Scottish Journal of Political Economy, Vol. 56, No. 1, February 2009

MONEY DEMAND STABILITY AND INFLATION PREDICTION IN THE FOUR LARGEST EMU COUNTRIES

Kai Carstensen, Jan Hagen**, Oliver Hossfeld*** and Abelardo Salazar Neaves*****

Abstract

In this paper, we analyze the money demand functions of the four largest EMU countries and of the four-country (EMU-4) aggregate. We identify reasonable and stable money demand relationships for Germany, France and Spain as well as the EMU-4 aggregate. For the case of Italy, results are less clear. From the estimated money demand functions, we derive both EMU-4 and country-specific measures of money overhang. We find that the EMU-4 overhang measure strongly correlates with the country-specific measures, particularly since the start of EMU, and is useful to predict country-specific inflation. However, it generally does not encompass country-specific money overhang measures as predictors of inflation. Hence, aggregate money overhang is an important, but by far not an exhaustive, indicator for the disaggregate level.

I Introduction

Since the middle of 2001, M3 growth in the euro area has consistently exceeded the reference value of 4.5% set by the European Central Bank (ECB), while consumer price inflation remained near the target of 2%. These observations raise doubts about the stability of money demand as well as the information content of M3 growth for future inflation – two properties that were the main reasons named by the ECB to build its monetary policy strategy around a monetary aggregate. Hence, further analysis is clearly indicated.[1] While a wide range of recent studies deals with the money demand relationship in the euro area, it has been analyzed almost exclusively on the basis of aggregate euro area data.[2] At the first look, this may not be surprising since the ECB should be

*Ifo Institute for Economic Research and Ludwig Maximilians University of Munich, Germany
**European University Institute, Italy
***Leipzig Graduate School of Management, Germany
****University of Nottingham, UK

[1] See e.g. ECB (2003a, p. 21) and Goodhart (2006).

[2] See Section II of this paper for a brief review of this literature.

exclusively concerned with the development in the euro area as a whole. However, a disaggregate analysis on the basis of individual country data can lead to additional important insights both for the European Monetary Union (EMU) member countries and for the euro area as a whole.

As concerns the individual EMU member countries and their central banks, they should be interested in the timely detection of national imbalances. Assuming that monetary aggregates and, in particular, money overhang, which is defined as the deviation of actual M3 from the money demand equilibrium, carry important information with respect to the state of the monetary and financial system, they should closely track the evolution of these quantities at the country level. This is ever more important if one follows Milton Friedman's proposition that inflation is always and everywhere a monetary phenomenon because then money overhang may indicate future inflationary pressure for the respective country. But a sensible measure of excess money is not necessarily invariant to the country of interest. This obviously holds for the 4.5% reference value that was derived by the ECB from aggregate developments in the euro area and, thus, disregards any deviating developments in the individual member countries. It may also hold for more elaborate measures like the money overhang because the monetary and banking systems, the preferences of households and, hence, the money demand functions are probably not equal across countries.

As concerns the euro area as a whole, there are at least three reasons why national developments should be of interest. First, for the optimal conduct of monetary policy it may prove beneficial to use national information if the national monetary transmission mechanisms are asymmetric (de Grauwe and Senegas, 2003). Second, and related to the first point, inflation forecasts constructed by aggregating country-specific models outperform inflation forecasts constructed by using aggregate euro area data only (Marcellino *et al*., 2003). Similarly, country-specific inflation rates help to explain area-wide inflation even after controlling for aggregate macroeconomic information (Beck *et al*., 2006). This implies that if monetary developments have predictive content for inflation, it should pay off to augment the aggregate information set with national money overhang measures. Third, even if the national variables did not carry additional information over the aggregate ones, the construction of the ECB Governing Council would nevertheless entail considerable importance for national developments because the majority of the council members represent national central banks and may come into strong national pressure if the national developments diverge from the aggregate ones (Heinemann and Hüfner, 2004). In such a situation, it is at least possible that they will feel committed to the countries they represent rather than to the euro area as a whole.

As a first illustration of the cross-country differences, compare euro area M3 growth with the growth of the contributions to M3 of the four largest countries in the EMU, see Figure 1. After a short drop in early 2004, euro area M3 has again been growing excessively compared to the reference value defined by the ECB. For the single countries, a quite diverse picture emerges. In Germany, the

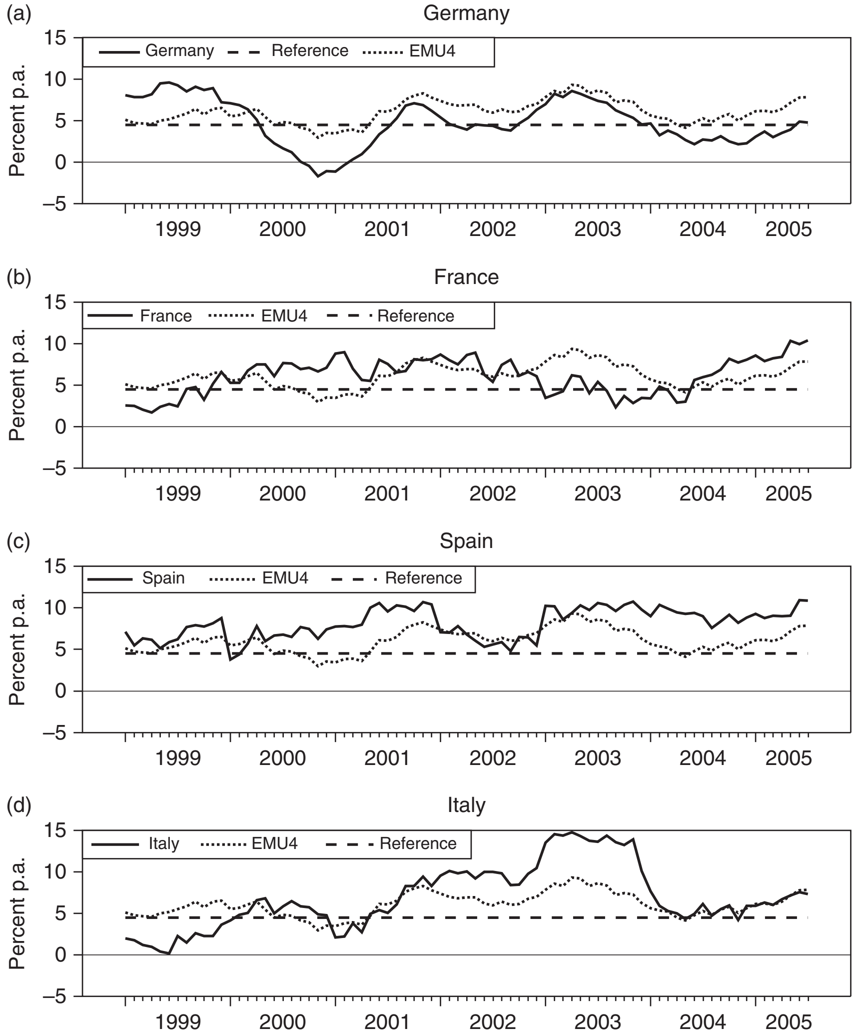

Figure 1. Individual country and areawide M3 growth.

M3 growth fluctuates around the (EMU-12) reference value over the whole EMU period without showing any sign of protracted excess money growth, especially since 2004. In France, the M3 growth exceeded the reference value between January 2000 and December 2002 and since the middle of 2004, but there were at least also short periods of low M3 growth. In contrast, Italy and particularly Spain experienced M3 growth rates in excess of the reference value for almost all the EMU Stage Three period. Hence, developments in the single countries exhibit different patterns than in the aggregate. This indicates that the countries may be subject to asymmetric shocks and exhibit different underlying trends and transmission mechanisms so that the area-wide reference value is of limited use to assess national M3 growth rates. Therefore, it may in fact be fruitful to analyze the monetary conditions within each country separately.

This is reinforced by previous empirical comparisons of national and aggregate money demand functions. Golinelli and Pastorello (2002), Dedola *et al.* (2001) and Wesche (1997) reject the hypothesis that aggregate and national money demand specifications and coefficient estimates conform with each other.[3] Therefore, Dedola *et al.* (2001) conclude that information from country-level analysis of money demand may therefore be useful for euro area monetary policymaking. This is corroborated in a more direct way by Wesche (1997) who finds that the average fit of the national money demand functions is better than the fit of the aggregate money demand function.

The present paper adds to this literature by assessing the forecasting power for national inflation rates of national, as opposed to aggregate, monetary indicators, particularly money overhang. To this end, we separately specify and estimate single country and aggregate money demand functions for the four largest countries of the monetary union (EMU-4): Germany, France, Italy and Spain. As these four countries account for more than 70% of aggregate M3, the relationship between these four individual countries and the four-country aggregate should be a good indicator of the relationship between country-level data and the EMU-12 aggregate.[4] Then, we formally analyze the stability of the four disaggregate, as well as the EMU-4 aggregate, money demand functions because stability is often quoted as a precondition for good forecasting power. Finally, and most importantly, we assess to what extent the information content of measures of money overhang with respect to future national inflation rates differs between country-level measures and aggregate measures. In this regard, our data set allows for a first look at the question whether these indicator properties have changed since the introduction of the euro.

The remainder of this article is organized as follows. In Section II, we present a brief review of the recent literature on euro area money demand. In Section III, we analyze the long-run money demand functions of the four individual countries and the EMU-4 aggregate. The estimation results are used in Section IV to construct and compare measures of money overhang and their information content with respect to future inflation. Section V concludes.

II Recent Literature on Euro Area Money Demand

For the euro area, there is a large number of papers that estimate aggregate money demand functions and test their stability. Most of them exclusively use synthetic data for the pre-EMU period,[5] but the more recent papers add data on

[3] Cassard *et al.* (1997) report that the aggregation restrictions for the core ERM countries cannot be rejected. However, they only analyze the small and not very recent sample from 1980 to 1990.

[4] In fact, the EMU-4 aggregate M3 growth closely tracks the EMU-12 aggregate M3 growth. See the working paper version of this paper for a figure.

[5] See, e.g., Hayo (1999), Bruggemann (2000), Clausen and Kim (2000), Coenen and Vega (2001), Funke (2001), Müller and Hahn (2001), and Golinelli and Pastorello (2002).

the first years of EMU.[6] Overviews are presented by Golinelli and Pastorello (2002) and Brand *et al.* (2002).

Almost all papers find euro area money demand to be stable until the EMU started in 1999, even though they differ in many respects (sample, variables, estimation procedure, geographic area, aggregation method). A further outstanding result for studies with sample periods ending prior to 1999 is the higher stability of the area-wide compared with the country-specific money demand functions. It is, however, not clear how this can be explained properly, see Müller and Hahn (2001) and Calza and Sousa (2003) for a discussion. The stability issue has received particular attention since M3 growth started to accelerate in 2001. While some authors found the EMU money demand function to be stable (Bruggemann *et al.*, 2003; Dreger and Wolters, 2006), others are more skeptical (Greiber and Lemke, 2005; Alves *et al.*, 2006; Carstensen, 2006b). Therefore, the stability question remains unsettled.

III Cointegration and Stability of Money Demand

In this section, we present estimated long-run money demand functions of the EMU-4 countries and of the EMU-4 aggregate for the sample from 1979Q4, after the start of EMS I, to 2004Q4.[7] We used the data set of Golinelli and Pastorello (2002) extended until 2004Q4. Details are given in the Appendix.

Including pre-EMU data in the analysis is standard in the literature even though the introduction of the euro may have created a structural break in relationships like money demand. However, the limited amount of observations since 1999 prevents the exclusive use of post-EMU data. To check for the potential stability problem, we report a number of stability tests. Moreover, a money demand instability will bias the forecasting results against the national money overhangs because it is well documented that aggregate money demand is more stable than national ones. If national money overhangs nevertheless turn out to be important, this is an even stronger result.

This also holds for another problem with our approach. Money balances are measured according to the residence concept, which means that money holdings of all residents of the EMU are taken into account. Hence, cross-border money holdings within the EMU are included in the national M3 series. To the extent that, e.g., French agents hold deposits in Italy or cash associated with Germany, the information content of national M3 for home inflation should be reduced. This again leads to unstable national money demand functions. Thereby, it introduces a bias against, and reinforces any forecasting success of, national monetary indicators.

Following the literature, we assumed that real money demand depends on real GDP as the transaction variable and one or more indicators of the opportunity costs of holding M3 like an interest rate or inflation rate. Since there

[6] See, e.g., Brand and Cassola (2000), Calza *et al.* (2001), Kontolemis (2002), Bruggemann *et al.* (2003), Greiber and Lemke (2005), and Carstensen (2006b).

[7] Because we used up to two lags for the VAR models, the effective sample start for all countries is set to 1980Q2.

are various such indicators available, we examined a large number of different specifications for each country, of which we only report the most promising ones. For the EMU-4 and Germany this was the long-term interest rate, for France the spread between the long-term and short-term interest rate and the German short-term interest rate (to account for currency substitution), for Spain the inflation rate, and for Italy the spread between the long-term and short-term interest rate. It was not possible to find the same specification leading to sensible and stable results for all countries and the EMU-4 aggregate. This indicates that the assumption of homogenous countries often implicitly made when analyzing the euro area is not supported by the data.

For each set of variables, we first performed a cointegration analysis. To this end, we set up a VAR model with a lag order selected by the Bayesian information criterion (BIC) and the Hannan-Quinn criterion (HQ)[8] and tested for cointegration by means of the Bartlett corrected trace test (Johansen, 2002) and the Saikkonen and Lütkepohl (2000) S&L-test. Then we estimated the long-run money demand parameters both with the full information maximum likelihood (FIML) method of Johansen (1988) and, as a robustness check, with fully modified ordinary least squares (FM-OLS) proposed by Phillips and Hansen (1990). Finally, we analyzed the stability of the resulting cointegration relationships with the help of several stability tests that are designed for cointegrated models. We did this not only because it is generally advisable to formally investigate the stability of the cointegrating relationships, as emphasized, inter alia, by Bruggemann *et al.* (2003), but particularly because our sample includes the start of EMU that may induce a break in the variables, specifically so in M3.

The cointegration tests in Table 1 indicate that there exists one long-run relationship within the set of variables analyzed for each country.[9] The corresponding long-run parameters are displayed in Table 2. They appear sensible and are grossly in line with the previous literature. In particular, the income elasticity is near one and the effect of the opportunity cost variables is negative. Only for Italy, the large estimate for the income elasticity and the differences between FIML and FM-OLS indicate some problems. Given these estimates, it is not surprising that the economically interesting hypothesis of a unit income elasticity is rejected for France and Italy (Table 1, bottom panel). In addition, the exclusion of the opportunity cost variables from the cointegration space is strongly rejected for all countries. Therefore, we use the unrestricted estimates.

The stability tests are presented in Table 3. The EMU-4 money demand function is stable by all criteria. For Germany, only the *supQ* statistic of the VAR model indicates instability. This is probably due to the German unification

[8] We use the BIC and HQ due to their consistency in nonstationary systems as shown in, e.g., Paulsen (1984).

[9] For France and Italy, the S&L-test even indicates two long-run relationships. However, if we impose a cointegration rank of two, we obtain for both countries two irreducible cointegration vectors (Davidson, 1998) the linear combination of which almost exactly resemble the cointegration vector estimated under the assumption of one long-run relationship.

Table 1
Cointegration Tests

	EMU-4	Germany	France	Spain	Italy
VAR lag order					
BIC	2	1	1	2	1
HQ	2	1	1	2	2
Trace statistics (Bartlett corrected)					
Rank $\leq$ 0	28.32**	27.48*	48.90**	33.36**	30.68**
	(0.073)	(0.090)	(0.039)	(0.019)	(0.039)
Rank $\leq$ 1	6.76	3.64	20.22	3.86	11.24
	(0.606)	(0.930)	(0.407)	(0.915)	(0.197)
Rank $\leq$ 2	0.70	0.00	4.15	0.32	2.77
	(0.404)	(0.977)	(0.891)	(0.569)	(0.102)
Rank $\leq$ 3	–	–	0.31	–	–
			(0.581)		
Saikkonen and Lütkepohl test					
Rank $\leq$ 0	21.66**	28.85***	37.81**	14.00	21.40**
	(0.039)	(0.003)	(0.029)	(0.331)	(0.043)
Rank $\leq$ 1	5.01	4.33	19.66*	3.62	9.93**
	(0.335)	(0.422)	(0.075)	(0.526)	(0.049)
Rank $\leq$ 2	–	–	5.03	–	–
			(0.333)		
Test of unit income elasticity					
LR statistic	0.001	1.013	6.818***	1.940	6.718***
	(0.980)	(0.314)	(0.009)	(0.164)	(0.009)

Note: *, **, *** Denote significance at the 10%, 5%, and 1% level, respectively.

because the reported maximum of 2.34 is attained as a single peak in 1991Q1. We checked that adding a dummy variable for this period leaves the estimates nearly unchanged. In addition, all the other stability tests are not significant and the literature typically reports stable money demand specifications for Germany, see, e.g., Lütkepohl and Wolters (2003) and the references therein. Therefore, we do not put much weight on this single test result and assume a stable money demand function for Germany.

For France, the *SupF* test signals instability. While this is, again, only one test out of six, it is more worrisome because the recursive *F* tests on which the *SupF* test is based start to rise at the sample end and, hence, indicate that the instability occurred recently and may even be related to the start of the EMU. On the other hand, the parameter estimates are reasonable and compare well with findings in the literature (e.g., Cassard *et al.*, 1997). We will come back to this issue when the forecasting potential of the French money overhang in the EMU sample is assessed.

For Spain, stability is not rejected at the 5% level by all tests. For Italy, the results look most problematic with four out of six tests indicating instability and the differences between the FIML and FM-OLS estimates documented above. This is not unexpected because it is notoriously difficult to find a proper money

Table 2
Estimation Results

	EMU-4		Germany		France		Spain		Italy	
	Johansen	FM-OLS	Johansen	FM-OLS	Johansen	FM-OLS	Johansen	FM-OLS	Johansen	FM-OLS
yr	0.994	1.058	1.138	1.163	1.379	1.400	1.162	1.416	2.886	1.308
	(8.65)	(8.16)	(13.00)	(11.47)	(24.02)	(27.37)	(18.52)	(15.35)	(6.47)	(6.80)
lt	−0.030	−0.023	−0.055	−0.046	–	–	–	–	–	–
	(−5.10)	(−3.68)	(−7.34)	(−5.39)						
Spread	–	–	–	–	−0.017	−0.020	–	–	−0.162	−0.019
					(−2.43)	(−3.28)			(−3.35)	(−0.092)
st_D	–	–	–	–	−0.012	−0.003	–	–	–	–
					(−2.56)	(−0.64)				
Inflation	–	–	–	–	–	–	−0.026	−0.009	–	–
							(−7.42)	(−1.94)		

Note: Asymptotic *t*-values in brackets below the estimates.

Table 3
Stability Tests

Test	EMU-4	Germany	France	Spain	Italy
Eigenvalue fluctuation	1.15	0.73	1.03	1.31*	1.42**
Nyblom (*supQ*)	1.17	2.34**	0.90	0.69	1.88*
Nyblom (*meanQ*)	0.22	0.64	0.36	0.21	0.69*
SupF	9.29	9.70	22.68***	4.61	8.51
MeanF	3.66	3.14	4.82	2.23	4.43
L_c	0.19	0.26	0.25	0.20	0.50*

Note: The eigenvalue fluctuation and Nyblom-type tests for constancy of the cointegrating vector by Hansen and Johansen (1999) are based on the VAR models. The *SupF*, *MeanF* and L_c stability tests by Hansen (1992) are based on FM-OLS.
*, **, *** Denote significance at the 10%, 5% and 1% level, respectively.

demand function for Italy (Juselius, 1998; Gennari, 1999; Nielsen *et al*., 2004). Again, we keep the specification – which is the best we could find – and ask whether the derived money overhang has nevertheless any forecasting power for future inflation.[10]

The results of the stability tests imply that the start of the EMU did not change the money demand functions for the EMU-4 aggregate, Germany and Spain, while there is at least one test that indicates a structural shift for France. For Italy, this question is difficult to answer because the money demand function does not appear to be very stable over a larger part of the sample.

The parameter estimates and the stability tests also allow us to assess the question whether the reported relationships can truly be interpreted as money demand (as opposed to money supply) functions. While a formal identification is beyond the scope of the paper, the parameter estimates and the stability results indicate that our interpretation as money demand functions is sensible. In particular, we find evidence for exactly one cointegrating relationship involving the real monetary aggregate, real GDP and measures of the opportunity costs of holding money, throughout. The parameter estimates coincide with those found in the literature as well as with predictions of theory in both size and sign. This warrants the interpretation of the reported relationships as money demand functions in accordance with Müller (2003). Moreover, the stability of these relationships (at least for the EMU-4 aggregate, Germany and Spain) ties in well with Hayo (1999), who highlights stability as a precondition for the identification of relationships including monetary aggregates as money demand functions. Finally, Bischoff and Belay (2001) argue that the identification problem is less central than previously emphasized, 'regardless of the way the monetary authority determines money supply, as long as the money supply mechanism depends on at least one variable not in the money demand function.'

[10] For a more thorough discussion of the cointegration and stability results for all countries, please consult the working paper version of this paper, which is available from the authors upon request.

Given the compactness of the relationships identified here, this condition is very likely to be met by the broad-based two-pillar framework within which the ECB conducts EMU monetary policy.

To summarize, the estimation and testing results imply that the long-run relationships estimated for the EMU-4 aggregate, Germany and Spain can be interpreted as stable money demand functions while this is less obvious for France and especially Italy. Because our main focus in on using the money overhang derived from these money demand functions, we do not try to further analyze this issue here. Instead, we take the forecasting power of the overhang measures for national inflation rates as our ultimate criterion whether it makes sense to consider national monetary developments or not.

IV Money Overhang and Inflation in the EMU-4

In this section, we analyze the monetary stance of the EMU-4 countries by means of the money overhang series calculated from the estimated long-run money demand relationships and check the leading indicator properties of the money overhang for future inflation. A stable long-run money demand function should give rise to stable and good leading indicator properties of money overhang. Hence, we should expect that the EMU-4 aggregate should be a fairly good leading indicator for aggregate but probably also for country-specific inflation. In addition, country-specific variables should perform particularly well in Germany and Spain (where money demand is stable) and particularly bad in Italy (where it is difficult to find a stable money demand function).

Money as an inflation predictor in the euro area

There has been a long discussion concerning the relevance of money growth, or a related monetary measure, as a predictor of future inflation. While there is strong evidence against the relevance of money growth in the United States (Friedman and Kuttner, 1992; Estrella and Mishkin, 1997; Stock and Watson, 1999), the results are much more mixed for the euro area. For simple money growth, it is typically difficult to establish a good leading indicator property for future inflation (Gerlach and Svensson, 2003). This changes if one relates low-frequency movements in money growth to inflation (Neumann and Greiber, 2004; Assenmacher-Wesche and Gerlach, 2006a, b). The drawback of the low-frequency approach is, however, that it typically entails using symmetric filters, which may be unproblematic for *ex post* analyses but is unfavorable for true (real-time) forecasting. Instead, several studies use measures derived from the money demand function like the money overhang and the money gap of the P-star model (Nicoletti-Altimari, 2001; Trecroci and Vega, 2002; Gerlach and Svensson, 2003). The results confirm the relevance of these measures as indicators of future inflation. In this paper, we focus on the money overhang because it is directly derived from our estimated money demand functions, while the calculation of the money gap requires additional, potentially controversial assumptions regarding the long-run output growth path and the equilibrium interest rate. In addition, Carstensen (2006a) reports that, among various monetary measures, the money overhang can best explain the interest rate setting of the ECB.

Money overhang

A positive overhang indicates excess money and, thus, a soft monetary stance that, according to the monetarist view, results in future inflation. A negative overhang indicates a tight monetary stance. However, it is not obvious what a non-zero overhang at the euro area level means for the individual countries because the monetary stances and the transmission mechanisms may differ from country to country.

Therefore, we constructed three different measures of money overhang for the EMU-4 countries. The first measure, $ov_{\text{EMU-4}}$, is simply the money overhang of the EMU-4 aggregate and is, thus, the same for all four countries. It signals the aggregate money supply situation. The second measure, $ov^i_{\text{EMU-4}}$, where $i =$ D, F, ES, IT, is a semi country-specific money overhang that uses the country data but the EMU-4 specification and parameters. It is calculated as

$$ov^i_{\text{EMU-4}} = m^{real}_{t,i} - \left(\beta_{1,\text{EMU-4}} y_{t,i} + \beta_{2,\text{EMU-4}} r^l_{t,i}\right), \quad i = \text{D, F, ES, IT}.$$

This measure indicates how the single countries 'contribute' to the aggregate money overhang but neglects that money demand functions differ between the countries. Finally, the third measure, ov_i, is a fully country-specific money overhang that uses the country data, specification and parameters. It signals the country-specific monetary situation, but is not necessarily consistent with the aggregate picture.

The three measures of money overhang are displayed in Figure 2.[11] In most cases, there seems to be an overall correspondence between the aggregate measure, $ov_{\text{EMU-4}}$, and the fully country-specific measure, ov_i. In fact, the three overhang measures are significantly and positively correlated both in the pre-EMU and in the EMU samples, but the correlation is sometimes considerably below one. The correlations increase from the first to the second sample, which indicates a closer relationship of the monetary developments since the start of EMU.[12] From this perspective, we can conclude that the aggregate money overhang is a good indicator of the monetary situation in the single countries.

The information content of money overhang for future inflation

This does not mean, however, that the money overhang measures are necessarily also a very good indicator of current and future inflation. To analyze this, we estimated simple inflation forecasting equations for several forecast horizons h: 1-quarter-ahead ($h = 1$), 1-year-ahead ($h = 4$) and 2-year-ahead ($h = 8$).

[11] To construct the Spanish overhang we used year-on-year instead of quarter-on-quarter inflation because the former is much less volatile and improves readability of the graph.

[12] Detailed correlation coefficients can be found in the working paper version of this paper.

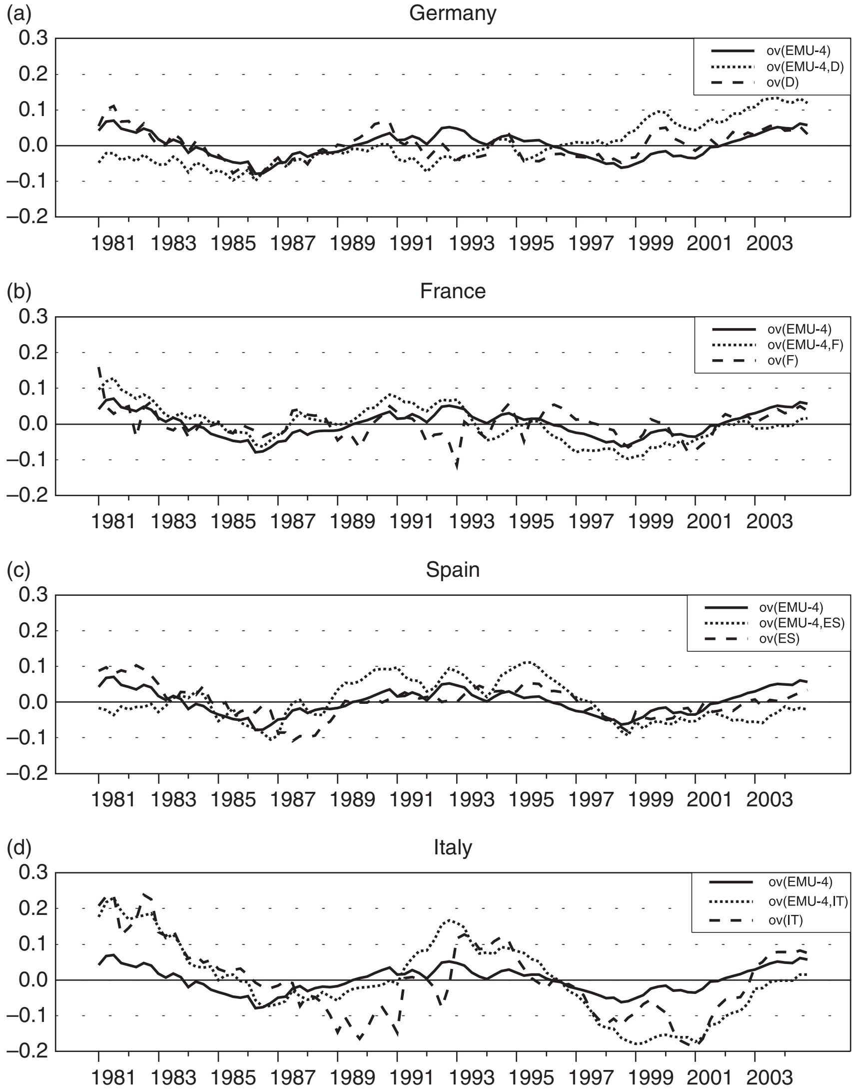

Figure 2. Measures of money overhang.

Following Stock and Watson (1999), we specified

$$\pi^h_{t+h} - \pi_t = a + b\,(L)\,\Delta\pi_t + c\,(L)\,x_t + \varepsilon_{t+h},$$

where π^h_{t+h} is the annualized h-quarter inflation rate, $\pi_t = \pi^1_t$, and x_t is one of the three money overhang measures. The lag order was set to four since the data are quarterly. In Table 4, we report the test statistics and p-values of the hypothesis that the money overhang measures can be excluded from the equations. Because

Table 4
Results of the forecasting regressions

	Germany		France		Spain		Italy	
Sample end	1998Q4	2004Q4	1998Q4	2004Q4	1998Q4	2004Q4	1998Q4	2004Q4
1-quarter-ahead inflation prediction								
$ov_{\text{EMU-4}}$	6.14	7.41	6.15	8.46	2.32	5.02	13.46	18.94
	(0.19)	(0.12)	(0.19)	(0.08)	(0.68)	(0.29)	(0.01)	(0.00)
$ov^i_{\text{EMU-4}}$	1.83	3.17	4.77	7.51	1.94	2.35	7.50	10.68
	(0.77)	(0.53)	(0.31)	(0.11)	(0.75)	(0.67)	(0.11)	(0.03)
ov_i	2.99	3.70	4.19	3.16	8.70	8.38	6.17	8.31
	(0.56)	(0.45)	(0.38)	(0.53)	(0.07)	(0.08)	(0.19)	(0.08)
1-year-ahead inflation prediction								
$ov_{\text{EMU-4}}$	43.89	30.76	14.94	16.41	9.50	13.26	10.82	17.33
	(0.00)	(0.00)	(0.01)	(0.01)	(0.09)	(0.02)	(0.06)	(0.00)
$ov^i_{\text{EMU-4}}$	1.90	5.21	9.49	18.63	4.32	3.40	16.19	25.68
	(0.86)	(0.39)	(0.09)	(0.00)	(0.50)	(0.64)	(0.01)	(0.00)
ov_i	6.52	7.22	7.50	8.45	8.53	12.17	19.97	33.72
	(0.26)	(0.20)	(0.19)	(0.13)	(0.13)	(0.03)	(0.00)	(0.00)
2-year-ahead inflation prediction								
$ov_{\text{EMU-4}}$	122.13	97.55	11.35	11.40	16.53	20.51	15.16	18.00
	(0.00)	(0.00)	(0.04)	(0.04)	(0.01)	(0.00)	(0.01)	(0.00)
$ov^i_{\text{EMU-4}}$	1.85	4.40	15.41	26.89	7.12	4.70	18.51	26.78
	(0.87)	(0.49)	(0.01)	(0.00)	(0.21)	(0.45)	(0.00)	(0.00)
ov_i	9.94	12.47	14.40	19.62	23.05	22.93	25.18	51.49
	(0.08)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: The χ^2-statistics are reported together with p-values in brackets.

the 24 observations of the EMU sample were not enough to estimate the equations, we performed the tests both for the pre-EMU and for the full sample.

The test results indicate that the money overhang measures are not very useful to predict 1-quarter-ahead inflation. In contrast, they do have predictive power for 1-year-ahead and 2-year-ahead inflation. This resembles the findings of Nicoletti-Altimari (2001) who attests money overhang good leading indicator properties for inflation in the medium run. The aggregate EMU-4 money overhang is significant for all countries at horizons of 1 and 2 years, while the fully country-specific overhang measures are mainly significant for the 2-year horizon. The semi country-specific overhang is only significant for France and Italy, perhaps reflecting currency substitution effects.

To gain further insights, we performed a recursive out-of-sample forecasting exercise for the last 6 years before the start of EMU (1993–1998) and the first 6 years since the start of EMU (1999–2004), using the forecasting equations specified above. In Table 5, the root mean-squared prediction errors (RMSPE) for the pre-EMU and EMU samples are displayed. There are several interesting findings. First, with the exception of Spain, the 1-year-ahead and 2-year-ahead inflation forecasts are generally more precise in the EMU sample than in the pre-EMU sample. However, this does not necessarily mean that the overhang

Table 5
Root mean-squared prediction errors of the forecasting exercise

	Germany		France		Spain		Italy	
Sample start	1993Q1	1999Q1	1993Q1	1999Q1	1993Q1	1999Q1	1993Q1	1999Q1
Sample end	1998Q4	2004Q4	1998Q4	2004Q4	1998Q4	2004Q4	1998Q4	2004Q4
1-quarter-ahead inflation prediction								
$ov_{\text{EMU-4}}$	2.34	1.66	1.40	1.81	1.52	2.23	1.28	2.12
$ov^{i}_{\text{EMU-4}}$	2.46	1.66	1.45	1.81	1.58	2.41	1.41	2.17
ov_i	2.42	1.61	1.31	1.96	1.71	2.43	1.26	2.13
1-year-ahead inflation prediction								
$ov_{\text{EMU-4}}$	1.15	0.89	1.28	0.83	1.11	1.21	1.65	0.74
$ov^{i}_{\text{EMU-4}}$	1.32	0.82	1.17	0.79	0.98	1.51	1.58	0.72
ov_i	1.21	0.86	0.94	1.08	0.85	1.23	1.62	0.66
2-year-ahead inflation prediction								
$ov_{\text{EMU-4}}$	1.62	0.84	1.75	0.91	1.16	1.54	2.22	1.10
$ov^{i}_{\text{EMU-4}}$	2.10	0.85	1.42	0.77	1.14	1.94	1.89	0.97
ov_i	2.00	0.86	0.94	1.23	0.81	1.46	1.98	0.65

measures have become better suited to forecast inflation, but may simply reflect the lower inflation rates in the EMU sample. Second, for France, Spain and Italy the EMU-4 overhang measure performs worst in the pre-EMU sample but much better in the EMU sample. While this may indicate an increased importance of area-wide developments for the single countries, there is always at least one of the country-specific overhang measures that remains well-suited for each country even in the EMU sample. Hence, country-specific developments still play a role. Third, the aggregate EMU-4 overhang performs very well for Germany even in the pre-EMU sample. This may reflect the special role of Germany as the anchoring country of the EMS. However, in the EMU sample, the country-specific overhang measures perform roughly as well. Finally, there is no general pattern in the forecasting results that parallels the degree of money demand stability found in the previous section.

So far, we have shown that both country-specific and aggregate monetary information can be valuable to predict future inflation, particularly at horizons of 1 and 2 years. In a final exercise, we try to answer more directly the important question whether country-specific overhang measures contain information that is not already contained in the aggregate overhang measure and vice versa. To this end, we computed forecast encompassing tests as proposed by Harvey *et al.* (1998). A forecast f_{1t} is said to encompass a forecast f_{2t}, if the second forecast does not contain useful information absent in the first forecast. This implies that an optimal composite forecast $f_{ct} = (1 - \lambda) f_{1t} + \lambda f_{2t}$, $0 \leq \lambda \leq 1$, attaches a weight $\lambda = 0$ to the second forecast. For inference, we estimated an analogous equation with the forecast errors of the first and second forecasts, e_{1t} and e_{2t}, respectively,

$$e_{1t} = \lambda (e_{1t} - e_{2t}) + \varepsilon_t,$$

and test the null hypothesis of $\lambda = 0$ against $\lambda > 0$.

The estimated encompassing coefficients together with their autocorrelation-consistent t statistics are presented in Table 6. For each forecast horizon, the first two rows report the results for regressions of the aggregate measure, $ov_{\text{EMU-4}}$, on $ov^{i}_{\text{EMU-4}}$ and ov_i, while rows 3 and 4 report the results for regressions of the

Table 6
Encompassing tests

	Germany		France		Spain		Italy	
Sample start	1993Q1	1999Q1	1993Q1	1999Q1	1993Q1	1999Q1	1993Q1	1999Q1
Sample end	1998Q4	2004Q4	1998Q4	2004Q4	1998Q4	2004Q4	1998Q4	2004Q4
1-year-ahead inflation prediction								
$ov_{\text{EMU-4}}$ enc. $ov^{i}_{\text{EMU-4}}$								
λ	0.24	0.80	0.76	0.63	0.89	−0.94	0.80	0.52
t-stat	(1.33)	(1.70)	(2.54)	(2.82)	(1.43)	(−1.80)	(1.65)	(4.51)
MDM	(1.38)	(1.55)	(1.36)	(1.51)	(1.23)	(−1.30)	(1.25)	(3.49)
$ov_{\text{EMU-4}}$ enc. ov_i								
λ	0.38	0.57	0.75	−1.48	1.11	0.41	0.60	0.67
t-stat	(1.99)	(1.44)	(4.70)	(−6.62)	(12.32)	(0.82)	(0.91)	(6.70)
MDM	(1.51)	(0.97)	(1.24)	(−2.20)	(2.31)	(0.58)	(0.73)	(1.91)
$ov^{i}_{\text{EMU-4}}$ enc. $ov_{\text{EMU-4}}$								
λ	0.76	0.20	0.24	0.37	0.11	1.94	0.20	0.48
t-stat	(4.14)	(0.43)	(0.80)	(1.63)	(0.18)	(3.71)	(0.42)	(4.14)
MDM	(1.24)	(0.35)	(0.72)	(1.09)	(0.15)	(1.87)	(0.35)	(2.13)
ov_i enc. $ov_{\text{EMU-4}}$								
λ	0.62	0.43	0.25	2.48	−0.11	0.59	0.40	0.33
t-stat	(3.23)	(1.08)	(1.53)	(11.09)	(−1.23)	(1.16)	(0.62)	(3.29)
MDM	(1.49)	(1.02)	(1.60)	(2.11)	(−0.87)	(1.14)	(0.53)	(1.86)
2-year-ahead inflation prediction								
$ov_{\text{EMU-4}}$ enc. $ov^{i}_{\text{EMU-4}}$								
λ	0.04	0.49	1.03	0.64	0.54	−0.84	0.81	0.57
t-stat	(0.27)	(2.29)	(3.99)	(4.23)	(1.15)	(−2.10)	(2.88)	(3.16)
MDM	(0.18)	(1.84)	(1.27)	(1.98)	(0.78)	(−1.07)	(1.54)	(5.65)
$ov_{\text{EMU-4}}$ enc. ov_i								
λ	−0.04	0.49	1.10	−1.59	0.85	0.75	0.76	1.17
t-stat	(−0.13)	(3.15)	(18.16)	(−6.06)	(4.08)	(3.03)	(2.44)	(5.99)
MDM	(−0.09)	(1.37)	(1.36)	(−1.83)	(1.46)	(1.58)	(1.57)	(2.76)
$ov^{i}_{\text{EMU-4}}$ enc. $ov_{\text{EMU-4}}$								
λ	0.96	0.51	−0.03	0.36	0.46	1.84	0.19	0.43
t-stat	(6.44)	(2.38)	(−0.12)	(2.36)	(0.98)	(4.61)	(0.68)	(2.38)
MDM	(1.75)	(1.00)	(−0.08)	(0.80)	(0.63)	(1.57)	(0.34)	(1.06)
ov_i enc. $ov_{\text{EMU-4}}$								
λ	1.04	0.51	−0.10	2.59	0.15	0.25	0.24	−0.17
t-stat	(3.44)	(3.28)	(−1.66)	(9.87)	(0.70)	(1.02)	(0.78)	(−0.86)
MDM	(2.22)	(2.10)	(−0.84)	(2.11)	(0.53)	(0.59)	(0.45)	(−0.55)

Note: The null hypothesis is $\lambda = 0$, i.e., the variable listed first encompasses the variable listed second. The alternative hypothesis is $\lambda > 0$, i.e., the variable listed second does contain useful information not contained in the first variable. Since the tests are one-sided, the critical values of the t distribution as recommended by Harvey *et al.* (1998) are $t_{0.9}(23) = 1.319$, $t_{0.95}(23) = 1.714$ and $t_{0.99}(23) = 2.50$ at the 10%, 5% and 1% level, respectively. The MDM statistic is calculated as described by Harvey *et al.* (1998). Both the t statistics and the MDM statistics are based on a nonparametric covariance estimator that is robust to autocorrelation of the order $h-1$, where h is the forecast horizon.

country-specific measures, $ov^i_{\text{EMU-4}}$ and ov_i, on $ov_{\text{EMU-4}}$. In many cases, neither the aggregate measure encompasses both country-specific measures nor vice versa. Hence, both aggregate and country-specific measures contain mutually independent information that is useful to forecast inflation. For example, consider the 2-year-ahead forecasts, where the country-specific measures add useful information in 11 out of 16 cases and the aggregate measure adds useful information in eight out of 16 cases.

This general picture does not change when we follow Harvey *et al.* (1998) and replace the potentially oversized t test with the modified Diebold-Mariano (MDM) test that exhibits more stable sizes; however, at the cost of reduced power. While, not surprisingly, less significant test results are found, both aggregate and country-specific information remain important. For the 2-year-ahead forecasts, the country-specific measures add useful information in 10 out of 16 cases and the aggregate measure adds useful information in five out of 16 cases.

Overall, the forecasting results support the tentative results derived from the analysis of the money demand functions. The aggregate EMU-4 money overhang has substantial forecasting ability for inflation in all countries, which was expected because of the stability of the aggregate money demand function. At the same time, country-specific overhang measures add useful information that is not contained in aggregate monetary developments, even after the start of the EMU. This is particularly surprising for France and especially Italy, where the national money demand functions do not appear to be stable by all criteria.

V Summary and Conclusion

In this paper, we estimate and analyze the aggregate and individual long-run money demand functions of the four largest economies in the euro area. While we find a stable money demand function for the EMU-4 aggregate, it is somewhat more difficult to do the same for the individual countries. We end up with sensible money demand functions for Germany, France and Spain. Formal tests reveal at least a reasonably high degree of stability for all these long-run relationships, even if some doubts for France remain. In the case of Italy, the formal stability tests are less supportive but the cointegration relationships are comparable to previous results in the literature.

Based on the estimated parameters of the money demand functions, we derive different measures of money overhang for each country, which typically show a high degree of correspondence, particularly in the EMU sample. This implies that a measure of aggregate money overhang is also a good indicator of country-specific money overhang, a finding that is confirmed when we analyze the information content of the money overhang measures with respect to future inflation. Both aggregate and country-specific measures can be used to predict future inflation. At the horizon of 2 years, the aggregate measure seems even better suited than the country-specific measures. In addition, recursive out-of-sample forecasts indicate that there is predictive ability by both the aggregate and the country-specific money overhang measures. Forecast encompassing tests show that, with respect to inflation forecasting, country-specific overhang measures add significant information to the aggregate overhang measure, especially at the 2-year horizon.

We may thus conclude that it is possible to come up with stable and sensible money demand relationships for both the EMU-4 aggregate and the individual countries except for Italy. Derived from these relationships, the aggregate and country-specific money overhangs possess non-negligible forecasting power for future inflation. Because these measures generally do not encompass each other, forecasts and forecast-based decisions should be based on both of them as far as national developments are of concern.

As regards monetary policy in the EMU, the importance of national developments for policy decisions is not obvious. However, at least the public discussion in the single countries indicates that the ECB council members are always and particularly confronted with the (inflation) developments in their home countries. Given the emphasis of the current monetary policy strategy on monetary variables and the just confirmed forecasting power of national money overhang, a careful screening of the national monetary trends appears to be sensible. But even if the ECB really disregards any national development, it is still useful from an informational point of view not to stick with area-wide monetary indicators alone but supplement them with a national indicator like the money overhang. In addition, the finding that the predictive content of the area-wide money overhang differs from country to country indicates that the monetary transmission mechanism is not fully symmetric. This implies again that the ECB should also consider national developments in their monetary analysis to better understand the disaggregate situation and to detect national imbalances that may have repercussions on the area-wide monetary stance.

All this does not imply, however, that the monetary pillar in its present form and especially the reference value of 4.5% M3 growth, which was based on average area-wide trends, are of any use for the individual countries. In contrast, the country-specific money overhangs are based on national characteristics and are, thus, much better suited for disaggregate analyses and forecasts than simple M3 growth rates.

Acknowledgements

We thank the Editor, two unknown referees, and seminar participants in Kiel, Hamburg, Bayreuth, Frankfurt and Lille for many helpful comments and discussions. A first version of the paper was written while the authors were affiliated with the Kiel Institute for the World Economy, which is gratefully acknowledged.

Appendix: Construction of the Data

We start out from the 'Euro Area Countries Database' constructed and used by Golinelli and Pastorello (2002, hereafter GP). This database comprises quarterly, country-level time series for the monetary aggregate M3, real GDP, a GDP deflator, the Harmonized Index of Consumer Prices (HICP), as well as short-term and long-term interest rates for the period 1978Q1 to 1998Q4. (Owing to the introduction of the EMS in 1979, we restrict the sample start to 1979Q4.) We carefully update the series for France, Germany, Italy and Spain until 2004Q4, using data from the same sources as GP, OECD's Main Economic Indicators (MEI), IMF's International Financial Statistics (IFS) database as well as data from national central banks (NCBs). In the following, we briefly go through the crucial steps of the updating procedure by variable.[13]

We update the M3 series with data on the contributions to euro area M3 published by the national central banks. Growth rates and levels of GP's time series and of those used for updating are very similar over the overlapping sample for all countries. We update the series with the help of growth rates. To get real money balances, we deflate the M3 series with the respective HICP deflator.

One issue that is raised frequently in the context of euro area money demand, is the treatment of cross-country holdings of components of M3.[14] These may pose a problem to the extent that they were not included in most pre-EMU national aggregates, but are taken into account in series calculated using the euro area resident concept underlying the ECB's definition of monetary aggregates. The use of series constructed in accordance with the ECB's definition of national contributions to euro area M3 over the whole sample period ensures that data consistency problems of this type do not materialize in our study.

GP's output measure, GDP, is taken from the OECD Main Economic Indicators (MEI). We updated our series from the same source, again using the growth rates of the new series. In line with GP, we use 3-month treasury bill rates as the short-term interest rate and 10-years government bond yields as the long-term interest rate. All data are taken from IMF International Financial Statistics (IFS). The spread is constructed as the difference between the long-term and short-term interest rates. The interest rates and the spread are expressed as percentage values. HICP series are updated with correspondent observations from the MEI data set. Data on quarterly exchange rates (last month of quarter) are taken from the IFS database.

In the construction of four-country (EMU-4) aggregates of Germany, France, Spain and Italy, we closely follow the aggregation approach put forward by GP for the construction of their area-wide (EMU-12) aggregates. Series for real M3 and real GDP are obtained by simply adding up the respective single-country data series, which are all denoted in euro. EMU-4 time series for the interest rates and the inflation rate are constructed as a weighted average of single-country data, where time-variable shares of national real GDP are used as weights.

[13] We refer the reader to Golinelli and Pastorello (2002) and in particular to their separate data appendix, Golinelli and Pastorello (2000), for further details on the initial construction of the database and to the Working Paper version of this paper for more details on the updating procedure.

[14] See e.g. Angeloni *et al.* (1994) and Monticelli (1996) for early studies on the implications of cross-country holdings for the stability of (synthetic) area-wide money demand relationships.

All variables used, except for the interest rates, are in logs. We tested all series for non-stationarity, applying various unit root tests like the DF-GLS test of Elliott *et al.* (1996) and the common ADF and Phillips-Perron tests. Not surprisingly, real M3, real GDP and the interest rates were found to be integrated of order 1 for all countries. However, the results for the interest rate spreads and the inflation rates are not always clear-cut.[15]

References

Alves, N., Marques, C. R. and Sousa, J. (2006). Some issues concerning the use of M3 for monetary policy analysis in the euro area. *Banco de Portugal Economic Bulletin*, **12**, pp. 1–15.

Angeloni, I., Cottarelli, C. and Levy, A. (1994). Cross-border deposits, aggregation, and money demand in the transition to EMU. *Journal of Policy Modeling*, **16**, pp. 27–54.

Assenmacher-Wesche, K. and Gerlach, S. (2006a). Interpreting euro area inflation at high and low frequencies. CEPR Discussion Paper No. 5632.

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

Beck, G. W., Hubrich, K. and Marcellino, M. (2006). Regional inflation dynamics within and across euro area countries and a comparison with the US, ECB Working Paper No. 681.

Bischoff, C. W. and Belay, H. (2001). The problem of identifcation of the money demand function. *Journal of Money, Credit and Banking*, **33**, pp. 205–15.

Brand, C. and Cassola, N. (2000). A money demand system for euro area M3. ECB Working Paper No. 39.

Brand, C., Gerdesmeier, D. and Roffia, B. (2002). Estimating the Trend of M3 Income Velocity Underlying the Reference Value for Monetary Growth. ECB Occasional Paper No. 3.

Bruggemann, A. (2000). The stability of EMU-wide money demand functions and the monetary policy strategy of the European Central Bank. *Manchester School*, **68**, pp. 184–202.

Bruggemann, A., Donati, P. and Warne, A. (2003). Is the demand for euro area M3 stable? ECB Working Paper No. 255.

Calza, A., Gerdesmeier, D. and Levy, J. (2001). Euro area money demand: Measuring the opportunity costs appropriately. IMF Working Paper No. 01/179.

Calza, A. and Sousa, J. (2003). Why has broad money demand been more stable in the euro area than in other economies? A literature review. In O Issing (ed.), *Background studies for the ECB's evaluation of its monetary policy strategy*. Frankfurt: ECB, pp. 229–43.

Carstensen, K. (2006a). Estimating the ECB policy reaction function. *German Economic Review*, **7**, pp. 1–34.

Carstensen, K. (2006b). Stock market downswing and the stability of European Monetary Union money demand. *Journal of Business and Economic Statistics*, **24**, pp. 395–402.

Cassard, M., Lane, T. D. and Masson, P. R. (1997). Core ERM money demand and the effects on inflation. *Manchester School*, **65**, pp. 1–24.

Clausen, V. and Kim, J.-R. (2000). The long-run stability of European money demand. *Journal of Economic Integration*, **15**, pp. 486–505.

Coenen, G. and Vega, J.-L. (2001). The demand for M3 in the euro area. *Journal of Applied Econometrics*, **16**, pp. 727–48.

Davidson, J. (1998). Structural relations, cointegration and identification: some simple results and their application. *Journal of Econometrics*, **87**, pp. 87–113.

Dedola, L., Gaiotti, E. and Sillipo, L. (2001). Money Demand in the Euro Area: Do National Differences Matter? Banca d'Italia Working Paper No. 405.

de Grauwe, P. and Senegas, M.-A. (2003). Common monetary policy with transmission asymmetry and uncertainty: Is there a case for using national data in EMU? manuscript.

[15] The implications of possibly stationary spreads for the money demand functions of France and Italy are discussed in the Working Paper version of this paper.

DREGER, C. and WOLTERS, J. (2006). Investigating M3 money demand in the euro area – new evidence based on standard models. DIW Discussion Paper No. 561.

ECB (2003a). Background studies for the ECB's evaluation of its monetary policy strategy. ECB, Frankfurt.

ELLIOTT, G., ROTHENBERG, T. J. and STOCK, J. H. (1996). Efficient tests for an autoregressive unit root. *Econometrica*, **67**, pp. 813–36.

ESTRELLA, A. and MISHKIN, F. S. (1997). Is there a role for monetary aggregates in the conduct of monetary policy? *Journal of Monetary Economics*, **40**, pp. 279–304.

FRIEDMAN, B. M. and KUTTNER, K. N. (1992). Money, income, prices, and interest rates. *American Economic Review*, **82**, pp. 472–92.

FUNKE, M. (2001). Money demand in Euroland. *Journal of International Money and Finance*, **20**, pp. 701–13.

GENNARI, E. (1999). Estimating money demand in Italy 1970–1994. EUI Working Paper No. 99/7.

GERLACH, S. and SVENSSON, L. E. O. (2003). Money and inflation in the euro area: a case for monetary indicators? *Journal of Monetary Economics*, **50**, pp. 1649–72.

GOLINELLI, R. and PASTORELLO, S. (2000). The Euro Area Country Database: A Statistical Appendix. Mimeo, University of Bologna, available at http://www2.dse.unibo.it/golinelli/research/appendix.pdf.

GOLINELLI, R. and PASTORELLO, S. (2002). Modelling the demand for M3 in the euro area. *European Journal of Finance*, **8**, pp. 371–401.

GOODHART, C. A. E. (2006). The ECB and the conduct of monetary policy: Goodhart's law and lessons from the euro area. *Journal of Common Market Studies*, **44**, pp. 757–78.

GREIBER, C. and LEMKE, W. (2005). Money demand and macroeconomic uncertainty. Deutsche Bundesbank Discussion Paper No. 26/2005.

HANSEN, B. E. (1992). Tests for parameter instability in regressions with I(1) processes. *Journal of Business and Economic Statistics*, **10**, pp. 321–35.

HANSEN, H. and JOHANSEN, S. (1999). Some tests for parameter constancy in cointegrated VAR-models. *Econometrics Journal*, **2**, pp. 306–33.

HARVEY, D. I., LEYNOURNE, S. J. and NEWBOLD, P. (1998). Tests for forecast encompassing. *Journal of Business and Economic Statistics*, **16**, pp. 254–59.

HAYO, B. (1999). Estimating a European demand for money. *Scottish Journal of Political Economy*, **46**, pp. 221–44.

HEINEMANN, F. and HÜFNER, F. P. (2004). Is the view from the Eurotower purely European? National divergence and ECB Interest rate policy. *Scottish Journal of Political Economy*, **51**, pp. 544–58.

JOHANSEN, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, **12**, pp. 231–55.

JOHANSEN, S. (2002). A small sample correction of the test for cointegration rank in the vector autoregressive model. *Econometrica*, **70**, pp. 1929–62.

JUSELIUS, K. (1998). Changing monetary transmission mechanisms within the EU. *Empirical Economics*, **23**, pp. 456–81.

KONTOLEMIS, Z. G. (2002). Money demand in the euro area: Where do we stand (today)? IMF Working Paper No. 02/185.

LÜTKEPOHL, H. and WOLTERS, J. (2003). Transmission of German monetary policy in the pre-euro period. *Macroeconomic Dynamics*, **7**, pp. 711–33.

MARCELLINO, M., STOCK, J. H. and WATSON, M. W. (2003). Macroeconomic forecasting in the euro area: country specific versus area-wide information. *European Economic Review*, **47**, pp. 1–18.

MONTICELLI, C. (1996). EU-wide money and cross border holdings. *Weltwirtschaftliches Archiv*, **132**, pp. 215–35.

MÜLLER, C. (2003). *Money Demand in Europe*. Germany: Physica-Verlag.

MÜLLER, C. and HAHN, E. (2001). Money demand in Europe: evidence from the past. *Kredit und Kapital*, **34**, pp. 48–75.

NEUMANN, M. J. M. and GREIBER, C. (2004). Inflation and core money growth in the euro area. Bundesbank Discussion Paper 36/2004, Series 1.

NICOLETTI-ALTIMARI, S. (2001). Does money lead inflation in the Euro area? ECB Working Paper No. 63.

NIELSEN, H., TULLIO, G. and WOLTERS, J. (2004). Currency substitution and the stability of the Italian demand for money before the entry into the monetary union, 1972–1998. *International Economics and Economic Policy*, **1**, pp. 73–85.

Paulsen, J. (1984). Order determination of multivariate autoregressive time series with unit roots. *Journal of Time Series Analysis*, **5**, pp. 115–27.
Phillips, P. C. B. and Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I(1) processes. *Review of Economic Studies*, **57**, pp. 99–125.
Saikkonen, P. and Lütkepohl, H. (2000). Testing for the cointegrating rank of a VAR process with an intercept. *Econometric Theory*, **16**, pp. 373–406.
Stock, J. H. and Watson, M. W. (1999). Forecasting inflation. *Journal of Monetary Economics*, **44**, pp. 293–335.
Trecroci, C. and Vega, J. L. (2002). The information content of M3 for future inflation. *Weltwirtschaftliches Archiv*, **158**, pp. 22–53.
Wesche, K. (1997). The stability of European money demand: an investigation of M3H. *Open Economies Review*, **8**, pp. 371–91.

Date of receipt of final manuscript: 26 March 2008