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Asymmetries of Demand for Money Functions Amongst EMU Countries

PHILIP ARESTIS
IRIS BIEFANG-FRISANCHO MARISCAL
ANDREW BROWN
MALCOLM SAWYER *

INTRODUCTION

The European Central Bank (ECB) uses a "two pillar" strategy to achieve its objective of price stability in the eurozone. It announces an explicit inflation target for the harmonised consumer price index, currently at 2% per annum, and a reference value of M3 growth of 4.5% for 1999/2000 (ECB, 1999a; ECB, 1999b). The ECB appears to believe that the overall price level is determined in the long run by the demand for money relative to the supply of money. Even in the absence of explicit monetary targeting, the stability between money and prices affects the role of monetary aggregates in the conduct of monetary policy. The stability of the money-price link depends ultimately on the behaviour of money holders that is, it depends on the properties of the demand for money relationship.

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* Philip Arestis is at the Levy Economics Institute of Bard College, Iris Biefang-Frisancho Mariscal is at the University of the West of England and Andrew Brown and Malcolm Sawyer are at the University of Leeds. E-mail: p.arestis@levy.org and mcs@lubs.leeds.ac.uk.

A number of aggregate money demand equations for the eurozone have been estimated and we only mention a few prominent estudies, as for example those by Coenen and Vega (1999), Hayo (1999), Vlaar and Schubert (1999), and more recently, Bruggeman (2000) and Brand and Cassola (2000). Furthermore, there is evidence that the ECB takes money stock growth seriously. For example, in November 1999 the rise in the interest rate took place when the *only* indicator that was growing above its target range was the Economic and Monetary Union (EMU) wide money supply (Hughes Hallet and Piscitelli, 1999).[1]

This paper is concerned with the demand for money functions in individual EMU countries, whether such demand functions can be identified and, where identified, whether they are broadly similar across countries. A change in the ECB interest rate will trigger the same change in the short-term interest rate for all EMU countries. As a consequence, the cost of borrowing will change in the EMU countries, which will affect the demand for bank loans. The size of the latter effect may vary from country to country, depending on the institutional setting and may thus give rise to asymmetries in the monetary mechanism (Dornbusch *et al.*, 1997). The extent to which the expansion of the stock of money consequent upon expansion of loans remains in existence depends upon the demand for money. The demand for money may differ across EMU economies, and hence the expansion of the stock of money would be different across countries.

It can be argued, and a referee of this journal has made the point, that the paper does not refer to other aspects of integration and convergence, and to the transmission mechanism across the emu member countries (see, for example, Suardi, 2001; Clements *et al*., 2001; Mihov, 2001). These authors address convergence/divergence in terms of the coefficients of the Phillips curve equation, indicating the responsiveness of the

[1] It should be noted, though, that the M3 monetary target has never been met (ECB, Monthly Bulletin, various issues).

unemployment rate to the difference between actual and expected inflation rates. This might affect the way in which the ECB takes into account the objectives of monetary and output stability. They also address convergence/divergence across EMU countries in terms of the integration of their financial markets. The latter might affect consumption and portfolio transactions (see, also, the European Commission's, *European Economy*, No. 73, 2001). Clearly, these are interesting questions, but well beyond the objective of this paper. This paper concentrates on one aspect of the possible asymmetries of the monetary transmission mechanism, namely that which arises from the interest rate elasticity of the demand for money.

We proceed as follows. In section 1 we formulate the demand-for-money relationship to be estimated in the case of all eleven eurozone countries. In section 2 we discuss the econometric methodology pursued along with the results of the estimation procedure. There are important implications for the conduct of monetary policy in the eurozone which are brought out and discussed. Section 3 briefly summarises the argument and concludes.

THE DEMAND FOR MONEY IN EMU COUNTRIES

The quantification of the differences of the behaviour of money holders is based on a traditional long-run demand for money relationship, as in [1]:

$$(m-p)_t = \alpha_1 y_t + \alpha_2 OWN_t + \alpha_3 R_t + \alpha_4 \Delta p_t \qquad [1]$$

where lower case letters denote the logarithm of a variable. We use M3 as the money variable, p stands for the price level, y is real income, OWN is the own rate of interest, R_t is the opportunity cost of holding money, proxied by either the long-term rate of interest (R_L) or the short-term rate (R_S), and p_t is the inflation rate. In some cases, we find $\alpha_2 = -\alpha_3$, in which case it would be the spread (OWN_t-R_t) that stands for the opportunity cost of holding money. Some theories predict particular values for α_1, as for example, formulations of the quantity theory of money that predict homogeneity between money and income. Empirically, we occasionally find $\alpha_1 \succ 1$, which is usually interpreted as proxying effects due to omitted variables, particularly wealth effects (Browne *et al.*, 1997). Formulation [1] is also the underlying model for the estimation of aggregate European money demand studies as, for example, in Coenen and Vega (1999).

Our empirical results show that on the basis of equation [1] no money demand functions can be identified for Finland, Luxembourg and the Netherlands. For the remaining countries, the long-run estimated demand equations appear to be stable and vary to a minor degree with respect to the income elasticity, but widely with respect to the interest rate elasticity. For the latter countries, we have two broad types of results: for six countries, money demand is, to a varying degree, interest elastic, while for the remaining countries, interest rates do not play any role in the demand for money relationships. This implies that for one group of countries, monetary adjustment affects predominantly the real sector, while for the other group adjustment occurs mainly through financial assets. These results are important because country unspecific monetary targeting may enforce asymmetries due to the fundamentally different adjustment to monetary shocks.[2]

We elaborate on the results just summarised in the section that follows. We discuss the results of the long-run relationships first, followed by those of dynamic modelling.

EMPIRICAL RESULTS

We apply the "encompassing VAR" approach as in Hendry and Mizon (1993) and Hendry and Doornik (1994) for the estimation of the money demand equations. This approach attempts to recover structural economic models from congruent statistical representations of the data. The starting

[2] The existing literature reports significant income and interest elasticities for EMU countries (see, for example, the overview by Browne *et al.*, 1997).

point is an unrestricted vector autoregressive model (UVAR) which serves as a baseline model for marginalisation and identification of trends and breaks. Its reparameterisation into an unrestricted vector error correction model (VECM) isolates the long run from the short-run dynamics (Johansen, 1988). Structural models are recovered from the unrestricted VECM by imposing identifying and overidentifying restrictions on the long-run and short-run reduced form parameters of the VECM (Pesaran and Shin, 1994; Johansen and Juselius, 1992).[3]

Long-run Relationships

The results of the long-run relations are presented in table 1 and the results of the restrictions on the cointegration and adjustment vectors are reported in table 2.[4] The estimated relationships for Belgium, France, Germany, Italy, Portugal and Spain may be interpreted as conventional money demand functions and they are subsumed as group 1 for

[3] All estimations were carried out with the programme package PcFiml (Doornik and Hendry, 1997). The estimation period is for most countries from 1979 quarter 1 until 1998 quarter 3 (for a detailed description on the data, see Arestis *et al.*, 2000). The M3 series for Belgium, Finland and France had severe breaks that could not be accommodated for by dummy variables. Consequently, the periods were shortened to 1990 quarter 2 until 1998 quarter 3 for the latter two countries, and for Belgium the estimation period ended in 1994 quarter 2. Data sources are IFS CD-ROM, MIMAS Online Database and OECD Main Economic Indicators. All data are seasonally adjusted except for Austria. The short-term interest rate for Belgium, Germany and Spain are the call money rate and for Italy the money market rates. Long-term interest rates are the government bond yield for France and Portugal. The own rate for France is proxied by the deposit rate and for Spain by the 3-month-interbank rate. The income variable is GDP and we use the GDP price deflator.

[4] Multivariate tests of the UVAR models revealed no misspecification problems at all, so that the systems were treated as data congruent The maximal eigenvalue and trace tests indicate only one cointegrating vector for each country. Stability was tested on the basis of recursive eigenvalues and all cointegrating relationships were constant. These sets of results are not reported here but may be obtained from the authors upon request.

convenience.[5] In this group, interest rates play a significant role in the long-run demand for money equations. Only for France could we find a significant effect of the own rate on broad money demand, which could be restricted to a spread (SP_L) between the own and the long-run rate. In the Spanish money demand relationship, the interest rate spread (SP_S), defined as the difference between the own and the short-run interest rates, also plays a significant role. The semi-elasticities of the short-run (R_S) and long-run (R_L) rates vary considerably between the countries in this group. For example, the German semi-elasticity is slightly less than half of that in Italy, and one seventh of that in Belgium. For all countries in this group, except for Belgium and Germany, we find that trend-adjusted velocity is cointegrated with interest rates. The homogeneity restriction cannot be accepted in either Belgium or Germany. This is actually a common result for Germany and conventionally attributed to omitted variables, typically to the omitted wealth effect (Browne *et al.*, 1997).[6] Weak exogeneity tests for all countries in the first group reject the weak exogeneity of money, as expected.[7]

The second group of countries comprises Austria, Finland, Ireland, Luxembourg and the Netherlands. In this group, the results are unexpected. In all cases, the (trend-adjusted) relationship between income and real money is stationary. Since interest rate variables are integrated of order

[5] Originally, in our study, inflation was included as in equation [1], describing the substitution process between money and real assets. Unsurprisingly, we did not find this role for inflation in the money demand functions. Over the sample period, European countries experienced low inflation rates and in countries with quite sophisticated financial markets, a greater substitutability between money and financial assets than between money and real assets may be expected. See, for a similar result, Hayo (1999) and Vlaar and Schuberth (1999).

[6] A wealth effect variable that is consistent for all individual EMU countries is not available.

[7] In fact, France is a borderline case in this group. On the basis of a significant error correction term in the money growth equation, we tend to interpret the cointegration relation as the expected money demand function.

one, velocity and interest rates cannot co-integrate.[8] Furthermore, since there is only one cointegration relation, interest rates do not co-integrate with each other. In fact, the data accept the overidentifying restrictions (see table 2). Weak exogeneity tests for all countries in the second group suggest that money is weakly exogenous, except for Ireland and Austria.[9] The interest rate insensitivity of the demand for money in Austria and Ireland implies that adjustments in response to a monetary shock are transmitted to the real sector through fluctuations in employment and output, which is in contrast to the results in group 1 countries.

The differences in results between countries have important implications in the conduct of monetary policy. Monetary policy in the eurozone has been conducted on the basis of one instrument, namely the ecb interest rate. The behaviour of money holders in response to a monetary shock differs substantially throughout eurozone. This is one channel through which a common monetary policy has significantly different effects on output and employment amongst the member countries. In fact, the conventional aggregate emu money demand function as, for example, in Coenen and Vega (1999) or Hayo (1999), appears to be irrelevant for some emu countries. Such asymmetries are then likely to destabilise the business cycle and place countries out of phase with each other. Given the stability and growth pact arrangements, deficit constrained national fiscal policies could not correct these asymmetries. Furthermore, the literature on aggregate (broad) emu money demand functions suggests that long-term interest rates are important determinants. Coenen and Vega (1999) report for the emu countries a semi-elasticity of –0.820, Hayo (1999) finds for the same long-term bond yield (although a longer time period), a value of –0.023, Bruggeman (2000) finds –0.019 for the semi-elasticity of the long-run interest rate and Brand and Cassola (2000)

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8 Note that estimations started from a general model.

9 Austria is a borderline case. As in the French case, there is a significant error correction term in the money growth equation, and we tend to interpret the cointegration relation as trend adjusted velocity.

report a semi-elasticity of –1.608. There is diversity of the European wide M3 interest elasticity as the studies above show. Furthermore, even on the basis of a common sample period and variable definitions, our empirical results indicate diversity in the behaviour of money holders amongst EMU countries.

Dynamic Modelling

Economic theory is generally vague on the dynamic structure of economic models. In line with the recent literature (Johansen and Juselius, 1992; Hendry and Doornik, 1994), we begin with the short-run unrestricted reduced form model in which the cointegrating relations from the previous analysis are fixed. This unrestricted, statistically well-defined model typically is overparameterized with insignificant variables. In a stepwise procedure, this general model was reduced to a parsimonious vector error correction model (PVECM) that was data congruent and encompassed previous models. Since we do not have strong prior hypotheses about identifying restrictions, we were mainly concerned about the plausibility of signs and, where possible, the size of the derivatives. Particularly, we are concerned with plausible estimates of the error correction terms with respect to the identified long-run relationships since the adjustment coefficients relate the short-run structure with that of the long-run relationships.

On the basis of weak exogeneity tests in the cointegration analysis and tests of the significance of the error correction term(s) in dynamic equations, a conditional PVECM was derived. When we found large correlations in the correlation matrix of the conditional models, indicating that there are simultaneous effects between error correction models, we included lagged endogenous variables as additional right-hand-side variables. The estimates of the conditioned dynamic models and their likelihood ratio tests with *k*-overidentifying restrictions are shown in table 3. These tests give strong support for the imposed restrictions. Furthermore, the usual diagnostic statistics do not indicate any serious specification problems. We find that for Germany and Portugal the interest rates representing opportunity costs are weakly exogenous, while for Belgium and Italy the short-run interest is endogenous and we could condition on GDP. For France and Germany, the interest rate spread and GDP growth are endogenous, while for Spain the spread is endogenous.

We begin with the discussion and the comparison of the dynamic demand for money equations across the six countries for which we could identify a long-run (conventional) money demand relationship. The error correction terms in the short-run money demand equations are all significant and correctly signed. The adjustment process in response to a disequilibrium error varies in the six countries quite significantly. Spain has the lowest rate of adjustment. Full adjustment is achieved after less than one year in Italy, France and Portugal, after about two and a half years in Belgium and after slightly less than three years in Germany. In all countries, interest rate effects play a significant role in the growth of M3. Except for Belgium, the interest rate has, as expected, a negative effect on money demand growth. In the case of Belgium, the positive effect of the interest rate on money growth may, at least over some part of the sample period, be due to a learning process of economic agents in view of rapid financial innovations. Furthermore, in Italy and France, there is evidence of inertia in the money demand growth equation. While in France and Germany the growth of income increases the growth of money demand, there is in Italy a negative coefficient on income growth with respect to money. This result is consistent with precautionary and buffer stock theories of money demand (see for an overview Milbourne, 1988). Although these models predict that in the long-run target real balances increase with income, they allow for a negative relationship between money and economic activity in the short-run, so that changes in GDP are partly financed by running down M3 balances.

We turn to the equations for changes in interest rates and income growth. These relationships are potentially useful for economic investigation in that we may identify an economic structure in a well-defined statistical system. However, since the set of variables used in the system is broadly insufficient to model these variables, we can only give indicative interpretations, which are mainly related to the effects of the disequilibrium errors from the long-run relationships. We start with the discussion of the interest equations for Belgium, Italy, France, and Spain. These interest rate equations show inertia and are significantly explained by the error correction term from the money demand equation. When economic agents hold money in excess of the equilibrium position described by the cointegration relationship, they will tend to use the excess holding of money to buy other assets as for example bonds or goods and services, or pay off loans. As a consequence, the price for bonds will rise, which implies a fall in the short-run interest rate. This is the mechanism suggested by the interest rate equation for Belgium, Italy, and Spain. The French interest rate spread depends positively on the equilibrium error derived from the cointegrated money demand relationship. This effect may be explained by economic agents' tendencies to reduce excess holdings of money by buying other financial assets. These may be, for example, bonds. In a competitive banking market, banks are inclined to offer higher deposit rates. As a consequence, the spread between deposit and long-term interest rates narrows.

The income growth equations for Germany relates the monetary and the real sector through the disequilibrium error in the money demand function, where an excess of money holding is transferred into growth in GDP. This effect is reinforced by a lagged effect of monetary expansion on income growth in the German case. Although these equations are statistically satisfactory, their economic interpretation is limited which may be due to missing variables, as for example the terms of trade.

Stability of the dynamic equations was tested with various versions of Chow tests (Doornik and Hendry, 1997). The reported equations appear to be stable.[10]

[10] Results of these tests may be obtained from the authors upon request.

SUMMARY AND CONCLUSIONS

This study is concerned with the demand for money functions in all EMU countries. The data set, estimation period and the basic traditional money demand model were chosen so that they are comparable for all countries. We do not know of any other recent studies that include all countries on this basis. Comparisons are thus difficult to make between this and other studies since estimation periods and variable definitions vary significantly.

We find the following results of this study important: Firstly, on the basis of our traditional demand function, there is not a single long-run money demand relationship over the full sample period for Belgium, Finland and France. For these countries, the sample period had to be shortened since breaks could not be modelled by dummy variables. Secondly, for Finland, Luxembourg and the Netherlands, a long-run money demand relationship could not be identified. Thirdly, interest rates do not play any role in the money demand functions for Austria and Ireland. Only for the remaining six countries, we find conventional money demand relationships. However, even in these countries, the interest rate coefficients vary extensively.

These differences in the estimated demand for money functions amongst the EMU member countries contain certain interesting implications. The differences in the interest rate semi-elasticities amongst the EMU countries pose serious problems in the conduct of the ECB common monetary policy. This problem is particularly prevalent in those countries where no money demand relationship was identified and where money demand was interest inelastic. On *a priori* grounds, the one club policy approach currently implemented, could potentially produce serious discrepancies in economic performance amongst the EMU member states. There is evidence that suggests that this is already happening (see, for example, Arestis *et al*., 2002).

APPENDIX

TABLE **1**
Cointegrating vectors

Austria:	$(m\text{–}p)$	=	y					+	$0.00T$
Belgium:	$(m\text{–}p)$	=	$4.86y$	–	$7.62R_S$			–	$0.02T$
			(0.63)		(1.35)				(0.00)
Finland:	$(m\text{–}p)$	=	y					–	$0.02T$
									(0.003)
France:	$(m\text{–}p)$	=	y			+	$1.87SP_L$	–	$0.01T$
							(0.62)		(0.001)
Germany:	$(m\text{–}p)$	=	$1.29y$	–	$1.09R_S$			–	$0.00T$
			(0.02)		(0.17)				
Ireland:	$(m\text{–}p)$	=	y					–	$0.05T$
									(0.01)
Italy:	$(m\text{–}p)$	=	y	–	$2.12R_S$			–	$0.01T$
					(0.38)				(0.00)
Luxembourg:	$(m\text{–}p)$	=	$6.61y$					–	$0.06T$
			(1.19)						(0.02)
Netherlands:	$(m\text{–}p)$	=	y					+	$0.00T$
Portugal:	$(m\text{–}p)$	=	y	–	$1.77R_L$			–	$0.002T$
					(0.21)				(0.000)
Spain:	$(m\text{–}p)$	=	y			+	$5.86SP_S$	+	$0.004T$
							(0.60)		(0.000)

Notes:
Standard errors are in brackets. When no standard errors are reported, the coefficient was restricted.
Various impulse dummies were necessary to accommodate for outliers. For details see Arestis *et al*. (2000).

TABLE **2**

Test results of restrictions on cointegrating and adjustment vectors

Country	*Restrictions on the estimated* β *(estimated a unrestricted)*	*Test of weak exogeneity*
Austria	β' = (1,–1,0) Chi^2 (2) = 3.35 [0.19]	β'= (1,–1,0) α = (0,u) Chi^2 (3) = 3.97 [0.27]
Belgium	β' = (1,u,u,u) No binding restrictions	β'= (1,u,u,u) α= (0,u,u) Chi^2 (1) = 13.01 [0.00]**
Finland	β' = (1,–1,u) Chi^2 (1) = 0.001 [0.90]	β'= (1,–1,u) α= (0,u) Chi^2 (2) = 0.09 [0.96]
France	β'= (1,–1,u,u) Chi^2 (1) = 0.12 [0.73]	β' = (1,–1,u,u) α= (0,u,u) Chi^2(2) = 2.69 [0.26]
Germany	β' = (1,u,u,0) Chi^2 (2) = 0.97[0.62]	β' = (1,u,u,0) α= (0,u,0) Chi^2 (3) = 10.55 [0.02]*
Ireland	β'= (1,–1,u) Chi^2 (1) = 1.55 [0.21]	β'= (1,–1,u) α= (0,u) Chi^2 (2) = 21.15 [0.00]**
Italy	β'= (1,–1,u,u) Chi^2 (1) = 2.18 [0.14]	β'= (1,–1,u,u) α= (0,u,u) Chi^2 (2) = 6.06 [0.05]*
Luxembourg	β' = (1,u,u) No binding restrictions	β'= (1,u,u) α= (0,u) Chi^2 (1) = 0.06 [0.80]*
Netherlands	β' = (1,–1,0) Chi^2 (2) = 3.40 [0.18]	β' = (1,–1,u) α= (0,u) Chi^2 (3) = 3.82 [0.28]
Portugal	β'= (1,–1,u,u) Chi^2 (1) = 0.01[0.92]	β' = (1,–1,u,u) α= (0,u,u) Chi^2 (2) = 15.78 [0.00]**
Spain	β' = (1,–1,u,u) Chi^2 (1) = 1.76 [0.19]	β' = (1,–1,u,u) α= (0,u,u) Chi^2 (2) = 5.21 [0.07]

Notes:

For the countries where weak exogeneity of money was only marginally rejected, we also report the error correction terms in the dynamic model for money growth. They are –0.152(2.74) for Italy, and –0.039(2.32) for Spain, where *t*-values are in brackets. For Austria and France, the null hypothesis is not rejected when restricting the loading matrix. However, in the dynamic model, the error correction terms are significant for Austria and France with a coefficient of –0.038 (2.38) and –0.201(2.40), respectively. This contradictory test result may be due to inefficiencies in the VAR and we tend to interpret the cointegration vectors for both countries as money demand relations.

TABLE **3**

Dynamic Models

Belgium

$$\Delta(m-p)_t = -0.103 ecm_{t-1} + 0.372 \Delta r_{s,t-1} + 1.058 \Delta y_t - 2.608 \Delta y_{t-1} - 1.374 \Delta y_{t-5} - 9.742$$

(5.06) (2.17) (2.50) (5.13) (3.34) (5.06)

$s = 1.04\%$
$\chi_1^2(9) = 16.12[0.07]$
$AR(4,41) = 1.82[0.14]$
$\chi_2^2(2) = 0.81[0.67]$
$ARCH(4,37) = 0.82[0.49]$
$HET(20,24) = 0.95[0.55]$

$$\Delta r_{s,t} = -0.066 ecm_{t-1} + 0.150 \Delta r_{s,t-1} + 0.217 \Delta r_{s,t-2} + 0.186 \Delta r_{s,t-4} + 0.170 \Delta r_{s,t-5}$$

(5.21) (1.22) (1.75) (1.66) (1.44)

$$-1.183 \Delta y_{t-3} - 6.234$$

(3.37) (5.22)

$s = 0.83\%$
$\chi_1^2(9) = 16.12[0.07]$
$AR(4,41) = 2.34[0.07]$
$\chi_2^2(2) = 3.87[0.15]$
$ARCH(4,37) = 0.23[0.92]$
$HET(20,24) = 1.73[0.10]$

France

$$\Delta(m-p)_t = -0.201 ecm_{t-1} + 0.303 \Delta(m-p)_{t-1} + 1.090 \Delta(m-p)_{t-2} + 0.749 \Delta sp_{l,t-2}$$

(2.40) (2.13) (1.31) (1.79)

$$-0.755 \Delta y_t + 1.06 \Delta y_{t-2} + 0.004$$

(2.13) (2.79) (1.09)

$s = 10.85\%$
$\chi_1^2(8) = 5.93[0.66]$
$AR(3,22) = 3.91[0.02]^*$
$\chi_2^2(2) = 2.45[0.29]$
$ARCH(3,19) = 0.91[0.46]$
$HET(16,8) = 0.30[0.98]$

$$\Delta sp_{l,t} = 0.078 ecm_{t-1} + 0.176 \Delta sp_{l,t-2} - 0.001$$

(3.03) (1.19) (1.37)

$s = 0.36\%$
$\chi_1^2(8) = 5.93[0.66]$
$AR(3,22) = 2.76[0.07]$
$\chi_2^2(2) = 1.45[0.49]$
$ARCH(3,19) = 0.33[0.81]$
$HET(16,8) = 0.76[0.69]$

Germany

$$\Delta(m-p)_t = \underset{(2.36)}{-0.088}ecm_{t-1} - \underset{(2.98)}{0.545}\Delta r_{s,t-1} + \underset{(16.32)}{0.145}D_{90Q3} - \underset{(4.71)}{0.041}D_{97Q2} + \underset{(5.17)}{0.046}D_{97Q3} - \underset{(2.33)}{0.659}$$

$s = 0.88\,\%$
$\chi_1^2(5) = 6.66\,[0.57]$
$AR\,(5,56) = 1.50\,[0.20]$
$\chi_2^2(2) = 4.63\,[0.10]$
$ARCH\,(4,53) = 0.84\,[0.50]$
$HET\,(14,46) = 0.35\,[0.98]$

$$\Delta y_t = \underset{(3.57)}{0.171}\,ecm_{t-1} + \underset{(5.81)}{0.362}\,\Delta(m-p)_{t-2} + \underset{(1.91)}{0.409}\,\Delta r_{s,t} + \underset{(1.52)}{0.015}\,D_{90Q3} - \underset{(0.39)}{0.004}\,D_{97Q2}$$
$$+ \underset{(0.04)}{0.0004}\,D_{97Q3} + \underset{(3.18)}{0.251}\,\Delta y_{t-4} + \underset{(3.57)}{1.299}$$

$s = 1.00\,\%$
$\chi_1^2(5) = 6.66\,[0.57]$
$AR\,(5,56) = 1.86\,[0.12]$
$\chi_2^2(2) = 2.79\,[0.25]$
$ARCH\,(4,53) = 0.31\,[0.87]$
$HET\,(14,46) = 0.58\,[0.87]$

Italy

$$\Delta(m-p)_t = \underset{(2.74)}{-0.152}\,ecm_{t-1} + \underset{(5.81)}{0.349}\,\Delta(m-p)_{t-4} - \underset{(1.91)}{0.363}\,\Delta r_t - \underset{(1.52)}{0.993}\,\Delta y_{t-1} - \underset{(0.39)}{0.285}\,\Delta r_{s,t-1}$$
$$- \underset{(0.04)}{0.296}\,\Delta r_{s,t-2} - \underset{(3.18)}{0.363}\,\Delta r_{s,t-3} - \underset{(3.57)}{0.004}\,D_{92Q3} - \underset{(2.93)}{0.015}$$

$s = 1.4\,\%$
$\chi_1^2(5) = 4.50\,[0.48]$
$AR\,(5,59) = 0.18\,[0.97]$
$\chi_2^2(2) = 0.24\,[0.89]$
$ARCH\,(4,56) = 1.79\,[0.14]$
$HET\,(14,49) = 1.18\,[0.32]$

$$\Delta r_{s,t} = \underset{(4.07)}{-0.1171}\,ecm_{t-1} + \underset{(1.82)}{0.180}\,\Delta r_{s,t-1} + \underset{(5.30)}{0.043}\,D_{92Q3} + \underset{(2.87)}{0.007}$$

$s = 0.8\,\%$
$\chi_1^2(5) = 4.50\,[0.48]$
$AR\,(5,59) = 1.25\,[0.30]$
$\chi_2^2(2) = 3.37\,[0.19]$
$ARCH\,(4,56) = 2.69\,[0.04]^{*}$
$HET\,(14,49) = 0.48\,[0.93]$

Portugal

$$\Delta(m-p)_t = \underset{(4.50)}{-0.268}\, ecm_{t-1} - \underset{(3.21)}{0.303}\,\Delta(m-p)_{t-3} + \underset{(2.54)}{0.228}\,\Delta(m-p)_{t-4} - \underset{(3.27)}{0.317}\,\Delta(m-p)_{t-5}$$
$$- \underset{(2.37)}{0.738}\,\Delta r_{l,t} - \underset{(2.21)}{0.666}\,\Delta r_{l,t-1} + \underset{(2.05)}{0.921}\,\Delta r_{l,t-2} - \underset{(2.44)}{0.723}\,\Delta r_{l,t-4} + \underset{(2.18)}{0.846}\,\Delta sp_{l,t-2}$$
$$+ \underset{(1.93)}{0.535}\,\Delta sp_{l,t-3} + \underset{(3.50)}{0.078}\, D_{85Q3} + \underset{(2.05)}{0.006}$$

$s = 2.0\%$
$F(14,40) = 1.0[0.47]$
$AR(5,49) = 0.80[0.56]$
$\chi_2^2(2) = 0.58[0.75]$
$ARCH(4,46) = 0.58[0.68]$
$HET(21,32) = 0.33[0.56]$

Spain

$$\Delta(m-p)_t = \underset{(2.32)}{-0.039}\, ecm_{t-1} - \underset{(3.04)}{0.665}\,\Delta y_t - \underset{(0.78)}{0.008}\, D_{82Q4} + \underset{(0.33)}{0.003}\, D_{82Q2} - \underset{(1.36)}{0.008}$$
$$+ \textit{seasonal dummies}$$

$s = 0.93\%$
$\chi_1^2(6) = 5.75[0.45]$
$AR(5,57) = 2.25[0.05]^*$
$\chi_2^2(2) = 0.83[0.66]$
$ARCH(4,54) = 0.32[0.87]$
$HET(14,49) = 0.45[0.95]$

$$\Delta sp_{s,t} = \underset{(10.97)}{0.140}\, ecm_{t-1} + \underset{(2.99)}{0.236}\,\Delta sp_{s,t-1} + \underset{(5.31)}{0.387}\,\Delta sp_{s,t-2} + \underset{(5.04)}{0.292}\,\Delta sp_{s,t-3} - \underset{(2.79)}{0.357}\,\Delta y_t$$
$$+ \underset{(5.22)}{0.654}\,\Delta y_{t-3} - \underset{(9.14)}{0.047}\, D_{82Q4} - \underset{(4.72)}{0.024}\, D_{82Q2} + \underset{(10.23)}{0.042} + \textit{seasonal dummies}$$

$s = 0.48\%$
$\chi_1^2(6) = 5.75[0.45]$
$AR(5,57) = 0.62[0.68]$
$\chi_2^2(2) = 5.36[0.07]$
$ARCH(4,54) = 0.54[0.71]$
$HET(14,49) = 0.42[0.96]$

Notes: The tests are those reported by PcFiml and described fully in Doornik and Hendry (1997). The notation is as follows: s stands for the standard error, χ_1^2 a test of overidentifying restrictions, AR, the test for autocorrelation is a LM test based on a regression of the residuals on the original variables and lagged residuals; ARCH, the autoregressive conditional heteroscedasticity test is an LM test based on a regression of the squared residuals against their lagged values and a constant; χ_2^2, the normality test is that of Doornik and Hansen (1994); Het, the heteroscedasticity test is White's test based on a regression of the squared residuals on the original regressors and all their squares.

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