The Stability of Money Demand in Germany and in the EMS: Impact of German Unification

By

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I. Introduction

After the de facto break-down of the European Monetary System (EMS) in August 1993, the future of the current system is still open for debate. An increasing number of economists seem to doubt that the European Monetary Union (EMU) will come into existence at the end of this century. Nonetheless, EMU is still on the political agenda after the ratification of the Maastricht Treaty by all member countries in autumn of 1993 and the establishment of the European Monetary Institute in the beginning of 1994. Irrevocably fixed exchange rates or a common currency would necessitate a common monetary policy. Concomitantly, the European System of Central Banks (ESCB) – headed by the European Central Bank (ECB) – would have to choose an appropriate monetary strategy in order to fulfill its objectives as laid down in Article 105 of the Treaty on European Union.

Although the importance of monetary aggregates as an intermediate target for central banks has decreased in most industrial countries during the last decade, monetary targeting remains among the potential strategies for the ESCB.[1] One of the most crucial preconditions for monetary targeting would be that money demand is stable in the enlarged currency area. So far, opposing results exist in particular with respect to the stability of the aggregate demand for narrow money in the EMS.

Remark: We thank an anonymous referee for helpful suggestions. The paper was written when the second author was still a research associate at the Kiel Institute of World Economics.

[1] For a theoretical analysis of alternative monetary policy strategies, including money supply targeting, nominal GNP targeting, and inflation rate targeting, see e.g. Frankel and Funke (1993).

In Section II, we briefly survey the existing results regarding the stability of the aggregate demand for money in Europe. In Section III, we expand the existing literature in several directions. On the one hand, we directly compare the stability of money demand in two selected European currency areas to the stability of money demand in Germany. This comparison is interesting because the Bundesbank has been the anchor of the EMS for a long time and has revealed a relatively close ex ante commitment to its monetary target. On the other hand, we try to assess the impact of German unification on the stability of money demand. It has been feared that the unification shock caused serious troubles that may not only be temporary but even be long-lasting.[2] This might not be only the case for Germany but also for larger currency areas. The last section discusses policy implications.

II. The Aggregate Demand for Money in Europe: An Overview

So far, only a few analyses exist that try to assess the stability of the aggregate demand for money in Europe. The specifications of the estimated money demand functions differ in several respects: the sample period, the monetary aggregate and the currency area under consideration, the method of data aggregation, and the estimation technique (Table 1).

Most current analyses focus on the EMS period, although the observation period varies. Longer sample periods for a larger number of countries are restricted by data availability. Furthermore, harmonized definitions for broad monetary aggregates are not yet available for the EMS period. Studies focussing on broader aggregates have to rely on a number of proxies in the construction of aggregate money supply.

After the selection of the currency area and the sample period, national time series have to be aggregated by using appropriate exchange rates. Two conversion rates have mainly been used: current exchange rates or fixed base-period exchange rates (the latter measured as actual exchange rates or purchasing power parity (PPP) rates of a base year).

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[2] The analysis is restricted to the consideration of narrow monetary aggregates. Until recently, broad aggregates, rather than narrow ones, have been used as indicators and/or targets in a majority of European countries. Using a narrow monetary aggregate on the European level as an indicator and intermediate target would have the advantage that the ECB could control this aggregate more easily and accurately. Furthermore, definitions for broader aggregates are not yet sufficiently harmonized.

Table 1 – *The Aggregate Demand for Money in the EMS: Empirical Analyses*

Author	Kremers and Lane (1990)	Barr (1992)	Monticelli and Strauss-Kahn (1992)	Artis et al. (1993)	Cassard et al. (1994)	Wesche (1994)
Monetary aggregate	M1	M1	Broad money	M1 and M2	M3	M1
Sample period	78.4–87.4	79.1–90.4	77.1–90.3; 79.1–89.3	77.1–90.4	80.4–92.3	70.1–92.4
Currency area[a]	EC-7	EC-7	EC-9	EC-7	EC-5	EC-4 (EC-3)
Aggregation method						
Purchasing power parity	×	×			×	×
Base-period rates			×	×	×	
Current rates			×			
Estimation method						
Engle/Granger method	×	×	×	×	×	×
One-step error-correction model (ECM)			×	×	×	
Johansen			×		×	
Cointegration	yes	weak	yes	yes	yes	yes
Specification:						
Short and long rate (*RS*, *RL*)	*RS*, Δ*RS*, Δ*RL*	*RS*, Δ*RS*, Δ*RL*	*RS* or *RL*, Δ*RS* or Δ*RL*	*RS*, Δ*RS*	*RS* (or *RL*) – own rate of M3	*RS*, Δ*RS*
Real income (log)	×	×	×	×	×	×
Ecu/US$ (log)	×	×	×	(×)		
Lagged inflation	×	×				

(Table continued on next page)

(Table 1 – continued)

Author	Kremers and Lane (1990)	Barr (1992)	Monticelli and Strauss-Kahn (1992)	Artis et al. (1993)	Cassard et al. (1994)	Wesche (1994)
Monetary aggregate	M1	M1	Broad money	M1 and M2	M3	M1
Sample period	78.4–87.4	79.1–90.4	77.1–90.3; 79.1–89.3	77.1–90.4	80.4–92.3	70.1–92.4
Currency area[a]	EC-7	EC-7	EC-9	EC-7	EC-5	EC-4 (EC-3)
Price level						
Consumer price index	moving average	moving average		×	×	×
GDP/GNP deflator			×		×	
Regression results						
Adjustment speed, M1	−0.95	−0.50		−0.73		−0.38 (−0.31)
M2; M3			−0.2 – −0.45	−0.37	−0.32	
Long-run income elasticity	1.00 (constrained)	1.00 (constrained)	1.3–1.6	1.2	1.62 (0.65 ECM)	0.88 (0.85)
Long-run interest semi-elasticity	−0.0067	not significant	−0.0056 (−0.0118)	−0.007	−0.008 (−0.01)	−0.01 (−0.01)

[a] EC-9 includes Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, the United Kingdom and Spain. EC-7 includes all EC-9 countries except the United Kingdom and Spain. EC-5 includes all EC-7 countries except Italy and Ireland. EC-4 consists of France, Germany, Italy and the United Kingdom. EC-3 is identical to EC-4 excluding the United Kingdom.

Monticelli and Strauss-Kahn (1992) argue in favor of using current exchange rates because actual purchasing power would be appropriately measured by current exchange rates. The use of current exchange rates would allow for a consistent market evaluation of the stocks of financial assets. Nevertheless, the use of current exchange rates may lead to large distortions in the aggregation of national time series, e.g., when aggregating real income in the EMS with current exchange rates, aggregate real income expressed in deutsche mark roughly remained constant over the 1979–91 period although real income grew on average in each EMS country.[3]

Using PPP rates has the advantage that the weight of each country in the aggregate reflects the size of the real economy. In addition, exchange rate shocks do not affect aggregated time series.[4] From an economic perspective the choice of an arbitrary base-period exchange rate appears less convincing. Nonetheless, similar results may be obtained compared to the aggregation with PPP rates due to the specific choice of the base period (see, e.g., Kremers and Lane 1990).

So far, mainly two estimation techniques have been used: the two-step procedure suggested by Engle and Granger (1987) as well as the more recent approach to estimate the error-correction model in one step (Kremers et al. 1992). Both approaches are valid ways of proceeding only if the data have certain characteristics. In the Engle-Granger two-step method the variables in the first-step equation must be integrated of order one (I(1)). The residuals of this equation must be stationary. In the one-step procedure level variables must be I(1) and differenced variables I(0). For large samples both techniques should lead to identical results. In smaller samples, however, results may diverge (e.g., Cassard et al. 1994). The advantage of using the one-step error-correction model is that the common-factor-restriction implied by the residual-based cointegration test is avoided (Kremers et al. 1992; Hansen 1993).

Those analyses focussing on broader aggregates identified rather similar aggregate money demand functions (Table 1). Opposing results exist as to the stability of the aggregate demand for narrow money in the EMS. Kremers and Lane (1990) were among the first to analyze the stability of the aggregate demand for money (M1) in the

[3] In empirical estimates of real money demand this distortion is, however, frequently offset by corresponding distortions in the aggregation of the real money stock.

[4] PPP rates may also lead to distortions if productivity growth differs significantly in the participating countries. Since the sample period is relatively short, this should not cause serious problems.

EMS. They reported a stable money demand function for the EMS as a whole in the period of 1978 fourth quarter to 1987 fourth quarter (1978.4–1987.4). Aggregate money demand seemed to have more satisfactory properties than similar estimates for single European countries. In his attempt to re-estimate these results, Barr (1992) claimed to have found some apparent instabilities in the aggregate money demand function when extending the estimation period up to the fourth quarter of 1990. He has thus challenged the stability of the aggregate demand for narrow money for the EC-7 countries consisting of the original members of the European exchange rate mechanism (ERM). [5] In the following, we will therefore readdress the issue. In constrast to the analysis of Artis et al. (1993), the longer sample period will allow us to assess the effects of German unification. In comparison to Wesche (1994), we consider a larger and a different set of currency areas.

III. Methodology and Empirical Results

We will compare the demand for narrow money in Germany to the aggregate demand for narrow money in two currency areas: EC-3 (Germany, France, the Netherlands) and EC-7 (Belgium, Denmark, France, Germany, Ireland, Italy and the Netherlands). Both currency areas might play an important role when introducing EMU with different speed. Monetary policy in Germany and the Netherlands has always been closely linked and the narrow band of ± 2.25 percent in the ERM of the EMS still exists. France remains one of the leading advocates of a common currency. The EC-7 countries comprise the original ERM members in 1979 (except Luxembourg).

Estimation of the demand for money requires careful specification of the demand function and an underlying adjustment process. Similar to previous analyses, we assume that the demand for real money (m)[6] depends positively on real income (y) as a proxy for transactions, and negatively on a short-term interest rate (RS) reflecting the opportunity costs of holding money. Furthermore, we include an exchange rate (ex) to take account of possible currency substitution effects.

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[5] Luxembourg is excluded because not all the required data are available.

[6] For algebraic simplicity, we denote m as real money instead of the more conventional notation $(m-p)$. Lower-case letters denote natural logarithms. Without loss of generality, we start with a first-order model.

The starting point for the money demand function in the form of an error-correction model is a linear autoregressive distributed-lag model of the following type:

$$m_t = \alpha_0 + \alpha_1 m_{t-1} + \beta_0 y_t + \beta_1 y_{t-1} + \gamma_0 RS_t + \gamma_1 RS_{t-1} + \delta_0 ex_t + \delta_1 ex_{t-1} + \varepsilon_t, \quad (1)$$

where $\varepsilon_t \sim N(0, \sigma^2)$ and $|\alpha_1| < 1$ (see, e.g., also Banerjee 1993).

In the long-run equilibrium in which all changes have ceased, the long-run values are given by the unconditional expectations of the form $E(m_t)$. Defining $m^* = E(m_t)$, $y^* = E(y_t)$, $RS^* = E(RS_t)$ and $ex^* = E(ex_t)$ we get:

$$m^* = \alpha_0 + \alpha_1 m^* + \beta_0 y^* + \beta_1 y^* + \gamma_0 RS^* + \gamma_1 RS^* + \delta_0 ex^* + \delta_1 ex^*, \quad (2)$$

since $E(\varepsilon_t) = 0$. After rearranging, we obtain:

$$m^* = \frac{\alpha_0 + (\beta_0 + \beta_1) y^* + (\gamma_0 + \gamma_1) RS^* + (\delta_0 + \delta_1) ex^*}{(1 - \alpha_1)} \equiv \varkappa_0 + \varkappa_1 y^* + \varkappa_2 RS^* + \varkappa_3 ex^* \quad (3)$$

with $b_0 \equiv \frac{\alpha_0}{1-\alpha_1}$ and $\varkappa_1 \equiv \frac{\beta_0 + \beta_1}{(1-\alpha_1)}$, $\varkappa_2 \equiv \frac{\gamma_0 + \gamma_1}{(1-\alpha_1)}$, $\varkappa_3 \equiv \frac{\delta_0 + \delta_1}{(1-\alpha_1)}$,

where $\varkappa_1$ is the long-run multiplier of m with respect to y, and $\varkappa_2$ is the long-run multiplier of m with respect to RS, and $\varkappa_3$ is the long-run multiplier of m with respect to ex.

Subtracting m_{t-1} from both sides of (1) and adding and subtracting $(\beta_0 + \beta_1) y_{t-1}$, $(\gamma_0 + \gamma_1) RS_{t-1}$ and $(\delta_0 + \delta_1) ex_{t-1}$ on the right-hand side of the equation, we obtain:

$$\Delta m_t = \alpha_0 + (\alpha_1 - 1)(m_{t-1} - \varkappa_1 y_{t-1} - \varkappa_2 RS_{t-1} - \varkappa_3 ex_{t-1}) + \beta_0 \Delta y_t + \gamma_0 \Delta RS_t + \delta_0 \Delta ex_t + \varepsilon_t. \quad (4)$$

In (4), the term $(\alpha_1 - 1)$ represents the short-run adjustment to a "discrepancy". If $\alpha_1 - 1 < 1$, the adjustment process is stable and an adjustment of m_t will take place towards the long-run equilibrium $m^* = \varkappa_1 y^* + \varkappa_2 RS^* + \varkappa_3 ex^*$. The closer $\alpha_1 - 1$ to 1, the faster the adjustment process is.

To obtain the standard deviation and the t-statistics of the long-run coefficients, the Bewley transformation of the model has to be estimated afterwards. The Bewley transformation is obtained by adding and subtracting $\beta_0 y_{t-1}$, $\gamma_0 RS_{t-1}$, $\delta_0 ex_{t-1}$ on the right-hand

side of (1), and subsequently by subtracting $\alpha_1 m_t$ from both sides and dividing by $(1-\alpha_1)$. We obtain:

$$m_t = b_0 - \frac{\alpha_1}{1-\alpha_1}\Delta m_t + \varkappa_1 y_{t-1} + \varkappa_2 RS_{t-1} + \varkappa_3 ex_{t-1} + \frac{\beta_0}{1-\alpha_1}\Delta y_t + \frac{\gamma_0}{1-\alpha_1}\Delta RS_t + \frac{\delta_0}{1-\alpha_1}\Delta ex_t + \varepsilon_t. \quad (5)$$

Equation (5) has to be estimated by the instrumental variable technique because ordinary least square estimation is inconsistent due to the correlation between the error term and Δm_t (Banerjee 1993).

So far, we restricted the analysis to the consideration of a first-order model. In the more general case where also the short-term effects of earlier quarters are considered we get (4'),[7] which will subsequently be used for all estimations in the first step. We include a dummy variable to take account of German reunification. The dummy variable is set 1 in the second quarter of 1990 and 0 otherwise.[8]

$$\Delta m_t = \alpha_0 - d\,\text{Dummy} + (\alpha_1 - 1)(m_{t-1} - \varkappa_1 y_{t-1} - \varkappa_2 RS_{t-1} - \varkappa_3 ex_{t-1}) + \sum_j h_j \Delta y_{t-j} + \sum_j f_j \Delta RS_{t-j} + \sum_j i_j \Delta ex_{t-j}. \quad (4')$$

The corresponding Bewley transformation is estimated in the second step.

All data are taken from the International Monetary Fund's *International Financial Statistics*.[9] Although we have argued in favor of

[7] The error-correction model (4') is estimated with ordinary least square. The explanatory variables have to be weakly exogenous with respect to the parameters of interest for consistent and unbiased estimates. Preliminary tests have revealed that the interest rate and exchange rate are weakly exogenous. However, some ambiguous results were obtained for real income, hinting at multiple cointegrating vectors.

[8] We have chosen the second instead of the third quarter, because reported money supply already increased in the second quarter. Furthermore, when data are aggregated with current exchange rates, we add an interest rate dummy after 1991.1 for the EC-3 and EC-7 estimation. The dummy may be justified by gradually increasing tensions in the EMS caused by the direct impact of German unification on (domestic) interest rates as well as by the starting recession in some European countries (de Grauwe 1994). Although the estimation results with current rates thus hint at some parameter instabilities, this finding should not be overemphasized because of the potentially distorting effects caused by the specific aggregation method.

[9] Data aggregation follows Kremers and Lane (1990). From the second quarter of 1990 onwards, data are adjusted to include East Germany. For a more detailed description of the data source see the Appendix. In contrast to Kremers and Lane who use the four-quarter moving geometric average of the consumer price index we deflate nominal money supply with the implicit GDP/GNP deflator.

aggregating data with the PPP rates of a base year, we also present estimation results based on the aggregation with current exchange rates in order to check for the robustness of the results. All variables are natural logarithms except the nominal interest rate. The nominal interest rate is expressed in percent/100, e.g., a 7 percent interest rate is written as 0.07.[10]

In order to test for cointegration, we use the recent test suggested by Kremers et al. (1992) which is based on the t-value of the error-correction term $(\alpha_1 - 1)$ in the dynamic model. Critical values have been calculated by Banerjee et al. (1992) and Banerjee (1993). The null hypothesis of no cointegration is rejected at the 5 percent significance level, if the t-ratio is smaller than the critical boundary of -3.82 and -4.05 for three and four explanatory variables. In addition, the results of the augmented Dickey-Fuller test (ADF) for the residuals from the static regression are reported as well.

Table 2 reports the estimated money demand functions[11] for Germany, EC-3 and EC-7. The reported coefficients for $y(-1)$, $RS(-1)$ and $ex(-1)$ are the respective values of the long-term elasticities (or semi-elasticities), $\varkappa_1$, $\varkappa_2$ and $\varkappa_3$ which are obtained from the instrumental variable estimation of the Bewley transformation of the error-correction model. We distinguish between two sample periods: 1977.4–1990.1 and the whole period 1977.4–1992.4.[12] All coefficients have the expected sign. The weighted ECU/US dollar exchange rate was not significant in most aggregate demand functions. Based on the t-value of the error-correction term as well as the ADF-test the hypothesis of no cointegration is rejected in all cases at the 5-percent level.[13] The adjustment to the long-run equilibrium varies between 38 and 48 percent in Germany, between 45 and 82 percent in EC-3 and between 39 and 58 percent in EC-7.

The development of the long-run elasticities is of particular interest. The long-run income elasticity in Germany (1.52 and 1.50) clearly

[10] The coefficients of interest semi-elasticities in the present study have to be divided by 100 to be comparable to the results of the studies listed in Table 1 which are based on interest rates expressed as percentage numbers.

[11] Real money balances, real income, interest rates and the exchange rates were found to be integrated of order 1. See the Appendix.

[12] Instead of choosing the starting data 1979 first quarter, when the ERM was established, we decided to start fourth quarter of 1977. This slightly improved the estimation results. A longer sample period is restricted by data availability.

[13] One exception is the demand for money in Germany until the first quarter of 1990. Extending the period from first quarter 1974 to first quarter 1990 confirms cointegration. See for a recent study on Germany Hansen and Kim (1995).

Table 2 – *Money Demand in Germany and Aggregate Money Demand in Europe*

	$c(c+d1)$[a]	$m(-1)$	$y(-1)$	$RS(-1)$	$RS \times d2$ (-1)[b]	$ex(-1)$	Δy	$\Delta y(-1)$	$\Delta y(-3)$	ΔRS	ΔRS (-4)	R^2	DW	ADF
							Germany							
77.4–90.1	−3.80	−0.38	1.52	−1.73	–	0.16[c]	0.48	–	–	−1.14	–	0.52	2.17	−5.06
	(−3.49)	(−3.50)	(19.7)	(−5.40)		(5.10)	(2.25)			(−4.11)				
77.4–92.4	−4.73 (−4.63)	−0.48	1.50	−1.56	–	0.16[c]	0.64	–	–	−1.19	–	0.69	1.87	−6.43
	(−4.65)	(−4.55)	(38.0)	(−7.44)		(6.32)	(4.37)			(−4.25)				
Aggregation with current rates							EC-3							
77.4–90.1	−7.48	−0.82	1.37	−1.10	–	–	0.89	–	–	−0.33	–	0.74	1.93	−5.66
	(−7.64)	(−8.22)	(26.6)	(−12.7)			(6.77)			(−1.71)				
77.4–92.4	−7.17 (−7.13)	−0.79	1.35	−1.11	−0.51	–	0.86	–	–	−0.38	–	0.74	2.13	−4.30
	(−8.08)	(−8.41)	(31.3)	(−11.9)	(−6.14)		(7.33)			(−1.93)				
Aggregation with PPP rates														
77.4–90.1	−5.11	−0.65	1.21	−1.18	–	–	0.51	–	–	−0.27	0.25	0.61	2.12	−5.67
	(−5.78)	(−6.32)	(37.5)	(−9.98)			(2.33)			(−1.63)	(1.44)			
77.4–92.4	−3.21 (−3.16)	−0.45	1.13	−1.45	–	–	0.56	–	–	−0.39	0.47	0.56	1.61	−4.45
	(−4.82)	(−5.14)	(37.4)	(−7.69)			(3.08)			(−2.02)	(2.35)			
Aggregation with current rates							EC-7							
77.4–90.1	−5.44	−0.58	1.39	−1.14	–	–	0.88	–	–	−0.41	–	0.73	1.75	−4.81
	(−5.48)	(−5.58)	(29.8)	(−8.84)			(7.26)			(−2.12)				
77.4–92.4	−4.90 (−4.88)	−0.54	1.36	−1.21	−0.45	–	0.77	–	–	−0.39	–	0.74	2.12	−3.88
	(−5.74)	(−5.85)	(28.6)	(−8.69)	(−5.70)		(7.73)			(−2.06)				
Aggregation with PPP rates														
74.4–90.1	−2.36	−0.39	1.04	−1.47	–	–	0.03	–	0.15	−0.18	0.19	0.71	1.75	−4.55
	(−4.52)	(−5.52)	(25.2)	(−7.23)			(0.17)		(1.03)	(−1.46)	(1.41)			
77.4–92.4	−2.66 (−2.64)	−0.42	1.05	−1.36	–	–	0.28	–	0.13	−0.22	0.31	0.68	1.81	−5.17
	(−5.48)	(−6.06)	(47.0)	(−8.37)			(1.91)		(1.04)	(−1.73)	(2.33)			

[a] The reunification dummy (1990.2) is added to the constant in parentheses. The dummy is significant in all cases at the 1-percent significance level. – [b] Interest rate dummy. – [c] Exchange rate is DM/US$ rate. – The long-run coefficients are those obtained from the instrumental variable estimation from the Bewley transformation of the error-correction model. t-values in parentheses below the coefficient.

exceeds unity and is substantially higher than in the two currency areas EC-3 and EC-7.[14] In the EC-3 area, long-run income elasticity varies between 1.13 and 1.37 and in the EC-7 area between 1.04 and 1.39. Estimates larger than unity are in line with the presumption that real money is a superior good. However, as countries with a lower GDP per capita are included in the currency area, the income elasticity tends to fall. In the EC-7 area the hypothesis of a unit income elasticity of money cannot be rejected.[15]

Our long-run interest semi-elasticities for the two European currency areas (-1.10 to -1.47) are substantially higher than those presented by Kremers and Lane (1990). The low interest semi-elasticity of -0.0067 reported there seems to be the result of including both, the expected inflation rate and the short-term interest rate. The correlation coefficient between the expected inflation rate and the short-term interest rate is 0.89 for the sample 1978.4–1987.4, thus hinting at multicollinearity problems. Our estimates are much closer to those of national money demand functions for Germany and other countries (see, e.g., Fase and Winder 1993).

The estimated equations appear to be free from residual autocorrelation and heteroscedastic errors (Table 3). To analyze the structural stability of the demand functions, we performed two Chow tests for the period up to the first quarter 1990. The results are shown in the lower part of Table 3. In the first test, we split the sample in half; in the second test we choose 1987.4 as break-point. The latter was chosen to reassess the results of Barr (1992). Some parameter instability is visible in Germany at the 5-percent level in the second Chow test, while the H_0 hypothesis of no structural breaks cannot be rejected for EC-3 and EC-7.[16]

Furthermore, the dummy variable 1990.2 is significant in all cases. However, as to be expected, the size of the effect decreases with the size of the currency area.

German monetary union thus appears to have had an impact on the stability of money demand. This is not only true for Germany (see also von Hagen 1993) but also for the larger currency areas EC-3 and

[14] The relatively large estimated income elasticity of money in Germany disappears if a longer period starting 1974.1 is considered (results are not shown here).

[15] An alternative explanation for high income elasticities of money demand is that, like in nearly all other estimations, wealth is not explicitly included as explanatory variable because of measurement problems (Laidler 1993).

[16] The structural break for Germany disappears if the estimation period already starts in 1974.1.

Table 3 – *Test Results for Money Demand Estimations in Table 2*

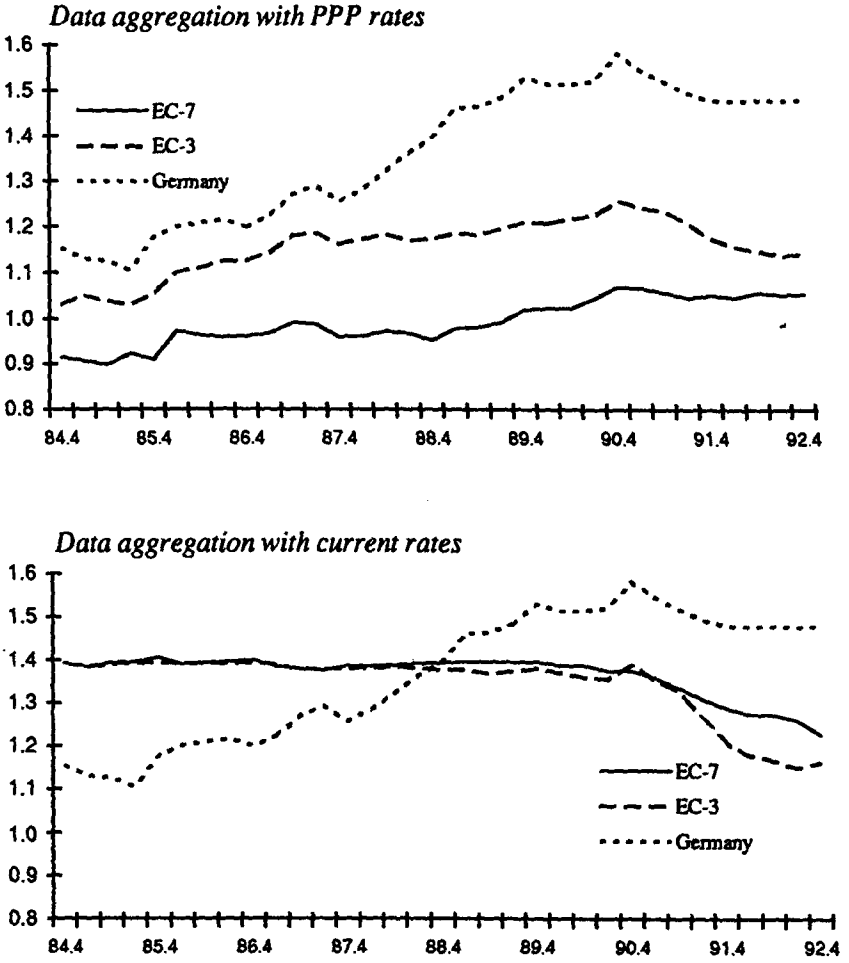
Test	Germany	EC-3		EC-7	
		Aggregation with		Aggregation with	
		current rates	PPP rates	current rates	PPP rates
	result [critical value][a]	result [critical value][a]	result [critical value][a]	result [critical value][a]	result [critical value][a]
Serial correlation[b]					
LM(1)	2.66	1.55	2.12	0.24	0.71
	[3.84]	[3.84]	[3.84]	[3.84]	[3.84]
LM(4)	3.94	5.32	6.36	3.85	5.72
	[9.49]	[9.49]	[9.49]	[9.49]	[9.49]
Heteroscedasticity					
HET[c]	2.04	1.41	4.97	3.40	4.97
	[14.1]	[12.6]	[14.1]	[12.6]	[15.5]
ARCH[d]	0.22	1.10	2.91	0.0001	2.91
	[3.84]	[3.84]	[3.84]	[3.84]	[3.84]
Structural stability					
Chow1[e]	1.70	1.14	2.27	1.65	1.48
	[2.27]	[2.34]	[2.27]	[2.34]	[2.18]
Chow2[f]	2.35	0.24	0.36	0.67	0.69
	[2.21]	[2.21]	[2.21]	[2.21]	[2.21]

[a] 5-percent critical value. – b Lagrange multiplier test for first-order or first-to-fourth-order serial correlation. – [c] Breusch-Pagan test for heteroscedasticity. Critical values are HET[$\chi^2(6)$] for EC-3 and EC-7 with current rates, HET[$\chi^2(7)$] for Germany and EC-3 with PPP rates, HET[$\chi^2(8)$] for EC-7 with PPP rates. – [d] The first autoregressive conditional heteroscedasticity test [$\chi^2(1)$]. – [e] The sample is splitted in half. – [f] Break-point is 1987.4. For details of tests, see. e.g. Cuthbertson et al. [1992].

EC-7. To substantiate these findings, the recursive long-run coefficients for real income and the nominal interest rate are shown in Figures 1 and 2.[17] Looking at the recursive coefficients of the long-run income elasticity of money demand, one observes an increasing trend in Germany until unification. After an initial rise following unification, the income elasticity decreased substantially in Germany

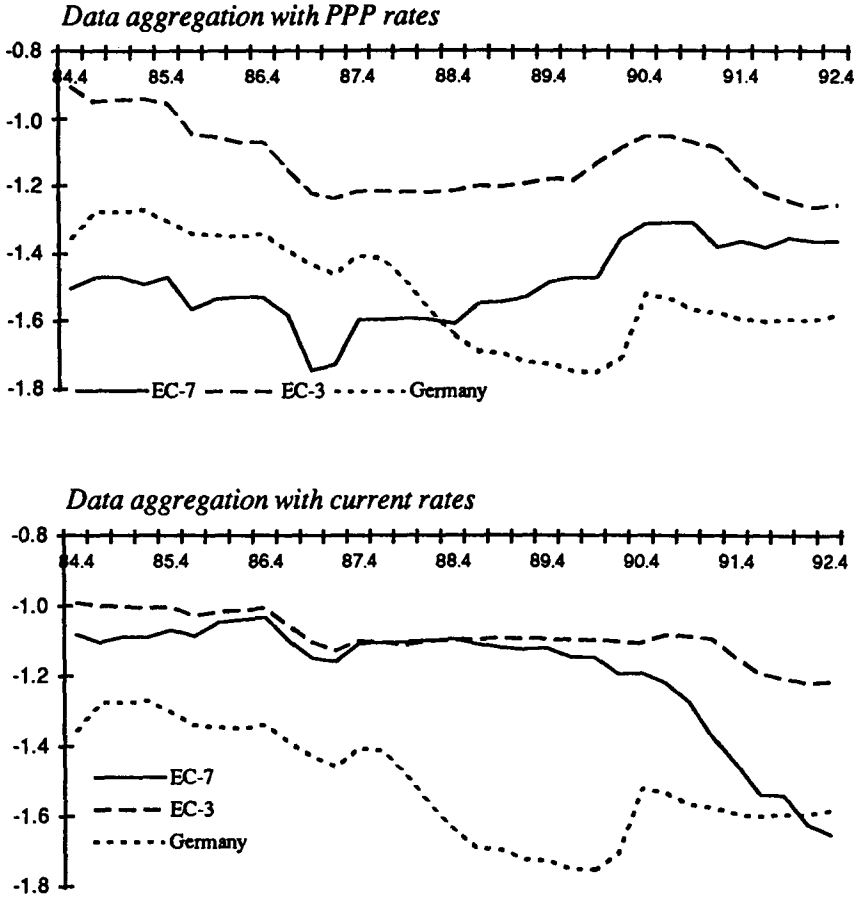
[17] All graphical representations are based on estimations without the slope dummy for the interest rate.

Figure 1 – *Long-Run Income Elasticity of Money Demand in Germany, EC-3 and EC-7*



and in the two European currency areas. A rather impressive result is obtained when data are aggregated with current exchange rates. From the mid-1980s until the end of the last decade, the income elasticity remained virtually constant in both EC currency areas and dropped thereafter (bottom chart in Figure 1). The decreasing income elasticity of money may be explained with superior-good considerations. One would expect a lower income elasticity in eastern Germany because of the lower level of development.

Figure 2 – *Long-Run Interest Semi-Elasticity of Money Demand in Germany, EC-3 and EC-7*



Similar to the case of the income elasticity of money demand, German unification has also affected the long-run interest semi-elasticity.[18] In comparison to Germany, the interest semi-elasticities are only slightly smaller in the EC-3 and EC-7 area. Figure 2 reveals again an interesting pattern. While the absolute value of the interest-rate

[18] The speed of adjustment to short-run discrepancies decreased substantially when the interest rate dummy was omitted. The absolute value of the interest semi-elasticity increased after 1991.1 in the case of EC-3 and EC-7 (aggregation with PPP rates) (see Figure 2). This suggests that some instabilities may not directly be attributed to German reunification.

elasticity decreased immediately after unification, the interest semi-elasticity increased again in 1991. This may be explained with the development of the banking system. Since the banking system in eastern Germany was not well developed in the very beginning and private agents had to get used to western banking facilities, the interest semi-elasticity might have been smaller, contributing to the decrease of the absolute value. The quick adjustment of the banking system reverted this trend.[19]

IV. Conclusions

This paper has aimed at presenting new evidence with respect to the stability of narrow money demand in Germany and the aggregate demand for money in the EMS. Previous analyses as to the stability of money demand led to ambiguous results. Special attention has been drawn to the effects of German unification.

The main conclusion is that the stability of the aggregate demand for money cannot be rejected during the EMS period until German unification. German unification had a significant impact on money demand in Germany as well as on money demand in Europe. However, the effect seems to be only of a temporary nature. As to be expected, the effects were smallest in the largest currency area (EC-7). After a short initial rise of the income elasticity of money demand in EC-7, the income elasticity remained nearly constant thereafter in the case where national time series are aggregated with PPP rates. In contrast, the absolute value of the interest semi-elasticity of money demand in the EC-7 countries decreased initially, but this also became more stable afterwards. The overall evidence suggests that there remains a close link between real money, real income, and the interest rate despite the temporary effect caused by German monetary union. This is particularly true for the EC-7 group.

The results suggest that a narrow monetary aggregate remains a potential candidate as indicator and/or intermediate target for the ECB in the case of EMU. These results may, however, be only interpreted as first evidence as to the choice of the appropriate strategy. The introduction of a common currency may itself lead to instabilities in money demand. Financial innovations are another potential threat to the usefulness of monetary aggregates. Under these circumstances

[19] Wagner (1993) analyzes the development of the banking system in former East Germany.

monetary policy strategies that aim at offsetting these disturbances, such as a nominal GNP target or an inflation target, may be preferable.

Appendix

Table A1 – *Unit Root Tests: Augmented Dickey-Fuller Test (ADF)* [20]

Variable	Germany	EC-3		EC-7	
		Aggregation with		Aggregation with	
		current rates	PPP rates	current rates	PPP rates
m1	1.74	−0.02	0.63	−2.54	0.56
$\Delta m1$	−5.93*	−6.26*	−6.41*	−3.28*	−5.01*
y	1.11	−0.26	1.15	−1.65	−0.04
Δy	−4.72*	−3.26*	−4.49*	−3.47*	−3.72*
RS	−2.55	−2.62		−2.15	
ΔRS	−3.21*	−5.05*		−4.86*	
ex	−1.21	−1.83		−1.86	
Δex	−3.29*	−4.23*		−4.21*	

* Significant at the 5-percent level.

Source: Own calculations. The average interest rates are computed as a weighted average of the national rates, using as weights the shares of the national currency in ECU. The exchange rate is the DM/US$ exchange rate (column 1) or the Ecu/US$ exchange rate (columns 2 and 3), adjusted according to the currency area. In the case of EC-3 it is the weighted average of the DM/US$, FF/US$ and Hfl/US$ exchange rate. All variables except the interest rates are in natural logarithms.

The following equations are estimated:

$$\Delta X_t = \beta_0 + \beta_t X_{t-1} + \sum_i \alpha_i \Delta X_{t-i} + e_t. \qquad \text{(A1)}$$

$H_0: \beta_1 = 0$. Thus, $\beta_1 < 0$ implies that X_t is not integrated of order one, I(1). If $\beta_1 = 0$, X_t is at least I(1). In this case, it has to be tested whether $X_t \sim$ I(2) can be rejected.

To reject H_0, the t-statistics of the coefficient β_1 must be smaller than the critical value. The 5-percent critical value is −2.93.

[20] The number of lags was determined on the basis of the rule suggested by Campbell and Perron (1991). Including a trend in the ADF test did not alter the qualitative results.

The equation for I(2) is:

$$\Delta X_t - \Delta X_{t-1} = \Delta^2 X_t = \gamma_0 + \gamma_t \Delta X_{t-1} + \sum_i \delta \Delta^2 X_{t-i} + e_t. \quad \text{(A2)}$$

$H_0: \gamma_1 = 0$. If $\gamma_1 < 0$, $X_t \sim$ I(1).

Table A2 – *Data Sources*

All data are quarterly (unless noted otherwise) and taken from the International Monetary Fund *International Financial Statistics* (IFS). Where necessary, data for Germany have been adjusted to include eastern Germany (Statistisches Bundesamt 1993) and for seasonality.

Variable	Definition and source
Money	Narrow money (M1), seasonally adjusted, IFS, line 34..b
Nominal income	Nominal GNP or nominal GDP (according to availability); Germany: GNP–IFS, line 99a.c.; France, Italy, the Netherlands: GDP–IFS, line 99b.c.; Belgium: GNP (yearly data) – IFS, line 99a; Denmark, Ireland: GDP (yearly data)–IFS, line 99b
Real income	GNP/GDP in 1985 prices; Germany: GNP–IFS, line 99a.r.; France, Italy, the Netherlands: GDP–IFS, line 99b.r.; Belgium: GNP (yearly data)–IFS line 99a.p; Denmark, Ireland (yearly data)–IFS line 99b.p
Industrial production	Used to interpolate annual data of GNP/GDP for Denmark, Belgium, Ireland; Belgium, Ireland: seasonally adjusted – IFS, line 66..b; Denmark: seasonally adjusted – IFS, line 66..c
Short-term interest rate	Money market rate – IFS, line 60b
Exchange rate	ECU exchange rate and US Dollar exchange rate, period average; Belgium: IFS, line wf and eb; Denmark, France, Germany, Italy, the Netherlands: IFS, line rf and eb; Ireland: IFS, line rh and ed

Table A3 – *Exchange Rates for the Aggregation of National Time Series*

Purchasing power parity rates, 1985			
DM/BFR	0.055605	DMHfl	0.976378
DM/DK	0.253320	DM/Ir£	3.434903
DM/FF	0.341598	DM/Ital. Lira	0.001906

Source: OECD (1987); own calculations based on the US dollar cross-rates.

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Abstract: The Stability of Narrow Money Demand in Germany and Aggregate Money Demand in the EMS: Impact of German Unification. – This paper shows that the German monetary union not only had an impact on the stability of the narrow money demand in Germany but also on the stability of the aggregate demand for money in two larger European currency areas, consisting of three and seven EMS countries. However, the impact was only of a temporary nature. The empirical results show that the close link between real money, output, and the interest rate still exists. In a European Monetary Union, narrow money thus remains a potential candidate as an indicator and/or intermediate target for the European Central Bank. JEL No. E41, E58

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Zusammenfassung: Die Stabilität der engen Geldnachfrage in Deutschland und der aggregierten Geldnachfrage im EWS: Die Wirkung der deutschen Vereinigung. – Die Verfasser zeigen, daß die deutsche Währungsunion sich nicht nur auf die Stabilität der engen Geldnachfrage in Deutschland ausgewirkt hat, sondern auch auf die der aggregierten Geldnachfrage in zwei größeren europäischen Währungsräumen, die aus drei bzw. sieben EWS-Ländern bestehen. Allerdings handelte es sich nur um eine vorübergehende Wirkung. Die empirischen Ergebnisse zeigen, daß die enge Verbindung zwischen realer Geldmenge, Produktion und Zinsen noch besteht. Demnach bleibt in einer Europäischen Währungsunion ein enges Geldmengenaggregat ein möglicher Kandidat für den Indikator und/oder die Zwischen-Zielgröße der Europäischen Zentralbank.