0.41	0.38	0.46	0.41					

Notes: All variables are measured relative to the euro area average. Data are at quarterly frequency. Panel includes euro area Member States except MT, CY, and SI. t-values are below the coefficient estimates in bold. * (**, ***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

estimate of the aggregate money demand equation.

Overall, the estimation results thus document rather standard money demand elasticities in the period, where the aggregate euro area money demand equation has become un-stable, namely 2001/3-2008. Moreover, the estimated coefficients are also similar to the coefficients estimated for individual euro area countries prior to joining the euro, see for example for Germany Scharnagl (1998).

This suggests that the underlying deep parameters of the utility function of euro area agents have not changed. As in standard money demand functions, economic agents hold more real balances with increasing incomes and less with larger opportunity costs of holding money.

The strong increase in real money balances in the last seven years can therefore not be considered to result from changing income and/or interest rate elasticities. Rather, the results support the notion that other variable(s) of macroeconomic relevance, which are not captured in the standard money demand equation, are behind the rise of real balances.

4.2 Robustness checks

In view of the heterogeneity in money growth across euro area countries, our results could be sensitive to the exclusion of individual countries. Table 4 present our robustness test with regard to sub-sample stability. In columns A and D, we exclude the largest EMU country, Germany, as it might unduely influence the estimates because of its size. Moreover, we exclude the three countries with the lowest monetary growth rates since the introduction of the euro, namely Portugal, Belgium and Greece (columns B and E) as well as the three countries with the most dynamic monetary developments, namely Ireland, Spain and France (columns C and F).

Overall, the robustness checks reveal a considerable degree of sub-sample stability. While the income elasticity is smaller than in the entire sample when one excludes the countries with strong monetary growth, the point estimate is still in the range usually encountered in empirical money demand studies, i.e. around 1. Thus, excluding the countries with very dynamic monetary developments reduces somewhat the income elasticity. By contrast, the income elasticity does hardly change compared to our baseline scenario when Germany or the countries with the lowest money growth rate are excluded from the sample.

The estimates on the interest rate semi-elasticity are stable and not affected by

Table 4: Robustness checks: results of panel co-integration estimation

Variable	A	B	C	D	E	F
real GDP	**1.64*****	**1.77*****	**0.92*****	**1.61*****	**1.68*****	**0.85*****
	5.77	5.6	5.08	6.79	6.54	4.92
short term interest	**-0.06****	**-0.08****	**-0.14****			
	-2.19	-2.77	-2.66			
long term interest rate				**-0.26*****	**-0.15***	**-0.19*****
				-4.44	-1.93	-3.17
N	209	171	171	231	189	189
omitted countries	de	pt, be, el	ie, es, fr	de	pt, be, el	ie, es, fr

Notes: All variables are measured relative to the euro area average. Data are at quarterly frequency. Panel includes euro area Member States except MT, CY, and SI. t-values are below the coefficient estimates in bold. * (**, ***) indicates significance at a 10 (5, 1) percent level. Estimation is dynamic OLS with country fixed effects. The sample ranges from 2001Q1 for the LT interest rate and 2003Q1 for the ST interest rate to 2008Q3.

the discussed changes in the sample. We consistently find a negative elasticity of the short-term and long-term nominal interest rate.

5 Conclusions

In the present paper we show that notwithstanding the strong monetary dynamics since 2001, the coefficients of a conventional money demand equation specified in national deviations from the euro area average are stable. The monetary overhang observed in the estimation of the aggregate monetary developments can thus not be explained by changed behaviour of economic agents with respect to income and opportunity costs of holding money. The corresponding deep parameters of the utility function indeed appear to be stable. Our results have two implications: First, an explanation for the aggregate monetary overhang should be related to new factors and variables becoming relevant. Second, this suggests to closely monitor monetary developments as they cannot easily be explained by changing standard preferences for holding money but might actually be a sign of imbalances.

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A Appendix

Table A-1: Johansen cointegration rank tests (trace statistics)

Number of cointegrating relationships	0	1	2
Critical value	29.8	15.5	3.84
sample 1980Q1-2000Q4	34.06*	12.41	0.126
sample 1980Q1-2008Q3	27.94	5.16	0.09

Notes: * denotes rejection of the null hypothesis at the 0.05 level; critical values due to MacKinnon, Haug and Michelis (1999). Variables employed: (m-p) , gdp , interest rate

Table A-2: Overview of money demand studies for the euro area since 2001 (selection)

	GDPR	RS	RM	RL	RS-RM	RL-RS	UNCER	INFL	DSPRICE	SPRICE	HOUSE	RL-US	PE	PE US
Coenen, Vega (2001)	1.14					0.82		-1.46						
	(0.06)					(0.35)		(0.32)						
Gerdesmeier et al. (2001)	1.34				-0.86									
	(0.04)				(0.29)									
Kontolemis (2002)	1.00	-1.45												
	(n.a.)	(n.a.)												
Bruggemann et al. (2003)	1.38	-0.81	1.31											
	(0.02)	(0.31)	(0.62)											
Brand, Cassola (2004)	1.34			-2.03										
	(0.03)			(0.15)										
Dreger, Wolters (2006)	1.24							-5.16						
	(0.09)							(0.72)						
Greiber, Lemke (2005)	1.29				-0.88		0.50							
	(0.04)				(0.22)		(0.06)							
Carstensen (2006)	1.30				-1.40		0.00			-0.09				
	(0.04)				(0.41)		(0.01)			(0.05)				
Banque de France (2006)	1.00			-0.04	-0.01				-0.05					
	1.00			(0.01)	(0.01)				(0.01)					
Greiber, Setzer (2007)	0.59			-0.48							0.48			
	(0.08)			(0.17)							(0.03)			
Boone, van den Noord (2008)	0.98	-0.44		-0.87						-0.03	0.32			
	(0.08)	(0.14)		(0.20)						(0.01)	(0.02)			
De Santis et al. (2008)	1.84			1.37								-1.37	0.38	-0.38
	(0.05)			(0.42)								(0.42)	(0.04)	(0.04)

Notes: standard errors in brackets; GDPR=real GDP, RS=short-term interest rate, RL=long-term interest rate, RM=own rate of return on money stock, INFL=inflation rate (for the GDP deflator), UNCER=uncertainty, HOUSE=house prices/wealth, SPRICE=stock prices, DSPRICE=change in stock prices, US=USA, P/E=price earnings-ratio