DEMAND EQUATIONS OF THE NEW MONETARY AGGREGATES

Alberto Cabrero, José Luis Escrivá
and Teresa Sastre

Banco de España - Servicio de Estudios
Estudios Económicos, nº 52 - 1993

DEMAND EQUATIONS OF THE NEW MONETARY AGGREGATES

Alberto Cabrero, José Luis Escrivá
and Teresa Sastre

Banco de España - Servicio de Estudios
Estudios Económicos, nº 52 - 1993

El Banco de España al publicar esta serie pretende facilitar la difusión de estudios de interés que contribuyan al mejor conocimiento de la economía española.

Los análisis, opiniones y conclusiones de estas investigaciones representan las ideas de los autores, con las que no necesariamente coincide el Banco de España.

ISSN: 0213-2699
ISBN: 84-7793-209-3
Depósito legal: M-2205-1993

Imprenta del Banco de España

C O N T E N T S

Pages

INTRODUCTION (*)

Traditionally, central banks have studied the properties of the money demand function in their economies because the stability of this relationship was a fundamental requirement for influencing nominal expenditure through control of the money supply.

In the European Community (EC) and, specifically, in the Exchange Rate Mechanism of the European Monetary System (EMS), the capacity of national economic authorities to pursue an independent monetary policy based on control of the domestic money supply has been severely limited by increased efforts by most member states in recent years to ensure the stability of their exchange parities (the last general realignment in the EMS was in January 1987) and by liberalization of capital movements in the run-up to the European Single Market. The German Federal Republic has, however, been a significant exception since, in its role of provider of monetary discipline in the EMS, it has been pursuing a stringent policy of monetary control aimed at safeguarding the domestic stability of the German economy.

As progress is made towards European Monetary Union (EMU), these already reduced limits on regulation of demand by monetary measures will gradually narrow further, until national sovereignty in the area of monetary policy is fully transferred to the European System of Central Banks towards the end of the decade.

Against this background, the virtuality of studies of the demand for money and their usefulness in a country, such as Spain, immersed in the move to EMU could be questioned.

In response, it would be useful to establish certain premises. First, without denying the value of exchange stability as a mechanism of mone-

(*) We are grateful to José Antonio Cuenca and Marta Manrique for their work on the preparation of the basic statistics used in this paper and the comments of J. J. Dolado, F. Gutiérrez, J. L. Malo de Molina, J. Pérez and J. L. Vega.

tary discipline, the exchange rate is not a sufficient nominal anchor in an economy as big and open as Spain's.

Second, the EC economies are immersed in a process of nominal convergence under the "Maastricht agreements", and considering the different starting position of each country regarding the scale of its macroeconomic disequilibria, some including Spain will have to make maximum use of the headroom available to them to apply monetary and fiscal policies that are tighter than the EC average. Here, the behaviour of monetary aggregates can be useful in evaluating the effects of the varying degrees of monetary control adopted by Community members. Moreover, in the run-up to economic and monetary union, the role of monetary aggregates will be further strengthened if a strategy of harmonized targets for money supply is established by the Community states. This strategy would help to replace the existing asymmetry when setting the tone of monetary policy for the region as a whole and serve as a transition to a system based on control of the aggregate money supply of the monetary union in the final stage of the move towards EMU.

Moreover, the slow adjustment processes of the economy mean that, the impacts of shocks on prices and income are felt only after a significant time lag. For this reason, direct observation of trends in price levels or nominal expenditure often does not reveal excess liquidity in the money market, the reflection of which in terms of higher inflation rates comes about at some delay. Hence, it is necessary to identify at the earliest possible stage the incipient presence of inflationary tensions of a monetary nature. To do this, growth rates in the money supply have to relate to reference paths coherent with the desired expansion in prices and income.

This process is the normal strategy for setting targets in terms of a monetary aggregate, and the money demand functions, in so far as they reliably represent the relationship between liquidity and nominal expenditure, can be very useful in anticipating inflationary tensions, if the information they provide is correctly used. In any event, it is not worthwhile making an excessively mechanical reading of this process. The relationship between money and prices, extracted from the demand functions, has a long-run nature; at the same time, short-term temporary financial disturbances can have an intense effect on the money supply. The possibility of distinguishing these short-term phenomena from persistent and potentially inflationary excess liquidity is somewhat uncertain, particularly if short-term diagnoses are to be made.

The use of demand for money as a reference for setting growth targets for the money supply and for monetary targeting has long been traditional in the Banco de España. The fact that the exchange rate constraint now in place can limit capacity for response by monetary authorities to deviations by monetary aggregates from growth targets, does not invalidate the informativeness of these deviations; in any event, they serve as warnings of undesirable economic situations and/or of an unsuitable economic policy mix which could require, in the absence of monetary instruments, alternative tools for regulating domestic demand.

However, the possibility of basing monetary policy programming on the relationship between money and the final variables underlying the demand functions has not been free from difficulty in most of the countries where monetary conduct has depended on control of some liquidity aggregate, and Spain has been no exception. These difficulties, caused mainly by the recent processes of innovation and deregulation in national financial systems, have been reflected in changes in the composition of the monetary aggregates subject to control. Central banks have made these changes to adapt the definitions to changing financial conditions, and in an effort to improve the specification and methods of estimation of money demand functions whose properties had deteriorated.

After two decades of more or less active use of monetary policy, the confidence in the stability of demand for money prevailing at the outset of the seventies began to dwindle as financial innovation and deregulation began to gain hold, giving rise to a somewhat controversial situation (1). This situation was due to symptoms of instability displayed by the equations estimated in the seventies and which some saw as a clear indication that monetary policy could no longer be based on the control of a monetary aggregate.Countering this, other authors countended that the instability detected in the demand equations was attributable to phenomena that had altered the economic conditions underpinning agents' decisions (institutional changes, liberalization of the financial system, financial innovation, etc.) and that had not been taken into account when the money demand equations were specified. In this case, the symptoms of structural change detected would but be the consequence of having omitted relevant variables.

Lastly, recent opinion is that the signs of instability displayed by the money demand equations were largely the result of an incorrect statistical specification. This line is espoused by many of the works of the London School of Economics (LSD) based on methodological propositions (2) and of Professors D.F.Hendry and J.F.Richard. This methodology is closely connected to the theory of cointegrated variables and the specification of error correction mechanism (ECM) models, which have also ad-

(1) Many of the arguments in this controversy were set out in Judd & Scadding (1982) and, more recently, in Goldfeld & Sichel (1990).

(2) The seminal work on demand for money applying this methodology is by Hendry & Mizon (1978).

vanced the idea that long-run stability of the demand for money can be identified when suitable statistical techniques are used.

The results of the demand for money equations, which in general are obtained by applying cointegration techniques and error correction models, fall within the paradigm of monetary disequilibrium and a concept of money as a buffer stock (for example, see the works of Laidler (1984 and 1987), Knoester (1984) and Goodhart (1984) (3). This approach is based on a very elaborate monetarist concept of monetary transmission mechanisms, which harmonizes the existence of a long-run money demand relationship with the persistence for lengthy periods of deviations in the trend of nominal balances with respect to the path marked by that relationship.

These empirical approaches to demand for money as a behavioural relationship, essentially confirmed in the long term, have helped to discard the idea of short-term demand for money as an instrument for guiding day-to-day monetary policy decisions. The idea was also weakened during the eighties by the general acceptance of the concept that, in the short term, central banks should concentrate on stable interest and exchange rates and that the re-directing of the growth of the money supply to the desired rates makes sense as a medium-term objective.

In Spain, empirical works on the subject have tended to follow a pattern similar to that described in the preceding paragraphs. The early studies (Rojo and Pérez (1977), Dolado (1982,1983)) showed a stable relationship between the money supply and its explicative variables: income, prices and interest rates. Later, the works of Dolado (1985) and Mauleón (1987) tried to distinguish between real shifts in the demand function and phenomena associated with liberalization and financial innovation which have been causing shifts of private portfolios, but which can be readily explained if changes in the relative return on financial assets are accurately introduced.

Dolado (1988) and Dolado and Escrivá (1991) put forward the hypothesis that liberalization and innovation in the Spanish financial system have not changed the long-term stable relationship between money supply, income, prices and interest rates, though they have caused some instability in the short-term dynamic. This is clear in the case of ALP (pri-

---

(3) Surprisingly, the connection between the ECM estimate of money demand equations and the buffer-stock monetary disequilibrium approach is not usually established in the literature on demand for money - an exception is Goodhart (1989) - and, in fact, empirical testing of buffer-stock monetary theories often inclines towards the application of approaches, such as “rational expectations”, far from the basic principles of the theory. Cuthbertson and Taylor (1986), Davidson (1986) and Milbourne (1988) provide an overview of empirical approximations to the buffer-stock monetary approach.

vate-sector liquidity), but less so for some of the narrower re-definitions of ALP (Dolado and Escrivá (1991)). The latter work considers new econometric procedures, such as cointegration techniques and analysis of integrated variables, to be extremely useful in identifying long-run relationships in the demand for money and their degree of stability.

Lastly, the evolution of the European Community into a single financial space and the gradual reduction in exchange risk has reawakened discussion in member states on the reliability of money demand relationships. Several arguments have been put forward in favour of the inevitability, in the move towards economic and monetary union, of a significant deterioration in the relationship between monetary aggregates and the level of prices evaluated at national level, and a considerable increase in the instability of the related demand functions (4).

Some of the reasons used by advocates of this thesis involve simply shifting to EC level the factors of instability underlying the national processes of financial innovation. Even so, though these processes have distorted the course of the aggregates, they have generated, in most countries, temporary disturbances which have not caused a significant deterioration in the long-run relationship of the monetary aggregates to the final variables (5).

Greater importance should be given to arguments based on the deterioration of the informativeness of monetary aggregates as a result of intensified cross-border operations. The conditions created by full liberalization of capital movements and increased confidence in the stability of exchange rates may generate processes of currency substitution and relocation abroad of deposits. Aside from the statistical problems involved in accurately defining monetary aggregates in this new setting, the new conditions tend to create instability in underlying behavioural relationships (6).

However, were a generalisation of cross-border transactions leading to an appreciable loss in the informativeness of the monetary aggregates to be confirmed, the correct procedure would be to improve information on such transactions. Hence, by incorporating liabilities issued by non-resident financial institutions to resident non-bank private agents into the definition of the aggregates, shifts in liquid-asset portfolios denominated

---

(4) Giovannini (1991) makes a radical defence of this position.

(5) The test research includes: Angeloni and Giucca (1991), who defend this same point of view and provide evidence for the cases of Germany, France and Italy; and Deutsche Bundesbank (1992), which presents results on the reliability of the relationship of the final variables to M3 for the German case. The results given in Artis (1992) for a broad group of countries point in the same direction.

(6) See, for example, Woodford (1990).

in different currencies or the delocalisation of national-currency-denominated deposits would be neutralised within the aggregate thus defined.

In response to the problems created by the prospect of a single financial space, the approach of the Committee of EC Central Bank Governors to cross-border operations has been to harmonize monetary aggregates at Community level along the lines indicated in the preceding paragraph. The Committee has decided to emphasize monetary targets in terms of the growth rates of money supply in the "ex-ante" coordination and "ex-post" evaluation exercises of member-state monetary policies. This requires harmonization of the definitions of liquidity used in EC member states and their adaptation to the new financial situation of the single market and the process of monetary union. The work on redefining monetary aggregates by the Banco de España is part of this process which led to reform of the aggregates at the beginning of 1992 (see the Economic Bulletin, Banco de España, January 1992).

This study examines the properties of the money demand functions for a broad range of monetary aggregates. The aggregates are defined in accordance with the sectorization criteria adopted in the 1992 reform. The analysis of money demand equations presented in the article is based on several objectives.

First, the reform of the aggregates makes major changes to the delimitation of liquid asset holders and issuers, as well as the classification of the latter. As a result, a study is required of the properties of the equations of the redefined monetary aggregates. The paper evaluates these properties and compares them, in the case of ALP, with those of the previous definition of this aggregate.

Second, the study takes into account the contribution of the analysis of money demand equations to the choice of liquidity definitions that the Banco de España, in the 1992 reform, decided to elaborate systematically as money supply growth indicators. Thus, in addition to the five aggregates selected (M1, M2, M3, ALP and ALP2), the properties are given of other liquidity definitions that were considered as alternatives to the aggregates finally chosen. These alternative aggregates are mainly situated around M3, which is the variable most affected by the reform and on which most doubts existed at the time of definition.

Finally, the study aimed to go beyond approaches to the money demand equations centred on mere competition between the goodness of aggregates, or on individual analysis of the statistical properties of a particular equation. Rather, the properties of demand for monetary aggregates covering the entire spectrum of liquid assets were jointly evaluated to provide information on the operation of the monetary sector of the economy and to try to explain the not always coincident paths of the various monetary aggregates. The evaluation was based on differences in the regularities deduced from the demand equations: relevant financial variables, long-term elasticities, adjustment dynamics or the scale of shocks in the short term. This sequential study of the demand equations of this broad range of aggregates reveals differences in agents' behaviour in the demand for financial assets; it provides information on the differentiated role played by these assets in spending and portfolio decisions; and it identifies switching processes in certain segments of the spectrum defined by liquid assets.

The work is structured as follows. Section 1 defines the monetary aggregates studied and indicates the criteria used. Section 2 deals with the formulation of the demand equations, focusing on the relevant variables in these equations and on the chosen econometric specification. Section 3 details the empirical results obtained. It emphasises the statistical information and the estimation methods used; it describes the long-term properties of the aggregates; and it details the dynamics, fit and stability of the equations. Section 4 is a structural analysis of the course of the aggregates under consideration, expressed in terms of their velocity of circulation, based on the results obtained from their demand equations. Finally, the main conclusions of the study are given in Section 5.

I

THE MONETARY AGGREGATES CONSIDERED

The process of selecting the most suitable aggregates as indicators of the growth of the money supply in Spain involved an evaluation of the properties of the demand functions of a broad set of definitions of liquidity. In combination with more institutional studies by the Banco de España and with the work by the Committee of Governors to harmonize monetary aggregates in EC states, those aggregates which showed the worst results were gradually rejected and the study concentrated on a limited group. Here we will comment on results from the seven broad definitions of liquidity that were finally selected.

The definition of these seven aggregates is adjusted to the new criteria of sectorization of holders and issuers of liquid assets, which was part of the 1992 reform of the monetary aggregates described in the January 1992 edition of the Economic Bulletin. The changes introduced by these criteria with respect to the previous aggregates are drawn together in Fig I.1.

In addition to these seven aggregates, the demand properties of the ALP aggregate used for setting monetary targets until recently are given. This aggregate is defined in accordance with the sectorization criteria prior to the 1992 reform. The results for this aggregate, denoted in the text as ALP_v, serve as a point of reference for the new definitions of liquidity considered. Similarly, the demand functions of the two narrowest aggregates (M1 and M2) are given; these are hardly affected by the new criteria introduced in the 1992 reform, and complete the sequence of monetary aggregates developed by the Banco de España.

Fig I.2 depicts the nine aggregates considered, ranking them from broadest to narrowest. It begins with the definition of ALP2, which inclu-

FIGURE I.1

COMPARISON BETWEEN THE NEW AGGREGATES AND THOSE IN USE UNTIL 1991

(a) Only includes notes maturing at less than one year.
(b) Includes asset participations.
(c) Excludes subordinate bonds subject to the cash ratio included in the aggregates in use until 1991.
(d) Includes notes maturing at over one year.
(e) Endorsed bills and guarantees on commercial paper, insurance transactions and asset transfers.

EEFF: Firms and households; OUP:Other public agencies; ECAOL: Bank-like institutions.

des the balance of commercial paper held by the private sector; the next aggregate, ALP, differs in that it does not include this balance.

The definition of the aggregate termed ALP_a excludes the set of financial instruments whose inclusion is, a priori, questionable in any broad definition of liquidity, based on the different criteria in use. First, bond issues by official credit institutions were rejected (including mortgage bonds of the Banco Hipotecario de España and notes issued by this institution for over one year) due to doubts about the yield characteristics, the structure of holders and the secondary market for these instruments. Second, insurance operations by savings banks asset transfer certificates and were excluded. These are financial assets which are not generally included in the monetary aggregates defined by other Community states and which, therefore, cannot form part of any harmonized definition. Lastly, notes issued by local governments and the Treasury held outright by the private sector were also excluded, as were sales of these assets under repurchase agreement (repos) made by financial institutions to the public.

It should be pointed out that insurance operations, asset transfers, local government and Treasury notes and sales of the latter under repurchase agreement, are all instruments which had a high degree of tax anonymity in the second half of the eighties. In Fig I.2, an initial horizontal line separates the ALP2, ALP and ALP_a aggregates from the narrower aggregates shown. This is because the first three include monetary instruments other than those issued by the credit system, specifically: liquid assets issued by general government and the private sector. The EC Committee of Governors considers that the dividing line between the harmonized definition of M4 and M3 at Community level is defined by the inclusion or exclusion of these types of instrument.

In Fig I.2, an initial horizontal line separates the ALP2, ALP and ALP_a aggregates from the narrower aggregates shown. This is because the first three include monetary instruments other than those issued by the credit system, specifically: liquid assets issued by general government and the private sector. The EC Committee of Governors considers that the dividing line between the harmonized definition of M4 and M3 at Community level is defined by the inclusion or exclusion of these types of instrument.

The next aggregate to be considered denominated $M3_{a,}$ already under the harmonized definition of M3, differs from ALP_a in that it does not include outright holdings of Treasury bills. Similarly, these holdings are not included in the definition of M3 either, though M3 does include repos on Treasury notes. The definitions of M3 and $M3_a$ differ, therefore, only with respect to these repos.

FIGURE I.2

DEFINITION OF THE NEW MONETARY AGGREGATES AND ALTERNATIVES CONSIDERED (a)

(a) The circles outlined in bolder print are the new aggregates; the others are the alternatives considered.

The definition of $M3_a$ responds to the logic of excluding all anonymous instruments, since these assets have been very close substitutes in private portfolios due to the specificity of the tax treatment of their yields. The definition is also based on criteria of coherence in sectorization and harmonization at Community level, so that Treasury note sales under repurchase agreement, being a bank monetary liability, are included (in line with the criteria adopted for harmonization) whereas outright holdings of Treasury and local government notes are excluded taking into consideration the criterion of issuer.

The last two monetary aggregates included in the harmonized definition of M3 are denominated $M3_b$ and $M3_c$. The former takes the definition of M3 as its starting point and excludes financial intermediaries repos on Treasury notes and bills, and public debt at over three months. The reference point for the second definition ($M3_c$) is the definition of $M3_a$ and excludes repos on bills and public debt at over three months with the public by financial intermediaries. These definitions, which use the term of the repos on government paper as a selection criterion, respond to the presumption that the public in general does not differentiate between outright holdings and repos of public debt placed with them by the banking system at terms near to those of issue.

The second dividing line in Fig I.2 separates the M3 definitions from the narrower M2 and M1 aggregates which, for the time being, are not subject to harmonization at Community level. Following the sequence established in Fig 2, the definition of M2 is obtained by excluding from $M3_b$ repos on public securities at less than three months and bond issues, term deposits and foreign currency deposits in the banking system. When savings deposits are excluded, the aggregate M1 is obtained which is made up solely of cash and sight deposits.

II

FORMULATION OF THE MONEY DEMAND EQUATIONS

II.1. Relevant variables

The decisions guiding the demand for a broad aggregate respond to at least two types of motive (7): the transactions motive and the “wealth” or investment motive. Theories stressing the former state that the optimum level of nominal balances is that at which the opportunity cost of maintaining balances at a zero rate of interest is equal to the reduction in the transaction costs derived from making fewer transfers of earning assets to liquid balances. According to the literature (8), the transactions demand for real balances (m_T^d) depends on the following variables: income (y), as indicator of the volume of transactions made, and the opportunity cost of maintaining idle balances, which is represented, in most of the models, by the interest rate on earning assets (r). Also, Friedman (1969) widens this range of variables by including the expected inflation rate (π^e) among the arguments of a money demand function, arguing that this variable is none other than the opportunity cost of maintaining nominal balances, expressed in terms of consumption foregone by keeping these balances; that is, the expected inflation rate reflects the degree of depreciation of money balances in relation to real assets.

The theories that explain demand for money as a consequence of the “wealth” motive are based on models of portfolio diversification in terms of return and risk on assets (9). Under this approach, the decision to hold money as a way of materializing wealth (m_W^d) is a function, first, of the amount of such wealth (W); second, of the utility derived from holding

(7) See the recent survey by Goldfeld & Sichel (1990).

(8) See Baumol (1952) and Tobin (1956)

(9) See Tobin (1958).

money balances (whether as a means of payment, or because the issuing institutions pay a certain interest rate for them (r^p) —, and lastly, of the return on alternative assets (real or financial) as well as of the degree of risk inherent in obtaining these returns (σ). In the case of real assets, the inflation rate (π) can be considered an approximation to the nominal return, when their real value remains constant. For financial assets thereon, this return is given by their interest rates (r^a). These relationships can be expressed in short form as:

$$m_T^d = m_T\,(y, r), \qquad r = \max\,(r^a, \pi^e)$$

$$m_W^d = m_w\,(W, r^p, r^a, \sigma, \pi)$$

If we consider that the demand for the monetary aggregates responds to decisions linked to transactions and to others related to choosing the assets in which the agents' wealth is held, the demand for these aggregates is a combination of m_T^d y m_W^d:

$$m^d = g\,(m_T^d, m_W^d)$$

which would be given by the following function of observable variables:

$$m^d = m\,(y, W, r^p, r^a, \sigma, \pi) \qquad [II.1]$$

where it is accepted that observed inflation, π, is a good proxy for expected inflation, π^e.

In practice, difficulties in measuring wealth and the degree of uncertainty often lead to omit these variables in the formulation of most of the equations (10). However, if it is accepted that wealth (or a concept of permanent income) can be approximated by the accumulation of present and past levels of income correctly weighted, its effect on money demand decisions would be indirectly included in the process of global adjustment to the level of income. In this case, the omission of wealth would not result in a bias due to omitted variables, although the problem of separating the effects of the two scale variables would persist.

In line with these considerations, in the equations for broad monetary aggregates in which income appears as the only scale variable, it is to be expected that elasticity to this variable would be greater than in the equations for narrow aggregates which would be closer to a transactions

(10) Examples of money demand equations which do include the wealth variable are: Grice & Bennett (1984), Bennett (1987) and, in the case of Spain, Manzanedo and Sebastián (1991).

mand. In the latter case, the expected range of this elasticity is 0.5–1 according to the literature, so that estimated values above unity are considered as evidence that there are wealth effects which have not been specifically included in the equations.

The option followed by this work, based on formulating linear approximations to a function of type [II.1] that includes the relevant variables in the demand for a broad monetary aggregate, differs from that adopted by other authors. Manzanedo and Sebastián (1991) specify two distinct demand functions: one for a narrow aggregate (M2), which includes demand due to the transactions motive, and another for the aggregate remaining after extracting from ALP the assets included in M2 (ALM in their terminology), which would include demand caused by the wealth accumulation motive. However, this argument does not fit situations where it is difficult to separate financial assets demanded for their capacity to be used as means of payment from those held in order to maximize return on the stock of wealth. The Spanish financial system has always been characterized by the peculiarities of its regulatory framework and the tax treatment of financial assets which have considerably blurred the dividing line between these two types of assets. Thus, originally, savings deposits were used as an instrument for placement of household savings when interest rates were regulated; they gradually lost this characteristic when interest rates on term deposits were liberalized. Later, liberalization of interest rates on sight deposits gave a wide sector of economic agents access to a very liquid financial instrument with a market return, in which it is difficult to separate the transactions motive from the wealth motive.

For this reason, it seems advisable in the Spanish case to consider, for both narrow and broad aggregates, functions such as expression [II.1], which include both demand for transactions and for wealth. In this way, it is the characteristics of the equations of each aggregate that establish a graduation between them, according to the type of decision (transaction or investment) governing each case. Predominance will depend on the characteristics of the assets in each definition (some will be more likely to satisfy a transaction demand while others serve as instruments for holding wealth), on the quantitative importance of each type of asset, and on their course over time.

II.2 Econometric specification

In line with recent literature (Dolado (1982, 1985, 1988), Von Hagen & Newman (1988), Dolado and Escrivá (1991), Mehra (1991) and Baba *et al*. (1992), among others), all money demand equations have been specified as a demand for real balances in the form of a model with error correction mechanism (ECM) of the type:

$$\Delta y_t = k + \alpha\,(y - \beta x)_{t-1} + \delta\,(\Delta y_{t-i}, \Delta x_{t-j}) + \varepsilon_t \qquad [II.2]$$

where "y" is the dependent variable and "x" the vector of explanatory variables. This formulation incorporates a long-run or equilibrium relationship, βx, defined by economic theory, as well as the dynamics implied by the deviations from this equilibrium path and the adjustment process to recover it, which is captured by the function of variables in differences, $\delta(\cdot)$, and the term of error correction $\alpha\,(y - \beta x)_{t-1}$.

The ECM models bear a close relationship to the concept of cointegrated variables developed by C. J. Granger and R. F. Engle (11), among others, based on the theory of integrated variables. According to this approach, the existence of cointegration relationships between the components of a vector of economic variables can be interpreted as equilibrium relationships between the variables, in accordance with economic theory; that is, relationships that persist over time, characterized by temporary deviations between observed values and the equilibrium positions. In systems where some variables are cointegrated, it is possible to re-parameterize the systems as ECM models (Engle & Granger [1987]) in which all the variables used are zero-order integrated, I(0), -stationary, in heuristic terms.

This work uses this methodology to analyze the existence of stable demand equations for the new aggregates defined in the 1992 reform, as well as for the alternative definitions also considered. This involves a study of the degree of integration of the variables used, as detailed in Appendix I.

The money demand equations were specified in terms of ECM models (whose single-equation expression is given in [II.2]) in which the dependent variable is the rate of change of the real balances and vector x of explanatory variables is a subset of the arguments of the demand function defined in expression [II.1]. Specifically, the explicative variables considered were: real income, interest rates and inflation rate. Thus, the specification of the equations responds to the following expression:

$$\Delta\,(m - p)_t = k + \alpha\,[m - p - m^d(\cdot)]_{t-1} + \delta_1\,(L)\,\Delta y_t + \\ + \delta_2\,(L)\,\Delta r_t^p + \delta_3\,(L)\,\Delta r_t^a + \delta_4\,(L)\,\Delta^2 p_t + \varepsilon_t \qquad [II.3]$$

(11) See Granger (1981), Granger & Weiss (1983) and Engle & Granger (1987).

being (12):

$$(m - p)_t - m^d\,(\cdot)_t = u_t \quad I(O)$$

$$m^d\,(\cdot) = \gamma_1 y_t + \gamma_2 r_t^p + \gamma_3 r_t^a + \gamma_4 \pi_t$$

In general, in almost all the aggregates considered, the equilibrium path given by $m^d(\cdot)$ is a linear combination of I(1) variables. In contrast, deviations of real balances from this path are I(0) under the cointegration hypothesis (see Appendix I).

This type of formulation imposes long-run homogeneity of prices, based on the results of the analysis of the degree of integration of the variables (see Appendix I) and on an approximate testing of this hypothesis, whose results are given in subsection III.3. Analysis of the degree of integration of the variables shows that changes in the real balances of the broad aggregates are I(0) variables, which has led to the formulation of ECM models in real balances, so that standard inference can be carried out.

The fact that equation [II.3] has been specified as a demand for real balances does not necessarily imply that economic agents immediately adapt their holdings of nominal balances to changes in the price level. Thus, when a model is specified in nominal balances of the type:

$$\Delta m_t = \beta \Delta p_t + h(\cdot) + \varepsilon_t \qquad [II.4]$$

where $h(\cdot)$ includes the right-hand terms of expression [II.3] except those in which the change in the price level appears, the value obtained for the «β» coefficient is in the region of 0.3-0.4, indicating that the adjustment in the nominal balances in response to changes in prices is not immediate. However, expression [II.4] can be considered as a re-parameterization of an ECM model in which the dependent variable is the change in real balances:

$$\Delta(m - p)_t = (\beta - 1)\,\Delta^2 p_t + \alpha\,[m - p - m^d(\cdot)]_{t-1} + \delta_1(L)\,\Delta y_t +$$

$$+ \delta_2(L)\,\Delta r_t^p + \delta_3(L)\,\Delta r_t^a + \delta_4(L)\,\Delta^2 p_t + \varepsilon_t \qquad [II.5]$$

$$m^d(\cdot)_t = \gamma_1 y_t + \gamma_2 r_t^p + \gamma_3 r_t^a + \frac{(\beta - 1)}{\alpha}\,\pi_t$$

taking into account that: $\pi_t \equiv \Delta p_t = \Delta^2 p_t + \Delta p_{t-1}$.

(12) $\delta_i(L)$, i=1...4, are polynomials in the lag operator L.

In line with this re-parameterization, a response of the nominal balances by 30-40 % of the changes in the price level can be interpreted as the result of a rapid adjustment in nominal balances and a response of the demand for real balances to the inflation rate of opposite sign. This is the re-parameterization used in this work, and the results presented in the next section are interpreted on this basis.

However, Mauleón (1989) criticizes this interpretation with two arguments: first, this author does not consider that a negative effect of the inflation rate on demand for real balances is justified on the basis of economic theory; second, he thinks that a bias of simultaneity exists on estimating the parameter (β – 1) in expression [II.5] which makes the empirical value obtained significantly different from zero and within the interval (–1.0), a value which is not coherent with the specification in nominal balances that he claims (13).

Though it is possible that there is a bias of simultaneity in the estimates, the theoretical justification for a negative effect of the inflation rate on the demand for real balances is quite solid, especially when the levels reached by this variable have been very high (see Friedman (1956, 1969) and Cesarano (1991) who discuss this theoretical foundation). Moreover, the inflation rate is an important explanatory variable in a large number of empirical studies of demand for money (14).

With respect to the controversy over a specification of the demand for money in nominal or real balances, the paper by Goldfeld & Sichel (1990) is illuminating. These authors state that it is impossible to determine whether an adjustment occurs in real or nominal balances and to see, simultaneously, whether there is an independent effect of inflation on demand for real balances. That is, while the inflation rate is defined as the change in the price level, the effect of variable Δp on the nominal balances obtained when estimating expression [II.4] can be a combination of a partial adjustment of nominal balances to the price level with some or no effect from the inflation rate, as well as the result of an adjustment in terms of real balances and a response to the inflation rate, which is the interpretation corresponding to re-parameterization [II.5]. Only by i) approaching variable Δp by the change in a price index other than that used to deflate the nominal balances, which were a more approximate indicator of the returns on holdings of real assets (e.g. a price index linked to the real estate sector) coherent with Friedman's interpretation of the inflation rate (1956); and ii) including a suitable measurement of expected

---

(13) According to this hypothesis β = 0 in [II.4] and (β-1) = –1 in [II.5].

(14) See Baba *et al.* (1992) for the American economy, Hendry (1979, 1988) on demand for money in Britain, and Dolado (1985, 1988) and Manzanedo and Sebastián (1991) on the Spanish economy.

inflation not based on observed values (15) in order to include the relationship defended in Friedman's (1969), can the effect of these new variables be distinguished from the process of adjustment in the nominal balances to changes in the general price level.

(15) When an expected inflation variable, proxied by the conditional expectation of a univariate model of the observed inflation rate, is included in the demand equations estimated in this work the results are not very satisfactory.

III

RESULTS OF THE DEMAND EQUATIONS

This section presents the characteristics of the money demand equations, estimated for all aggregates defined in Section I, from the perspective of the objectives set out in the introduction. Before giving the results, the first two subsections describe the estimation techniques and data used.

One of the objectives stated in the introduction was to collaborate in the choice of liquidity definitions useful as indicators of growth of the money supply and also suitable for setting annual targets. From this perspective, it is fundamental to establish the existence of a stable long-run demand function that allows rates of expansion of the aggregates to be traced over prolonged periods of time consistent with defined growth paths of nominal expenditure. This question, as well as the key aspects of the demand functions for the definitions of liquidity considered, are examined in subsection III.3.

The use of an aggregate for monitoring growth of the economy's liquidity requires a certain degree of stability in its short-term demand to make it possible to extract reliable information based on observation of its growth rates over short periods of time. Hence, preference will tend to be for those aggregates that compensate most internally for possible shifts in the demand for financial assets. For this reason, it is important to analyze the scale of random disturbances or shocks affecting each equation. This point is dealt with in subsection III.4, where, together with the goodness of fit of the equations, an analysis is made of the explanatory power of the arguments of a money demand function (income, prices and interest rates) in relation to other factors (seasonal variables, lags in the endogenous variable) more linked to purely inertial aspects of each aggregate. In general, these definitions of liquidity, where the latter aspects have greater weight, will have a more limited capacity to provide information on the course of the final variables.

Correct use of an aggregate as an indicator of movements in the final variables also requires knowledge of the dynamics of the adjustments in money balances occurring in response to fluctuations in the variables that determine its demand. This aspect is analyzed in subsection III.5.

Lastly, all these characteristics are considered together in the final part of this section, where the global stability of each equation and of their long-run relationships are analyzed, to discern as far as possible temporary instabilities of those that have more persistently affected the equations.

III.1. Data used

The data of the monetary aggregates used in the estimation of the demand equations are quarterly averages of end-of-month data largely obtained from the balance sheets sent by financial institutions to the Banco de España and from the information provided by the Central Book-Entry Office. Although the monetary aggregates are controlled and monitored in terms of monthly averages of daily data, the demand equations were estimated with data from the last day of each month in order to homogenize the quality of information used for the set of aggregates considered, and so that comparisons between them were not contaminated by heterogeneous sources of information.

To approximate the arguments of the real balances demand function given by expression [II.1], the following information was used:

— GDP quarterly data prepared by the Banco de España Research Department as an indicator of real income (y).

— A synthetic interest rate (r^p) of the return (after tax) on those financial assets included in the definition of each aggregate, in line with previous studies (Dolado (1988), Dolado and Escrivá [1991]) (16).

— The internal rate of return on public debt (after tax) was chosen as alternative interest rate (r^a), except for M1 and M2. For these aggregates, it has been preferred to use an average of this rate and the return (also after tax) on financial instruments that are close

(16) See Tejada (1988) and Cuenca (1991) on how to obtain these synthetic interest rates.

substitutes, that is, assets that form part of ALP but which are not included in M1 and M2, as the case may be.

This differentiated treatment is justified for several reasons. First, the results do not change when an average of the return on public debt and the interest rates on assets included in ALP, and not included in the broad aggregates, is used as an alternative interest rate for these definitions. This result is logical since the assets excluded from ALP for construction of the broad aggregates have had little significance (except in very specific periods) in comparison with medium- and long-term public debt. In contrast, in the case of M1 and M2, the consideration of the term deposits and government debt sales with repurchase agreements is relevant in the alternative interest rate, given their quantitative importance and the high degree of subsitutability between these instruments and sight and savings deposits.

— As a measure of inflation (π), the quarter-on-quarter change in the consumer price index was used, expressed in logarithms, (Δp), which is an approximation of the quarter-on-quarter growth rate of the index.

Wealth was not introduced into the estimated demand equations as an explanatory variable, since satisfactory approximations of this variable are not available for the Spanish economy on a quarterly basis. Similarly, indicators of risk or uncertainty associated with returns on the financial assets considered (17) have been excluded because of measurement problems, since Spain has only had a developed market in long-term financial assets since 1987.

III.2. Estimation Methods

The money demand equations were estimated for the aggregates defined in Section 2 according to the ECM formulation given by expression [II.3]. The equations were estimated by two procedures:

— A *linear estimate;* traditional in ECMs, based on linearizing expression [II.3]

$$\Delta(m-p)_t = k + \alpha(m-p)_{t-1} + \beta_1 y_{t-1} + \beta_2 r^p_{t-1} + \beta_3 r^a_{t-1} + \\ + \beta_4 \Delta p_t + \delta_1(L)\Delta y_t + \delta_2(L)\Delta r^p_t + \delta_3(L)\Delta r^a_t + \qquad [III.1]$$

(17) The paper by Baba *et al.* (1992) does introduce a moving standard deviation of returns on bonds as a measure of the risk of holding these assets.

$$+ \delta_4(L)\Delta^2 p_t + \varepsilon_t$$

where $\beta_i = \alpha\gamma_i$, so that the estimated parameters are the product of the coefficient of the error correction mechanism α and long-run elasticities γ_i.

— *A non-linear estimate* of [II.3], in which both α and the long-term parameters are estimated.

Appendix II gives detailed results for only the linear estimates of ECM equations for all aggregates considered, since both methods provide very similar results due to the negligible degree of non-linearity present in the model [II.3]. However, the non-linear estimate has the advantage of providing standard errors for the long-run parameters, so that a more approximate inference can be made on them than in the linear estimate (18). For this reason, the results of the non-linear estimate are used in subsection III.3 in reference to long-run properties. In the other sections, the results that appear in the summary tables were obtained from the linear estimates.

The estimates used in the tables of results relate to the period 1978.III-1989.II (unless otherwise indicated) which is immediately prior to the introduction of controls on the growth of bank credit. This is a relatively uniform period for analysis of the regularities of the demand equations, free from distortions caused by the enactment of regulations.

III.3. Long-term properties

In general, a cointegration relationship, interpretable as a money demand equation exists, in the case of all aggregates considered (see Appendix I and estimates of parameter α in Appendix II). The differences among them have to do with the variables intervening in that relationship, as well as with the values of some elasticities. Table III.1 summarizes the characteristics of these long-run equilibrium relationships.

In relation to the variables appearing in the demand equation, certain common characteristics between the closest aggregates can be observed. Thus, the long-run demand equation for the broadest aggregates (ALP_v, ALP y ALP2) would be defined by:

$$m_t^d = \gamma_1 y_t + \gamma_2 r_t^p + \gamma_4 \pi_t$$

(18) Since the coefficients of non-stationary variables do not have standard distributions, the usual standard errors only give an approximate idea of the confidence intervals for these coefficients.

III.1. LONG-RUN ELASTICITIES OF THE DEMAND FOR MONEY (a)

	Prices	Real income	*Annual inflation rate (%)*			*Own interest rate (%)*			*Alternative interest rate (%)*		
			Semielastic.	*Elasticity* (b)		*Semielastic.*	*Elasticity* (b)		*Semielastic.*	*Elasticity* (b)	
				(min)	*(max)*		*(min)*	*(max)*		*(min)*	*(max)*
ALP_v	1.00	1.46 (40.4)	–0.61 (5.8)	–0.01	–0.11	0.013 (5.7)	0.05	0.09	—	—	—
ALP	1.00	1.77 (32.9)	–0.57 (3.5)	–0.01	–0.10	0.011 (3.1)	0.04	0.07	—	—	—
ALP2	1.00	1.75 (29.3)	–0.52 (3.9)	–0.01	–0.10	0.015 (4.6)	0.05	0.10	—	—	—
ALP_a	1.00	1.84 (12.9)	–1.29 (2.8)	–0.02	–0.24	—	—	—	—	—	—
M3	1.00	1.27 (9.5)	–0.90 (3.0)	–0.02	–0.22	—	—	—	—	—	—
$M3_a$	1,00	1.74 (13.4)	–1.00 (2.8)	–0.01	–0.18	—	—	—	—	—	—
$M3_b$	1,00	1.10 (12.4)	–0.95 (3.7)	–0.01	–0.17	—	—	—	—	—	—
$M3_c$	1.00	1.30 (11,0)	–0.88 (2.7)	–0.01	–0.17	—	—	—	—	—	—
M2	1.00	0.62 (22.7)	—	—	—	0.155 (3.6)	0.32	0.62	–0.101 (4.1)	–0.67	–1.11
M1	1,00	0.54 (28.0)	—	—	—	0.131 (6.1)	0.11	0.65	–0.083 (3.8)	–0.42	–0.72

(a) This table gives the long-run values of the coefficients obtained in the non-linear estimate in the 1978.III-1989.II period, except for the equations of M1 and M2 in which the period chosen is 1978.III-1991.II. The t-ratio of the equations is given in brackets to give an approximate idea of the confidence intervals of the coefficients.

(b) The sample mean and the minimum and maximum values in the sample were used to calculate the elasticity of the interest and inflation rates.

while for the aggregates close to M3 (ALPa, M3, M3a, M3b and M3c) the relevant relationship appears to be:

$$m_t^d = \gamma_1 y_t + \gamma_4 \pi_t$$

The long-run demand equation estimated for the narrowest aggregates (M1 and M2) is:

$$m_t^d = \gamma_1 y_t + \gamma_2 r_t^p + \gamma_3 r_t^a$$

Long-run price homogeneity was imposed in the demand equations of all aggregates considered, based on the analysis of the degree of integration of the variables (19) and on an approximate testing of this hypothesis. The testing was done by the t-ratio of parameter γ_0 when model [II.3] is estimated incorporating the term $\gamma_0 p_{t-1}$ (see Table III.2). Thus, if γ_0 is not significantly different from zero, the unit elasticity hypothesis cannot be rejected. This form of testing is only approximate since tabulated critical values for it are not available, because p_{t-1} is a non-stationary variable. However, since these distributions usually have wide tails, critical values for this test will be higher in absolute value than those for standard distributions and, therefore, in the event of obtaining t-ratios with absolute values less than two (20), it is possible not to reject the null hypothesis ($\gamma_0 = 0$).

III.2. LONG-RUN PRICE HOMOGENEITY TEST (a)
(1978.III-1989.II)

	γ_0	*t-ratio* (b)		γ_0	*t-ratio* (b)
ALP_v	–0.00	0.29	$M3_a$	–0.00	0.80
ALP2	–0.02	1.66	$M3_b$	0.00	0.11
ALP	–0.01	1.16	$M3_c$	–0.01	1.60
ALP_a	–0.00	0.17	M2 (c)	0.02	1.46
M3	–0.00	0.15	M1 (c)	–0.01	0.30

(a) The model used in testing γ_0 significance is:

$$\Delta(m-p)_t = k + \alpha[m - p - m^d(\cdot)]_{t-1} + \gamma_0 p_{t-1} + \delta(\Delta y, \Delta r^p, \Delta r^a, \Delta\pi) + \varepsilon_t$$

(b) Absolute value.

(c) Estimate period: (1978.III-1991.II).

---

(19) For most of the aggregates their rate of change in nominal terms can be characterized as I(1) variables in this sampling period, while the corresponding rate in real terms can be approximated by an I(0) stochastic process.

(20) Critical value of the normal distribution for a size of 5%.

The value of the elasticity of demand for real balances in response to changes in the level of income is greater than unity in the broad aggregates (those which are close to M3 and ALP) fluctuating in a range of 1 to 2, as the case may be. These values suggest, as stated in Section 2, the existence of wealth effects that are captured by real income and an elasticity much greater than that which would have been obtained had wealth been introduced as an explanatory variable. The narrow aggregates, on the other hand, show an elasticity below unity, near the value 0.5, indicating that the transactions motive seems to have dominated in the demand for these aggregates.

These results contrast with some of the estimates on demand for money in Spain (Dolado (1985, 1986), Dolado and Escrivá (1991)), which formerly imposed a unit income elasticity in the broad aggregates, based on Friedman's interpretations of the velocity of circulation as connected to a money demand function (21). However, when data from the mid-seventies were included in these estimates, a quadratic trend was required in this period, and when data from the late eighties were included, a linear trend was necessary in the cointegration vector which captured a persistent fall in the velocity of circulation of ALP that was not sufficiently reflected by the demand equation variables.

In contrast to this deterministic treatment of shifts in the velocity of circulation of money, Vega (1991) in a study with annual data for the period 1964-90 detects the existence of a cointegration relationship of the type $(m-p-\beta \cdot y)$ for a broad aggregate ($m = ALP_v$) when income is used as a scale variable (y = GNP) and $\beta = 1.5$, without having to use period trends. This relationship, however, is much more doubtful in the case of $\beta = 1$. Similarly, Vega (1992) estimates an annual demand equation for ALP_v, jointly with credit demand equations for the period 1964-88, and obtains income elasticities of about 1.6. These results are coherent with the empirical evidence from previous studies on demand for money in Spain, in which estimated income elasticity was about 1.5 during the sixties and early seventies (22).

Yet although there are many studies for other countries in which the value of this parameter is restricted to unity, Boughton (1990) questions this practice because of its relative arbitrariness, given the lack of consensus on its theoretical value and the wide range of values obtained when this parameter is not restricted. Moreover, the most recent international evidence, except for the United States, tends to converge towards

---

(21) See Friedman (1956).

(22) Vega (1991) proposes an explanation of the fact that unit values for income elasticity are adequate in some sampling periods, and not so over more extended periods of time.

estimates of income elasticity exceeding unity for broad aggregates and lower values for narrow aggregates (23). Similarly, studies on demand for money by the EC Committee of Governors give income elasticities which fluctuate between 1.3 and 1.7 for an M3 monetary aggregate harmonized for the member states of the European Monetary System.

In line with all these results, a strategy modelling the quarterly equations of the new monetary aggregates was chosen, in which restrictions are not imposed on the value of the income elasticity parameter and, in general, deterministic elements that would affect the long-term solution of the equations are omitted. The results obtained can be considered satisfactory, since it has been possible to estimate demand functions without having to introduce these deterministic elements and, at the same time, it has been possible to continue to verify the cointegration relationships. Moreover, the fit and the stability of the equations did not deteriorate.

In the case of the demand for the broadest aggregates, the substitution of deterministic trends by long-run income elasticities generally greater than 1.5 provides a new interpretation of the speed-up of the fall in the velocity of circulation of these aggregates during the second half of the eighties. In line with this interpretation, this acceleration should not be understood so much as the result of financial innovation not reflected in the relative returns of the assets and captured “ad hoc” by means of deterministic variables; it should be linked rather to the cyclical upturn during this period, as reflected in high rates of growth of real income. The breakdown of the velocity of circulation of the aggregates on the basis of the estimated demand equations in Section 5 provides a quantification of these factors.

The presence of interest rates and inflation rate variables in the long-run demand of the monetary aggregates depends on the nature of the assets included in each aggregate, the degree of regulation on their returns and, lastly, the broadness of each aggregate.

In the broadest definitions of money, there has not appear to be an effect of the alternative interest rate on the long-run demand. This lack of sensitivity of demand to the behaviour of bond-market rates could be due to: first, the high share accounted for by these monetary aggregates in the set of financial assets in the Spanish economy; and second, the historically insignificant development of alternatives to money or short-term markets. In contrast, the alternative interest rate is very important for ex-

(23) See Boughton & Tavlas (1991), who estimate demand functions for the United States, Japan, German Federal Republic, United Kingdom and France, and Muscatelli and Papi (1990) for Italy.

plaining the demand for M1 and M2, since this variable incorporates both a good part of financial innovation (appearance of short-term public securities and repo operations, etc.) and liberalization of interest rates, especially on term deposits, which negatively affected demand for these aggregates.

The process of introduction of new assets and liberalization of interest rates must have also influenced the demand for M3 and other aggregates close to it which have been affected by frequent flows of funds into and out of them. However, unlike in the M1 and M2 equations, in these cases it has not been possible to capture these movements through the level of interest rates since these flows, which have been quantitatively significant for short periods, have tended to compensate each other in the long run, due to the speed with which they have changed direction and the more or less parallel development of the aggregates' own and alternative rates. As a result, these shifts in money demand in response to changes in relative returns have been captured in the equations by changes in interest rates, which have had a temporary effect, without affecting the overall trend of the demand for real balances.

The effect of their own interest rate on the narrowest aggregates (M1 and M2) appears in their long-run demand after the liberalization of interest rates in the first quarter of 1987; though, in the case of M2, its demand only starts to respond significantly to the trend in its own return from 1990, when remuneration of sight deposits comes closer to market rates with some carry-over of this effect to savings deposits.

The inflation rate appears as a relevant variable for explaining long-run demand for broad aggregates. In the case of ALP and ALP2, this variable has come to represent the main opportunity cost for holdings of monetary assets. The narrowness and insignificant development of medium- and long-term markets in Spain, which could act as alternative markets to holding liquid assets, has meant that return on real estate has been the primordial opportunity cost in portfolio decisions (24). However, it is likely that as financial markets develop and become more efficient, the inflation rate will cease to be a relevant variable for explaining demand for money (25) at least in broad aggregates where portfolio decisions have significant weight.

---

(24) Manzanedo and Sebastián (1991) put forward this hypothesis.

(25) Cesarano (1991) proposes the hypothesis that there is an inverse relationship between the degree of efficiency of financial markets and the importance of expected inflation in explaining demand for money.

III.4. Fit

This subsection comments on the results of different indicators relating to the goodness of fit of demand equations which provide information on relevant aspects of the use of aggregates for monetary policy and monitoring of the growth of liquidity. These indicators are shown in Table III.3.

III.3. GOODNESS OF FIT OF THE MONEY DEMAND EQUATIONS

%

	Standard error (1978.III-1989.II)	*T^1_4 Band to 95 %* (a)	*R^2 Pierce* (b)
ALP_v	0.25	±0.7	75.9
ALP	0.29	±0.8	69.1
ALP2	0.34	±0.9	52.0
ALP_a	0.48	±1.6	49.8
M3	0.42	±1.7	33.8
$M3_a$	0.43	±1.4	46.2
$M3_b$	0.42	±1.3	41.9
$M3_c$	0.48	±1.5	30.8
M2	0.68	±3.2	15.8
M1	1.12	±4.8	16.0

(a) Calculated with the standard deviation for the 1978.III-1989.II.

(b) $R^2 \text{ Pierce} = 1 \frac{\sigma^2_{demand}}{\sigma^2_{ARIMA}}$

σ^2_{demand} = residual variance of the demand equation in the period 1978.III-1989.II.

σ^2_{ARIMA} = residual variance of an ARIMA model for the same period as the demand equation.

The first column of this table shows the standard error of each equation. According to this indicator, an inverse relationship exists between the size of the aggregate and the scale of the innovations. This is confirmed for all aggregates considered except for ALP_a, whose demand equation has a standard deviation greater than those for the equations of the M3 aggregates. If we assimilate the value taken by these standard deviations with the importance of financial disturbances experienced by each monetary aggregate, the results confirm the traditional argument in favour of the broadest aggregates, since most shifts unexplained by changes in relative returns on assets are offset within them.

The second column relates to the width of a 95 % confidence interval for the year-on-year growth rate (T1.4) which would be obtained from dynamic predictions (with a time horizon of four quarters) provided by each estimated equation, conditioning on the observed values of income, prices and interest rates. This indicator reflects, therefore, the width that should be assigned to a hypothetical target band for the annual growth of each definition analyzed, if these targets were formulated on the basis of the properties of their demand equations. The band width depends on the standard error and on the dynamic specification of each demand equation.

The results of this column indicate that a possible target band for the M3-type aggregates, constructed from simulations with the demand equations, should have a width one to two points greater than for ALP, which, again, reflects the lower neutralization of the portfolio shifts in these intermediate aggregates. In the case of M3, the band widens somewhat in relation to the $M3_a$, $M3_b$ and $M3_c$ bands due to the appearance of lags in the endogenous variable in the demand equation.

With respect to M2 and M1, this hypothetical target band should be very wide, about four and eight points more respectively, due to the greater degree of erraticism and inertia detected in these equations. This erraticism is partly caused by the fact that very liquid assets are included in these narrower aggregates. These assets sustain the temporary adjustments required by expenditure and portfolio decisions of economic agents.

Finally, the third column of Table 3 shows Pierce's R^2. This indicator provides information on the power of the explanatory variables of the money demand functions (income, prices and interest rates) to explain the behaviour of each monetary aggregate. Pierce's R^2 depends on both the size of the innovations of the demand equation and on each aggregate erraticism, measured by the residual variance of its univariate ARIMA model. By comparing both variances, an indicator of the degree of linkage between monetary aggregates and the final variables is obtained. Thus, for example, in the case of M3 and $M3_a$, the latter has a higher Pierce's R^2, even when both demand equations have a residual variance of similar size. That is, $M3_a$ is explained more by the variables proper to a money demand equation than by more inertial factors, resulting from dynamic adjustment processes, or from seasonal fluctuations.

The most restricted definitions of liquidity (M1 and M2) maintain a weaker link with the expenditure variables, as deduced from the values taken by Pierce's R^2. In contrast, ALP gives the best result, since its demand function is capable of explaining a higher proportion of variance in the corresponding univariate model.

The results obtained for these three indicators point in the same direction: as more assets are included in the definition of liquidity, the equations give generally better properties according to the indicators of fit considered. However, while the results obtained for aggregates M1 and M2 indicate a significant deterioration in relation to the M3 definitions, this deterioration is much less marked in the latter with respect to the aggregates close to ALP. Moreover, in a comparison between ALP and ALP_v (the previous definition of ALP), the three indicators of Table 2 produce marginally better results for ALP_v.

III.5. Dynamics

The dynamics built into the demand equations (see Table III.4) are characterized by relatively rapid adjustments to changes in the explanatory variables; however, in the cases of real income and prices, some time is required for completion of the effect (the lag distributions have long tails). Furthermore, in all the aggregates, demand responds more rapidly to changes in the price level than to changes in real income, as is shown by both the mean and median lags, which are greater in the latter variable.

As Table 4 shows, at least 50 % of the effect of income and prices on the broad aggregates (all those considered except M1 and M2) occurs in the first year, with the adjustment of the broadest aggregates during this period being markedly higher. Thus, the accumulated response to changes in income in the first four quarters is 67 % in ALP and 70 % in ALP2, with adjustment to price level of 77 % and 78 %, respectively. In contrast, ALP_a adjusts more slowly, more in line with the results for the M3 aggregates.

If we compare the dynamics of the demand equations of the aggregates included in the harmonized definition of M4 with the dynamic of the definitions assimilable to M3, it is clear that, if changes occur in the nominal income, the demand for the aggregates close to ALP will record the effect of these changes more promptly (mean and median lags are smallest). Therefore, with respect to the dynamics of the adjustment processes, it can be said that ALP is the aggregate that combines the best properties for use as an indicator of the behaviour of the final variables.

In the narrowest aggregates (M1 and M2), two aspects are significant. First, responses to prices and income occur considerably more slowly than with the other aggregates, which induces more persistent deviations in their long-term paths and makes it difficult to relate observed growths for these variables to the behaviour of nominal expenditure. Second, the estimated response functions reflect a more complex dynamics than in the other aggregates, obtaining, on occasions, cyclica responses,

III.4. DYNAMIC PROPERTIES OF THE MONEY DEMAND EQUATIONS

	Median and mean lag				*Accumulated response* (a)					
	Prices		*Income*		*Own interest rate*			*Alt. interest rate*		
	(b)	(c)	(b)	(c)	*Half-year*	*Year*	*Total*	*Half-year*	*Year*	*Total*
ALP_v	2.5	0.9	3.0	1.6	0.08	0.11	0.07	0	–0.02	0
ALP	2.2	0.5	3.2	1.7	0.08	0.12	0.06	0	–0.02	0
ALP2	2.1	0.6	2.8	1.5	0.05	0.09	0.08	0	–0.02	0
ALP_a	5.2	2.6	7.0	2.0	0.10	0.12	0	–0.01	–0.02	0
M3	4.4	1.5	6.1	3.3	0.05	0.12	0	0	–0.03	0
$M3_a$	3.9	1.1	6.6	4.3	0.08	0.06	0	–0.01	–0.03	0
$M3_b$	3.6	1.4	4.2	2.1	0.06	0.06	0	0	–0.04	0
$M3_c$	3.6	0.9	4.8	2.6	0	–0.00	0	0	–0.02	0
M2	(d)	(d)	11.5	8.0	0.13	0.15	0.36	–0.13	–0.33	–0.90
M1	(d)	(d)	7.4	5.0	0.09	0.12	0.19	–0.27	–0.36	–0.59

(a) Expressed in terms of elasticity with respect to the sample mean for each interest rate.
(b) Mean lag.
(c) Median lag.
(d) In these aggregates, the dynamic response to the level of prices changes sign in some periods, thus the calculation of the mean and median lag does not apply.

though this does not affect long-term properties. These cyclical responses are a result of the appearance of a number of lags of the dependent variable on the right of the equations (see Tables A.II.9 and A.II.10 of Appendix II). These terms show the greater importance of very short-term fluctuations (erratic and/or seasonal changes) in explaining the quarterly course of these aggregates. This is an element which significantly differentiates the M1 and M2 equations from the equations for the broad aggregates, where the arguments of the demand function (income, price and interest rate) explain their course, with scarcely any need to introduce elements of inertia such as lags in the dependent variable.

The demand for all the broad aggregates is characterized by a short-term overshooting in the response to interest rates. Thus, in cases where long-run elasticity is other than zero, the response after one year is usually higher than the long-term effect. Similarly, when the long-term effect is zero, the demand for some aggregates, for example, ALP_a and M3, is significantly affected by movements in interest rates, mainly their own. Moreover, while the alternative interest rate has hardly any effect on demand for aggregates during the first half-year, it is in this period when their own rate causes greatest change in their demand. Consequently, according to these results, the demand function of the aggregates close to M3 and ALP is dominated, in the very short run, by the effect of changes in their own rate.

This type of dynamic response to interest rates has led, on occasions, to conclusions that elasticity to their own interest rate was important in the broad aggregates, a fact which tended to hinder monetary control. Hence, the implementation of restrictive measures by a general rise in interest rates which pushed up both their own rate and the alternative rate undoubtedly led to a short-term increase in the demand for these aggregates. However, as pointed out, the long-term effect of their own rate was less or even nil.

III.6. Stability

Several aspects of the stability of the demand equations of the aggregates were analyzed. These are summarized in Table III.5 and detailed results can be consulted in Appendices II and III. Special emphasis was given to the stability of the long-run relationship, due to its relevance in the design of monetary policy and the setting of annual targets.

Almost all the aggregates examined show a high degree of stability, since they maintain similar values in long-run elasticities when the equations are estimated for different periods of time (see Appendices II and III).

III.5. STABILITY OF THE DEMAND EQUATIONS

	ALP_v	ALP_2	ALP	ALP_a	$M3$	$M3_a$	$M3_b$	$M3_c$	$M2$	$M1$
Long-run relationship (less stable coeffic.)	—	γ_4	—	γ_1, γ_4	γ_4	γ_1, γ_4	γ_1, γ_4	γ_1, γ_4	γ_2	γ_2
Point instability (no. of quarters)	2	1	1	1	3	0	1	2	3	1
Persistent instability	no	no	no	no (?)	yes	no	no (?)	yes	no (?)	yes
Since:	—	—	—	1986	1986	—	1985	1986	1985	1984
Credit control (1989.III-1990.IV)	I SB	E SM	I SB	E SM	I IM	E SM	I IM	I IM	I SM	E D
After control (1991.I)	D	IM	D	IB	IB	IM	IB	IB	D	D
(1991.II)	SB	D	SB	IM	IB	IM	IB	IB	SM	SM

I = Inestability; E = Stability; D = Observation coincident with the prediction; IM = Moderate under-prediction; SM = Moderate over-prediction; IB = Extreme under-prediction; SB = Extreme over-prediction.

The intermediate-sized aggregates (ALP_a, M3, $M3_a$, $M3_b$ and $M3_c$) display more heterogeneous values in these statistics, while the narrowest aggregates (M1 and M2) are highly stable in their long-run relationships, after inclusion of their own return in order to incorporate the structural change following the liberalization of 1987. ALP, in both its former and new definition, is the aggregate that shows the most stable long-run relationship.

The estimates produced by including the period of credit control in the sample (1989.III-1990.IV) have to be excluded from these comments. In all the broad aggregates, except ALP2, symptoms of strong instability were detected which show up in changes in long-run parameters and in responses to interest rates, as well as in a marked increase in residual variance and prediction errors (see Tables A.III.1 and A.III.2 of Appendix III). This instability is particularly intense in ALP, more moderate in the intermediate aggregates, and particularly weak in ALP2, which records only a moderate increase in residual variance and a moderate over-forecast during the period of credit control.

The narrow aggregates, for their part, do not show signs of instability in this period, except for an increase in the degree of erraticism of M1 which puts the growth of this aggregate above forecast, due to the rapid growth in sight deposits in 1990, after high returns on this type of asset became widespread.

An analysis of the stability of the demand equations of the new aggregates should, therefore, avoid consideration of the 1989.III-1990.IV period, in which a combination of extraordinary events (26) occurred which by their nature tended to generate instability in the money demand equations. For this reason, a number of stability tests were made on these equations excluding this period from the analysis (see Appendix III).

The tests were of two types (27):

— Stability tests one period in advance, to detect point instabilities over very short periods of time.

— Stability tests with a variable time span, to detect more persistent instabilities which could be associated with structural changes. Though the values obtained from this test do not in most cases

(26) These events were: the adoption of controls on bank credit; a drastic reduction in the cash ratio; the extension of high returns on sight deposits; changes in the regulatory timetable for various taxes; changes in regulations affecting insurance operations and asset transfers; and agreements to reduce the balance of local government bonds.

(27) Both types of test were calculated in recursive form according to the procedure described by Hendry (1989).

exceed the critical values, on occasions a progressive narrowing of the gap can be observed. This indicates persistent or accumulated anomalous observations in relation to the structure captured by the demand equation.

The results of these tests include the following:

— The ALP equations, in their old and new definitions, ALP2, $M3_a$ and M2 do not show signs of persistent instability, although they do show some point instabilities.

— More doubtful cases exist, such as ALP_a and $M3_b$, in which a marked deterioration in stability occurred around 1985-1986.

— Lastly, the M3, $M3_c$ and M1 equations reflect a persistent instability which shows up in a large number of point instabilities (not all of them are significant), and in increasing values of the test with a variable time -span, a consequence of the changes induced by these point instabilities over time.

The tests do not distinguish between structural changes in the value of the parameters and changes in the variance of the innovations. For this reason, possible alterations in the coefficients were also evaluated by analyzing their recursive estimates, although for reasons of space the complete plot of these estimates has not been given. Even so, an idea of this can be obtained from the estimates with different sampling periods which appear in Appendix II. Recursive analysis was very important in establishing a comparison between the results of the M3 and $M3_a$ aggregates and for obtaining information on the part played by Treasury note repos over different periods of time. It was likewise important for the comparison between ALP and ALP2.

In the estimates with samples up to 1987, the M3 equation has better properties than the $M3_a$ equation, which differs from the former in that its definition does not include Treasury note repos. This result implies that during the early eighties Treasury notes repos acted essentially as a monetary instrument that was a very close substitute for bank deposits. As the eighties unfolded, and the interest rate on Treasury notes gradually became detached from market rates, the results for M3 progressively deteriorated and its demand showed signs of instability. This revealed that, in private portfolios during this period, Treasury notes repos were mainly exchanged for the block of tax- anonymous securities not included in this definition. In contrast, $M3_a$, during the second half of the eighties, maintained a stable demand for money.

Finally, comparison of ALP and ALP2 reveals that, during the period before credit control, the incorporation into ALP of the stock of commercial paper held by the public did not improve the behaviour of this aggregate. However, the regularities in the demand for ALP, which experienced a sharp break during the period of credit control, are largely safeguarded in the ALP2 aggregate.

IV

DEMAND FOR MONEY AND THE VELOCITY OF CIRCULATION

This section illustrates the relative weight of the variables included in the specifications of the demand equations. The demand equations of the monetary aggregates were reformulated in terms of velocity of circulation, which is a normal representation for evaluating movements in the demand for money. The effect on changes of this ratio of each of the variables explaining the demand was quantified. Appendix IV describes how this breakdown was made. The results are given in Charts IV.1, IV.2 and IV.3. Five aggregates (ALP, ALP2, $M3_a$, M2 and M1), which cover the range of definitions of liquidity considered, were chosen for the breakdown and the demand equations which had the best overall properties within the broad aggregates were used.

According to the breakdown, the fall in the velocity of circulation of the broad aggregates is largely explained by real income which, in the last five years, tended to dominate other effects due to its strong growth (28). In the narrow aggregates (M1 and M2), however, the effect of income was weaker and of a different sign compared with its effect on the broad aggregates (29).

The main effect on M1 and M2 is from interest rates which accounted for trend changes in velocity of circulation of both aggregates in the eighties. Thus, the alternative interest rate is the fundamental variable in explaining the depression in the demand for M1 and M2 after the process of

(28) With income-elasticities higher than unity, such as those estimated for ALP, ALP2 and $M3_a$, a speed-up in growth of real income added to the fall in velocity of circulation.

(29) An income elasticity lower than unity increases the velocity of circulation when income shows positive growth.

IV.1. BREAKDOWN OF THE VELOCITY OF CIRCULATION OF THE MONETARY AGGREGATES
Average annual growth

ALP

ALP2

IV.2. BREAKDOWN OF THE VELOCITY OF CIRCULATION OF THE MONETARY AGGREGATES
Average annual growth

ALP

M3a

IV.3. BREAKDOWN OF THE VELOCITY OF CIRCULATION OF THE MONETARY AGGREGATES

Average annual growth

M2

M1

interest rate liberalization begun in 1977. Following this process, a large portion of private savings, held as sight and savings deposits before liberalization, was slowly transformed into term deposits. Later, under the 1987 liberalization, banks were able to increase the return offered on sight deposits, and this changed the trend in the velocity of circulation of these aggregates. The process was more pronounced in M1 than in M2 due to the rigidity of the return offered by savings deposits.

The contributions of the own interest rate and the alternative rate have tended to offset each other in broad definitions of liquidity; however, in very specific periods the net effect was quite significant in ALP and ALP2. At the beginning of the decade, the liberalization of many of banks' deposit rates resulted in a net contribution from interest rates which explained about two points of the fall in velocity in 1982. Later, the sharp drop in interest rates between 1984 and 1986 slightly increased the velocity of ALP and ALP2 in net terms, returning to a negative contribution in the last three years following a general rise in interest rates. In particular, the increase in the aggregates' own rate, which caused the so-called "high-yielding accounts war", led to a fall of about one point in velocity in 1990, although the alternative interest rate largely offset this effect.

The contribution of interest rates to the trend in velocity of $M3_a$ was somewhat more moderate than with ALP and ALP2, as is to be expected with an aggregate whose demand responds temporarily to interest rates and has a nil response in the long run after making the portfolio readjustments which have been frequent in this aggregate (30).

The contribution of inflation was more marked in the fall in the velocity of $M3_a$ than in ALP and ALP2, due to the higher elasticity estimated in its demand equation. In these three aggregates, the contribution of inflation in 1989 and 1990 was positive due to the surge in that variable. The velocity of circulation of the narrow aggregates was hardly influenced by the inflation rate, which only had a significant effect on this ratio in the period (1986-1988).

In general, the determinants of each demand function explain changes in velocity reasonably well, except in the case of the narrowest aggregates. In these, the unexplained part is greater due to a higher degree of erraticism in the innovation of their equations and to the accumulation of some large errors in certain periods (31).

---

(30) Subsection III.3 proposes an explanation for these results.

(31) When analyzing velocity in terms of the annual average change, quarterly changes must be aggregated every four periods (see Appendix IV), causing an accumulation of errors which can sometimes be significant.

An increase also took place in the unexplained part of changes in velocity of ALP in 1990 and $M3_a$ in 1991. These anomalies were caused, on one hand, by restrictions on bank credit which reduced the growth of ALP to below the figure coherent with the demand determinants and led to a distortion in the trend of the velocity of some three-and-a-half points. This distortion hardly reached one point in ALP2 due to deviation of some bank credit to the commercial paper market. Furthermore, the expected fall in the velocity of $M3_a$ in 1991 was more than one point below the figure coherent with the basic determinants of its demand function. This is an indication that the aggregate was affected by a financial disturbance during the year, possibly linked to the flow of funds from tax-anonymous instruments to assets included in $M3_a$.

V

CONCLUSIONS

This research has addressed the properties of money demand functions for a broad range of monetary aggregates, covering the range of definitions of liquidity from the narrowest (M1) to the broadest (ALP2) measure. These aggregates were constructed in line with the new criteria incorporated in the 1992 reform of the monetary aggregates. In addition to the five aggregates chosen to form the set of growth indicators of the money supply and systematically published by the Banco de España (M1, M2, M3, ALP and ALP2), the properties of other definitions considered as alternatives to the final aggregates were also described. The definitions of these aggregates are close to that corresponding to M3, which is the aggregate most affected by the reform and which raised most doubts at the time of its definition.

The sequential study of a broad range of aggregates disclosed substantial differences in the value of the elasticities affecting their long-term trends. To be able to capture stable patterns in the secular relationship that demand for the aggregates maintains with the final variables, it is crucial to leave the income-elasticity parameter free. In the broadest aggregates, this parameter take values in the region of 1.7 which is coherent with the existence of significant wealth effects; this elasticity falls in the aggregates included in M3, although always remaining above 1; finally, the narrow aggregates (M1 and M2) show income elasticities slightly above 0.5, in line with the prescriptions of the transactions demand for money.

Very varied responses by demand for the aggregates to financial variables were also observed. The narrowest aggregates are much more sensitive to changes in the interest rates, both of the assets included in their definition and of alternative financial instruments. As the definition of the aggregate broadened, these portfolio adjustments are neutralized within the aggregate and sensitivity to interest rates diminishes; at the same time, financial movements are partly captured in the inflation rate, which approximates the opportunity cost of substituting financial assets for real estate. Likewise, the increased integration of switching processes between financial assets within the broadest monetary aggregates is reflected by the direct relationship between the size of the aggregates and the degree of fit of the demand equations.

This fact, combined with an appreciably slower dynamics in relation to price and income levels, significantly reduces the informativeness of the narrowest aggregates (M1 and M2) in comparison with the other definitions of liquidity considered, despite the fact that they maintain a stable and well-defined long-run relationship with the final variables.

The joint evaluation of the results in terms of fit, dynamics, stability and interpretability of the demand equations of the aggregates analyzed leads to the conclusion that ALP and ALP2 show good properties and are clearly distinguishable from the other narrower definitions of liquidity as more accurate indicators of the relationship between money and nominal expenditure. During the period prior to the credit restrictions, the incorporation into ALP of the stock of commercial paper held privately did not improve its performance. However, the regularities of demand for ALP, which underwent a sharp break during the period of credit control, were largely safeguarded in the ALP2 aggregate.

In the comparison of ALP with its former definition prior to the 1992 reform (ALP_v), no deterioration was observed in the properties of the aggregate. Yet differences did occur in the long run: in ALP, the velocity of circulation showed a more pronounced downward trend in the second half of the eighties than did ALP_v. These differences in the growth rates of the velocity of circulation for ALP are explained, in terms of the estimated demand equations, by higher long-term income elasticity, since the other two factors that underlie this downward movement of the velocity show similar parameters for both aggregates: a positive elasticity to its own interest rate in a period when this variable tended to increase constantly and a negative elasticity to the inflation rate, while in the eighties the variable had a clearly downward profile.

No improvements in the properties of the aggregates were observed when some of the more doubtful components were excluded. Conversely, a marked deterioration was noted in the stability and fit indicators for the ALP_a demand equation.

When the range of aggregates included in the harmonized definition of M3 is analyzed, the worsening of the properties of these narrower aggregates is reflected mainly in the fit indicators, in a blurring of the link with interest rates, in decreased stability, and particularly in the short-run parameters and residual variance. This deterioration seems to be the result of the frequent flows of funds between financial assets that have affected these aggregates. However, the relationship to the final variables was maintained, with the degree of stability varying according to the aggregate considered.

Considering the demand equations globally, $M3_a$ gives better results than M3, $M3_b$ and $M3_c$, particularly with respect to tests for stability and informativeness, measured by Pierce's R^2. Even so, in the estimates with samples to 1987, the M3 equation has better properties than $M3_a$ which excludes Treasury notes repos from its definition. This result implies that in the early eighties Treasury note repos were essentially monetary instruments that were very close substitutes for bank deposits.

As the eighties unfolded, and the interest rate on Treasury notes gradually separated from market rates, the results for M3 deteriorated and its demand showed signs of instability. These trends indicated that during this period Treasury note repos in private portfolios were exchanged for the block of tax-anonymous securities not included in this definition. In contrast, during the second half of the eighties, $M3_a$ maintained a stable demand for money.

REFERENCES

ANGELONI, I., and GIUCCA, P. (1991): “The Role of Monetary Aggregates in the Coordination of Monetary Policies in the EEC”, article presented in the seminar on money and financial markets, organized by the Italian Bankers' Association, Rome 4 and 5 April.

ARTIS, M. J. (1992): “The Transmission Mechanism of Monetary Policy in a Causal Framework”, article presented in the seminar on transmission of monetary policy in open economies, organized by the Schweizerische Nationalbank and the University of Rochester, Berne, 18-20 March.

BABA, Y., D. F. HENDRY and R. M. STARR (1992): “The Demand for M1 in USA: 1960-1988”. *The Review of Economic Studies*, 59, pp. 25-60.

BAUMOL, W. J. (1952): “The Transactions Demand for Cash: An Inventory Theoretic Approach”. *Quarterly Journal of Economics,* November, 66 (4), pp. 545-556.

BENNETT, A. (1987): “Wealth, Expenditure and the Demand For Money: The Case of France”. International Monetary Fund. *Working Paper* 87/26.

BOUGHTON, J. M. (1990): “Long-Run Money Demand in Large Industrial Countries”. International Monetary Fund. *Working Paper* 90/53.

BOUGHTON, J. M. and G. S. TAVLAS (1991): “What Have We Learned About Estimating the Demand For Money? A Multicountry Evaluation of Some New Approaches”. International Monetary Fund. *Working Paper* 91/16.

CESARANO, F. (1991): “Demand for money and expected inflation”. *Applied Economics,* 23, pp. 1649-1653.

CUENCA, J. A. (1992): “La construcción de variables financieras para el estudio del sector monetario de la economía española”, mimeo.

CUTHBERTSON, K. (1988): “The Demand for M1: A Forward Looking Buffer Stock Model”, *Oxford Economic Papers*, 40,1, pp. 110-131.

CUTHBERTSON, K. and M. P. TAYLOR (1986): “Buffer-Stock Money: An Assessment”, in D. A. Currie, C. A. E. Goodhart and D. Llewellyn (edit.) *The Operation and Regulation of Financial Markets,* Macmillan, London.

DAVIDSON, J. (1986): “Disequilibrium Money: Some Further Results with a Monetary Model of U. K.”, in D. A. Currie, C. A. E. Goodhart and D. Llewellyn (edit) *The Operation and Regulation of Financial Markets,* Macmillan, London.

DEUTSCHE BUNDESBANK (1992): “The correlation between monetary growth and price movement in the Federal Republic of Germany”, *Monthly Report*, January.

DOLADO, J. (1982): *Procedimientos de búsqueda de especificación dinámica: el caso de la demanda de M3 en España.* Estudios Económicos 24. Banco de España.

— (1985): “La estabilidad de la demanda de dinero en España (1974-84)”. *Boletín Económico*, Banco de España, September.

— (1988): “Innovación financiera, inflación y estabilidad de la demanda de ALP en España”. *Boletín Económico*, Banco de España, April.

DOLADO, J. and J. L. ESCRIVA (1991): “La demanda de dinero en España: definiciones amplias de liquidez”. Banco de España, Working document no. 9107.

ENGLE, R. F. and C. W. J. GRANGER (1987): “ Co-integration and Error Correction: Representation, Estimation, and Testing”. *Econometrica*, v.55, 2, pp. 251-276.

FRIEDMAN, M. (1956): “The Quantity Theory of Money, a Restatement” in M. Friedman (ed), *Studies in the Quantity Theory of Money*, University of Chicago Press.

— (1969): “The Optimun Quantity of Money” in M. Friedman (ed), *Optimun Quantity of Money and Other Essays*, Aldine, Chicago.

GIOVANINNI, A. (1991): “Money Demand and Monetary Control in an Integrated European Economy”, *European Economy*, Commission of the European Communities. Special edition, no. 1.

GOODHART, C. A. E. (1984): “Monetary Theory and Practice. The UK Experience”, Macmillan Press, London.

GOLDFELD, S. and D. E. SICHEL (1987) “Money Demand: The effects of inflation and alternative adjustment mechanisms’. *Review of Economics and Statistics,* 69, 511-515.

— (1990): “The Demand for Money” cap. 8 in B. M. Friedman and F. H. Hahn (edit.), *Handbook of Monetary Economics.*

GRANGER, C. W. J. (1981): “Some properties of time series data and their use in econometric model specification”. *Journal of Econometrics,* 16, pp. 121-130.

GRANGER, C. W. J. and A. A. WEISS (1983): “Time series analysis of error-correction models”, in S. Karlin, T. Amemiya and L. A. Goodman (edit.)., Studies in *Econometrics, Time Series, and Multivariate Statistics* (New York, Academic Press), 255-278.

GRICE, J. and A. BENNETT (1984): “Wealth and the Demand for £M3 in the United Kingdom 1963-1978”. *Manchester School* no. 3, pp. 239-271.

HENDRY, D. F. (1979): “Predictive Failure and Econometric Modelling in Macroeconomics: The Transactions Demand for Money”, cap. 9 in P. Ormerod (edit.), *Economic Modelling,* London, Heinemann Education Books, pp. 217-242.

— (1988): “The Encompassing Implications of Feedback versus Feedforward Mechanisms in Econometrics” *Oxford Economic Papers,* 40, 1, pp. 132-149.

— (1989): “PC-GIVE. An Interactive Econometric Modelling System”. Versión 6.0/6.01. University of Oxford*.*

HENDRY, D. F. and G. E. MIZON (1978): “Serial Correlation as a Convenient Simplification, Not a Nuisance: A Comment on a Study of the Demand for Money by the Bank of England”. *Economic Journal,* 88, pp. 549-563.

JUDD, J. P. and J. L. SCADDING (1982): “The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature”. J*ournal of Economic Literature,* pp. 993-1023.

KNOESTER, A. (1984): “Theoretical Principles of the Buffer Stock Mechanism, Monetary Quasi-Equilibrium and its Spillover Effect”, *Kredit und Kapital*, no. 2, pp. 243-260.

KREMERS, J. J., N. R. ERICSSON and J. J. DOLADO (1991): “The Power of Cointegration Tests” *Oxford Bulletin of Economics*, April.

LAIDLER, D. (1984): “The Buffer Stock Notion in Monetary Economics”, *The Economic Journal* (supplement) December, pp 17-34.

— (1987): “Buffer-stock money and the transmission mechanism”, *Economic Review Federal Reserve Bank of Atlanta*, March-April, pp. 11-23.

MACKINNON, J. (1991): “Critical Values for Cointegration Tests” in Engle & Granger (Ed.), *Long-Run Economic Relationships,* Oxford University Press.

MANZANEDO, L. and M. SEBASTIAN (1991): “La demanda de dinero en España: motivo transacción y motivo riqueza”, in C. Molinas, A. Bosch and M. Sebastián (ed). *La Economía española, una perspectiva macroeconómica.*

MAULEON, I. (1989): *Oferta and demanda de dinero: Teoría y evidencia empírica*. Alianza Editorial, Madrid.

MEHRA, Y. P. (1991): “An Error-Correction Model of U.S. M2 Demand”. Federal Reserve Bank of Richmond, *Economic Review,* May/June.

MILBOURNE, R. D. (1988): “Disequilibrium Buffer Stocks Models: A Survey”, *Journal of Economic Surveys*, no. 3.

MUSCATELLI, V. A. and L. PAPI (1990): “Cointegration, Financial Innovation and Modelling the Demand for Money in Italy”. *Manchester School*, 58, pp. 242-259.

TEJADA, F. (1988): “Determinación de un tipo de interés representativo de la rentabilidad propia de ALP”. *Boletín Económico*, April. Banco de España.

TOBIN, J. (1956): “The Interest-Elasticity of Transactions Demand for Cash” *Review of Economics and Statistics,* August, 38 (3), pp. 241-247.

— (1958): “Liquidity Preference as Behavior Towards Risk”. *Review of Economic Studies,* February, 25 (67), pp. 65-86.

VEGA, J. L. (1991): “Tests de raíces unitarias: aplicación a series de la economía española y al análisis de la velocidad de circulación del dinero (1964-1990)”. Banco de España, working document no. 9117.

— (1992): *El papel del Crédito en el mecanismo de transmisión monetaria,* Serie Estudios Económicos no. 48. Banco de España.

VON HAGEN, J. and M. J. M. NEUMANN (1988): “Instability Versus Dynamics: A Study in West German Demand for Money”. *Journal of Macroeconomics*, v. 10 no. 3, pp. 327-349.

WOODFORD, M. (1990): “Does Competition between Currencies lead to Price Level and Exchange Rate Stability? NBER, *Working Paper* no. 3441.

APPENDIX I

DEGREE OF INTEGRATION AND COINTEGRATION RELATIONSHIPS BETWEEN THE VARIABLES OF THE MONEY DEMAND EQUATIONS

The results of the analysis of the degree of integration of the variables of the money demand equations (see tables in this appendix) are ambiguous, particularly with respect to monetary aggregates, income and prices (32). This ambiguity could be caused by the use of quarterly data, the treatment of which could be better done by unit root tests in the seasonal frequencies.

Based on the results of some of the tests it was decided to adopt the following set of hypotheses:

— It is considered that broad aggregates in real terms, income and the inflation rate are I(1) variables, with deterministic trends detected in some of them. Similarly, it is considered that the inflation rate is first order integrated, although in this particular sample period it would be better treated as a I(0) variable around a downward trend.

— The interest rates are I(1), except in the case of the own returns of M1 and M2 which could be I(2) variables .

— The narrow aggregates deflated by the CPI, however, appear to be I(2) variables. Nonetheless, a cointegration relationship exists between these aggregates and their rates of return (which can be considered I(2)) so the deviations with respect to this relationship are I(1).

(32) The critical values used are from MacKinnon (1991).

Under this series of hypotheses it is possible to establish that:

a) Cointegration relationships exist between the broad aggregates expressed in real terms, and interest and inflation rates, all of them being I(1) variables.

b) A cointegration relationship exists between the narrow aggregates in real terms and their respective rates of return, which are distributed as a I(1) variable. This, in turn, forms a cointegration relationship with income and the alternative interest rates.

The test proposed by Banerjee et al (1986) was used to test for the existence of these relationships. The test is based on the t-ratio of parameter α in expressions [III.1] of the text and its values are given in Appendix II. The authors compare this test with other cointegration tests and conclude that it is one of the most powerful. Even so, the problem is that its distribution, under the alternative hypothesis of absence of cointegration, is not standard and therefore does not have tabulated critical values (33). For this reason, a criteria of prudence was followed in the application of the test, under which rejection of the null hypothesis of absence of cointegration requires the above-mentioned statistic to be over 3 in absolute-value terms.

(33) See Dolado *et al.* (1991) on the asymptotic properties and finite samples of this and other cointegration tests.

A.I.1. UNIT ROOT TEST (augmented Dickey-Fuller; $H_0 : \gamma = 0$)

$$\Delta x_t = \alpha + \beta t + \gamma x_{t-1} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} + \sum_{i=1}^{3} s_i Q_i + \varepsilon_t$$

x	*α ≠ 0, β ≠ 0*				*α ≠ 0, β = 0*			*α = 0, β = 0*		*Degree of integration*
	p	*α*	*β*	*γ*	*p*	*α*	*γ*	*p*	*γ*	
ΔALP$_v$	3	0.07 (4.77)	–0.52 (4.33)	–1.40 (4.86) (a)	2	0.01 (1.88)	–0.27 (2.01)	4	–0.02 (0.94)	I(1) or I(0) around a trend
ΔALP	1	0.05 (5.45)	–0.28 (4.07)	–1.01 (5.65) (a)	2	0.01 (2.06)	–0.33 (2.18)	3	–0.02 (0.90)	I(1) or I(0) around a trend
ΔALP2	1	0.05 (5.67)	–0.23 (3.81)	–1.04 (5.87) (a)	2	0.01 (2.36)	–0.41 (2.46)	3	–0.02 (0.81)	I(1) or I(0) around a trend
ΔALP$_a$	2	0.02 (2.49)	–0.05 (0.66)	–0.62 (2.70)	2	0.02 (2.64)	–0.56 (2.69) (c)	2	–0.01 (0.51)	I(1) or I(0) with non-null constant (at 10 %)
ΔM3	1 2	0.03 (3.35) 0.02 (2.29)	–0.17 (2.17) –0.12 (1.46)	–0.64 (3.59) (b) –0.51 (2.51)	2	0.01 (2.00)	–0.29 (2.12)	2	–0.02 (0.79)	I(1)
ΔM3$_a$	2	0.03 (2.36)	–0.09 (1.16)	–0.62 (2.54)	2	0.02 (2.28)	–0.44 (2.34)	2	–0.02 (0.61)	I(1)
ΔM3$_b$	2	0.02 (1.79)	–0.09 (0.95)	–0.46 (2.02)	2	0.01 (1.89)	–0.30 (1.98)	2	–0.02 (0.63)	I(1)
ΔM3$_c$	2	0.02 (2.17)	–0.11 (1.21)	–0.56 (2.38)	2	0.01 (2.10)	–0.35 (2.17)	2	–0.02 (0.59)	I(1)
ΔM2	2	0.01 (1.78)	–0.09 (1.08)	–0.42 (2.67)	2	0.01 (2.43)	–0.40 (2.56)	2	–0.04 (0.80)	I(1)
ΔM1	1	0.01 (2.01)	–0.22 (1.63)	–0.57 (3.84) (b)	1	0.02 (3.11)	–0.49 (3.44) (b)	2	–0.06 (1.00)	I(1) or I(0) around a trend
ΔIPC	2	0.03 (3.51)	–0.42 (3.14)	–0.78 (4.02) (b)	3	0.00 (1.02)	–0.15 (1.78) (b)	3	–0.07 (2.24) (b)	I(1) or I(0) around a trend

(a) Coefficient significant at 1 %.
(b) Coefficient significant at 5 %.
(c) Coefficient significant at 10 %.

A.I.1. UNIT ROOT TEST (augmented Dickey-Fuller; $H_0 : \gamma = 0$) (continuation)

$$\Delta x_t = \alpha + \beta t + \gamma x_{t-1} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} + \sum_{i=1}^{3} s_i Q_i + \varepsilon_t$$

x	*α ≠ 0, β ≠ 0*				*α ≠ 0, β = 0*			*α = 0, β = 0*		*Degree of integration*
	p	*α*	*β*	*γ*	*p*	*α*	*γ*	*p*	*γ*	
$\Delta ALPR_v$	1	0.00 (1.03)	0.23 (2.73)	–0.98 (6.44) (a)	2	0.01 (3.48)	–0.64 (3.74) (a)	2	–0.17 (1.45)	I(0) with constant or around a trend
ΔALPR	2	0.00 (1.02)	0.24 (2.31)	–0.87 (4.06) (b)	2	0.01 (3.18)	–0.51 (3.32) (b)	3	–0.06 (0.62)	I(0) with constant or around a trend
ΔALP2R	1	0.00 (0.09)	0.47 (5.26)	–1.28 (8.28) (a)	3	0.01 (2.74)	–0.41 (2.53)	3	–0.03 (0.32)	I(1) o I(0) around a trend
$\Delta ALPR_a$	2	–0.00 (0.40)	0.39 (2.89)	–0.87 (3.84) (b)	2	0.01 (2.57)	–0.32 (2.43)	2	–0.06 (0.66)	I(1) o I(0) around a trend
ΔM3R	1	0.00 (0.01)	0.35 (4.02)	–1.14 (7.29) (a)	2	0.01 (3.14)	–0.56 (3.27) (b)	2	–0.14 (1.19)	I(0) with constant or around a trend
$\Delta M3R_a$	2	–0.00 (0.13)	0.38 (3.14)	–0.97 (4.21) (a)	2	0.01 (2.85)	–0.36 (2.67) (c)	3	–0.00 (0.03)	I(0) with constant or around a trend
$\Delta M3R_b$	2	0.00 (0.04)	0.35 (3.36)	–1.13 (4.72) (a)	2	0.01 (3.09)	–0.51 (3.03) (b)	2	–0.10 (0.89)	I(0) with constant or around a trend
$\Delta M3R_c$	2	0.00 (0.07)	0.35 (3.22)	–1.05 (4.46) (a)	2	0.01 (2.98)	–0.44 (2.86) (c)	3	–0.01 (0.09)	I(0) with constant or around a trend
ΔM2R	2	–0.01 (1.66)	0.35 (2.13)	–0.50 (2.66)	2	0.00 (1.08)	–0.18 (1.53)	2	–0.15 (1.31)	I(1)
ΔM1R	1	–0.01 (1.86)	0.55 (2.37)	–0.56 (2.92)	2	0.00 (1.00)	–0.20 (1.62)	2	–0.16 (1.38)	I(1)

(a) Coefficient significant at 1 %.
(b) Coefficient significant at 5 %.
(c) Coefficient significant at 10 %.

A.I.2. UNIT ROOT TEST (augmented Dickey-Fuller; $H_0 : \gamma = 0$)

$$\Delta x_t = \alpha + \beta t + \gamma x_{t-1} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} + \varepsilon_t$$

x	$\alpha \neq 0,\ \beta \neq 0$				$\alpha \neq 0,\ \beta = 0$			$\alpha = 0,\ \beta = 0$		*Degree of integration*
	p	α	β	γ	*p*	α	γ	*p*	γ	
$r^p(ALP_v)$	1	0.39 (2.47)	–0.00 (1.23)	–0.06 (2.02)	1	0.36 (2.32)	–0.06 (2.26)	1	0.00 (0.31)	I(1)
$r^p(ALP)$	1	0.40 (2.46)	–0.08 (1.05)	–0.06 (2.02)	1	0.39 (2.40)	–0.07 (2.33)	1	0.00 (0.40)	I(1)
$r^p(ALP2)$	1	0.40 (2.45)	–0.00 (0.86)	–0.06 (2.04)	1	0.40 (2.44)	–0.07 (2.37)	1	0.00 (0.38)	I(1)
$r^p(ALP_a)$	1	0.38 (2.43)	–0.00 (0.92)	–0.06 (2.10)	1	0.35 (2.31)	–0.06 (2.26)	1	0.00 (0.22)	I(1)
$r^p(M3)$	1	0.38 (2.46)	–0.00 (1.18)	–0.06 (2.07)	1	0.35 (2.29)	–0.06 (2.23)	1	0.00 (0.32)	I(1)
$r^p(M3_a)$	1	0.37 (2.42)	–0.00 (1.06)	–0.06 (2.08)	1	0.33 (2.24)	–0.06 (2.19)	1	0.00 (0.23)	I(1)
$r^p(M3_b)$	1	0.37 (2.42)	–0.00 (1.28)	–0.06 (2.07)	1	0.31 (2.14)	–0.06 (2.08)	1	0.00 (0.26)	I(1)
$r^p(M3_c)$	1	0.37 (2.42)	–0.00 (1.26)	–0.06 (2.08)	1	0.31 (2.14)	–0.06 (2.09)	1	0.00 (0.23)	I(1)
$r^p(M2)$	2	0.17 (1.54)	0.00 (1.69)	–0.12 (1.86)	2	0.17 (1.53)	–0.09 (1.45)	3	0.01 (0.91)	I(1) or I(2) (a)
$r^p(M1)$	4	–0.18 (2.38)	0.01 (2.14)	0.08 (2.14)	3	0.01 (0.12)	–0.03 (0.70)	3	0.03 (1.49)	I(1) or I(2) (a)
r^a (b)	4	2.25 (2.75)	–0.02 (2.16)	–0.16 (2.61)	4	1.01 (1.66)	–0.10 (1.73)	4	–0.00 (0.57)	I(1)
r^a (M2)	1	0.87 (2.61)	–0.01 (2.59)	–0.07 (2.32)	1	0.28 (1.08)	–0.03 (1.10)	1	–0.00 (0.25)	I(1)
r^a (M1)	1	0.58 (2.49)	–0.00 (2.10)	–0.06 (2.10)	1	0.37 (1.71)	–0.05 (1.69)	1	0.00 (0.08)	I(1)
ΔPIB	2	–0.00 (0.58)	0.19 (2.86)	–0.81 (3.93) (2)	2	0.00 (1.96)	–0.38 (2.51)	4	–0.06 (0.63)	I(1) or I(0) around a trend

(a) The unit root tests do not determine if the changes in these interests rates are variables I(1) or I(0).
(b) Alternative interest rate of broad aggregates (ALP's and M3's).
(1) Coefficient significant at 1 %.
(2) Coefficient significant at 5 %.
(3) Coefficient significant at 10 %.

APPENDIX II

ERROR CORRECTION MODELS FOR THE MONETARY AGGREGATES CONSIDERED (34)

This appendix presents the results of the linear estimate of the error correction models corresponding to the demand equations of the ten aggregates considered (estimates of expression [III.1] of the main text) for four different sample periods. The implied long-run solution is given for each model.

Definitions of the variables and symbols appearing in the tables are given below:

y:	log (real GDP).
P:	log (CPI).
r^p:	own interest rate.
r^a:	interest rate on marketable medium- and long-term public debt. For M1 and M2, the return on the assets in ALP not included in M1 and M2 respectively are also incorporated.
Q_1:	seasonal dummy variables, in deviations to fourth quarter.
$IC_{85.3}$:	variable with value one in 1985.III, value –1 in 1985.IV and zero in the remainder.
$I_{89.4}$:	variable with value one in 1989.IV and zero in the rest.
$s_{87.2}$:	variable with value zero until 1987.1 and value 1 from that date.

(34) The t-ratio for each parameter appears in brackets in the tables.

R^2: coefficient of determination.

σ_ε: standard deviation of equation errors.

Q(4): Box-Pierce-Ljung correlation statistic of fourth order in the residuals.

ARC(4): auto-regressive heteroscedasticity of fourth order.

B – J(2): Bera-Jarque normality test.

A.II.1. ALP_v DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(alp_v - p)_t = k + \alpha(alp_v - p)_{t-1} + \beta_1 y_{t-1} + \beta_2 r^p_{t-1} + \beta_4 \Delta p_t + \delta_1 \Delta y_t +$$

$$+ \delta_2 \sum_{i=1}^{2} \Delta r^p_{t-i} + \delta_3(\Delta r^a_{t-2} + \sum_{i=4}^{5} \Delta r^a_{t-i}) + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–2.09 (4.80)	–2.17 (5.11)	–1.95 (5.05)	–0.20 (0.57)
α	–0.28 (6.13)	–0.28 (4.75)	–0.27 (5.74)	–0.10 (1.83)
β_1	0.43 (5.52)	0.44 (5.47)	0.41 (5.42)	0.09 (1.17)
β_2	0.38 (3.00)	0.38 (2.89)	0.36 (2.79)	–0.15 (1.02)
β_4	–0.64 (7.85)	–0.62 (7.25)	–0.67 (9.39)	–0.88 (7.75)
δ_1	0.30 (4.00)	0.29 (3.62)	0.28 (3.61)	0.19 (1.39)
δ_2	1.36 (3.40)	1.22 (4.85)	1.05 (5.26)	1.21 (3.70)
δ_3	–0.34 (7.17)	–0.30 (6.43)	–0.27 (7.03)	–0.31 (4.85)
s_1	–0.42 (4.54)	–0.49 (5.35)	–0.46 (5.63)	–0.44 (3.31)
s_2	0.03 (0.33)	0.08 (1.02)	0.40 (0.55)	0.15 (1.13)
s_3	0.25 (3.40)	0.25 (3.43)	0.27 (7.03)	0.30 (2.63)
σ_ε (%)	0.24	0.26	0.25	0.45
R^2	0.96	0.95	0.95	0.85
Q(4)	6.71	3.07	2.73	4.35
ARC(4)	4.47	0.91	3.93	4.45
B – J(2)	0.76	1.73	1.29	1.68

UNDERLYING LONG-RUN RELATIONSHIP

$$alp_{v,t} = \gamma_0 p_t + \gamma_1 y_t + \gamma_2 r^p_t + \gamma_4 \Delta p_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
γ_0	1.00	1.00	1.00	1.00
γ_1	1.54	1.57	1.53	0.90
γ_2	1.36	1.36	1.33	–1.50
γ_4	–2.29	–2.21	–2.48	–8.80

A.II.2. ALP DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(alp - p)_t = k + \alpha(alp - p)_{t-1} + \beta_1 y_{t-1} + \beta_2 r^p_{t-1} + \beta_4 \Delta p_t + \delta_1 \Delta y_t +$$

$$+ \delta_2 \sum_{i=1}^{2} \Delta r^p_{t-i} + \delta_3(\Delta r^a_{t-2} + \sum_{i=4}^{5} \Delta r^a_{t-i}) + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–2.26 (4.29)	–2.35 (4.45)	–2.42 (4.87)	–0.82 (1.39)
α	–0.26 (5.17)	–0.26 (4.79)	–0.26 (4.91)	–0.13 (2.01)
β_1	0.44 (4.78)	0.45 (4.63)	0.46 (4.96)	0.19 (1.68)
β_2	0.28 (2.12)	0.29 (2.02)	0.28 (2.06)	–0.13 (0.76)
β_4	–0.63 (6.79)	–0.61 (6.04)	–0.58 (6.90)	–0.82 (7.30)
δ_1	0.31 (3.50)	0.30 (3.14)	0.30 (3.25)	0.28 (2.01)
δ_2	1.31 (2.76)	1.11 (3.60)	1.24 (5.48)	1.03 (3.27)
δ_3	–0.34 (6.12)	–0.28 (5.01)	–0.30 (6.53)	–0.30 (4.60)
s_1	–0.40 (3.80)	–0.48 (4.35)	–0.47 (5.01)	–0.34 (2.61)
s_2	0.05 (0.56)	0.13 (1.33)	0.14 (1.57)	0.15 (1.22)
s_3	0.22 (2.63)	0.21 (2.33)	0.19 (2.42)	0.19 (1.70)
σ_ε (%)	0.28	0.31	0.29	0.44
R^2	0.94	0.94	0.94	0.86
Q(4)	4.51	3.89	2.51	4.47
ARC(4)	1.77	3.25	4.07	8.07
B – J(2)	0.09	0.12	0.01	0.91

UNDERLYING LONG-RUN RELATIONSHIP

$$alp_t = \gamma_0 p_t + \gamma_1 y_t + \gamma_2 r^p_t + \gamma_4 \Delta p_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	1.69	1.73	1.77	1.46
γ_2	1.08	1.12	1.08	–1.00
γ_4	–2.42	–2.35	–2.23	–6.31

A.II.3. ALP2 DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(alp2 - p)_t = k + \alpha(alp2 - p)_{t-1} + \beta_1 y_{t-1} + \beta_2 r^p_{t-1} + \beta_4 \Delta p_t + \delta_1 \Delta y_t +$$

$$+ \delta_2 \sum_{i=1}^{2} \Delta r^p_{t-i} + \delta_3(\Delta r^a_{t-2} + \sum_{i=4}^{5} \Delta r^a_{t-i}) + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–2.48 (4.37)	–2.28 (4.29)	–2.56 (4.90)	–2.56 (4.54)
α	–0.25 (5.06)	–0.27 (5.10)	–0.28 (5.02)	–0.30 (4.90)
β_1	0.46 (4.76)	0.45 (4.66)	0.49 (5.02)	0.50 (4.73)
β_2	0.31 (2.34)	0.40 (2.83)	0.40 (2.65)	–0.39 (2.43)
β_4	–0.65 (6.77)	–0.66 (6.28)	–0.59 (6.08)	–0.71 (6.93)
δ_1	0.33 (3.68)	0.36 (3.54)	0.36 (3.34)	0.37 (2.94)
δ_2	1.06 (2.15)	0.10 (0.30)	0.61 (2.21)	0.51 (1.76)
δ_3	–0.31 (5.40)	–0.24 (4.56)	–0.32 (5.88)	–0.32 (5.36)
s_1	–0.38 (3.52)	–0.44 (3.82)	–0.43 (3.84)	–0.32 (2.71)
s_2	0.04 (0.46)	0.11 (1.11)	0.16 (1.61)	0.20 (1.77)
s_3	0.24 (2.69)	0.23 (2.56)	0.18 (1.90)	0.15 (1.46)
σ_ε (%)	0.28	0.32	0.34	0.40
R^2	0.94	0.92	0.92	0.88
Q(4)	5.75	3.81	3.45	5.06
ARC(4)	0.75	1.89	0.58	4.03
B – J(2)	0.05	0.25	0.64	0.39

UNDERLYING LONG-RUN RELATIONSHIP

$$alp2_t = \gamma_0 p_t + \gamma_1 y_t + \gamma_2 r^p_t + \gamma_4 \Delta p_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	1.84	1.67	1.75	1.67
γ_2	1.24	1.48	1.42	–1.30
γ_4	–2.60	–2.44	–2.11	–2.36

A.II.4. ALP_a DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(alp_a - p)_t = k + \alpha(alp_a - p)_{t-1} + \beta_1 y_{t-1} + \beta_4 \Delta p_t + \delta_2 \sum_{i=0}^{2} \Delta r^p_{t-i} +$$

$$+ \delta_3 \Delta_4 r^a_{t-1} + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + i_0 IC_{85.3} + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–1.16 (2.17)	–1.69 (3.92)	–1.48 (3.28)	–1.71 (3.26)
α	–0.14 (3.13)	–0.14 (3.03)	–0.14 (2.95)	–0.18 (3.45)
β_1	0.23 (2.70)	0.29 (3.76)	0.27 (3.25)	0.32 (3.39)
β_4	–0.68 (4.44)	–0.59 (3.99)	–0.75 (5.93)	–0.80 (5.72)
δ_2	0.68 (1.85)	1.03 (3.72)	1.03 (3.94)	1.04 (3.48)
δ_3	–0.15 (2.12)	–0.12 (1.80)	–0.08 (1.23)	–0.10 (1.30)
s_1	–0.69 (3.96)	–0.81 (4.95)	–0.65 (4.27)	–0.60 (3.66)
s_2	–0.15 (1.04)	–0.09 (0.69)	–0.09 (0.67)	–0.05 (0.28)
s_3	0.70 (5.15)	0.70 (5.33)	0.67 (4.98)	0.73 (4.80)
i_0	–1.35 (3.71)	–1.25 (3.46)	–1.40 (3.61)	–1.51 (3.30)
σ_ε (%)	0.44	0.44	0.48	0.58
R^2	0.87	0.90	0.88	0.83
Q(4)	2.82	3.84	1.53	3.81
ARC(4)	8.40	1.90	2.56	9.52
B – J(2)	0.67	0.55	1.18	0.04

UNDERLYING LONG-RUN RELATIONSHIP

$$alp_{a_t} = \gamma_0 p_t + \gamma_1 y_t + \gamma_4 \Delta p_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	1.64	2.07	1.93	1.78
γ_4	–4.86	–4.21	–5.35	–4.44

A.II.5. M3 DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(m3 - p)_t = k + \alpha(m3 - p)_{t-1} + \beta_1 y_{t-1} + \beta_4 \Delta p_t + \delta_2 \sum_{i=1}^{2} r^p_{t-1} + \delta_3(\Delta r^a_{t-2} +$$

$$+ \Delta r^a_{t-4}) + h_1 \Delta m3_{t-1} + h_2 \Delta m3_{t-4} + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–0.42 (0.94)	–0.36 (1.33)	–0.65 (3.11)	–0.86 (3.56)
α	–0.14 (4.11)	–0.14 (3.69)	–0.15 (3.93)	–0.19 (4.50)
β_1	0.14 (2.21)	0.14 (2.75)	0.17 (3.78)	0.23 (4.16)
β_4	–0.81 (6.89)	–0.84 (6.39)	–0.74 (6.70)	0.76 (6.07)
δ_2	1.20 (2.15)	0.84 (2.05)	1.05 (2.86)	1.46 (3.73)
δ_3	–0.29 (3.27)	–0.22 (2.27)	–0.29 (3.17)	–0.37 (3.41)
h_1	0.33 (2.39)	0.20 (1.33)	0.28 (2.18)	0.05 (0.40)
h_2	–0.35 (2.42)	–0.20 (1.36)	–0.22 (1.57)	–0.12 (0.93)
s_1	–0.69 (4.26)	–0.63 (3.74)	–0.68 (4.29)	–0.56 (3.36)
s_2	0.11 (0.79)	0.14 (0.93)	0.20 (1.54)	0.17 (1.09)
s_3	0.70 (4.87)	0.54 (3.82)	0.54 (3.98)	0.48 (3.19)
σ_ε (%)	0.35	0.42	0.42	0.52
R^2	0.92	0.88	0.88	0.82
Q(4)	5.10	6.67	3.78	4.96
ARC(4)	6.03	5.09	5.38	6.80
B – J(2)	0.67	0.34	0.68	0.66

UNDERLYING LONG-RUN RELATIONSHIP

$$m3_t = \gamma_0 p_t + \gamma_1 y_t + \gamma_4 \Delta p_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	1.00	1.00	1.13	1.21
γ_4	–5.79	–6.00	–4.93	–4.00

A.II.6. $M3_a$ DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(m3_a - p)_t = k + \alpha(m3_a - p)_{t-1} + \beta_1 y_{t-1} + \beta_4 \Delta p_t + \delta_2 \Delta r^p_{t-1} +$$
$$+ \delta_3 \Delta_4 r^a_{t-1} + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + i_0 IC_{85.3} + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–1.16 (1.74)	–1.54 (3.57)	–1.45 (3.79)	–1.63 (3.74)
α	–0.15 (3.14)	–0.16 (3.37)	–0.15 (3.45)	–0.19 (3.89)
β_1	0.24 (2.31)	0.29 (3.66)	0.27 (3.75)	0.32 (3.86)
β_4	–0.63 (3.40)	–0.55 (3.65)	–0.60 (5.44)	–0.68 (5.90)
δ_2	1.07 (1.03)	1.49 (2.40)	1.56 (2.97)	1.90 (3.44)
δ_3	–0.13 (1.77)	–0.11 (1.73)	–0.10 (1.76)	–0.14 (2.19)
s_1	–0.73 (3.79)	–0.81 (4.94)	–0.74 (5.39)	–0.67 (9.71)
s_2	–0.12 (0.78)	–0.05 (0.35)	–0.05 (0.41)	–0.00 (0.07)
s_3	0.68 (4.83)	0.66 (5.01)	0.65 (5.35)	0.64 (4.85)
i_0	–1.19 (3.06)	–1.08 (3.05)	–1.14 (3.38)	–1.24 (3.19)
σ_ε (%)	0.46	0.45	0.43	0.51
R^2	0.86	0.88	0.88	0.85
Q(4)	4.40	2.36	2.47	4.98
ARC(4)	4.96	4.06	3.90	5.09
B – J(2)	0.83	0.74	0.84	0.46

UNDERLYING LONG-RUN RELATIONSHIP

$$m3_{a_t} = \gamma_0 p_t + \gamma_1 y_t + \gamma_4 \Delta p_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	1.60	1.81	1.80	1.68
γ_4	–4.20	–3.44	–4.00	–3.58

A.II.7. $M3_b$ DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(m3_b - p)_t = k + \alpha(m3_b - p)_{t-1} + \beta_1 y_{t-1} + \beta_4 \Delta p_t + \delta_1 \Delta y_t + \delta_2 \sum_{i=0}^{2} \Delta r^p_{t-i} + $$
$$+ \delta_3 \sum_{i=2}^{4} \Delta r^a_{t-i} + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + i_0 IC_{85.3} + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–1.04 (2.21)	–0.62 (1.91)	–0.73 (3.07)	–0.86 (2.90)
α	–0.18 (4.11)	–0.18 (4.03)	–0.18 (4.28)	–0.18 (3.52)
β_1	0.24 (3.18)	0.19 (3.03)	0.20 (3.83)	0.22 (3.29)
β_4	–0.67 (4.47)	–0.70 (4.71)	–0.66 (5.53)	–0.63 (4.32)
δ_1	0.25 (2.04)	0.26 (2.07)	0.27 (2.23)	0.26 (1.67)
δ_2	1.00 (2.56)	0.48 (1.75)	0.59 (2.66)	0.91 (3.37)
δ_3	–0.20 (2.66)	–0.18 (2.55)	–0.19 (3.35)	–0.23 (3.24)
s_1	–0.66 (3.95)	–0.67 (4.20)	–0.67 (4.81)	–0.73 (4.47)
s_2	–0.20 (1.45)	–0.09 (0.72)	–0.07 (0.60)	0.04 (0.26)
s_3	0.64 (4.84)	0.60 (4.62)	0.60 (5.03)	0.66 (4.41)
i_0	–0.76 (2.23)	–0.75 (2.15)	–0.77 (2.30)	–0.87 (2.00)
σ_ε (%)	0.42	0.43	0.42	0.56
R^2	0.89	0.88	0.88	0.81
Q(4)	1.93	1.10	1.25	5.12
ARC(4)	3.52	5.33	5.50	7.30
B – J(2)	0.39	1.01	1.48	1.53

UNDERLYING LONG-RUN RELATIONSHIP

$$m3_{b_t} = \gamma_0 p_t + \gamma_1 y_t + \gamma_4 \Delta p_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	1.33	1.06	1.11	1.22
γ_4	–3.72	–3.89	–3.67	–3.50

A.II.8. $M3_c$ DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(m3_c - p)_t = k + \alpha(m3_c - p)_{t-1} + \beta_1 y_{t-1} + \beta_4 \Delta p_t + \delta_1 \Delta y_t + \delta_2 \Delta^2 r^p_{t-2} +$$

$$+ \delta_3 \sum_{i=2}^{4} \Delta r^a_{t-i} + s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + i_0 IC_{85.3} + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
k	–0.58 (1.05)	–0.85 (1.91)	–1.91 (2.63)	–1.24 (3.16)
α	–0.15 (2.67)	–0.16 (2.95)	–0.16 (3.28)	–0.19 (3.35)
β_1	0.16 (1.72)	0.20 (2.43)	0.21 (3.00)	0.27 (3.31)
β_4	–0.60 (3.34)	–0.58 (3.48)	–0.58 (4.46)	0.54 (3.65)
δ_1	1.28 (1.86)	0.28 (1.87)	0.29 (2.05)	0.22 (1.31)
δ_2	0.70 (0.90)	0.23 (0.43)	0.41 (0.83)	1.22 (2.23)
δ_3	–0.18 (2.13)	–0.14 (2.20)	–0.13 (2.34)	–0.16 (2.28)
s_1	–0.74 (3.70)	–0.80 (4.38)	–0.76 (4.83)	–0.77 (4.45)
s_2	–0.17 (1.03)	–0.13 (0.81)	–0.10 (0.70)	–0.03 (0.18)
s_3	0.66 (4.03)	0.71 (4.76)	0.69 (5.08)	0.71 (4.42)
i_0	–0.96 (2.33)	–0.90 (2.28)	–0.94 (2.53)	–1.03 (2.27)
σ_ε (%)	0.50	0.49	0.48	0.60
R^2	0.85	0.86	0.85	0.79
Q(4)	1.97	1.52	0.70	2.01
ARC(4)	0.17	3.45	4.97	6.94
B – J(2)	0.52	0.87	1.37	1.04

UNDERLYING LONG-RUN RELATIONSHIP

$$m3_{c_t} = \gamma_0 p_t + \gamma_1 y_t + \gamma_4 \Delta p_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	1.07	1.25	1.31	1.42
γ_4	–4.00	–3.63	–3.63	–2.84

A.II.9. M2 DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(m2-p)_t = \alpha(m2-p)_{t-1} + \beta_1 y_{t-1} + \beta_2 r^p_{t-1} + \beta_3 r^a_{t-1} + h_1\Delta(m2-p)_{t-1} +$$

$$+ h_2\Delta(m2-p)_{t-2} + \delta_2\Delta r^p_t + \delta_3(\Delta r^a_t S_{87.2}) + \delta_{40}\Delta^2 p_t + \delta_4\sum_{i=1}^{2}\Delta^2 p_{t-i} +$$

$$+ s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + i_0 I_{89.4} + \varepsilon_t$$

	78.III-87.II	*78.III-88.II*	*78.III-89.II*	*78.III-90.IV*
α	–0.05 (2.98)	–0.06 (3.32)	–0.07 (3.6)	–0.07 (3.71)
β_1	0.03 (3.04)	0.04 (3.46)	0.04 (3.63)	0.04 (3.97)
β_2			0.93 (2.79)	0.56 (2.35)
β_3	–0.92 (2.46)	–0.49 (3.03)	–0.53 (2.96)	–0.63 (3.76)
h_1	0.61 (3.91)	0.60 (3.96)	0.47 (3.08)	0.33 (2.38)
h_2	–0.27 (1.98)	–0.23 (1.76)	–0.25 (1.88)	–0.24 (1.79)
δ_2			–0.90 (0.56)	1.78 (1.66)
δ_3	–2.56 (1.18)	–2.22 (2.46)	–1.24 (1.44)	–1.83 (1.96)
δ_{40}	–1.02 (4.92)	–1.00 (4.84)	–0.90 (4.53)	–0.85 (3.86)
δ_4	–0.35 (1.93)	–0.33 (1.90)	–0.34 (1.99)	–0.38 (1.96)
s_1	–1.87 (5.45)	–1.93 (5.65)	–1.75 (4.53)	–1.74 (5.06)
s_2	1.59 (3.17)	1.48 (3.27)	1.14 (2.49)	0.83 (2.00)
s_3	1.15 (2.34)	1.32 (2.79)	1.29 (2.68)	1.26 (2.52)
i_0				–2.72 (2.83)
σ_ε (%)	0.65	0.66	0.68	0.77
R^2	0.94	0.94	0.94	0.93
Q(4)	2.56	1.96	2.62	6.00
ARC(4)	12.30	17.00	17.10	20.90

UNDERLYING LONG-RUN RELATIONSHIP

$$m2_t = \gamma_0 p_t + \gamma_1 y_t + \gamma_2 r^p_t + \gamma_3 r^a_t$$

γ_0	1.00	1.00	1.00	1.00
γ_1	0.63	0.64	0.63	0.63
γ_2			13.85	8.00
γ_3	–7.44	–8.50	–8.15	8.99

A.II.10. M1 DEMAND EQUATION
Linear estimation

ERROR CORRECTION MODEL

$$\Delta(m1-p)_t = \alpha(m1-p)_{t-1} + \beta_1 y_{t-1} + \beta_2 r^p_{t-1} + \beta_3 r^a_{t-1} +$$

$$+ h_1\Delta(m1-p)_{t-1} + \delta_2\Delta r^p_t + \delta_3(\Delta r^a_t S_{87.2}) + \delta_4 \sum_{i=0}^{1} \Delta^2 p_{t-i} +$$

$$+ s_1 Q1_t + s_2 Q2_t + s_3 Q3_t + i_0 I_{89.4} + \varepsilon_t$$

	78.III-87.II		78.III-88.II		78.III-89.II		78.III-90.IV	
α	–0.09	(2.95)	–0.10	(3.45)	–0.11	(3.52)	–0.10	(3.57)
β_1	0.05	(2.95)	0.06	(3.54)	0.06	(3.47)	0.06	(3.71)
β_2					1.69	(3.04)	1.16	(2.95)
β_3	–0.71	(2.36)	–0.93	(3.26)	–0.89	(2.84)	–0.87	(3.37)
h_1	0.41	(2.82)	0.46	(3.38)	0.30	(2.19)	0.22	(1.80)
δ_2					–0.11	(0.04)	4.94	(3.48)
δ_3	–0.93	(0.22)	–4.32	(2.10)	–2.01	(1.10)	–3.27	(1.82)
δ_4	–0.55	(2.66)	–0.55	(2.61)	–0.60	(3.03)	–0.60	(2.87)
s_1	4.38	(10.53)	–4.38	(11.24)	–3.91	(11.12)	–3.80	(11.43)
s_2	3.09	(4.16)	3.26	(4.92)	2.51	(3.84)	2.28	(1.35)
s_3	0.17	(0.41)	0.20	(0.50)	0.47	(1.18)	0.54	(1.35)
i_0							–3.14	(2.36)
σ_ε (%)	1.07		1.11		1.12		1.21	
R^2	0.90		0.90		0.90		0.90	
Q(4)	6.22		9.78		6.05		1.88	
ARC(4)	15.30		17.70		18.30		24.80	

UNDERLYING LONG-RUN RELATIONSHIP

$$m1_t = \gamma_0 p_t + \gamma_1 y_t + \gamma_2 r^p_t + \gamma_3 r^a_t$$

	78.III-87.II	78.III-88.II	78.III-89.II	78.III-90.IV
γ_0	1.00	1.00	1.00	1.00
γ_1	0.55	0.55	0.53	0.53
γ_2			15.36	11.26
γ_3	–7.98	–8.94	–8.09	–8.45

APPENDIX III

STABILITY TESTS ON THE MONEY DEMAND EQUATIONS

Charts A.III.1 to A.III.10 show three indicators for each aggregate considered:

A) The residuals of the equation estimated for the 1978.III-1989 sample normalized by their standard deviation.

B) Stability tests one period in advance, obtained recursively and normalized with respect to the critical value corresponding to an F (1, t – k) to a level of significance of 5 %

$$F_{1,\, t-k} = \frac{RSS_{t+1} - RSS_t}{RSS_t}(t-k); \qquad t = t_1, \ldots, T-1$$

where: t_1 = initial sample period, T = total sampling period and RSS_n = sum of squares of the residuals of the first n observations.

This test detects point instabilities within the considered sample period.

C) Stability tests of variable time-span, obtained recursively by successive incorporation of observations to the evaluation period of the stability of the model. The values obtained appear normalized with respect to the critical value of an F (j, t_1 – k), corresponding to a level of significance of 5 %.

$$F_{j,\, t_1-k} = \frac{RSS_{t_1+j} - RSS_{t_1}}{RSS_{t_1}} \frac{t_1-k}{j}; \qquad j = 1, \ldots, T - t_1$$

The evaluation of the stability of a model by the recursive calculation of this test is particularly suitable for detecting persistent instabilities which indicate the existence of structural changes.

Finally, Table A.III.1 gives the prediction errors one period in advance, obtained with the demand equations of the aggregates taken for the eight quarters of the 1989.III-1991.II period. Table A.III.2 gives the “t” statistics associated with each of the prediction errors in Table A.III.1.

A.III.1. ALP_V DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.2. ALP DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.3. ALP2 DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.4. ALP_a DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.5. M3 DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.6. $M3_a$ DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.7. $M3_b$ DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.8. $M3_c$ DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.9. M2 DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.10. M1 DEMAND EQUATION

A. Standardized residuals

B. One-step ahead recursive stability tests

C. Stability test adding successive observations

A.III.1. RECURSIVE PREDICTION ERRORS

	1989.III	*1989.IV*	*1990.I*	*1990.II*	*1990.III*	*1990.IV*	*1991.I*	*1991.II*	*Suma*
ALP_V	–1.24	–2.50	–2.43	–0.93	–2.27	–2.29	–0.02	–1.15	–12.83
ALP2	–0.74	–1.35	–0.29	0.58	–0.96	–0.82	0.65	–0.18	–3.11
ALP	–0.97	–1.69	–1.28	–0.96	–2.54	–2.43	–0.39	–1.28	–11.54
ALP_a	1.02	–1.88	–0.51	0.46	–1.20	–0.74	1.33	0.97	–0.55
M3	1.31	–1.05	1.46	1.70	–0.17	–0.47	1.73	1.75	6.26
$M3_a$	0.41	–1.42	–0.34	1.01	–1.17	–0.75	0.89	0.94	–0.43
$M3_b$	1.25	–1.26	0.11	2.13	0.36	0.78	2.22	2.36	7.95
$M3_c$	0.81	–1.53	0.28	2.24	0.34	0.63	2.21	2.06	7.04
M2	–0.83	–2.33	0.29	2.83	–2.70	–1.00	–0.18	–3.40	–8.32
M1	–0.74	–2.04	1.31	5.16	–2.38	–1.90	1.01	–3.73	–3.22

A.III.2. T STATISTICS

	1989.III	*1989.IV*	*1990.I*	*1990.II*	*1990.III*	*1990.IV*	*1991.I*	*1991.II*
ALP_V	–3.79	–7.73	–6.31	–2.20	–5.37	–5.19	–0.03	–2.96
ALP2	–1.64	–3.24	–0.68	1.31	–1.98	–1.75	1.45	–0.40
ALP	–2.55	–4.75	–3.39	–2.43	–6.07	–5.61	–0.91	–3.17
ALP_a	1.68	–3.14	–0.90	0.79	–1.84	–1.14	2.18	1.42
M3	2.55	–1.91	2.64	3.36	–0.29	–0.83	3.29	2.83
$M3_a$	0.76	–2.62	–0.67	1.94	–2.02	–2.31	1.70	1.68
$M3_b$	2.38	–2.44	0.22	4.00	0.63	1.37	7.45	4.12
$M3_c$	1.37	–2.61	0.48	3.70	0.55	1.01	3.68	3.28
M2	–0.95	–2.48	0.28	1.76	–2.10	–0.74	–0.14	–2.20
M1	–0.52	–1.30	0.80	1.93	–1.14	–0.91	0.45	–1.48

APPENDIX IV

BREAKDOWN OF VELOCITY OF CIRCULATION OF THE MONETARY AGGREGATES

This appendix reformulates the money demand equations in terms of velocity of circulation to obtain the effect of each variable on the trend of this ratio. This is based on expression [II.3] in the main text, rewritten in terms of the inverse of the velocity (in logarithms):

$$\Delta(m - p - y)_t = k + \alpha[m - p - \gamma_1 y - \gamma_2 r^p - \gamma_3 r^a - \gamma_4 \pi]_{t-1} +$$

$$+ [\delta_1(L) - 1]\Delta y_t + \delta_2(L)\Delta r_t^p + \delta_3(L)\Delta r_t^a + \delta_4(L)\Delta^2 p_t + \varepsilon_t$$

Finding $(m - p - y)_t$ and applying fourth-order differences (Δ_4) on both sides of the equation, thus cancelling out most of the seasonal trend, gives:

$$\Delta_4(m - p - y)_t = (1 + \alpha)\Delta_4(m - p - y)_{t-1} + \alpha(1 - \gamma_1)\Delta_4 y_{t-1} +$$

$$+ [\delta_1(L) - 1]\Delta_4\Delta y_t - \alpha[\gamma_2\Delta_4 r^p + \gamma_3\Delta_4 r^a + \gamma_4\Delta_4\pi]_{t-1} +$$

$$+ \delta_2(L)\Delta_4\Delta r_t^p + \delta_3(L)\Delta_4\Delta r_t^a + \delta_4(L)\Delta_4\Delta^2 p_t + \Delta_4\varepsilon_t$$

or:

$$\Delta_4 v_t^H = \frac{g_1(L)}{h(L)}\Delta_4 y_t + \frac{g_2(L)}{h(L)}\Delta_4 r^p + \frac{g_3(L)}{h(L)}\Delta_4 r^a + \frac{g_4(L)}{h(L)}\Delta_4\pi_t + \frac{1}{h(L)}\Delta_4\varepsilon_t \quad \text{[A.IV.1]}$$

where:

$v^H = (m - p - y)$

$h(L) = 1 - (1 + \alpha)L$

$g_1(L) = [\delta_1(L) - 1]\Delta + \alpha(1 - \gamma_1)L$

$g_2(L) = \delta_2(L)\Delta - \alpha\gamma_2 L$

$g_3(L) = \delta_3(L)\Delta - \alpha\gamma_3 L$

$g_4(L) = \delta_4(L)\Delta - \alpha\gamma_4 L$

Expression [A.IV.1] explains the year-on-year changes in the inverse of the velocity based on the effect of each of the variables occurring in the demand for real balances. The trend in the velocity in terms of changes in the annual mean can also be obtained by aggregating [A.IV.1] every four periods (35). Tables A.IV.1 to A.IV.5 give the mean changes in velocity (p + y – m), and the effect of the arguments of the money demand function for aggregates: ALP, ALP2, $M3_a$, M2 and M1.

(35) When this aggregation is made, an accumulation of errors also occurs which can occasionally cause a significant discrepancy between the change observed in the velocity and the change explained by the equations.

A.IV.1. BREAKDOWN OF THE GROWTH RATE OF THE VELOCITY OF CIRCULATION OF ALP ACCORDING TO THE ARGUMENTS OF ITS DEMAND FUNCTION

	ALP velocity rate	*Explained by demand*	*Unexplained*	*Income effect (a)*	*Inflation effect (b)*	*Interest rate effect*	*Own rate effect*	*Altern. rate effect*
	1=2+3	2=4+5+6	3	4	5	6=7+8	7	8
1982	–2.04	–1.70	–0.33	0.29	–0.23	–1.76	–0.48	–1.28
1983	–1.20	–1.96	0.77	–0.65	–0.79	–0.52	–0.22	–0.31
1984	–1.68	–1.15	–0.53	–0.63	–0.63	0.11	–0.11	0.22
1985	–2.62	–2.64	0.02	–1.67	–1.05	0.08	1.20	–1.12
1986	–0.77	–1.07	0.30	–1.36	–0.24	0.53	1.34	–0.81
1987	–2.28	–2.30	0.02	–1.59	–1.45	0.74	0.58	0.16
1988	–3.56	–3.44	–0.12	–3.78	–0.46	0.80	–0.42	1.22
1989	–3.57	–4.05	0.48	–3.77	0.57	–0.85	–0.57	–0.28
1990	–0.92	–4.53	3.61	–4.28	0.09	–0.34	–1.18	0.84
1991 (p)	–3.13	–3.76	0.63	–3.23	–0.29	–0.25	0.01	–0.26

(a) Subsumes the effect of a long-run income elasticity greater than one (1.77) and the dynamic adjustment of the nominal balances to changes in income.
(b) Subsumes the effect of the inflation rate and the dynamic adjustment of the nominal balances to changes in the price level.
(p) Estimate made in accordance with the monetary policy hypotheses for 1992.

A.IV.2. BREAKDOWN OF THE GROWTH RATE OF THE VELOCITY OF CIRCULATION OF ALP2 ACCORDING TO THE ARGUMENTS OF ITS DEMAND FUNCTION

	ALP velocity rate	*Explained by demand*	*Unexplained*	*Income effect* (a)	*Inflation effect* (b)	*Interest rate effect*	*Own rate effect*	*Altern. rate effect*
	1=2+3	2=4+5+6	3	4	5	6=7+8	7	8
1982	–2.04	–1.99	–0.04	0.25	–0.21	–2.03	0.71	–1.32
1983	–1.50	–2.23	0.73	–0.72	–0.77	–0.75	–0.48	–0.27
1984	–2.35	–1.37	–0.98	–0.65	–0.59	–0.13	–0.38	0.25
1985	–2.98	–3.21	0.23	–1.69	–1.01	–0.51	0.65	–1.16
1986	–1.13	–1.32	–0.20	–1.41	–0.19	0.28	1.06	–0.78
1987	–2.19	–2.21	0.02	–1.71	–1.42	–0.92	–0.72	0.20
1988	–2.40	–2.86	0.46	–3.78	–0.40	1.31	0.06	1.25
1989	–3.96	–3.65	–0.31	–3.67	0.58	–0.56	–0.23	0.33
1990	–3.17	–4.12	0.94	–4.10	0.07	–0.09	–0.94	0.85
1991 (p)	–4.60	–3.97	–0.63	–3.01	–0.29	–0.67	–0.37	–0.30

(a) Subsumes the effect of a long-run income elasticity greater than one (1.75) and the dynamic adjustment of the nominal balances to changes in income.

(b) Subsumes the effect of the inflation rate and the dynamic adjustment of the nominal balances to changes in the price level.

(p) Estimate made in accordance with the monetary policy hypotheses for 1992.

A.IV.3. BREAKDOWN OF THE GROWTH RATE OF THE VELOCITY OF CIRCULATION OF $M3_a$ ACCORDING TO THE ARGUMENTS OF ITS DEMAND FUNCTION

	$M3_a$ velocity rate	*Explained by demand*	*Unexplained*	*Income effect* (a)	*Inflation effect* (b)	*Interest rate effect*	*Own rate effect*	*Altern. rate effect*
	1=2+3	2=4+5+6	3	4	5	6=7+8	7	8
1982	–1.93	–0.80	–1.13	0.26	–0.58	–0.48	0.07	–0.55
1983	–0.03	–1.23	1.20	–0.12	–1.24	0.13	0.30	–0.17
1984	–0.83	–0.91	0.08	–0.25	–1.03	0.37	0.34	0.03
1985	–2.10	–2.50	0.40	–0.98	–1.56	0.04	0.85	–0.81
1986	–1.04	–0.42	–0.63	–0.52	–0.73	0.83	1.20	–0.36
1987	–2.37	–2.31	–0.07	–0.12	–2.02	–0.17	–0.22	0.05
1988	–3.86	–3.79	–0.08	–2.57	–1.12	–0.09	–0.65	0.55
1989	–3.59	–3.60	0.01	–3.31	0.31	–0.60	–0.62	0.03
1990	–3.83	–4.77	0.94	–4.44	0.09	–0.42	–0.79	0.37
1991 (p)	–5.53	–4.29	–1.24	–4.07	–0.32	0.09	0.27	–0.18
1992 (p)	–2.70	–2.45	–0.24	–2.68	–0.35	0.57	1.21	–0.63

(a) Subsumes the effect of a long-run income elasticity greater than one (1.80) and the dynamic adjustment of the nominal balances to changes in income.
(b) Subsumes the effect of the inflation rate and the dynamic adjustment of the nominal balances to changes in the price level.
(p) Estimate made in accordance with the monetary policy hypotheses for 1992.

A.IV.4. BREAKDOWN OF THE GROWTH RATE OF THE VELOCITY OF CIRCULATION OF M2 ACCORDING TO THE ARGUMENTS OF ITS DEMAND FUNCTION

	M2 velocity rate	*Explained by demand*	*Unexplained*	*Income effect (a)*	*Inflation effect (b)*	*Interest rate effect*	*Own rate effect*	*Altern. rate effect*
	1=2+3	2=4+5+6	3	4	5	6=7+8	7	8
1982	3.39	7.83	–4.44	0.46	0.25	7.12	–0.24	7.35
1983	5.98	5.77	0.21	0.93	–0.43	5.26	–0.54	5.80
1984	5.73	4.96	0.77	0.90	–0.15	4.22	–0.03	4.25
1985	1.33	1.26	0.07	1.22	–0.41	0.45	0.08	0.37
1986	–1.70	–0.35	–1.35	2.33	0.87	–3.55	0.15	–3.70
1987	–0.03	–4.14	4.11	3.84	–1.12	–6.86	–0.44	–6.42
1988	–4.52	–2.29	–2.23	2.95	0.86	–6.11	–0.36	–5.74
1989	–2.32	–1.40	–0.91	2.32	0.91	–4.63	–1.68	–2.95
1990	–3.38	–5.32	1.95	0.97	–0.08	–6.22	–5.60	–0.62
1991 (p)	–6.14	–9.96	3.82	0.21	–0.21	–9.97	–9.07	–0.90

(a) Subsumes the effect of a long-run income elasticity greater than one (0.63) and the dynamic adjustment of the nominal balances to changes in income.
(b) Subsumes the effect of the inflation rate and the dynamic adjustment of the nominal balances to changes in the price level.
(p) Estimate made in accordance with the monetary policy hypotheses for 1992.

A.IV.5. BREAKDOWN OF THE GROWTH RATE OF THE VELOCITY OF CIRCULATION OF M1 ACCORDING TO THE ARGUMENTS OF ITS DEMAND FUNCTION

	M1 velocity rate	*Explained by demand*	*Unexplained*	*Income effect* (a)	*Inflation effect* (b)	*Interest rate effect*	*Own rate effect*	*Altern. rate effect*
	1=2+3	2=4+5+6	3	4	5	6=7+8	7	8
1982	2.30	6.80	–4.50	0.84	0.26	5.70	0.02	5.68
1983	8.81	5.52	3.29	1.18	–0.44	4.79	0.19	4.60
1984	5.95	4.83	1.12	1.15	0.12	3.55	0.24	3.31
1985	1.48	1.29	0.19	1.33	–0.48	0.43	0.08	0.35
1986	–3.19	0.16	–3.35	2.33	0.81	–2.98	0.02	–3.00
1987	–1.52	–5.11	3.59	3.83	–1.03	–7.92	–2.58	–5.34
1988	–8.20	–5.58	–2.62	2.90	0.85	–9.33	–4.52	–4.81
1989	–4.69	0.71	–3.99	2.32	0.80	–3.83	–3.35	–0.49
1990	–9.49	–6.82	–2.67	1.17	–0.21	–7.78	–9.53	1.76
1991 (p)	–9.73	–8.97	–0.76	0.49	–0.25	–9.21	–11.53	2.32

(a) Subsumes the effect of a long-run income elasticity greater than one (0,53) and the dynamic adjustment of the nominal balances to changes in income.

(b) Subsumes the effect of the inflation rate and the dynamic adjustment of the nominal balances to changes in the price level.

(p) Estimate made in accordance with the monetary policy hypotheses for 1992.