The Demand for Money in the European Union: Further Empirical Results[1]

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Abstract

This study estimates a European Union wide demand for money function, for both narrow and broad definitions of money, which differs from others in terms of the specification of the long run function, the definition of the explanatory variables, the sample period, the coverage of the aggregated data and the estimation methodology. The empirical findings presented suggest the existence of stable EU demand for money functions for both M1 and M2. This implies that increasing coordination of national monetary policies through the European Monetary Institute is likely to yield benefits for member countries.

1. Introduction

The success of the European Monetary System (EMS) in inducing increasing stability in intra-EMS nominal exchange rates during the 1980s, the complete elimination of capital and exchange controls by almost all European Union countries and the policy issues associated with the full implementation of the Maastricht Treaty have generated interest in the determinants of EU wide variables. Thus Kremers and Lane (1990), Monticelli and Straus-Kahn (1993) and Artis, Bladen-Hovell and Zhang (1993) have investigated the existence of a stable EU demand for money function. Further, Cassard, Lane and Masson (1994) have estimated demand for money functions involving aggregation only across the "core" countries of the Exchange Rate Mechanism (ERM). All four studies' empirical findings suggest that a stable function is identifiable either at the EMS or the 'core' ERM level. However, aspects of these studies raise doubts as to how robust the presented statistical evidence is and in terms of their consistency with theory. For example, Barr (1992) has effectively challenged certain aspects of the empirical work of Kremers and Lane (1990). This study considers some of the issues relating to the estimation of an EU money demand function and presents new empirical evidence indicating the existence of stable EU functions for both M1 and M2.

Section 1 outlines the origins of the arguments for and against the international approach to the study of the demand for money. Section 2 is devoted to a critical appraisal of the studies of the EU demand for money function and an explanation of how this study differs from these. Section 3 briefly describes the data used. Our statistical findings are presented and discussed in section 4. Finally, our conclusions and their policy implications are considered in section 5.

1. Introduction

Johnson (1972a) asserted that the major industrialised countries were 'linked together in a world economy by the maintenance of a system of fixed exchange rates, just as the regions of a single country are linked together in a single monetary domain by the use of a common currency' (p.331). This property of the Bretton Woods system led Johnson (1972b) to argue, when explaining the monetary approach to the balance of payments determination, that 'the rate of inflation in the world economy will be determined by the rate of world monetary expansion relative to the world rate of real economic growth' (p.85). Therefore, when Johnson (1972b) maintained that inflation was an international monetary problem rather than 'a series or collection of individual national problems, essentially sociological in origin' (p.9), he was in fact asserting that there did exist a stable world demand for money function. However, it did not follow from Johnson (1972b) that the statistical testing of the proposition that inflation was an international monetary problem necessarily required the identification of such a world function. This particular diagnosis of the character of inflation was a logical extension of the analysis of balance of payments disequilibria as manifestations of monetary disequilibria. But the monetary approach to balance of payments determination rests on the existence of stable *national* demand for money functions. For example, Frenkel and Johnson (1976) explained that 'the essential assumption of the monetary approach, like the restated quantity theory of money according to Friedman, is that there exists an aggregate demand function for money that is a function of a relatively small number of aggregate economic variables' (p.24). As no systematic consideration of the relationship between a world function and national money demand functions was provided it is arguable that the proponents of the view that inflation was an international monetary phenomenon perceived the statistical identification of stable *national* functions as both necessary and sufficient for their particular diagnosis of the nature of inflation to be empirically valid. Mundell (1971) and Swoboda (1977), for example, derived a stable world money demand function by simply adding up stable national functions. In brief, then, the literature which maintained that inflation was an international monetary problem did not provide an unambiguous rationale in favour of estimating a world function rather than a series of national demand for money functions.

It was not, however, only developments in international monetary theory which prompted the search for causes common to all industrialised countries when attempting to explain the emergence of inflation as a world wide policy problem. The closed economy approach to the study of the determinants of inflation, irrespective of whether or not it emphasized sociological factors, could not explain the observed evolution of inflation rates across the major industrialised economies. Pattison (1976) and Genberg and Swoboda (1977) presented detailed statistical evidence demonstrating the high degree of convergence of the major countries' inflation rates after 1958 and before the collapse of the Bretton Woods system in March 1973. Cost push models of the determination of inflation, Phillips curve analyses or the evolution of domestic monetary aggregates could not explain this phenomenon. Nor could they explain the simultaneous acceleration of inflation rates throughout the industrialised world in the second half of the 1960s. Finally, the rejection of the closed economy approach to the study of the determinants of inflation raised fundamental issues relating to the relative merits of alternate exchange rate regimes at a time when the Bretton Woods system was rapidly disintegrating. If inflation were indeed the outcome of a world money supply growth rate that persistently and increasingly exceeded the world demand for money growth rate, then it followed that exchange rate flexibility offered the best prospects for the individual country to insulate itself from externally generated inflationary pressures.

Gray, Ward and Zis (1976) by aggregating the Group of Ten countries estimated a stable 'world' demand for money function but refrained to consider the relationship between it and the national money demand functions. But if the latter were stable, Miller (1976) asked what did the 'aggregate analysis demonstrate over and above what would have been found from the individual country results?' (p.180). In addressing this question Duck and Zis (1978) showed that in the absence of price integration and, therefore, in a world segmented in as many independent monetary areas as the number of national currencies, the aggregation of stable national demand for money functions would yield a stable 'world' function only under the highly unlikely circumstances of the national functions being identically the same. They also demonstrated that an implication of the distinction between the demand for money and the demand for a currency is that a stable world demand for money function is consistent with unstable demand functions for national currencies. Therefore, the difficulties involved in specifying the demand for money function for an open economy on fixed exchange rates argued in favour of the international approach. It was generally agreed that only under fixed exchange rates was the international approach potentially applicable. Variables such as the 'world' money supply, demand for money, real income and price level could only be defined if exchange rates were fixed. This consensus, was challenged by McKinnon (1982) who maintained that even under flexible exchange rates the individual country's rate of inflation is affected by the world money supply growth rate. He argued that 'in general, growth in the world money supply is a better predictor of American price inflation than is US money growth' (p.324). Further, he presented empirical evidence, not particularly systematic, of correlation between the world money supply growth rate and the world rate of inflation over the period 1960 to 1980. In order to overcome the measurement problems associated with the post-1973 exchange rate flexibility, McKinnon constructed a world money supply growth rate series from national growth rates weighted by countries' GNP in 1970. The same weights were used in the construction of the world rate of inflation. Spinelli (1983) criticised McKinnon on both theoretical and empirical grounds. While McKinnon's statistical work was suggestive rather than technically sophisticated his conclusions regarding the implications of economic agents holding diversified currency portfolios were well founded. Nor could he be faulted on the policy prescriptions that he advanced, essentially that the US, Germany and Japan should coordinate their monetary policies. However, McKinnon's construction of world variables is seriously flawed. Under flexible exchange rates world variables are operationally meaningless.

2. The EU Money Demand Function

Kremers and Lane (1990), Monticelli and Straus-Kahn (1993), Artis, Bladen-Hovell and Zhang (1993), and Cassard, Lane and Masson (1994), (hereafter KL, MS-K, AB-HZ and CLM respectively) were motivated by very similar considerations in their attempts to investigate whether there exists a stable demand for money function at the EU or 'core' ERM level. They all emphasize the difficulties encountered in recent years in identifying stable country demand for money functions as an argument for the adoption of the aggregate approach. That is, an EU function could potentially contain information which either can not be captured by, or is difficult to extract from, country studies. Second, it is suggested that the conventional specifications of the money demand function are no longer appropriate for the highly integrated EU countries. On the other hand, specifying an EU function is relatively easier. Third, it is argued that diversified currency portfolios requires that the demand for money is studied at the EU level. Finally, it is observed that the gradual monetary unification of the EU, as prescribed by the Maastricht Treaty, raises policy issues which can be clarified through the investigation of whether or not there exists a stable EU demand for money function.

All four studies emphasize currency substitution as an important component of the rationale in favour of the aggregate approach. However, it is not clear that it is currency substitution per se that justifies the adoption of the aggregate rather than the national approach to the study of the demand for money. It is beyond dispute that a variety of developments have resulted in EU countries' currencies becoming closer substitutes for each other. But it is because they continue to be imperfect substitutes that economic agents have an incentive to hold diversified currency portfolios. This diversification becomes a source of instability in the event of economic agents effecting a change in the *composition* of their currency portfolios in anticipation of exchange rate changes. In turn, the speed at which portfolio compositions can be adjusted and the cost involved in such adjustments depend on the degree of capital mobility. Again, for a variety of reasons capital within the EU has become significantly more mobile, particularly during the 1980s. This increased capital mobility implies that deviations of actual from optimum portfolio compositions are now smaller and of shorter duration. That is, it is the imperfect substitutability of EU countries' currencies which, in combination with the increased degree of capital mobility, justifies the adoption of the aggregate approach rather than currency substitution per se. Frankel (1983) distinguishes between perfect asset substitutability and perfect capital mobility. The implications of this distinction for the rationale in favour of the aggregate approach to the study of the demand for money deserve more careful consideration than they have received so far.

Irrespective of the above observations KL and AB-HZ fail to make the case for the inclusion of the dollar/ECU exchange rate as an explanatory variable of the EU demand for money function. The same is true of MS-K who present estimates of EU functions with and without the four-quarter rate of change in the dollar/ECU exchange rate. A careful consideration of their empirical findings suggests that it is the equations which include the rate of change in the dollar/ECU exchange rate which are the most robust in statistical terms. KL describe the rationale for including the dollar/ECU rate as 'tentative' (p.793) while Artis (1994) considers the inclusion of this rate as 'analytically embarrassing' (footnote 26). Given, then, the absence of a well founded justification for the inclusion of either the dollar/ECU exchange rate or its rate of change we have ignored this variable in our empirical work. We do not feel that it captures currency substitution.

All four studies refer to the increased stability of intra-EMS nominal exchange rates as an argument for adopting the aggregate approach. A source of potential difficulties in the application of the aggregate approach is that the EMS is not a system of fixed exchange rates and not all EU countries operated the ERM since 1979. Between 1979 and September 1992 there were eleven realignments of intra-EMS exchange rates. In the cases of KL, MS-K and AB-HZ the sample period begins in 1979, that is, it covers all eleven realignments. Further, somewhat surprisingly, MS-K included the UK and Spain in their construction of the aggregate variables. In contrast, CLM in recognition of the importance of exchange rate fixity for the applicability of the aggregate approach confine their aggregation to the 'core' ERM countries, defined to be France, Germany, the Benelux countries and Denmark as they had consistently operated the narrow band of the ERM and had not realigned their currencies against the German mark since at least January 1987. These criteria explain the exclusion of Italy but not of Ireland. Further, their sample period begins in 1982Q4, that is, it covers the major 1983 realignment. In order to minimise the distortionary effects of exchange rate changes our sample period extends from 1983Q2 to 1991Q4, during which four of the eleven realignments occurred. In constructing the aggregate variables we excluded the UK, Spain, Portugal and Greece.

KL, MS-K and AB-HZ all used as their aggregate opportunity cost variable a weighted average of national interest rates. The weights used are the 1989 shares of the national currencies in the ECU. No justification for this particular way of weighting has been offered. Since 1979 a set of economic criteria are combined with subjective considerations to determine the share of each currency in the ECU. The former consist of the share of the country in the GDP of the EU and its shares in intra-EU trade and in the EMS financial support system. But as Gros and Thygesen (1992) have observed currencies' shares in the ECU do not simply reflect these objective criteria. Subjective considerations have resulted in the shares of the German mark and the Dutch guilder significantly exceeding the shares that are implied if only the above criteria were applied to determine the composition of the ECU. Therefore, it is not clear that the weights applied are appropriate for the construction of the opportunity cost variable in the EU money demand function. The bias towards the mark and the guilder is potentially a source of distortion. Weber (1991) has presented empirical evidence suggesting that the EMS has operated as a bipolar system in which the French franc has provided a soft currency option in contrast to the hard currency option of the German mark. This feature can not be captured by a weighted average which assigns excessive importance to German and Dutch interest rates. Instead, a principal component analysis of national interest rates was carried out to derive the opportunity cost variable to be used in the estimation of the EU money demand function. The resultant variable is weighted by the variability of national interest rates. This is a desirable feature of the approach adopted. It captures not only the impact of changes in the relative attractiveness of alternative currencies but also the potential impact of capital controls, in force throughout the 1980s in most EU countries, on the demand for a currency. An increase in, say, the variability of French interest rates would have affected not only the desired composition of the currency portfolios held by French economic agents but also, because of capital controls, the size of the portfolio. Therefore, the principal difference between this and the other studies of the EU money demand lies in the way we have proxied the opportunity cost of money holding.

KL, MS-K, AB-HZ AND CLM all used the Engle and Granger (1987) two step cointegration procedure. MS-K use the Johansen (1988) and Johansen and Juselius (1990) methodology to confirm the empirical findings derived from the Engle and Granger procedure. CLM present also estimates based on the former estimation technique. We employ the general to specific methodology as applied, for example, in Hendry and Doornik (1994) which relies on the Johansen methodology to establish cointegration.[3]

In summary, then, the principal differences between our study and the other four are: first, our sample period covers only four of the pre-September 1992 intra-EMS exchange rate realignments. Second, we utilised principal component analysis in constructing the opportunity cost variable. Further, in contrast to KL, AB-HZ and MS-K we have not used the dollar/ECU exchange rate or its rate of change as an explanatory variable. Finally, we employed the general to specific methodology.

3. Data

In principle, any single EU national interest rate could be chosen as the opportunity cost variable for the purpose of estimating an EU money demand function if all national interest rates moved together. Whether or not each rate contains significant independent information can be ascertained through a principal component analysis of national rates. The results of carrying out such an analysis of national short interest rates are presented in table 1. Two rates stand out, those of Germany and Holland. While the first principal component explains more than 70 per cent of the variance of each of the other rates, in their case the variance explained is less than 40 per cent. Evidently, then, no single rate could be selected to represent the opportunity cost variable for the purpose of estimating the EU money demand function. Second, the results support the decision to reject the average of national rates, weighted by currencies' ECU shares, as an inappropriate measure of the opportunity cost of holding money. Third, they are consistent with the Weber (1992) thesis that the EMS operated as a bipolar system. Therefore, the first and second principal components were used as separate explanatory variables in estimating the EU money demand function. Between them, they explain over 90 per cent of the cumulative variance of the national rates.

For the construction of the aggregate EU variables we converted national currency values into ECUs at the central ECU exchange rates established following the January 1987 intra-EMS exchange rate realignment. The UK, Spain, Portugal and Greece were excluded. The EU price index was proxied by the average of national consumer price indices, weighted by countries' shares in the constructed EU income variable.

Demand functions for both M1 and M2 were estimated. As we relied for our data on the *International Financial Statistics* from the IMF,

Table 1: The percentage of variance of each short interest rate accounted for by each principal component (1982:1-1991:4)[a]

	PC1	*PC2*	*PC3*	*PC4*	*PC5*	*PC6*	*PC7*	*PC8*
GER	38.33	59.55	0.06	0.72	0.42	0.01	0.00	0.90
FR	91.24	2.26	0.40	3.28	1.57	0.09	1.00	0.16
IT	73.31	20.31	2.71	0.05	1.65	1.05	0.92	0.00
LUX	84.32	2.63	8.82	0.67	1.13	2.36	0.01	0.05
IR	75.00	8.56	7.09	8.68	0.54	0.01	0.09	0.03
DEN	78.57	5.12	10.53	3.96	1.37	0.20	0.26	0.00
HOL	23.02	74.85	0.05	0.63	0.31	0.28	0.28	0.57
BEL	86.75	6.61	0.57	0.32	2.94	2.62	0.16	0.03
Total[b]	68.80	22.50	3.80	2.30	1.20	0.80	0.30	0.20

Notes:

a. The numbers in this table may also be interpreted as the R^2 that would be obtained from a regression of each component on each interest rate.

b. This row gives the percentage of the generalised variance of the rates explained by each components.

our measure of broad money is narrower than those of MS-K and CLM who used national sources. Our adopted definition of M2 also excludes cross-border currency holdings but Monticelli (1993) demonstrated that equations that feature EU aggregates extended to include such holdings do not outperform these involving the summing of national monetary aggregates as traditionally defined.

4. Empirical results

Inevitably the particular demand for money function chosen for investigation involves the reduction of the data generation process through the omission of variables relevant to the system under consideration. Whether or not the implied degree of marginalisation is valid is an empirical issue. If the conditions for weak exogeneity are satisfied, then there is no loss of information involved in analysing the marginal density only. In our case the 'variables of interest' are real money balances, real income and the first and second principal components of EU national short interest rates. That is, we have hypothesized that, assuming long-run price homogeneity, the EU demand for real money balances depends on real income and an opportunity cost variable proxied by the first and second principal components of the national short interest rates. This is the simplest demand for money function consistent with economic theory. One possible extension of the estimated function would be the inclusion of an 'own rate of return'. In what follows *m* is the log of real money balances, *y* the log of real income, *PC1* the first principal component and *PC2* the second principal component. There exist, therefore, two systems in the four stochastic variables (*m, y, PC1* and *PC2*), one for M1 and one for M2, with a constant and a trend. However, before we proceed with the empirical analysis the treatment of the deterministic variables needs clarification. Following Germany's monetary unification the country's money supply growth rate behaved erratically for a brief while. Thus Germany's M1 grew at 22 per cent during the first quarter of 1991 and M2 increased by 14 per cent in the second quarter of 1990. These sharp rises in Germany's money supply resulted in the EU wide money aggregates exhibiting ephemeral volatility. Thus we employed a dummy variable, D91Q1, for M1 and one for M2, D90Q2. However, given that Germany's

Table 2: Unit root tests for European aggregated variables (83:2 - 91:4)

	Lags[1]	ADF	PP	Lags[1]	ADF	PP
Variables in levels				Variables in first differences		
m1	5	-2.537	-2.063	0	-5.958**	-6.061**
m2	8	-2.185	-4.306*	1	-5.540**	-8.511**
y	1	-2.666	-2.935	0	-6.442**	-6.761**
pc1	1	-1.539	-1.383	0	-4.579*	-4.687*
pc2	1	-0.857	-0.865	0	-5.652**	-4.597*

Notes:
1. Critical values are given in Mackinnon(1991). Significant at the 1% level(**), 5% level(*). The ADF and PP test statistics are computed for the level and the first difference in a regression that includes a constant, time trend and the appropriate number of lags of the dependent variables which remove any manifest residual serial correlation.

monetary unification had only a short-term impact on the evolution of the EU's money supply growth these dummy variables are included in the short run dynamics but excluded from the long run cointegration space. Second, as M2 is seasonally unadjusted, three seasonal dummies are also included in the M2 system. Again, these are included only in the short-run dynamics but excluded from the long-run relationship. Thirdly, following Hendry and Doornik (1994), the intercept appears restricted only in the short run dynamics but the trend only in the long run cointegration space. We began by testing the order of integration of the stochastic variables by employing the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. Table 2 suggests that they all are I(1) variables.

Next, starting from the VAR with four lags on all stochastic variables we established through simplification tests the adequacy of 2 lags. This reduction was implemented by using likelihood ratio tests adjusted for degrees of freedom. The relevant statistics are $F(32,53) = 0.96$ [0.54] and $F(32,42) = 1.21$ [0.28]. As they are both insignificant, the simplification for both M1 and M2 is accepted.

The residual correlations and summary statistics for these two simplified systems are presented in table 3, where $\hat{\sigma}$ denotes a residual standard deviation; F denotes F-tests for no serial correlation (F_{ar}, against 4th-order autoregression), no autoregressive conditional heteroscedasticity (F_{arch}, against fourth order), no heteroscedasticity (F_{het}); a chi-square test for normality, X^2_{nd}; analogous vector tests are denoted by the superscript ^{v}. As all these tests are satisfied the implication is that the two simplified VAR systems are an adequate characterization of the data.

As a preliminary to the cointegration analysis the break-point Chow test was employed as an informal test of parameter constancy. For none of the individual equations do the test values exceed the 5% significance level which is consistent with parameter constancy.[4]

The next step in our empirical analysis is to test for cointegration in the four equation systems. Table 4 presents eigenvalues (λ) and associated maximum eigenvalue, $T\log(1-\lambda)$, and trace, $T\sum\log(1-\lambda)$ statistics and the estimated cointegrating vectors. Cheung and Lai (1993) have argued that the trace test is the more powerful. It would appear, then, that a single cointegrating vector for each system is marginally identifiable. This implies that the problems associated with the identification of more than one cointegrating vector, discussed by Wickens (1993), are not present in this case and we may, therefore, proceed to test for weak exogeneity.

The unrestricted cointegration vectors in

Table 3 Residual correlations, Goodness of fit and evaluation

M1

Residual correlations

	m1	y	pc1	pc2
y	0.25	--	--	--
pc1	-0.17	0.02	--	--
pc2	-0.03	-0.06	0.46	--

Goodness of fit and evaluation

	m1	y	pc1	pc2	VAR
$\hat{\sigma}$	0.8%	0.6%	0.6%	0.3%	
$F_{ar}(4, 21)$	0.67[0.61]	0.36[0.83]	0.41[0.80]	0.29[0.29]	
$F_{arch}(3, 19)$	0.22[0.88]	0.37[0.78]	0.22[0.88]	0.54[0.66]	
$F_{het}(10, 6)$	0.50[0.66]	0.16[0.99]	0.93[0.59]	0.87[0.63]	
$\chi^2_{nd}(2)$	3.37[0.18]	3.41[0.19]	0.03[0.98]	0.39[0.82]	
$F^v_{ar}(64, 25)$					1.14[0.37]
$\chi^v_{het}(180)$					186.99[0.54]
$\chi^{2v}_{nd}(8)$					6.92[0.34]

M2

Residual correlations

	m2	y	pc1	pc2
y	0.22	--	--	--
pc1	-0.25	-0.11	--	--
pc2	-0.22	-0.11	0.38	--

Goodness of fit and evaluation

	m2	y	pc1	pc2	VAR
$\hat{\sigma}$	0.7%	0.6%	0.7%	0.4%	
$F_{ar}(4, 18)$	0.78[0.55]	0.45[0.77]	0.88[0.49]	0.21[0.93]	
$F_{arch}(3, 16)$	0.02[0.99]	0.37[0.78]	0.32[0.81]	1.54[0.24]	
$F_{het}(18, 3)$	0.30[0.96]	0.15[0.99]	0.31[0.95]	0.40[0.91]	
$\chi^2_{nd}(2)$	1.41[0.49]	0.35[0.84]	2.15[0.34]	1.46[0.48]	
$F^v_{ar}(64, 14)$					1.21[0.36]
$\chi^v_{het}(180)$					188.90[0.31]
$\chi^{2v}_{nd}(8)$					10.57[0.12]

* Probability of each test statistic reported in square brackets.

table 4 were then tested for lying in the cointegration space when testing for *y*, *PC1* and *PC2* being long run weakly exogenous for the money demand parameters. Weak exogeneity requires that the first column of α has the form (*, 0, 0, 0) when β is identified. First, the hypothesis that H_1:α_1=(*, 0, 0, 0) was tested for M2. The LR(3) test statistic is 4.34 suggesting that *y*, *PC1* and *PC2* are long run weakly exogenous for the money demand parameters. Next, we investigated whether restricting the income elasticity for m1 to 0.5, in line with the Baumol (1952) and Tobin (1956) models of the transactions demand for money, is acceptable. This involves testing the hypothesis that H_2:β_1 = (1, -0.5, *, *). The imposed restriction on the income elasticity was accepted. Therefore, third, we proceeded to test jointly hypotheses H_1 and H_2. The LR(4) test statistic is 6.93 implying acceptance of the joint hypothesis. Table 5 presents the estimated restricted cointegrating vectors for M1 and M2.

Table 4: Cointegration analysis of M1 and M2

Eigenvalues and Test Statistics For (m1)

H_0	Eigenvalue(λ_i)	$Tlog(1 - \lambda_i)$	$T\Sigma log(1 - \lambda_i)$
$r \leq 3$	0.1042	3.85	3.85
$r \leq 2$	0.2747	11.24	15.09
$r \leq 1$	0.4360	20.05	35.14
$r = 0$	0.5262	26.15	61.28*

Standardized β eigenvectors

m1	y	pc1	pc2	Trend
1.000	-0.052	3.071	-2.090	-0.0025
-1.096	1.000	-0.429	-0.686	0.0033
-0.478	-1.942	1.000	-1.639	0.0248
-0.948	-0.205	1.139	1.000	0.0106

Standardized α eigenvectors

m1	-0.106	0.542	0.151	0.009
y	-0.007	-0.192	0.144	-0.024
pc1	-0.044	0.148	-0.073	-0.042
pc2	-0.089	0.157	-0.012	-0.012

* test statistics above 10 per cent critical value (see Osterwald-Lenum, (1992)

Eigenvalues and Test Statistics For (m2)

H_0	Eigenvalue(λ_i)	$Tlog(1 - \lambda_i)$	$T\Sigma log(1 - \lambda_i)$
$r \leq 3$	0.1472	5.57	5.57
$r \leq 2$	0.2523	10.18	15.75
$r \leq 1$	0.4250	19.37	35.12
$r = 0$	0.5133	25.21	60.32*

Standardized β eigenvectors

m2	y	pc1	pc2	Trend
1.000	-0.960	0.742	-0.161	-0.0004
-0.495	1.000	1.832	-2.163	0.0020
-0.642	-1.913	1.000	-1.080	0.0248
-0.090	0.160	0.419	1.000	-0.0034

Standardized α eigenvectors

m2	-0.831	0.542	0.151	0.009
y	0.347	-0.192	0.144	-0.024
pc1	0.016	0.148	-0.073	-0.042
pc2	0.110	0.157	-0.012	-0.012

Table 5: Restricted cointegration vector ß* and loadings α*

M1					
	m1	y	sr1	sr2	Trend
$ß^*$	1.0000	-0.5000	0.6749	0.3205	-0.0056
α^*	-0.8490	0.0000	0.0000	0.0000	
M2					
	m2	y	sr1	sr2	Trend
$ß^*$	1.0000	-0.8633	0.5771	0.0647	-0.0017
α^*	-0.9305	0.0000	0.0000	0.0000	

The cointegrating vectors below may beinterpreted as long-run demand for money equations. The implied coefficients are theory consistent and, perhaps, more intuitively plausible than those obtained in the other studies of the EU demand for money function. This is especially the case with the estimated income elasticities. They are significantly lower than those presented in the other studies, particularly for M2 for which AB-HZ obtained an estimate of 1.99.

The next step is to map all the variables to I(0) space through differencing and cointegration transformations so that standard inference procedures are applicable. With the ECMs defined by:

$$Cm1_t = m1_t - 0.5y_t + 0.6749PC1_t + 0.3205PC2_t - 0.0056Trend$$

$$Cm2_t = m2_t - 0.8633y_t + 0.5771PC1_t + 0.0647PC2_t - 0.0001Trend$$

the ECM identities, retaining the differences of the four original variables, are given by:

$$Cm1_t \equiv \Delta m1_t - 0.5\Delta y_t + 0.6749\Delta PC1_t + 0.3205\Delta PC2_t - 0.0056 - Cm1_{t-1}$$

$$Cm2_t \equiv \Delta m2_t - 0.8633\Delta y_t + 0.5777\Delta PC1_t + 0.0647\Delta PC2_t - 0.0011 - Cm2_{t-1}$$

Table 6: Significance of ECMs(Cm1, Cm2) in the dynamic system of M1 and M2

M1 Equation	ECMs' coefficient	T-test[Prob]	M2 Equation	ECMs' coefficient	T-test[Prob]
$\Delta m1_t$	-0.7802	-3.917[0.0005]	$\Delta m2_t$	-0.5305	-3.043[0.0054]
Δy_t	0.0653	0.379[0.7076]	Δy_t	0.2991	1.336[0.1935]
$\Delta pc1_t$	-0.2073	-1.469[0.1530]	$\Delta pc1_t$	0.0583	0.250[0.8049]
$\Delta pc2_t$	0.0043	0.152[0.8806]	$\Delta pc2_t$	0.0396	0.270[0.7892]
Encompassing test			Encompassing test		
LR(3)	2.9372 [0.4014]		LR(3)	2.8670 [0.4126]	

Table 7: Dynamic equations of European money (M1 and M2) demand function

$\Delta m1_t$

Variable	Coeff	s.e.	T-test
Cons	0.0533	0.010	5.135
Δy_t	0.3706	0.181	2.045
$Cm1_{t-1}$	-0.5711	0.128	-4.479
D91Q1	0.0249	0.025	3.521

R^2	=	0.55
e	=	0.69%
$AR(4, 26)_i^4$	=	0.89 [2.74]
RESET(1, 29)	=	0.03 [4.18]
HET(5, 24)	=	0.26 [2.62]
ARCH(4, 22)	=	0.65 [2.82]
NORM(2)	=	5.82 [5.99]

$\Delta m2_t$

Variable	Coeff	s.e.	T-test
Δy_t	0.4040	0.125	3.227
$\Delta pc2_{t-1}$	-0.6380	0.214	-2.983
$Cm2_{t-1}$	-0.6668	0.042	-15.990
Q1	-0.0280	0.002	-14.022
Q2	-0.0253	0.002	-10.694
Q3	-0.0256	0.002	-11.455
D90Q2	0.0250	0.006	4.521

R^2	=	0.95
e	=	0.50%
$AR(4, 23)_i^4$	=	0.67 [2.80]
RESET(1, 26)	=	0.53 [4.23]
HET(10, 16)	=	0.38 [2.49]
ARCH(4, 19)	=	0.24 [4.50]
NORM(2)	=	2.94 [5.99]

Note: $AR(4, j)_i^{(i)}$, LM test for 4th order of serial correlation; HET(*i, j*) is F test for Heteroscedasticity; 4th order autoregressive conditional heteroscedasticity test is denoted by ARCH(*4, j*); Nonnormality test is denoted by NORM(2).

The resultant I(0) VAR systems involve the retention of the stochastic regressors Δm_{t-1}, Δy_{t-1}, $\Delta PC1_{t-1}$, $\Delta PC2_{t-1}$ and Cm_{t-1} while the deterministic part includes a constant, seasonal dummies and the dummy variables already discussed. The implied equations for each I(O) VAR were estimated by full information maximum likelihood (FIML). The results of the estimation are not reported but are available on request. However, it is worth noting that the correlations between actual and fitted values for the four stochastic variables are 0.65, 0.31, 0.45 and 0.44 for the M1 VAR while the corresponding values for the M2 VAR are 0.97, 0.52, 0.38 and 0.36. Further, in table 6 the coefficients on Cm1 and Cm2 in the four equations in each VAR are reported. Except for the money equations, these coefficients are insignificant. Table 6, also, reports the results of testing for over-identifying restrictions which support the conclusion that the restricted models parsimoniously encompass the VAR. It follows, then, that the weak exogeneity conclusion is confirmed enabling, therefore, the inclusion of contemporaneous observations of the weakly exogenous variables y, PC1 and

PC2, in the estimation of conditional dynamic demand for money equations.

The preferred specifications of the error correction formulation of the long run demand functions for M1 and M2 are presented in table 7. For both equations all the diagnostic tests are satisfied. The estimated coefficients are statistically significant and theory consistent. The coefficients on the error correction terms $Cm1_{t-1}$ and $Cm2_{t-1}$ imply significantly faster rates of adjustment than the findings of the other studies of the EU demand for money. Further, in contrast to AB-HZ the coefficient on $Cm1_{t-1}$ is lower than than on $Cm2_{t-1}$. In brief, the evidence reported in table 7 suggests that the estimated equations are reasonably data coherent representations. To check the constancy of the models over the sample actual outcomes and fitted values for $\Delta m1$ and $\Delta m2$ were plotted. The latter track the former reasonably well, particularly in the case of $\Delta m2$. Furthermore, inspection of the recursive FIML estimates highlights the models'[4] constancy in terms of residual sums of squares, one step residuals with ±2SE, one step Chow forecasting failure test and N-step Chow stability test. For both equations the one step errors lie within their approximate 95% confidence bands with constant errors while for each equation the values of the break-point Chow F-tests never exceed the 1% significance level. In summary, then, the models appear to be reasonably constant.

5. Conclusions

EU demand functions for M1 and M2, which differ sharply from all other studies in terms of specification, sample period and the proxying of the opportunity cost variable of money holding, were estimated. The statistical evidence presented is consistent with stable and well behaved M1 and M2 demand functions.

There exists a difficulty in explaining the contrast in the performance between EU and member country money demand functions. Emphasis has been placed on currency substitution as the reason why the former outperform the latter. However, the existence of a stable EU money demand function, which is not matched at the country level, is not necessarily evidence that only currency substitution is at work. There is need for currency substitution to be directly investigated to ascertain its significance and, therefore, provide or otherwise the foundations for the aggregate approach to the study of the demand for money. Only AB-HZ attempt to test for currency substitution. Their preliminary results provide some evidence that currency substitution is important. Further, within this context, the implications of the distinction between asset substitutability and capital mobility deserve greater attention.

The existence of a stable EU money demand function may partly reflect aggregation bias. AB-HZ found some evidence of such bias. In contrast, CLM presented evidence implying that aggregation bias is not significant. This issue requires clarification before confident policy prescriptions can be made. However, there now exists sufficient evidence to provide the foundations for the proposition that if the European Monetary Institute, which began its operations in January 1994, were to succeed in persuading member countries to target EU wide monetary aggregates the outcome would not be inconsistent with their professed anti-inflation objectives.

Endnotes

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2. London Guildhall University (Pu) and Manchester Metropolitan University (Zis)

3. A similar approach has been used by Hall, Henry and Wilcox (1990)

4. Copies of the graphical ouput for all diagnostic tests in this section are available from the authors on request.

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