

Falk, Martin; Funke, Norbert

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The stability of narrow money demand in Germany and aggregate money demand in the EMS: Impact of German reunification

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The Stability of Narrow Money Demand in Germany
and Aggregate Money Demand in the EMS:
Impact of German Reunification

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Martin Falk
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Institut für Weltwirtschaft
an der Universität Kiel
Düsternbrooker Weg 120
24105 Kiel

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Contents

I. Introduction.....	1
II. The Aggregate Demand for Money in Europe: An Overview	2
III. Methodology and Empirical Results.....	5
IV. Conclusions.....	14
Appendix Tables	15
Bibliography	18

Abstract

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 3 and 7 EMS-countries. However, despite fears harbored earlier the impact was only of a temporary nature and the reunification shock did not trigger permanent disruptions. The empirical results support the continued existence of a remaining close link between real money, output, and the interest rate. This is particularly true for the aggregate demand for money in Europe. In a European Monetary Union, narrow money thus remains a potential candidate as an indicator and/or intermediate target for the European Central Bank.

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.

In Part 2, we briefly survey the existing results regarding the stability of the aggregate demand for money in Europe. Then in Part 3, 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 was the anchor of the EMS for a long time and revealed a relatively close ex ante commitment to its monetary target. On the other hand, we try to assess the impact of German reunification on the stability of money demand. It has been feared, that the reunification shock caused serious troubles that were not only temporary but may even be long-lasting.² This might not be only the case for Germany but also for larger currency areas. The last section, Part 4, discusses policy implications.

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

² The analysis is restricted to the consideration of narrow monetary aggregates. Until recently, broad aggregates, rather the 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.

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, as well as the estimation technique (see 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. Those 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 been mainly used: current exchange rates or fixed base-period exchange rates. In the latter case the actual exchange rate of a base year was chosen or purchasing power parity (PPP) rates of a base-year.³

Monticelli and Kahn [1993] 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. This, as well as the different effects arising from the use of alternative exchange rates, may be illustrated by a numerical two-country example.

For simplicity, we assume that the two countries are identical in size and are called France and Germany. In period t the money supply amounts to FF 100 bn and DM 100 bn, respectively. The current exchange rate, which coincides with purchasing power parity (PPP), is supposed to be 1 DM/FF. Aggregate money supply measured at domestic currencies amounts thus to FF 200 bn or DM 200 bn. We assume that the nominal money supply in period $t+1$ is increased by 10% in France and 5% in Germany. Due to the assumed symmetry of the two countries nominal aggregate money supply increases by 7.5%. Furthermore, it is

³ The following discussion refers to the aggregation of money supply and real income. The average interest rates are computed as a weighted average of the national rates, using as weights e.g. the shares of the national currency in the ECU. The ECU-US\$ exchange rate is adjusted according to the participating countries.

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

	Kremers and Lane [1990]	Barr [1992]	Monticelli and Strauss-Kahn [1993]	Artis, Bladen-Hovell and Zhang [1993]	Cassard, Masson, Lane [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	X	X			X	X
Base Period Rates			X	X	X	
Current Rates			X			
Estimation Method						
Engle Granger Method	X	X	X	X	X	X
One Step Error-Correction Model (ECM)			X	X	X	
Johansen			X		X	
Cointegration						
	yes	weak	yes	yes	yes	yes
Specification:						
Short a. Long Rate (RS, RL)	RS, ΔRS, ΔRL	RS, ΔRS, ΔRL	RS or RL, ΔRS or ΔRL	RS, ΔRS	RS (or RL) - own rate of M3	RS, ΔRS
Real Income (log)	X	X	X	X	X	X
Ecu/US-\$ (log)	X	X	X	(X)		
Lagged Inflation	X	X				
Price Level						
Consumer Price Index	moving average	moving average		X	X	X
GDP/GNP-Deflator			X		X	
Regression Results						
Adjustment Speed, M1 M2; M3	-0.95	-0.50	-0.2 - -0.45	-0.73 -0.37	-0.32	-0.38 (-0.31)
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 Semi-Interest Elasticity	-0.0067	Not significant	-0.0056 (-0.0118)	-0.007	-0.008 (-.01)	-0.01 (-0.01)

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

assumed that real income does not change in the two countries and that the monetary expansion fully transmits to inflation, i.e. the quantity theory holds. If the current exchange rate follows PPP the exchange rate in $t+1$ is 0.9545 DM/FF. Aggregate money supply amounts thus to FF 220 bn or DM 210 bn. Aggregate money supply measured in FF would increase by 10%, measured in DM only by 5%. Using the initial equilibrium exchange rate of 1 DM/FF would result in a 7.5% increase in both currencies.⁴

The example reveals that using PPP rates of a base period appears to be preferable.⁵ 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. 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, 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 a valid way 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 stable aggregate money demand functions (see 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

⁴ The potentially distorting effects of using current exchange rates are also visible, when national time series of EMS countries are aggregated. When aggregating real income in the EMS with current exchange rates, aggregate real income expressed in DM roughly remained constant over the 1979-1991 period although real income grew on average in each EMS-country. In this respect, the good results of Monticelli and Kahn [1993] who used current exchange rates may appear surprising. It may be partly explained by the fact that the distortion of using inappropriate exchange rates might be relatively small as the same method is used for left hand and right hand variables.

⁵ 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.

stability of the aggregate demand for money (M1) in the 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 over a longer period of time (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).⁶ In the following we will therefore readdress the issue. In contrast to the analysis of Artis et al. [1993], the longer sample period will allow us to assess the effects of German reunification. 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 $\pm 2.25\%$ in the ERM of the EMS still exists. France remains one of the leading advocats 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)⁷ 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.

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:

⁶ Luxembourg is excluded because not all the required data are available.

⁷ 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.

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

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:

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

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

$$(3) \quad m^* = \frac{\alpha_0 + (\beta_0 + \beta_1)y^* + (\gamma_0 + \gamma_1)RS^* + (\delta_0 + \delta_1)ex^*}{(1 - \alpha_1)} \equiv \kappa_0 + \kappa_1 y^* + \kappa_2 RS^* + \kappa_3 ex^*$$

with $b_0 \equiv \frac{\alpha_0}{1 - \alpha_1}$ and $\kappa_1 \equiv \frac{\beta_0 + \beta_1}{(1 - \alpha_1)}$, $\kappa_2 \equiv \frac{\gamma_0 + \gamma_1}{(1 - \alpha_1)}$, $\kappa_3 \equiv \frac{\delta_0 + \delta_1}{(1 - \alpha_1)}$,

where κ_1 is the long-run multiplier of m with respect to y , and κ_2 is the long-run multiplier of m with respect to RS , and κ_3 is the long-run multiplier of m with respect to ex .

Subtracting m_{t-1} from both sides of equation (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 side of the equation, we obtain:

$$(4) \quad \Delta m_t = \alpha_0 + (\alpha_1 - 1)[(m_{t-1} - \kappa_1 y_{t-1} - \kappa_2 RS_{t-1} - \kappa_3 ex_{t-1})] + \beta_0 \Delta y_t + \gamma_0 \Delta RS_t + \delta_0 \Delta ex_t + \varepsilon_t.$$

In equation (4) $(\alpha_1 - 1)$ 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 $m^* = \kappa_1 y^* + \kappa_2 RS^* + \kappa_3 ex^*$. The closer $\alpha_1 - 1$ to 1, the faster is the adjustment process.

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 equation (1), and subsequently by subtracting $\alpha_1 m_t$ on both sides and dividing by $(1 - \alpha_1)$. One obtains:

$$(5) \quad m_t = b_0 - \frac{\alpha_1}{1 - \alpha_1} \Delta m_t + \kappa_1 y_{t-1} + \kappa_2 RS_{t-1} + \kappa_3 ex_{t-1} + \frac{\beta_0}{1 - \alpha_1} \Delta y_t + \frac{\gamma_0}{1 - \alpha_1} \Delta RS_t + \frac{\delta_0}{1 - \alpha_1} \Delta ex_t + \varepsilon_t.$$

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 equation (4')⁸, 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.⁹

$$(4') \Delta m_t = \alpha_0 + d \text{Dummy} + (\alpha_1 - 1)[m_{t-1} - \kappa_1 y_{t-1} - \kappa_2 RS_{t-1} - \kappa_3 ex_{t-1}] + \sum_j h_j \Delta y_{t-j} + \sum_j f_j \Delta RS_{t-j} + \sum_j i_j \Delta ex_{t-j}.$$

The corresponding Bewley transformation is then estimated in the second step.

All data are taken from the International Monetary Fund's International Financial Statistics.¹⁰ Although we have argued in favor of 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 expressed as 0.07.

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 in the dynamic model ($\alpha_1 - 1$). Critical values have been calculated by Banerjee [1992, 1993]. The Null-hypothesis of no cointegration is rejected at the 5% significance level, if the t-ratio is smaller than the critical

⁸ 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.

⁹ We have chosen the second instead of the third quarter, because reported money supply already increased in the second quarter. Furthermore, we add a dummy variable after 1991.1 for the semi-interest-elasticity for the EC-3 estimation as well as the EC-7 (data aggregation with current rates).

¹⁰ Data aggregation follows Kremers and Lane [1990]. Replicating their results (1) in sample for the 1978.4-1987.4 period reveals that our data aggregation(2) is compatible to theirs.

$$\begin{aligned} 1. (m-y)_t &= -5.92 - 0.67RS_t - 1.40\Delta p_{t-1} + 0.079ecu_t \\ &\quad (0.01) \quad (0.15) \quad (0.53) \quad (0.007) \\ 2. (m-y)_t &= -5.93 - 0.69RS_t - 1.26 \Delta p_{t-1} + 0.079ecu_t \\ &\quad (0.01) \quad (0.15) \quad (0.53) \quad (0.007) \end{aligned}$$

Deviations are within one standard error and much smaller than in Barr [1992]. 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 [1990] who use the four-quarter moving geometric average of the consumer price index we deflate nominal money supply with the implicit GDP/GNP deflator in the following.

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 2a reports the estimated money demand functions¹¹ for Germany, EC-3 and EC-7. The reported long-run coefficients are already those obtained from the instrumental variable estimation of the Bewley-transformation of the error-correlation model. We distinguish between two sample periods 1977 fourth quarter to 1990 first quarter (1977.4-1990.1) and the whole period 1977 fourth quarter to 1992 fourth quarter (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 estimated equations appear to be free from residual autocorrelation and heteroscedastic errors (Table 2b).

The adjustment to the long-run equilibrium varies between 36 to 46 percent in Germany, between 65 to 82 percent in EC-3 and between 39 to 58 percent in EC-7. The adjustment speed is higher in the two currency areas than in single countries [see also Monticelli, Strauss-Kahn, 1992].

The development of the long-run elasticities is of particular interest. The long-run income elasticity in Germany (1.51 and 1.48) clearly 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 1.21 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

¹¹ Pre-tests reveal that real money balances, real income, interest rates and the exchange rates are integrated of order 1. See Appendix I.

¹² Instead of choosing the starting date 1979 first quarter, when the ERM was established, we decided to start fourth quarter of 1977. This slightly improved the stability of the estimation results, as there was a recession in 1979. For a comparison, results for the period starting in the first quarter of 1979 are given in Appendix I.

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.

¹⁴ The relatively large estimated income elasticity of money in Germany drops if a longer period is considered. Results are not reported here. Similarly, the structural break, indicated by the second Chow-test (Table 2b) then disappears at the 5 percent level.

Table 2a - Money Demand in Germany and Aggregate Money Demand in Europe*

	c (e+dl) ^a	m(-1)	y(-1)	RS(-1)	RSx2(-1) ^b	ex(-1)	Δy	$\Delta y(-1)$	$\Delta y(-3)$	ΔRS	$\Delta RS(-4)$	R ²	DW	ADF	
Germany															
77:4-90:1	-3.72 (-3.43)	-0.36 (-3.41)	1.51 (18.6)	-1.75 (-5.20)	-	-	0.37 ^c (4.85)	0.46 (2.17)	-	-	-1.17 (-4.16)	-	0.52	2.17	-4.36
77:4-92:4	-4.63 (-4.53) (-4.60)	-0.46 (-4.51)	1.48 (34.8)	-1.58 (-7.23)	-	-	0.36 ^c (6.09)	0.62 (4.28)	-	-	-1.20 (-4.27)	-	0.69	1.89	-6.16
EC-3															
<u>Aggregation with Current Rates</u>															
77:4-90:1	-7.48 (-7.64)	-0.82 (-8.22)	1.37 (26.6)	-1.10 (-12.7)	-	-	0.89 (6.77)	-	-	-0.33 (-1.71)	-	0.74	1.93	-5.66	
77:4-92:4	-7.17 (-7.13) (-8.08)	-0.79 (-8.41)	1.35 (31.3)	-1.11 (-11.9)	-0.51 (-6.14)	-	0.86 (7.33)	-	-	-0.38 (-1.93)	-	0.74	2.13	-4.30	
<u>Aggregation with PPP Rates</u>															
77:4-90:1	-5.11 (5.78)	-0.65 (-6.32)	1.21 (37.5)	-1.18 (-9.98)	-	-	0.51 (2.33)	-	-	-0.27 (-1.63)	0.25 (1.44)	0.61	2.12	-5.67	
77:4-92:4	-5.21 (-5.17) (-6.16)	-0.65 (-6.54)	1.23 (44.0)	-1.16 (-9.89)	-0.40 (-4.24)	-	0.63 (3.78)	-	-	-0.35 (-2.00)	0.33 (1.77)	0.64	1.79	-4.45	
EC-7															
<u>Aggregation with Current Rates</u>															
77:4-90:1	-5.44 (-5.48)	-0.58 (-5.58)	1.39 (29.8)	-1.14 (-8.84)	-	-	0.88 (7.26)	-	-	-0.41 (-2.12)	-	0.73	1.75	-4.81	
77:4-92:4	-4.90 (-4.88) (-5.74)	-0.54 (-5.85)	1.36 (28.6)	-1.21 (-8.69)	-0.45 (-5.70)	-	0.77 (7.73)	-	-	-0.39 (-2.06)	-	0.74	2.12	-3.88	
<u>Aggregation with PPP Rates</u>															
77:4-90:1	-2.36 (4.52)	-0.39 (-5.52)	1.04 (25.2)	-1.47 (-7.23)	-	-	0.03 (0.17)	-	0.15 (1.03)	-0.18 (-1.46)	0.19 (1.41)	0.71	1.75	-4.55	
77:4-92:4	-2.66 (-2.64) (-5.48)	-0.42 (-6.06)	1.05 (47.0)	-1.36 (-8.37)	-	-	0.28 (1.91)	-	0.13 (1.04)	-0.22 (-1.73)	0.31 (2.33)	0.68	1.81	-5.17	

*The long-run coefficients are those obtained from the instrumental variable estimation from the Bewley-transformation of the error-correction model. T-values in parenthesis.

^a The reunification dummy (1990.2) is added to the constant in parenthesis. The dummy is significant in all cases at the 1 percent significance level. - ^b Interest rate dummy. -

^c Exchange rate is DM-US\$ rate.

Table 2b - Test Results for Money Demand Estimations in Table 2a

Test	Germany		EC-3				EC-7			
			Aggregation with				Aggregation with			
	Result	Critical Value ^a	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)	2.80	3.84	1.55	3.84	2.12	3.84	0.24	3.84	0.71	3.84
LM(4)	4.62	9.49	5.32	9.49	6.36	9.49	3.85	9.49	5.72	9.49
Heteroscedasticity										
HET ^c	1.57	14.1	1.41	12.6	4.97	14.1	3.40	12.6	4.97	15.5
ARCA ^d	0.23	3.84	1.10	3.84	2.91	3.84	0.0001	3.84	2.91	3.84
Structural Stability										
Chow1 ^e	1.96	2.27	1.14	2.34	2.27	2.27	1.65	2.34	1.48	2.18
Chow2 ^f	2.24*	2.21	0.24	2.21	0.36	2.21	0.67	2.21	0.69	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 1987.4. For details of tests, see e.g. Cuthbertson, Hall, Taylor [1992].

tends to fall. In the EC-7 area the hypothesis of a unit income elasticity of money cannot be rejected.¹⁵

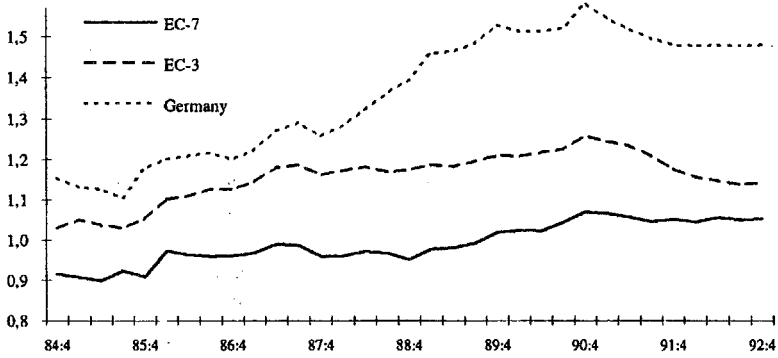
Our long-run semi-interest elasticities for the two European currency areas (-1.10 to -1.47) are substantially higher than those presented by Kremers and Lane [1992]. The low semi-interest elasticity of 0.67/100 reported there seems to be the result of including both, the expected inflation rate and 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 to 1987.4, thus hinting at multicollinearity problems. Our estimates are much closer to those of Germany and other national money demand functions [see e.g. Fase, Winter, 1993].

To analyze the structural stability of the demand functions, we performed Chow-tests for the period up to first quarter 1990 (see Table 2b). In the case of the Chow-test, we split the sample in half at first and then choose 1987 fourth quarter 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, while the H_0 hypothesis of no structural breaks cannot be rejected for EC-3 and EC-7. 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.

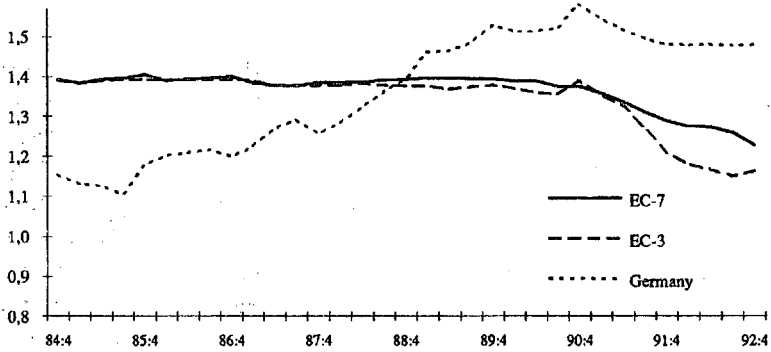
German monetary union thus appears to have had an impact on the stability of money demand. This is not only true for Germany [see also von Hagen, 1993] but also for the larger currency areas EC-3 and EC-7. To substantiate these findings, the recursive long-run coefficients for real income and the nominal interest rate are shown in Graph 1-2. Looking at the recursive coefficients of the long-run income elasticity of money demand, one observes an increasing trend in the long-run income elasticity in Germany until reunification. Furthermore, after German reunification fluctuations in Germany were particularly larger than in the EC-7 area (see Graph 1).¹⁶ After an initial short-term rise, the income elasticity decreased substantially in Germany 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 Graph 1). The decreasing income elasticity of money may again be (partly) explained with the superior good

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].

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



Data aggregation with PPP rates.

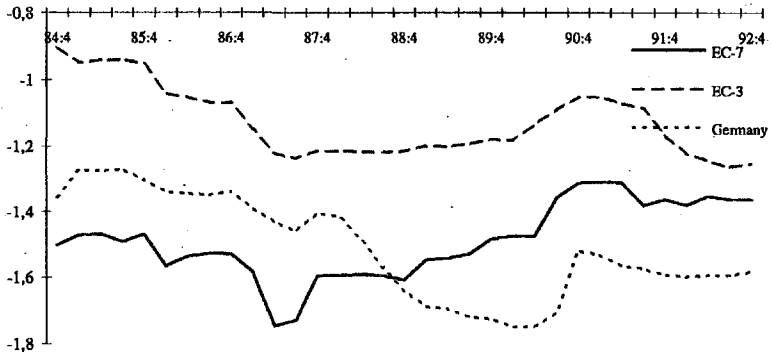


Data aggregation with current rates.

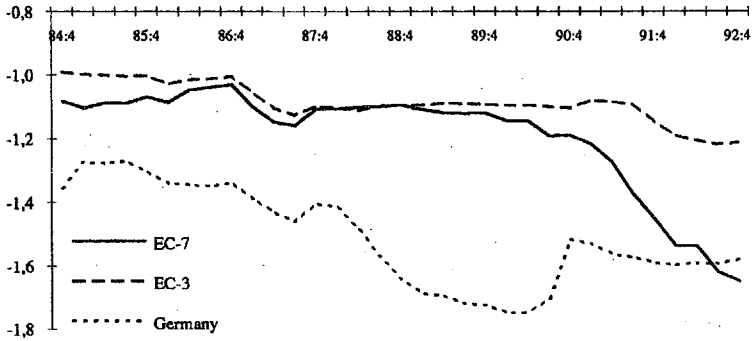
Source: Own calculations.

¹⁶ All graphical representations are based on estimations without the slope dummy for the interest rate.

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



Data aggregation with PPP rates.



Data aggregation with current rates.

Source: Own calculations.

assumption.¹⁷ One would expect a lower income elasticity in East Germany because of the lower level of development.

Similar to the case of the income elasticity of money demand, the German reunification has also affected the long-run semi-interest elasticity.¹⁸ In comparison to Germany, the semi-interest elasticities are only slightly smaller in the EC-3 and EC-7 area. Graph 2 reveals again an interesting pattern. While the absolute value of the interest rate elasticity decreased immediately after the reunification, the semi-interest elasticity increased again in 1991. This may be explained with the development of the banking system. Since the banking system in East Germany was not well developed in the very beginning and private agents had to get used to Western banking facilities, the interest rate elasticity might have been less elastic, contributing to the decrease of the absolute value. The quickly developing banking system reverted this trend.¹⁹

IV. CONCLUSIONS

This paper 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 was drawn to the effects of German reunification.

The main conclusion is that the stability of the aggregate demand for money cannot be rejected during the EMS period until German reunification. German reunification 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 when national time series are aggregated with PPP rates. In contrast, the absolute value of the semi-interest 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 of the temporary effect caused by German monetary union. This is particularly true for the EC-7 group.

¹⁷ In addition, the income elasticity tends to be lower in a recession.

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

¹⁹ Wagner [1993] analyses the development of the banking system in former East Germany.

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 obviously lead to some instabilities in money demand. Financial innovations are another potential threat to the usefulness of monetary aggregates. Under these circumstances monetary policy strategies that aim at offsetting these disturbances, such as a nominal GNP 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
Δ m1	-5.93*	-6.26*	-6.41*	-3.28*	-5.01*
yr	1.11	-0.26	1.15	-1.65	-0.04
Δ yr	-4.72*	-3.26*	-4.49*	-3.47*	-3.72*
RS	-2.55		-2.62		-2.15
Δ RS	-3.21*		-5.05*		-4.86*
ex	-1.84		-1.83		-1.86
Δ ex	-3.32*		-4.23*		-4.21*

* significant at 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 or the ECU/US\$ exchange rate, adjusted according to the currency area. All variables except the interest rates are in natural logarithms.

The following equations are estimated:

$$(1) \quad \Delta X_t = \beta_0 + \beta_1 X_{t-1} + \sum_i \alpha_i \Delta X_{t-i} + e_t$$

$H_0: \beta_1 = 0$. 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.

The equation for $I(2)$ is:

$$(2) \quad \Delta X_t - \Delta X_{t-1} = \Delta^2 X_t = \gamma_0 + \gamma_1 \Delta X_{t-1} + \sum_i \delta_i \Delta^2 X_{t-i} + e_x$$

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

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 although a trend in equation (1) is significant for the logarithm of real money at the 5 percent level for Germany, EC-3 (aggregation with PPP rates) and EC-7 (aggregation with PPP rates). The corresponding t-values are -0.05 for Germany, -2.06 for EC-3 and -2.76 for EC-7 with a critical value of -3.5.

Table A2 - Money Demand in Germany and Aggregated Money Demand in Europe*

	c (c+ δ)	m(-1)	y(-1)	RS(-1)	RS(-1) Δ D	ex(-1)	Δ y	Δ y(-1)	Δ y(-3)	Δ RS	Δ RS(-4)	R ²	DW	ADF
Germany														
79:1-90:1	-4.01 (-3.43)	-0.35 (-3.32)	1.61 (11.0)	-1.79 (-3.10)	-	0.32 (3.05)	0.50 (2.59)	-	-	-1.08 (-3.96)	-	0.59	2.31	-4.54
79:1-92:4	-4.46 (-4.36) (-3.85)	-0.44 (-4.19)	1.52 (23.5)	-1.62 (-4.44)	-	0.34 (3.94)	0.61 (4.25)	-	-	-1.13 (-3.92)	-	0.72	1.89	-6.06
EC-3														
Aggregation with Current Rates														
79:1-90:1	-6.31 (-4.72)	-0.70 (-5.17)	1.39 (19.9)	-1.25 (-6.80)	-	-	0.82 (5.13)	-	-	-0.28 (-1.33)	-	0.64	2.03	-4.34
79:1-92:4	-6.32 (-6.28) (-5.77)	-0.70 (-6.43)	1.35 (25.9)	-1.13 (-9.41)	-0.51 (-5.10)	-	0.81 (5.94)	-	-	-0.34 (-1.65)	-	0.69	2.21	-4.71
Aggregation with PPP Rates														
79:1-90:1	-4.30	-0.52 (-4.16)	1.27 (24.1)	-1.20 (-7.10)	-	-	0.29 (1.27)	-0.18 (-0.85)	-	-0.25 (-1.45)	0.18 (1.01)	0.47	1.97	-5.56
79:1-92:4	-2.43 (-2.39) (-3.37)	-0.35 (-3.84)	1.11 (23.7)	-1.44 (-7.21)	-	-	0.52 (2.80)	0.36 (2.31)	-	-0.47 (-2.56)	0.41 (2.15)	0.54	1.78	-4.43
EC-7														
Aggregation with Current Rates														
79:1-90:1	-4.88 (-3.67)	-0.52 (-3.96)	1.39 (20.0)	-1.25 (-6.80)	-	-	0.76 (5.08)	-	-	-0.35 (-1.59)	-	0.68	1.88	-4.48
79:1-92:4	-4.61 (-4.67) (-4.92)	-0.51 (-5.16)	1.35 (20.7)	-1.29 (-6.79)	-0.44 (-4.55)	-	0.69 (6.23)	-	-	-0.32 (-1.63)	-	0.74	1.98	-4.82
Aggregation with PPP Rates														
79:1-90:1	-4.01 (3.43)	-0.33 (-3.97)	1.04 (18.6)	-1.53 (-5.84)	-	-	-0.02 (-0.11)	-	0.24 (1.49)	-0.20 (-1.56)	0.18 (1.33)	0.60	1.70	-5.95
79:1-92:4	-2.29 (-2.27) (-4.04)	-0.36 (-4.31)	1.05 (38.0)	-1.43 (-6.74)	-	-	0.23 (1.50)	-	0.16 (1.28)	-0.25 (-1.83)	0.31 (2.31)	0.59	1.80	-5.78

*For further explanations see Table 2a.

Table A3 - 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 East Germany²¹ as well as seasonally adjusted.

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 99 a.c.; France, Italy, 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, 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, Netherlands: IFS, line rf and eb; Ireland: IFS, line rh and ed

Table A3 cont.- Exchange Rates for the Aggregation of National Time Series

	Base-period exchange rates	Purchasing Power Parity Rates
	1979	1985
DM/BFR	0.062514	0.055605
DM/DK	0.348435	0.253320
DM/FF	0.430769	0.341598
DM/Hfl	0.91369	0.976378
DM/Ir£	3.750633	3.434903
DM/Ital. Lire	0.002206	0.001906

Source: Base period exchange rate IMF[b], PPP rates OECD [1989]; own calculations based on the US dollar cross-rates.

²¹ Statistisches Bundesamt [1993].

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