BANCO DE ESPAÑA

A STUDY OF THE CHANGE IN THE INSTRUMENTAL VARIABLE OF THE MONETARY CONTROL OUTLINE IN SPAIN

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CONTENTS

A STUDY OF THE CHANGE IN THE INSTRUMENTAL VARIABLE OF THE MONETARY CONTROL OUTLINE IN SPAIN

1. Introduction

Over the last two decades central banks have played an increasingly more prominent role in regulating the high-powered money of the system and in managing interest rates. As a result, the treatment of these institutions when formulating models of the economy's monetary sector is of particular significance. In this respect, both the modelling of the behaviour of monetary authorities and their reaction mechanisms and the specification of the channels of influence their decisions take in the financial system as a whole are particularly relevant.

This research is part of a wider project to construct an econometric model for the Spanish economy's monetary sector. It analyses the behaviour of the Bank of Spain from the standpoint of the obtaining of functional forms which summarise appropriately its monetary policy conduct.

As its starting point, the paper takes the research by Mauleón, Pérez and Sanz (1986). This justified the formulation and use of a series of adjusted banking-system reserves as the most suitable summary variable of Bank of Spain actions aimed at controlling the monetary aggregates. Also, it estimated money-supply and liquidity-creation equations for the 1974-1983 period[1]. These equations depicted schematically the control exerted by the Bank of Spain on the supply of bank reserves in terms of specific targeted growth rates for a money supply aggregate and expected developments in the series of factors governing the relationship between both variables. This multiplier relationship between the instrumental variable (bank reserves) and the money supply variable acting as the intermediate target of monetary policy (M3 to 1983, liquid assets held by the public -ALP- thereafter) is thus the basic magnitude reflecting the decisions of the monetary authorities.

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[1] Other subsequent estimations related to the money multipliers in Spain can be found in Novales (1987) and Escrivá, Espasa, Pérez and Salaverría (1987).

This conception of the money creation process has sound theoretical foundations in the various models developed since the mid-sixties by K. Brunner and A. Metzler[2]. Following these were different empirical tests such as those by Frost (1977) and, more recently, Rasche and Johannes (1987 - for the case of the United States) and Von Hagen (1988, 1990 - for the case of Germany).

However, it is difficult with this approach to integrate various phenomena which have emerged increasingly in recent years and which have introduced a sizable and ever-greater component of endogenicity into the behaviour of bank reserves[3], outside the scope of the monetary authorities' decisions. Specifically, couching the liquidity-creation process in terms of multiplier equations makes it difficult to incorporate supply factors which may be pivotal in determining the money supply.

First, reference should be made to factors which influence the creation of the monetary base and which, once of a certain size, prompt a switch in the choice of the instrumental target towards the interest rate. In this connection, continuous, intense growth of the budget deficit is a good example, especially if it is financed unorthodoxly. It must also be borne in mind that intense disturbances are frequently recorded in the credit and foreign markets, the nature of which is not readily identifiable, at least not in the short run. These disturbances would require marked alterations to be made to interest rates, and high volatility thereof, if it were sought to ensure specific growth rates for bank reserves.

Second, there is a series of factors which prompts feedback in the money-creation process by means of changes in agents' behaviour that are mirrored by changes in the money multiplier. It must be borne in mind that the control of the monetary base frequently entails substantial changes to the level of interest rates. This, not usually explicit in multiplier models,

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[2] A compilation of the main work by these authors can be found in Brunner and Metzler (1989), and a conspectus of their view of the money supply is given in Brunner and Metzler (1990).

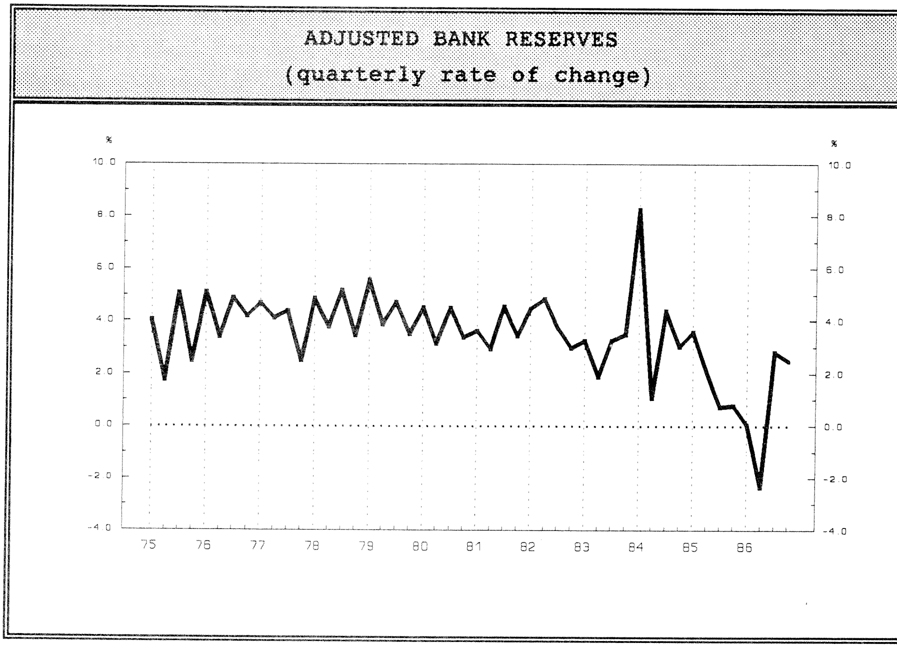
[3] As long ago as the early eighties, Charles Goodhart (1984) had shown the difficulties in applying an analysis of the money supply based on the money multipliers to the British case.

tends to prompt a response by private and public agents and financial intermediaries, whose decisions take the form of portfolio adjustments in response to relative price changes. Feedback in the liquidity-creation process thus occurs, and the fundamental parameters defining this portfolio-adjustment process therefore bear on the determination of the money supply. Noteworthy among these parameters, inter alia, is the elasticity of substitution between foreign and domestic assets and the elasticity of the demand for credit in relation to interest rates.

In the case of Spain, all these phenomena have increased notably in significance during the second half of the eighties. Accordingly, the first question this paper will address is whether the liquidity-creation equations of the type estimated by Mauleón, Pérez and Sanz continue, despite the incidence of such phenomena, to evidence sound properties once data from the mid-eighties are incorporated.

Chart 1, which shows the growth rates of adjusted bank reserves, would suggest something of a disjunction in the behaviour of this variable around 1984. This impression is confirmed by the estimates made, which evidence strong instability in the liquidity-creation equation as from that year. This instability is not eliminated when new variables are incorporated to the initial specification for the purpose of detecting new sources of fluctuation in the terms of the multiplier. The second section of the paper contains the estimated equations and an extensive discussion of the results obtained.

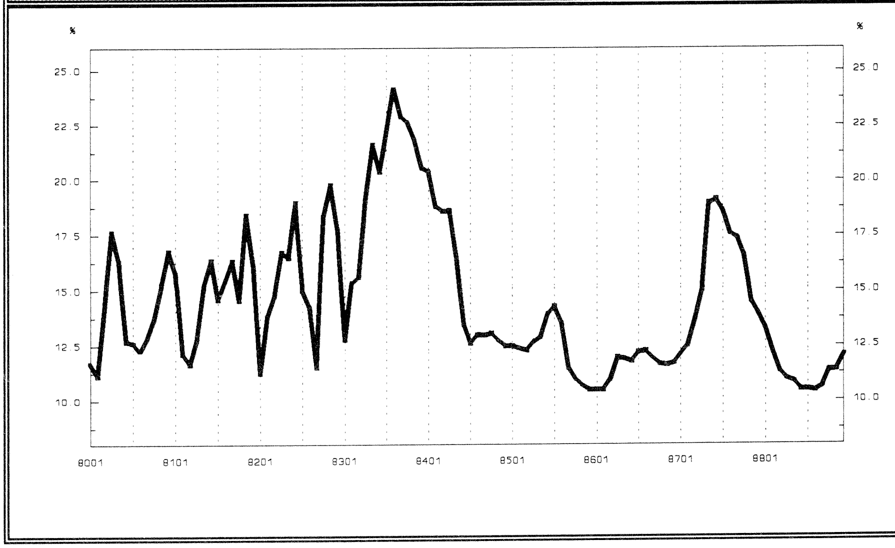
Chart 1



Since the liquidity-creation equations do not seem to describe suitably the Bank of Spain's monetary control actions in recent years, the third section of the paper explores a fresh approach. Complementing the message in Chart 1, Chart 2 depicts the behaviour of the Bank of Spain's intervention interest rates during the eighties. A marked change in the behaviour of this variable is visible, once more around 1984. The most characteristic features are first, an appreciable reduction in volatility; and second, discontinuities in its course, which are typical of what usually constitutes a control variable. It may be inferred from these phenomena that this interest rate has, as from 1984, lost much of its endogenous nature.

Chart 2

INTEREST RATE ON DISCOUNT WINDOW LOANS
(monthly average of daily data)



One initial and relatively immediate finding arising from the observation of the strong increase in the instability of the money multiplier is the existence of very substantial changes in the behaviour of private and public agents and financial intermediaries; these underlie the movements of the money multiplier. If, coupled with the instability of the multiplier, significant changes in the behaviour of the Bank of Spain's intervention interest rates are detected (as is the case), a second finding may be put forward: there has also been a change in the conduct of the monetary authorities in response to the changed behaviour of private agents[4]. An

[4] Foremost among the factors affecting the Bank of Spain's change in behaviour in the management of monetary control instruments were (i) factors relating to the conduct of private agents; and (ii) more general considerations relating to the overall design of monetary policy. In this connection see the Bank of Spain's 1988 "Informe Anual" (pp. 94-99).

analysis is thus required of the factors determining the conduct of monetary policy under a system of interest rates in the second half of the eighties. This analysis is addressed in the third section.

Lastly, the final section briefly summarises the main findings of the study.

2. The bank reserves multiplier.

With effect from 1973, the Bank of Spain adopted a two-level approach to monetary control. On the first level, the end goals of monetary policy, defined in terms of the growth rate of the level of prices and gross domestic product, would be pursued through the control of a monetary aggregate acting as an intermediate target, it being understood that the course of this aggregate would be informative as to the behaviour of the final variables. The M3 aggregate, which was replaced after 1984 by ALP (liquid assets held by the public), was selected as the intermediate target.

On the second level, the growth of the monetary aggregate would be monitored through the direct control of an instrumental variable: banking-system reserves.

This section of the paper will focus on the relationship posited in the foregoing outline between bank reserves and ALP. This relationship is simply expressed by means of the money multiplier derived in Appendix 1, as in the analysis by Mauleón, Pérez and Sanz (1986) for the case of M3.

As indicated by these authors, the use of bank reserves as a summary variable of the behaviour of the monetary authority is problematic. Indeed, since the establishment of the cash reserve requirement in 1973, numerous changes in its level have been recorded. These, whether offset or not by movements in the supply of banking reserves, have caused the statistical series of bank reserves to fluctuate sharply, preventing proper quantification of the high-powered money expansion paths monitored by the authorities.

Further, any change in the legal definition of eligible liabilities or assets for reserve requirement purposes has effects analogous to those mentioned in the preceding paragraph, and it is a fact that these changes, especially on the liabilities side, have occurred.

The real problem posed is to attempt to formulate the money-creation process more suitably. As far as possible, it is advisable to break down the money supply into (i) an instrumental variable reflecting the conduct of the monetary authority; and (ii) a money multiplier approximating the behaviour of the public and the banking system.

One way of tackling these problems is to make certain adjustments to the series of bank reserves in order to obtain a variable that is a truer reflection of the behaviour of the monetary authority. These adjustments encompass changes in the level of the reserve requirement, changes in the definition of eligible liabilities and the change in deposits held at the Bank of Spain by institutions exempt from reserve-requirement compliance. The series of bank reserves is progressively adjusted for the changes in its level derived from the aforementioned modifications. As a result, a new variable called "adjusted bank reserves" is obtained. The process is addressed and explained in great detail in the study by Mauleón, Pérez and Sanz (1986). These authors likewise include a formalised approach for deducing the money multiplier that links M3 with the adjusted assets[5]. Also, they tackle the estimation of money supply functions[6] based on the exogenous nature of the adjusted bank reserves. These estimates will be the starting point of the central discussion in this section.

It would first be best to summarise these estimates briefly: for both M3 and ALP an estimate is made of a two-equation model with quarterly data from 1974 to 1983 in which the endogenous variables are the related monetary aggregate and the interbank interest rate. The equation in which ALP, or M3, is determined constitutes a linearisation of the multiplier applying logarithmic differences, introducing dynamics in the relationship and replacing the terms of the multiplier by the related explicative variables. In the specification of Mauleón, Pérez and Sanz (1986) these variables are confined to the interbank interest rate (I1M), whereby fluctuations in the coefficient of excess bank reserves -one of the components of the multiplier (see Appendix 1) - are detected.

Based on these estimates the unit elasticity of the two monetary aggregates in relation to the adjusted bank reserves is tested for, and not

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[5] Appendix 1 offers an analogous approach for the case of ALP.

[6] Chapter 5 in the study referred to.

rejected. One important aspect, which is central to the purpose of this paper, is the stability of the money-supply equations. This matter is only addressed by Mauleón, Pérez and Sanz (1986) for the case of M3 with an additional sample of four observations relating to 1984.

The year 1984, for which these authors had data to perform the stability tests, was unfortunately one of the most dislocated monetary control episodes since the pursuance of an active monetary policy first began in 1973. Indeed, in January 1984 the cash reserve requirement regulations were substantially reformed; the requirement was raised to 20% (the maximum legal ceiling then permitted[7]), and the range of liabilities subject to compliance therewith was widened notably. These legal changes gave rise to marked financial instability and a transitory loss of monetary control.

These circumstances disrupted the even-trending course of the monetary series and, by extension, the multipliers. It was thus necessary to incorporate two dummy variables into the estimation for the first two quarters of 1984 to test the stability of the M3 model outlined in the authors' study. The stability test was thus based exclusively on the last two quarters of 1984 and, as a result, the stability of the liquidity-creation process remained questionable.

The specific purpose of this section is thus as follows: to ascertain whether, given a broader time-span and a greater number of observations to perform the stability tests, the money multiplier outline which had proven sufficient until 1983 to characterise the money supply, and the role played therein by the Bank of Spain, remained valid after 1983; and were this not the case, whether it could be concluded that the representation by this outline of the money-creation process is no longer correct. The loss of stability in this relationship would be an initial factor to consider when explaining the presence of a change of system for monetary policy intervention.

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[7] Currently, the Bank of Spain can raise the level of the reserve requirement to a ceiling of 7%.

2.1 The behaviour of the multiplier terms

If the linearised expression of the multiplier presented in Appendix 1 is taken as a starting point, and dynamics and a stochastic term are introduced, the specification of the liquidity-creation equation can be obtained. This may be simply expressed as follows:

$$\Delta \ln ALP_t = f(.) + \alpha(L) \, \Delta \ln ACC_t + \epsilon_t$$

where $\Delta \ln ALP_t$ and $\Delta \ln ACC_t$ approximate respectively to the growth rates of ALP and ACC; $\alpha(L)$ is a lag polynomial; f(.) denotes the determinants of the changes to the multiplier; and ϵ_t represents a series of random disturbances that follow a white noise process. A loss of stability in the foregoing equation may be triggered either by (i) alterations to the polynomial $\alpha(L)$, which may be the outcome of the greater endogenicity of the bank reserves[8], or (ii) a break in the process generating ϵ_t, which may be associated with greater variance of the disturbances; or (iii) instabilities in f(.) linked to changes in the behavioural relationships underlying the terms of the multiplier. With regard to this latter phenomenon, which may cause instability in the multiplier and thus annul the informativeness of the adjusted bank reserves, Chart 3 proves to be of interest. In it, certain multiplier ratios of ALP to eligible liabilities are depicted, and several conclusions can be drawn therefrom.

The ratio of cash held by the public to eligible liabilities (Chart 3A), which had held fairly stable during the seventies and early eighties, changed abruptly in 1985 and began to grow markedly[9].

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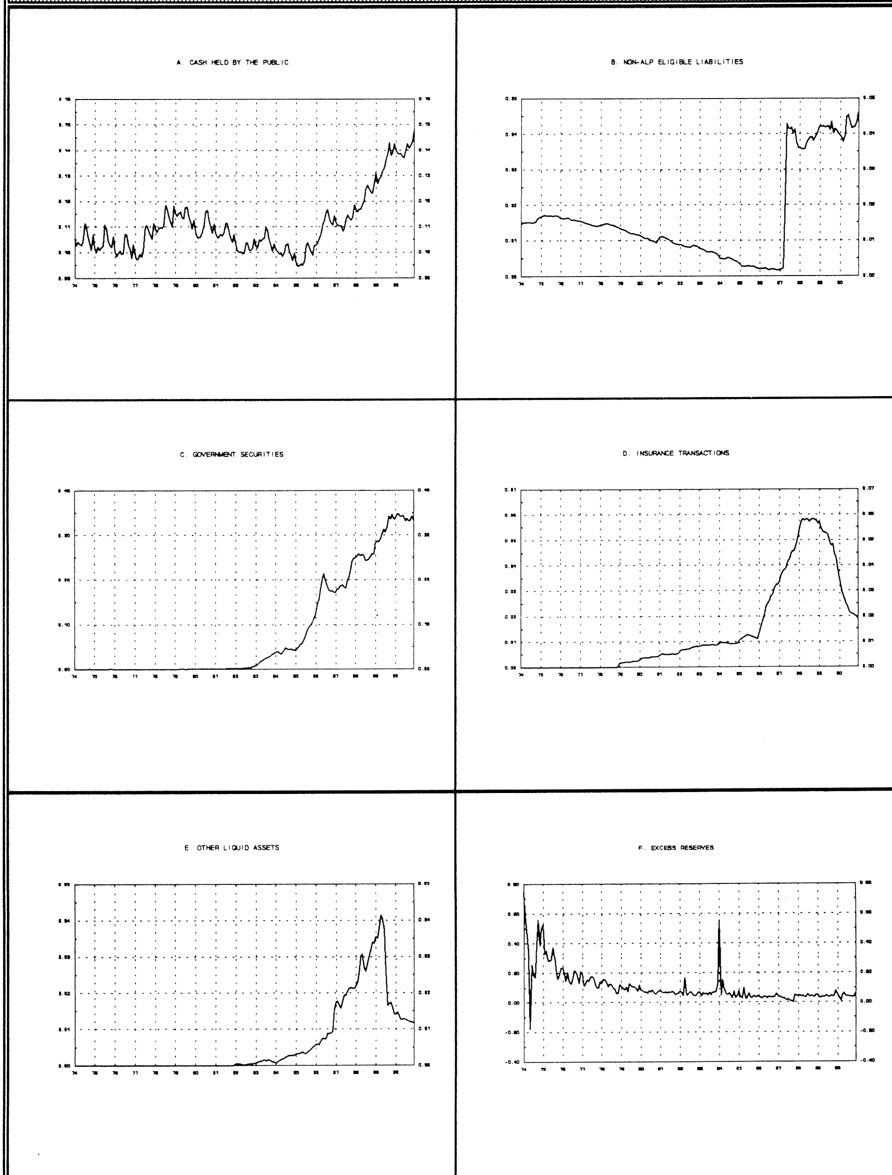
[8] The polynomial $\alpha(L)$ encompasses the series of factors that prompts feedback in the money-creation process, as a result of which the response by ALP to changes in bank reserves is not instantaneous. Changes in the scale of these factors, or the emergence of new phenomena, will bring about changes in the value of this polynomial's parameters.

[9] The reasons underlying this change are, essentially, tax-related (see Quirós (1990)).

Chart 3

TERMS OF THE MULTIPLIER BETWEEN ALP AND ELIGIBLE LIABILITIES



The multiplier term corresponding to the ratio of eligible liabilities not included in the definition of ALP to total eligible liabilities (Chart 3B) shows a break at the beginning of 1987, the result of the incorporation into the cash reserve requirement of the outstanding balance of banking-system non-resident deposits. Following the surge in the level of this ratio, an appreciable increase in the variance thereof was evident[10].

The ratio addressing deposits at the Bank of Spain behaved erratically at all times. However, this phenomenon is not of relevance to this discussion in view of its marginal significance within the multiplier. Nor is the ratio of deposits at mutual credit institutions to eligible liabilities very significant; here, a change in trend was recorded at the beginning of 1985 and, subsequently, there was a significant increase in the variance thereof[11].

The ratios for government debt, insurance transactions and other liquid assets (Charts 3C, 3D and 3E, respectively) were those that evidenced the most notable dislocations in the second half of the eighties and introduced most instability, from a statistical standpoint, into the behaviour of the multiplier. Underlying these phenomena were widespread financial innovation and resort to practices to elude financial and tax regulations[12].

The coefficient of excess reserves (Chart 3F) fell notably until 1982 and, following a period of irregular behaviour, remained relatively

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[10] The abrupt change in the level of this ratio does not pose difficulties for the management of the multiplier, as it can be resolved with the subsequent correction of the ACC series. However, the subsequent increase in the variance thereof proves more problematic. This evidences the incorporation into the eligible liabilities of an enormously volatile bank liability item which frequently plays the role of adjustment variable in the bank balance sheet.

[11] These irregularities in the ratio corresponding to mutual deposit institutions' deposits should be linked with the financial difficulties of certain rural savings banks. These difficulties led, in certain cases, to takeovers by other financial institutions, mainly savings banks.

[12] It should be borne in mind that the financial instruments that figure in the numerators of the previous ratios enjoyed- at least for part of the period under study- tax benefits in relation to the yield thereon. They were not eligible for reserve requirement purposes.

stable as from 1984[13]. In any event, changes in this coefficient are currently of secondary significance in relation to the overall fluctuations of the multiplier.

The overall impression from the analysis of the multiplier components is that they underwent abrupt and widespread changes in the 1984-1985 period. These may have been associated with departures by financial intermediaries and private agents from stable behavioural patterns.

2.2 Estimations of the liquidity-creation equation

In order to ascertain whether this appreciable increase in the instability of the multiplier has entailed a deterioration in the money supply process, a liquidity-creation equation along the lines of the work of Mauleón, Pérez and Sanz (1986) has been initially specified. The specification of this equation can be found in Table 1[14]. The first column of this table gives the estimated parameters with a sample of quarterly data for the 1974-1983 period, along with a set of statistics with which to evaluate the properties of the estimated equation[15]. This estimation gives similar results to those elicited from the model in the work referred to. Indeed, the elasticity of ALP in

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[13] The volatility of the excess reserves coefficient has not only diminished considerably in recent years; much of the fluctuations therein, moreover, are in response to well-defined and, to a certain extent, predictable behaviour by banking agents (see Escrivá and Espasa (1988)).

[14] The model has been estimated by minimum ordinary squares after performing a Hausman test in which the exogeneity of the interest-rate variable is not rejected by a wide margin. The variables in the interest-rate-determination equation presented in Mauleón and Pérez (1984) have been used as instruments. The value of the test is 1.07, which is distributed as a $\chi^2(1)$.

[15] In this and in the following tables where estimations are presented, the parameters estimated are accompanied by the related "t" statistics; SCR denotes the sum of the square of the residuals; n is the number of effective observations in the estimation; σ is the standard deviation of the innovations; R^2 is the determination coefficient calculated on the differentiated endogenous variable; Q(4) is the Box-Pierce-Ljung statistic testing for fourth-order autocorrelation; ARC (2) tests second-order autoregressive heteroskedacity; and B-J denotes the Bera-Jarque normality test.

relation to the adjusted bank reserves is unitary; the response function is analogous and the model adjustment is also similar. Further, the model evidences sound intra-sample statistical properties.

Nonetheless, the post-sample stability exercises are clearly unsatisfactory. When three years (the 1984-1986 period) are added to the sample, the estimation deteriorates, the strong reduction in elasticity between ALP and ACC (see column 2 of Table 1) proving particularly significant. Moreover, the goodness of fit of the previous model to 1983, and how such model deteriorates in the three following years, can be observed in Chart 4.

Chart 5 depicts the recursive estimation of the model's most significant parameters. Evidently, as from 1984, the model's main parameters drift to a more marked and persistent extent and show a greater degree of fluctuation.

Table 1

ESTIMATION OF THE LIQUIDITY-CREATION EQUATION
(First specification)

$$\Delta \ln ALP_t = \beta_0 + \beta_1 \Delta \ln ALP_{t-1} + \beta_2 \Delta \ln ACC_t + \beta_3 \Delta \ln ACC_{t-4} +$$
$$\beta_4 \Delta^2 I1M_t + \beta_5 T184_t + \beta_6 T284_t +$$
$$\beta_7 Q1_t + \beta_8 Q2_t + \beta_9 Q3_t + \epsilon_t$$

	QI 74 QIV 83	QI 74 QIV 86	QI 74 QIV 84	QI 74 QIV 86
β_0	0.45 (0.8)	1.59 (3.6)	0.76 (1.3)	1.81 (4.4)
β_1	0.30 (2.7)	0.32 (2.4)	0.21 (1.8)	0.23 (1.9)
β_2	0.50 (6.4)	0.21 (3.8)	0.51 (5.8)	0.27 (4.8)
β_3	0.13 (2.9)	0.09 (1.6)	0.13 (2.6)	0.07 (1.4)
β_4	0.03 (2.0)	0.04 (1.6)	0.02 (1.6)	0.03 (1.6)
β_5			-2.22 (4.9)	-1.48 (2.7)
β_6			0.26 (0.7)	0.50 (1.1)
β_7	0.24 (1.8)	0.36 (1.9)	0.18 (1.2)	0.35 (2.0)
β_8	-0.36 (3.1)	-0.41 (2.5)	-0.31 (2.4)	-0.33 (2.1)
β_9	0.78 (6.2)	0.90 (5.8)	0.78 (5.4)	0.79 (5.3)
SCR	2.74	11.75	3.99	9.95
n	35	47	39	47
σ	0.28	0.50	0.32	0.46
R^2	0.91	0.77	0.90	0.81
Q(4)	7.7	4.4	3,1	3.2
ARC(2)	2.3	0.4	2.6	3.2
B-J	1.1	1.4	0.6	1.7

Chart 4

RATE OF CHANGE OF ALP
(observed, adjusted series and predictions)

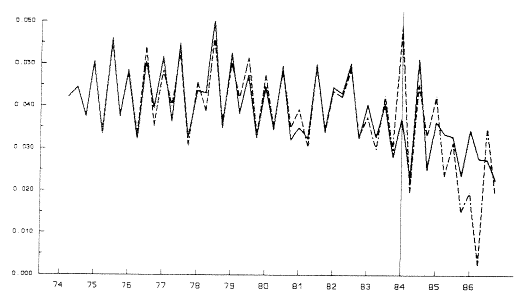


Chart 5

LIQUIDITY-CREATION EQUATION. RECURSIVE ESTIMATION
(First specification)

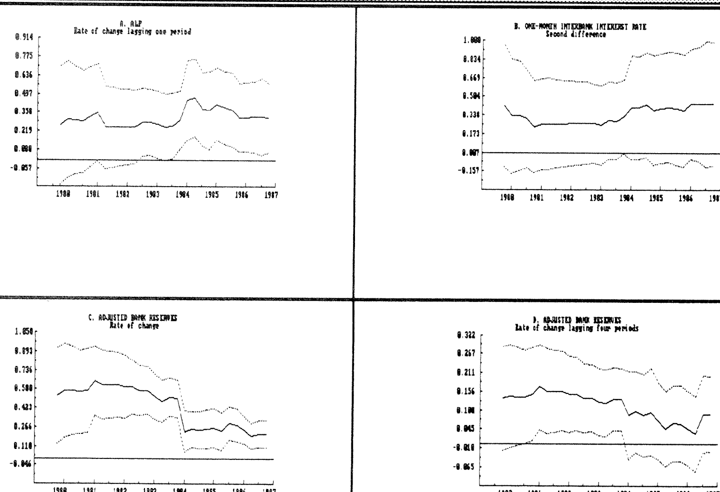
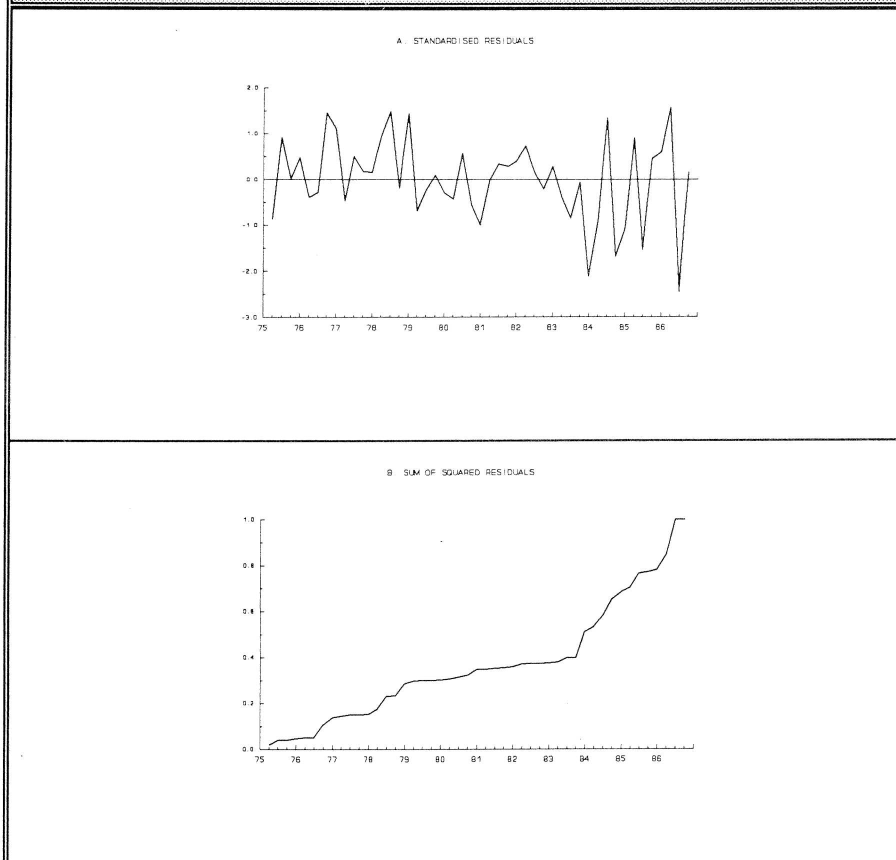


Chart 6B shows how the rate of growth of the sum of the squared residuals increases after 1984, since the variance of the residuals for the 1984-1986 period is considerably greater than that of the 1974-1983 period (see Chart 6A).

Chart 6

ANALYSIS OF LIQUIDITY-CREATION EQUATION RESIDUALS
(First specification)



Likewise, a test of the stability of the Chow-type parameters for the 1984-1986 period gave a value of 7.40 compared with the critical value of the $F(12,27)$ of 2.13. Accordingly, the stability of the model over this period is not accepted by a wide margin[16].

To ensure that these instability problems did not largely originate in the regulations enacted in early 1984, columns 3 and 4 of Table 1 offer estimations of the model with samples ending respectively in the final quarters of 1984 and 1986 into which two dummy variables are incorporated in the first two quarters of 1984. However, despite these interventions, the instabilities remain. Indeed, if the model is estimated with these variables and information to 1984, and a stability test is performed for the two remaining years, a value of 5.41 is obtained for the statistic while the critical value corresponding to the $F(8,29)$ is 2.28.

In the remaining part of this section, and taking into consideration the results obtained in previous estimates, a new specification of the liquidity-creation model is undertaken. In it are, on the one hand, variables which can, in principle, detect the influence of the new phenomena affecting the money multiplier; and, on the other, various alternative dynamic specifications have been tested.

In the first place it was wished to take into consideration financial institutions' strategy of eluding the cash reserve requirement. This took the form of their switching from liabilities eligible for reserve requirement purposes into those that were not, with the resulting increase in the value of the multiplier. Given that, as the level of the reserve requirement increases, financial institutions have a greater incentive to reduce the volume of their eligible liabilities (co-ordinating their deposit-raising policies through non-eligible instruments), a variable measuring changes in the level of the reserve requirement (COCA) was incorporated into the specification of the multiplier.

In parallel, to reflect the growing significance of the behaviour of the government debt/eligible liabilities ratio (which is now by far the

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[16] All critical values of the F distribution provided in the text refer to a level of significativeness of 5%.

most important component of the multiplier) to the changes in the multiplier, a variable (DIF) has been defined to represent the spread between the yield on bank deposits -which account for the bulk of eligible liabilities- and that on government securities. Favourable results have not been obtained with this variable since use of it began. Switching between deposits and government securities has unquestionably responded, to a certain extent, to changes in the yield spread. However, the impossibility of detecting this response econometrically may be due to the scant representativeness of the series of the interest rates on deposits during significant periods within the sample used. This was because first, until rates were liberalised, the payment of topped-up rates or payments in kind were common practice; and second, the zero- or low-interest-bearing rates on banking services in Spain distorted the formation of banking-system deposit rates.

Two variables to detect the fluctuation of the excesses coefficient have also been added to the model: first, the volatility of the interest rate on interbank market deposits at one day (VOL)[17]; and second, the spread between one-day and one-month rates in this market (I1D-I1M). The volatility variable attempts to reflect the degree of uncertainty under which entities operate while the spread referred to is a measure of how these entities are penalised when they are short of liquidity[18]. Both are thus positively related to the excesses coefficient and negatively so to ALP growth.

Table 2 details the specification of and findings from the model which gave the best results. As in the model in Table 1, estimates are given with the sample to 1983 and 1986 and excluding and including the dummy variables relating to the first two quarters of 1984.

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[17] Volatility has been approximated calculating standard deviations per quarter of the daily changes in overnight interbank deposits rate.

[18] Escrivá and Espasa (1988) offer a detailed explanation of the role these variables play in financial intermediaries' decisions regarding the level of their excess bank reserves.

Table 2

ESTIMATION OF THE LIQUIDITY-CREATION EQUATION
(Second specification)

$$\Delta \ln ALP_t = \beta_0 \Delta\Delta_2 \ln ACC_t + \beta_1 \Delta^2 \ln ACC_{t-1} + \Delta \ln ACC_{t-2} + \beta_2 (I1D-I1M)_{t-1} + (\beta_3+\beta_4 L) VOL_t + \beta_5 COCA_t + \beta_6 T184_t + \beta_7 T284_t + \beta_8 Q1_t + \beta_9 Q2_t + \beta_{10} Q3_t + \frac{1}{(1 - \beta_{11}L - \beta_{12}L^2)} \epsilon_t$$

	QI 74 QIV 83	QI 74 QIV 86	QI 74 QIV 84	QI 74 QIV 86
β_0	0.54 (12.1)	0.39 (6.4)	0.54 (12.4)	0.40 (8.0)
β_1	0.35 (12.1)	0.33 (7.4)	0.35 (12.4)	0.39 (9.2)
β_2	-0.06 (2.9)	-0.08 (1.6)	-0.06 (3.0)	-0.09 (2.4)
β_3	-0.02 (2.4)	-0.02 (1.3)	-0.02 (2.5)	-0.03 (2.0)
β_4	-0.03 (2.8)	-0.04 (2.1)	-0.03 (2.8)	-0.02 (1.5)
β_5	0.08 (4.3)	0.06 (3.3)	0.08 (4.5)	0.08 (4.9)
β_6			-0.03 (8.7)	-0.03 (5.0)
β_7			-0.02 (4.9)	-0.03 (5.0)
β_8	0.13 (1.7)	0.03 (0.6)	0.13 (1.7)	0.17 (1.6)
β_9	-0.39 (5.5)	-0.33 (2.3)	-0.39 (5.7)	-0.24 (2.3)
β_{10}	0.82 (10.8)	0.79 (5.3)	0.82 (11.0)	0.78 (7.0)
β_{11}	0.62 (5.0)	0.61 (4.5)	0.62 (5.2)	0.80 (6.3)
β_{12}	-0.25 (2.6)	-0.13 (1.0)	-0.25 (2.7)	-0.29 (2.5)
SCR	2.19	17.49	2.44	10.38
n	35	47	39	47
σ	0.25	0.61	0.25	0.47
R^2	0.94	0.67	0.94	0.80
Q(4)	1.2	1.8	1.5	2.2
ARC(2)	0.9	9.2	0.91	10.4
B-J	1.0	6.1	0.8	2.9

After testing, unit elasticity in three lags was imposed in these estimates[19]. The specification presented in Table 2 is a suitable reparametrisation to incorporate this restriction. This model differs from the previous one in that it presents a response function that expends itself more rapidly; however, the first two values of this response function are similar to those obtained previously. Moreover, the dynamics of the model also differ in that the lagging endogenous variable disappears and that the noise presents a second-order autoregressive structure.

Although the new model offers an appreciably better intra-sample fit than that based on the paper by Mauleón, Pérez and Sanz (1986) and although the new variables have the correct sign and are highly significative statistically, the post-sample instability problems remain and no benefit is drawn from this area. Chart 7 depicts the recursive estimate of the main coefficients of the model. These evidence how the variance of the different parameters increases as from the observation relating to the first quarter of 1984. This is particularly so in the case of the coefficients relating to the adjusted bank reserves.

Chart 8 shows the break in the first quarter of 1984. As stated earlier, this break could be thought to be essentially related to the regulatory changes during this period, which could perhaps be reflected by an intervention variable. However, severe stability problems continue to emerge for the last two years of the sample. Chart 8 attests to this, depicting the residuals for the case of the model estimated with intervention variables (column 4, Table 2).

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[19] When unit elasticity is tested using the entire sample available, a statistic of 1.009 is obtained compared with a critical value of the $F(1,36)$ of 4.11 for the case of the model which does not incorporate dummy variables; however, for the case in which these variables are considered, the value of the statistic is 1.865, the critical value of the $F(1,34)$ being 4.13.

Chart 7

LIQUIDITY-CREATION EQUATION. RECURSIVE ESTIMATION
(Second specification)

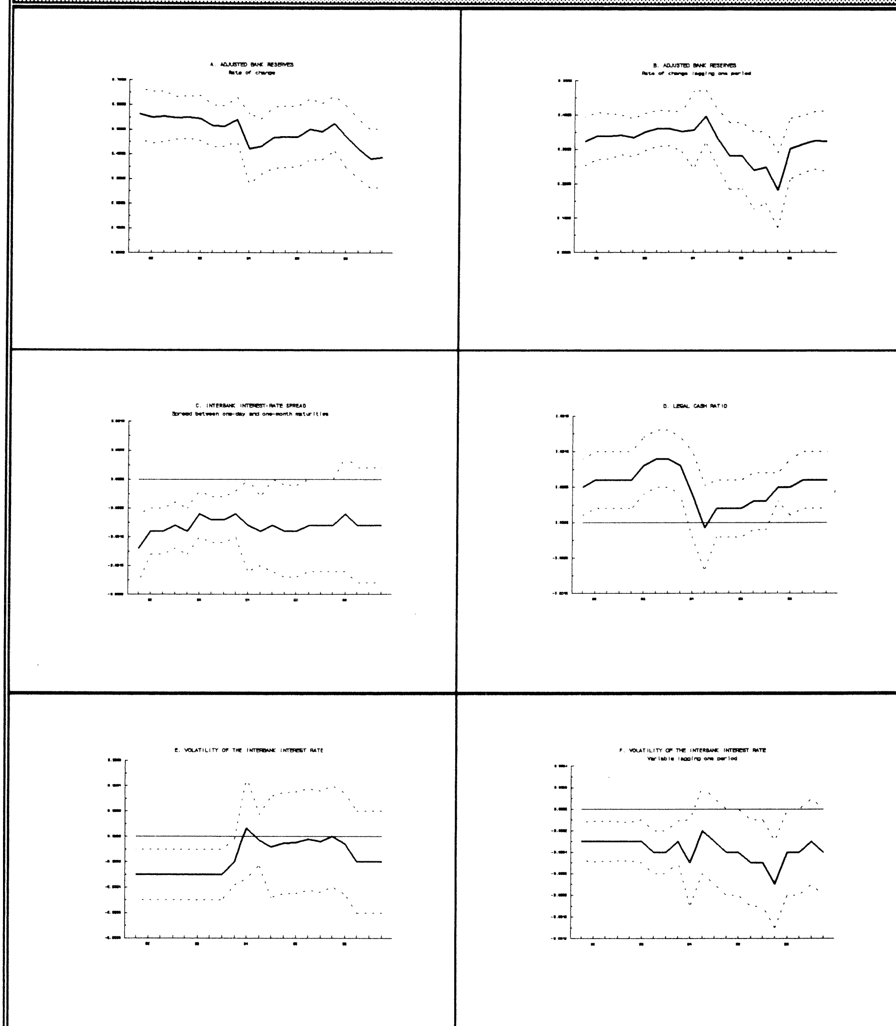
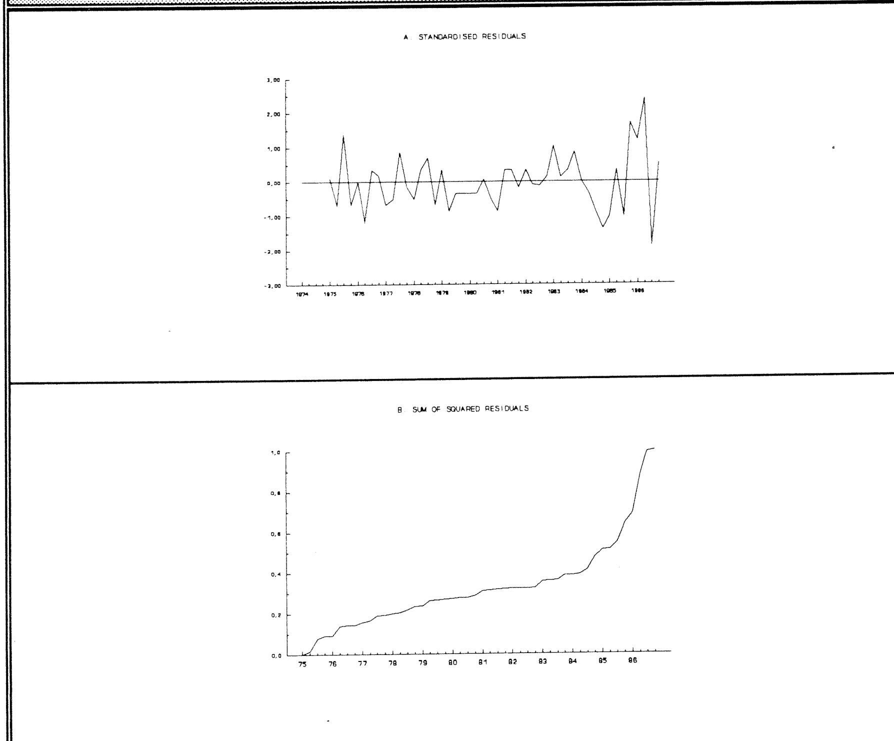


Chart 8

ANALYSIS OF LIQUIDITY-CREATION EQUATION RESIDUALS
(Second specification)



It remains only to point out that the stability test on the 1984-1986 period gives a value of 13.97 to the statistic compared with the critical value of 2.18 for the F(12,24). The same test on the model with intervention variables corroborates the rejection of the model's stability since, compared with the critical value of 2.32 of the F(8,26), the statistic takes a value of 10.57.

There is a build-up of evidence as from 1984 that it is impossible to re-establish a representation of the money supply process characterised by the setting by the Bank of Spain of growth rates for the system's high-powered money that are compatible -given a multiplier value- with specific ALP growth targets. Accordingly, the following section considers an interest-rate-based instrumental variable outline under which the Bank of Spain's conduct is reflected in a reaction function for such rate, noteworthy among whose arguments are the changes in the monetary aggregate ALP.

3. The reaction function of the interest rate

Given the change in conduct by private agents and the new monetary policy stance that has gradually come to prevail in recent years, the move from a quantity-based to an interest-based instrumental variable[20] may be digested. Notably, the monetary policy decision-making process underlying this reaction function outline is more complex than the one represented by the liquidity-creation equations. In the latter, given the changes in the multiplier and in view of the exogenous nature of bank reserves, there arose a linear relationship between the instrumental variable, bank reserves and the intermediate target, the monetary aggregate ALP. In the case of an interest-rate instrumental variable, the relationship to the intermediate target is less immediate and would require full modelling of the economy's financial sector to address the complex mechanisms through which monetary signals via interest rates are routed.

However, from the standpoint of the behaviour of the monetary authorities, the relationship between an interest-rate instrumental variable and the money supply target may have a simple representation within the framework of a reaction function. In addition, this formulation approximates better to the way in which actions by many central banks have shaped decision-making at the intermediate level of the scheme of monetary control and the relationship thereof to the instrumental variable. Money supply targets generally continue to play a central reference role for monetary policy decision-making; however, they tend to be weighted with the information from other indicators. As a result, monetary control takes the form of the management of an interest-rate instrumental variable, the level of which changes depending on the central bank's ongoing assessment of a broad set of data[21]. In Spain's case, the direct monitoring of final variables -especially

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[20] This assumption entails something of a simplification, since in practice there are no entirely pure outlines.

[21] Estimations of interest-rate reaction functions addressing forms of central-bank conduct responding to this monetary control outline can be found, for the British case, in Coudert (1987) and Dua (1988); for the US case in Abrams, Froyen and Wauld (1980); and for the French case in Artus, Barraux and Pecha (1987) and Coudert (1987).

the inflation rate and the behaviour of the exchange rate- has acquired particular relevance within this data set.

Undoubtedly, the Bank of Spain has, in certain periods, been able to take into consideration other types of information when modifying the level of intervention rates: these include developments in specific financial markets, for instance, changes in certain foreign interest rates or the behaviour of the counterparts of bank reserves and/or of the money supply. Indeed, the potential number of macroeconomic and financial variables that the monetary authorities could have responded to is very high. However, bearing in mind constraints on the degree of freedom to make the empirical tests and the difficulties in translating some of these possible determinants into variables susceptible to be incorporated into econometric research, it was decided to define initially a limited number of variables. In principle, and in accordance with the traditional measures of the Bank of Spain and its approach to the conduct of monetary policy, these variables would adequately reflect most systematic reaction factors of the monetary authorities. Once a reaction function of the interest rate is obtained from these variables (the results of which are presented in section 3.2), the specification obtained serves as a basis for trying out possible extensions of this function and thus for testing whether the a priori selection of the set of most relevant variables was correct.

3.1 Definition of variables

The first problem that arises when specifying the reaction function is to select the interest rate constituting the monetary authorities' response variable. It should be borne in mind that the Bank of Spain has, in the period under study, used different instruments. Further, its benchmark interest rates have progressively tended to be established in terms of bands for the shorter-dated interbank rates. Some of these instruments have acquired considerable importance in certain periods (as was the case for three-month repos at times when liquidity-absorption requirements were high). Yet viewing the eighties overall, the interest rate most representative of the Bank of Spain's conduct was deemed to be the marginal rate on monetary regulation loan (discount window) auctions (TM). A monthly-average variable has been constructed on the basis of the daily data on this interest rate, using the following criteria:

a) For days on which no loan auction took place, the rate on the most recent day on which an auction was held is used for calculating the average.

b) From January 1978 to April 1983, Saturdays and days preceding holidays were excluded from the calculation since the formula then used to define reserve requirement compliance over the stipulated ten-day accounting periods introduced substantial heterogeneity into the behaviour of rates on such days.

c) As from June 1987, the Bank of Spain ceased to intervene on the market on Saturdays whereby this day is disregarded in the calculation of the daily-data average.

For the arguments of the reaction function three sorts of variables have been selected. These are deemed to summarise suitably the overall information on which the Bank of Spain has systematically drawn in conducting its monetary policy within a decision-making framework at monthly level such as that defined. The three sorts are: variables measuring deviations from money supply targets; variables that observe directly the final magnitudes; and exchange-rate variables.

Two variables were selected as money-supply-deviation variables: the monthly deviations from ALP in relation to the annual path, expressed in logarithms ($alp-alp^{ol}$), and the deviations from this aggregate in relation to the monthly targets for ALP ($alp-alp^{oc}$), likewise expressed in logarithms. In this way both short-and medium-term money-supply-target-setting strategies are taken into consideration. The data used are those observed at each moment by the monetary authorities (see Escrivá and Peñalosa, 1989). This helps avoid a frequent problem when estimating models of this type; namely, that revisions of monetary series (which are habitual and sometimes entail changes of some size) prevent exact knowledge of the specific information available at the time decisions were made.

As to the final variables, the consumer price index (ipc), expressed in logarithms, was considered a key variable for incorporation in the formulation of the reaction function, which is expressed in terms of changes in the year-on-year inflation rate in the final model specification. An attempt was made to construct a variable of deviations from the government's annual inflation targets. However, it proved impossible to reconstruct such a variable for the whole of the sample given the discontinuity with which the economic authorities have set these targets and the lack of any publication or systematic record of this information. Since an inflation target cannot be considered, symmetrical behaviour by the authorities in terms of the modification of the intervention interest rate in the presence of positive or negative changes in the inflation rate is assumed. Although this assumption is generally not acceptable, it may be considered as a reasonable simplification for the period under study in view of the initial level of inflation.

With regard to the exchange rate, three variables have been constructed to consider the three different peseta-exchange-rate indicators observed by the authorities in the period selected:

$$tc1 = \begin{cases} 1984.2\text{-}1985.12 & \ln TCPD_t \\ 1986.1\text{-}1988.12 & \ln TCPD_{1985.12} \end{cases}$$

$$tc2 = \begin{cases} 1984.2\text{-}1985.12 & \ln TCEE_{1985.12} \\ 1986.1\text{-}1987.6 & \ln TCEE_t \\ 1987.7\text{-}1988\text{-}12 & \ln TCEE_{1987.6} \end{cases}$$

$$tc3 = \begin{cases} 1984.2\text{-}1987.6 & \ln TMAR_{1987.6} \\ 1987.7\text{-}1988.12 & \ln TMAR_t \end{cases}$$

Prior to 1986, the exchange-rate indicator observed by the Bank of Spain was an index of the effective nominal exchange rate of the peseta against the currencies of the developed countries (TCPD), which were appropriately weighted in terms of their importance in foreign trade with Spain. The variable tc1 thus reflects the value this index, expressed as a monthly average of daily data and in logarithms, took from February 1984 to December 1985, this value being repeated for the rest of the sample. After Spain joined the EC at the outset of 1986, the Bank of Spain began to observe an index of the nominal effective exchange rate against Community countries (TCEE), Greece and Portugal excluded. The variable tc2 was constructed with the value of this index, likewise expressed as an average of daily data and in logarithms, for the period from January 1986 to May 1987. In the sample period prior and subsequent to this interval, the index values in December 1985 and May 1987, respectively, were held constant. For reasons pertaining to the Bank of Spain's means of operating on the foreign exchange markets and to the working of the ERM, with the D-Mark as the dominant currency, Spanish exchange-rate policy progressively took the D-Mark as its basic benchmark. Informally to mid-1987, and formally as from the beginning of 1988 to Spanish ERM membership in June 1989, the Bank of Spain let exchange-rate conduct be governed by the nominal exchange rate of the peseta to the D-Mark (TMAR). The variable tc3 takes its value from the average monthly peseta/D-Mark exchange rate, expressed in logarithms, from July 1987 to the end of the sample, December 1988. In the prior period the value taken by the index in May 1987 held constant. As in the case of ALP, time series incorporating no subsequent revision of their content were constructed for these three exchange-rate variables.

3.2 Estimation of the reaction function

The final results from several trial, alternative specifications of the model are shown in Table 3. As expected in the light of the results in section 2, data could only be incorporated into the sample as from 1984[22]. When the sample is enlarged with observations from the first third of the eighties, the models show marked signs of instability. Therefore, for the results shown the estimation period begins in February 1984.

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[22] For further reading see Mauleón (1988), where the estimation of a Bank of Spain reaction function under a bank reserves instrumental variable outline during the 1974-1983 period is given.

The model was specified "a priori" in differences, taking changes in the level of TM as an endogenous variable. From the outset a specification in levels was discarded because the sample used was too small to discern long-term relationships. In any event, the search for such relationships would have been overambitious for the type of regularities that can be detected in a reaction function of this nature. Further, it should be borne in mind that the initial intervention interest rate level at the beginning (early 1984) of the sample used was the outcome of a combined series of very specific economic factors particular to that period, notable among which were the budget deficit and the financing mechanisms therefor (see Mauleón and Pérez, 1984).

In line with the foregoing considerations, the temptation to extrapolate the findings of the reaction function estimation out of the sample should be avoided. Their efficacy in providing a simplified representation of the Bank of Spain's monetary control policy conduct is confined to the period defined. As indicated in section 1, it is unlikely, given the scale of the changes since 1989 in the broad framework of monetary policy, that the reaction function of the monetary authorities will be maintained in the form in which it is presented in this research[23].

Excepting tcl, which did not prove significative, all the other variables fit appropriately in the model, with correct signs and plausible dynamics. Thus, with the set of variables considered, many of the monetary authorities' responses can be explained in terms of changes to the marginal rate on auctioned loans. A study of the estimated model's dynamics is particularly worthwhile since it enables the way in which the monetary authorities systematically observed the reaction variables to be appreciated.

[23] With Spanish ERM entry in June 1989, the interest rates of ERM members should be reaction variables in the conduct of the monetary authority. However, the placing of restrictions on the growth of bank credit to the private sector and on foreign borrowing by Spanish companies to the beginning of 1991 made it possible, to a certain extent, to isolate domestic interest rates from movements in rates on European financial markets. This precludes any study of the importance of external interest rates for Bank of Spain decisions in terms of a reaction function such as that described in this study.

Table 3

ESTIMATION OF THE REACTION FUNCTION

$$\Delta\ TM_t = \beta_0 + (\beta_1+\beta_2 L)\,(alp-alp^{oc})_t + \beta_3\ \Delta\ (alp-alp^{o1})_{t-1} +$$

$$\beta_4 \sum_{i=1}^{3} \Delta\ \Delta_{12}\ ipc_{t-i} + \beta_5 \sum_{i=1}^{4} \Delta\ tc2_{t-i} + \beta_6 \sum_{i=1}^{5} \Delta\ tc3_{t-i} +$$

$$\beta_7\ \Delta\ MY87_t + \beta_8\ \Delta\ NO87_7 + \frac{1}{1-\beta_9 L}\ \epsilon_t$$

	February 84 December 88	February 84 July 87	February 84 June 88	July 85 December 88
β_0	-0.21 (1.6)	-0.13 (1.0)	-0.29 (2.2)	-0.22 (1.3)
β_1	0.28 (2.5)	0.25 (2.4)	0.28 (2.5)	0.33 (2.5)
β_2	0.50 (4.9)	0.50 (5.3)	0.51 (5.0)	0.55 (3.9)
β_3	0.16 (2.0)	0.16 (1.9)	0.17 (2.1)	0.18 (1.8)
β_4	0.23 (4.1)	0.20 (3.9)	0.22 (3.8)	0.28 (3.7)
β_5	-0.28 (2.9)	-0.23 (2.7)	-0.29 (3.2)	-0.27 (2.3)
β_6	-0.14 (2.4)		-0.15 (2.6)	-0.14 (2.3)
β_7	1.40 (7.1)	1.61 (8.6)	1.40 (7.2)	1.40 (7.0)
β_8	-0.66 (3.4)		-0.65 (3.4)	-0.67 (3.4)
β_9	0.58 (5.0)	0.54 (3.7)	0.54 (4.3)	0.59 (3.9)
SCR	6.68	3.13	5.54	4.43
n	53	35	47	35
σ	0.35	0.30	0.34	0.36
R^2	0.859	0.895	0.878	0.853
Q(12)	4.4	6.6	5.9	9.7
ARC(2)	1.2	1.3	1.6	1.1
B-J	2.7	3.1	3.0	2.5

As to deviations from short-term ALP targets, the Bank of Spain reacted to the average deviations of the contemporaneous and preceding month. This contemporaneous effect of the deviations from target may seem surprising. However, it should be remembered that thrice-monthly projections are made in-house at the Bank of Spain on the course of ALP. These make for a fairly accurate approximation to the growth of the aggregate in the same month such growth occurs.

Regarding deviations from annual ALP targets, the Bank of Spain has hitherto evaluated such deviations at month-end. As a result, it is deviations from targets in the preceding month which determine interest-rate movements. Further, in accordance with the estimated dynamics, what has been relevant for the Bank is not the scale itself of the deviation in relation to the annual path but the rate at which such deviation is widening or narrowing. In terms of the model's specification, this implies that it is changes in the deviations from the annual ALP targets which emerge.

As to prices, tests were performed using, together with simpler dynamics based on moving averages, rational structures addressing the possibility that the Bank might accord greater importance to the most proximate inflation data. Likewise, different transformations of the price index were used: monthly rates (T_1^1), annual rates (T_{12}^1) and moving-average rates (T_3^3 and T_{12}^{12}). The best results are obtained if regard is had to the fact that what has been relevant for the monetary authorities are changes recorded in the annual rate of inflation, which are evaluated by averaging, with equal weightings, the behaviour of ipc over the three preceding months: the simple average of the last three changes recorded in the annual rate of the consumer price index.

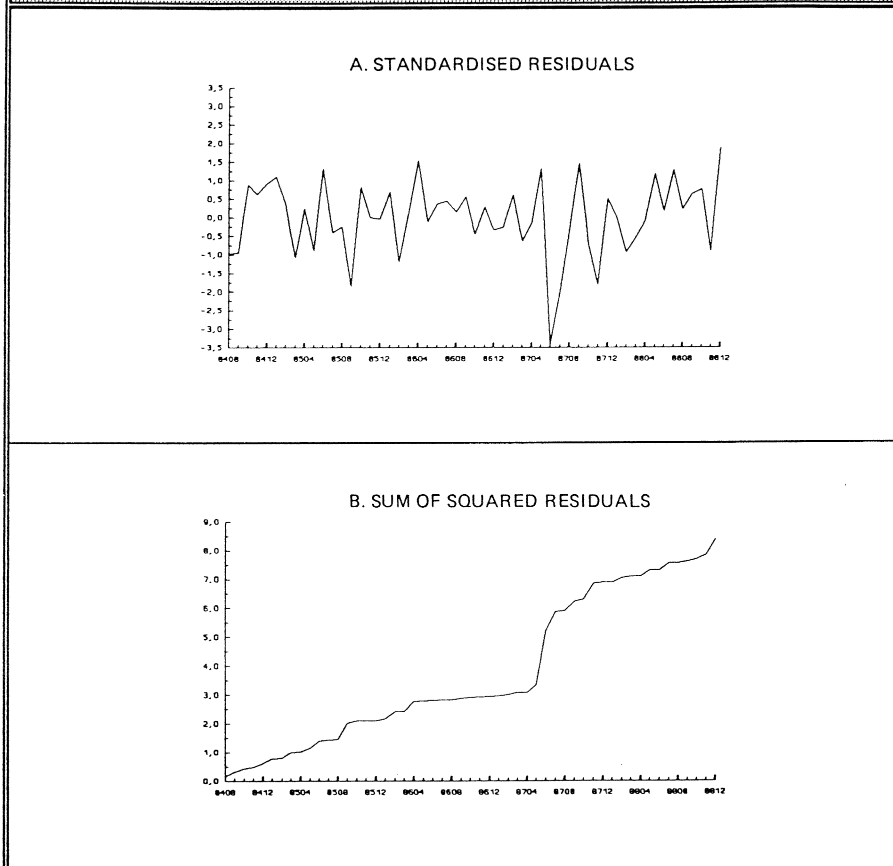
Lastly, it may be pointed out that the exchange rate can only be considered as a systematic variable to which the monetary authorities react as from 1986. As previously stated, the tc1 variable, which reflects the exchange-rate index observed prior to 1986, does not figure in the model. In the 1986-1988 period, in accordance with the dynamics arising from the reaction function estimation, the role of the exchange rate as a reaction variable differed considerably from that it may currently have; with the peseta in the exchange rate mechanism of the EMS, there is an effective short-term constraint on interest-rate movements. However, in the period under study, the monetary authorities have appreciated the prior behaviour of the exchange rate globally over a sufficiently extensive period of time -four or five months according to the model- and it is this observation of the exchange rate which has influenced movements in interest rates.

Although cointegration techniques have not been used for the specification of the reaction function, an a posteriori assessment of the model can be made in terms of the degree of integration of the variables. All the variables intervening in the model are I(O). Interest-rate changes, as is usually the case for a variable of this type, are stationary. Deviations from short-term ALP targets are also stationary since the Bank of Spain has reconsidered its targets monthly to adapt them progressively to the levels attained by the aggregate. It is not the same for long-term targets, which are normally reconsidered only once a year; here, in relation to the monthly ALP values, deviations of a specific sign usually persist for relatively long periods. However, what emerges in the reaction function is the first difference of such deviations, which is a I(O) variable. The ipc variable, meanwhile, is transformed in the model by means of a first regular difference and a first seasonal difference. In the five-year period addressed in the model, this transformation seems sufficient to make the price index stationary. Lastly, the growth rates of the exchange rate variables are I(O), as is usually the case with prices negotiated on foreign exchange markets.

Although the size of the sample is not big enough to make reliable tests of model stability, the subsample-based estimations made show the parameters to have a considerable degree of constancy; and nor do problems of autocorrelation, absence of normality or heteroskedisticity in the residuals arise (see Table 3 and Chart 9). Nonetheless, model instability problems would undoubtedly have arisen had the exchange rate factor not been segmented in three variables. Moreover, when data from the first half of 1989 are incorporated, there is a perceptible and significant reduction in the value of the parameters for deviations from the money supply targets and an increase in the value for the inflation rate, even though the model just passes a post-sample stability test.

Chart 9

ANALYSIS OF REACTION FUNCTION RESIDUALS



The model incorporates two types of deterministic variables: first, an inaccurately estimated constant which is the least stable parameter of the model; and second, two impulse-type dummy variables (MY87 and NO87), since in two months of the sample period analysed there were marked changes in the marginal interest rate that cannot be adequately attributed to the model's exogenous variables. In May 1987, against a very complex monetary background[24], the Bank of Spain opted for a strategy of staggered

[24] See Bank of Spain's 1987 "Informe Anual" (pp. 69-84).

interest-rate rises. This was an atypical move compared with what had been the habitual behaviour of the monetary authorities in the period under study. In November that same year, in response to the great uncertainty prevailing and the financial instability generated by the stock market crash, the Bank of Spain cut its intervention rate by a margin that was likewise not habitual.

3.3 Monetary control episodes within the framework of the estimated reaction function

The results of the estimated reaction function have been used to characterise on a period-by-period basis the different episodes marking the behaviour of the Bank of Spain's intervention interest rates from mid-1984 to end-1988. With all due precaution in the performance of such an exercise being taken, the aim is to determine how the Bank of Spain's reaction variables trended, as the model establishes they were observed, in each period in which differentiated behaviour in interest-rate policy is detected.

Table 4 presents the findings of this exercise. Seven periods have been identified in terms of the course of the endogenous variable of the reaction function: the marginal interest rate on discount window loans.

Two periods are discerned in which the stability of this interest rate prevails, without significative changes in level: the first runs from the second half of 1984 through the first quarter of 1985; the second covers the whole of 1986. Likewise, two episodes marked by intense reductions in the interest rate are identified: the first is from August to December, 1985; the second covers the second half of 1987 and the first half of 1988. Lastly, three periods in which upward-trending rates prevail are identified: the first, with rises of some size, from April to July, 1985; the second, with very intense interest rate rises, during the first half of 1987; and the third, with more modest rises, during the second half of 1988.

These seven periods are characterised in the fourth column of Table 4 in terms of the monthly change which, on average, the marginal rate has undergone in each. These average changes are adjusted in the fifth column by the estimated deterministic factors which intervene in the model. As a result, these adjusted values are easier to compare with the part explained by the reaction variables. The contribution of these variables is presented in the last three columns. This contribution is expressed in terms of the average monthly change in the intervention rate explained in each period, respectively, by the deviations from the money supply targets, by the ipc and by the exchange rate, in accordance with the dynamics and parameters estimated in the model. Some conclusions may be elicited from the results in Table 4:

1. The two periods of high interest-rate stability nevertheless conceal dissimilar behaviour by the reaction variables. In the first period (August 1984 to March 1985) stability was the outcome of the compromise between the unfavourable behaviour of ALP, which evidenced significant upward deviations in relation to targets, and the positive path of the CPI (the exchange rate was not yet a reaction variable). In the second period (1986), though, this stability was in response to the essentially neutral behaviour of all the variables: ALP, the CPI and the exchange rate alike.

2. The two episodes of interest-rate falls identified in the sample are characterised by the intensity of the cuts and in that they were accompanied by a more favourable CPI performance in the preceding months. In the first period (the second half of 1985) the fall in rates was further prompted by appreciable -though not very intense- downward deviations in relation to ALP targets. In the second period (the second half of 1987 and the first half of 1988) it was, rather, the behaviour of the exchange rate -with strong appreciation by the peseta in the preceding months- which, together with the CPI, brought about the fall in rates. The poor performance of ALP, meanwhile, mitigated the scale of the cuts. Nonetheless, it is in this second period that the part not explained by the reaction function variables is greater. Two events can help explain this phenomenon. First, the conjunction of financial disturbances which weakened the informativeness of ALP, whereby the Bank of Spain disregarded somewhat the upward deviations in relation to the targets set for this aggregate. Second, following the stock market

crisis in November 1987, the risk of a worldwide economic depression triggered widespread interest-rate cuts by most central banks.

3. In line with the foregoing, it may be pointed out that the estimated reaction function appears to detect better the episodes of interest-rate rises and stability than of falls. With regard to interest-rate falls, factors not incorporated into the specification and related to the economic cycle and/or the stability of financial markets may have played a relevant role.

4. The two episodes of intense interest-rate rises can essentially be explained by the strong upward deviations in relation to ALP targets. In the first period (April-June, 1985) the contribution of the CPI was virtually neutral. In the second period (the first half of 1987), by contrast, it checked the rising trend of rates. The increase in the level of the intervention rate in this latter period was, in any event, on a very large scale: 1.24 points on average per month for six consecutive months. This was because first, the deviations from ALP targets acquired an abnormal intensity; and second, the behaviour of the exchange rate of the peseta in the preceding months initially facilitated this strategy (from August 1986 to March 1987 the peseta depreciated heavily vis-à-vis the EC by about 7% in nominal terms). The subsequent appreciation of the peseta prompted the change in sign in interest-rate movements (see the last two lines of Table 4).

Table 4

CHARACTERISATION BY PERIOD OF THE BEHAVIOUR OF THE BANK OF SPAIN INTERVENTION RATE

	Interest-rate circumstances	Number of months	Average monthly change in TM	Adjusted average change in TM (1)	Contribution CPI	Contribution ALP	Contribution ER
August 84 **March 85**	STABILITY	8	-0.04	+0.17	-0.16	+0.37	
April 85 **July 85**	APPRECIABLE RISE	4	+0.49	+0.70	+0.05	+0.67	
August 85 **December 85**	INTENSE FALL	5	-0.75	-0.54	-0.18	-0.10	
January 86 **December 86**	STABILITY	12	+0.10	+0.31	+0.04	+0.12	+0.03
January 87 **June 87**	INTENSE RISE	6	+1.24	+1.22	-0.32	+1.09	+0.63
July 87 **June 88**	INTENSE FALL	12	-0.72	-0.45	-0.11	+0.25	-0.25
July 88 **December 88**	MODERATE RISE	6	+0.26	+0.47	+0.19	+0.06	-0.15

(1) Average monthly change in TM adjusted for the value of the constant and of the model's intervention variables.

3.4 Possible extensions of the reaction function

This section explores several ways of extending the estimated reaction function. As indicated earlier, limitations as to the degrees of freedom influenced the equation specification and estimation process. It was opted to formulate a concise specification in which, by means of simple response functions, a limited number of parameters and few variables, the essence of the information systematically used by the Bank of Spain for modifying its intervention interest rate could be detected.

Taking as a starting point the results of the equation estimated in section 3.2 in accordance with this formulation, this section addresses possible extensions of this equation in a dual direction[25].

First, Bank of Spain response functions that are more complex than the linear reaction mechanisms of the basic equation presented in section 3.2 will be tested. Specifically, tests will be made for the existence of asymmetrical or non-proportionate responses with regard to changes in any of the reaction variables.

Second, a check will be made as to whether variables not incorporated in principle into the reaction function might have had systematic influence on the Bank of Spain's decisions. On selecting the set of reaction variables in section 3.1, an implicit assumption was made of a monetary policy implementation model clearly oriented to controlling inflation -reacting either directly to the behaviour of inflation or indirectly through the deviations from money supply targets-, with an added concern for the behaviour of the exchange rate. Therefore, within the framework of a monthly decision-making process in terms of an interest-rate instrumental variable, the possibility was discarded that the change in the Bank of Spain intervention rate might be in response to the behaviour of variables such as those reflecting the course of the real sector of the economy (the industrial production index (IPI), unemployment, the balance of payments on current account), other monetary variables (domestic credit to households and firms,

[25] The sample period used for the different tests provided below incoporates six new observations relating to the first half of 1989 so as to obtain a greater number of degrees of freedom.

foreign reserves) or variables summarising the economic and financial activity of the State (budget deficit, borrowing from the Bank of Spain, changes to interest rates on government debt issues). It will be sought in this section to check "a posteriori" whether there are signs that the "a priori" exclusion of the reaction function of any of these variables might not have been apt.

3.4.1 Asymmetrical responses

An initial exercise was performed to address the possibility of an asymmetrical response by intervention interest rates in the presence of changes of dissimilar signs in some of the reaction variables of the model presented in Table 3. This possible asymmetry was taken into consideration for the case of short-term deviations from the money supply targets, long-term deviations from these same targets and changes in the annual inflation rate. The exercise was not performed for the exchange-rate variables given the limited number of observations available for each of them.

The procedure for the asymmetrical response test was as follows. Each of the reaction variables was broken down into two according to the positive or negative value it took in each observation. Thus:

$$[alp\text{-}alp^{oc}]_t^+ = \begin{cases} (alp\text{-}alp^{oc})_t & if\ (alp\text{-}alp^{oc})_t \geq 0 \\ 0 & if\ (alp\text{-}alp^{oc})_t < 0 \end{cases}$$

$$[alp\text{-}alp^{oc}]_t^- = \begin{cases} (alp\text{-}alp^{oc})_t & if\ (alp\text{-}alp^{oc})_t < 0 \\ 0 & if\ (alp\text{-}alp^{oc})_t \geq 0 \end{cases}$$

$$[\Delta(alp\text{-}alp^{ol})]_t^+ = \begin{cases} \Delta(alp\text{-}alp^{ol})_t & if\ \Delta(alp\text{-}alp^{ol})_t \geq 0 \\ 0 & if\ \Delta(alp\text{-}alp^{ol})_t < 0 \end{cases}$$

$$[\Delta(alp-alp^{ol})]_t^- = \begin{cases} \Delta(alp-alp^{ol})_t & if\ \Delta(alp-alp^{ol})_t < 0 \\ 0 & if\ \Delta(alp-alp^{ol})_t \geq 0 \end{cases}$$

$$[\sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i}]^+ = \begin{cases} \sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i} & if\ \sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i} \geq 0 \\ 0 & if\ \sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i} < 0 \end{cases}$$

$$[\sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i}]^- = \begin{cases} \sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i} & if\ \sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i} < 0 \\ 0 & if\ \sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-i} \geq 0 \end{cases}$$

Once these variables were constructed, the following equations were estimated:

$$\Delta\ TM_t = (\beta_1^+ + \beta_2^+ L)\ [alp-alp^{oc}]_t^+ + (\beta_1^- + \beta_2^- L)\ [alp-alp^{oc}]_t^- + f_1(.) \qquad (1)$$

$$\Delta\ TM_t = \beta_3^+[\Delta(alp-alp^{ol})]_{t-1}^+ + \beta_3^-[\Delta(alp-alp^{ol})]_{t-1}^- + f_2(.) \qquad (2)$$

$$\Delta\ TM_t = \beta_4^+[\sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-1}]^+ + \beta_4^-[\sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-1}]^- + f_3(.) \qquad (3)$$

where $f_1(.)$, $f_2(.)$ and $f_3(.)$ denote the set of determinants of the reaction function, in accordance with the specification of Table 3, that are other than the variable broken down in each case.

On the basis of the results of the estimation of equations (1) to (3) and of those obtained for the basic specification in section 3.2., information can be obtained regarding the degree of symmetry of the response to the reaction variables testing the null hypothesis that $\beta^+ = \beta^-$ by means of a standard test of F. Table 5 details the results of the tests. The second column gives the value of the parameter relating to each of the variables of the basic specification; for the case of alp-alp^{oc} (a variable affected by two parameters), what is provided is the sum of the parameters β_1 and β_2. The third and fourth columns provide the values β^+ and β^- obtained in the estimation of equations (1) to (3). Lastly, the fifth and sixth columns present the value of the test of the F and its critical value at 5%, respectively.

Table 5

ASYMMETRICAL RESPONSE TESTS

	ß	**β^+**	**β^-**	**Value of the statistic**	**Critical value at 5%**
alp-alp^{oc}	0.71	0.87	0.54	F(2,48) 2.42	3.19
alp-alp^{ol}	0.20	0.18	0.22	F(1,49) 3.27	4.04
ipc	0.27	0.08	0.42	F(1,49) 5.80	4.04

As Table 5 shows, the hypothesis of symmetrical response to positive or negative deviations from ALP targets is not rejected, either for the short- or long-term targets. However, this does not occur with the changes in the year-on-year inflation rate: the negative values for this variable are affected by a significantly greater parameter than that for positive observations. This might be a sign that in the 1984-1988 period there was a certain propensity to react rapidly, lowering the level of interest rates in the presence of initial gains in terms of the reduction of the inflation rate.

3.4.2 Non-proportionate responses

The second extension of the basic equation tested consists of exploring the possibility that the intervention rate response to variables of the deviations from money supply targets and from the price level is not proportionate; i.e. the intensity of the response depends on the scale of the deviations from ALP targets or on the scale of the deviations from the annual inflation target.

The test was performed as follows. It was assumed that the parameters of the reaction function depend on the absolute value that the corresponding variable takes in accordance with a simple functional relationship. Thus, for a generic reaction variable x_t, $\beta=\gamma_0+\gamma_1|x_t|$, where $|x_t|$ is the absolute value of x_t. Under this assumption, the following equations were estimated:

$$\Delta TM_t=(\gamma_{01}+\gamma_{02}L)(alp-alp^{oc})_t+(\gamma_{11}+\gamma_{12}L)[(alp-alp^{oc})_t|(alp-alp^{oc})_t|]+g_1(.) \quad (4)$$

$$\Delta TM_t=\gamma_{03}\Delta(alp-alp^{ol})_{t-1}+\gamma_{13}[\Delta(alp-alp^{ol})_{t-1}|(alp-alp^{ol})_{t-1}|]+g_2(.) \quad (5)$$

$$\Delta TM_t=\gamma_{04}\sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-1}+\gamma_{14}[\sum_{i=1}^{3}\Delta\Delta_{12}ipc_{t-1}|\sum_{1=1}^{3}\Delta\Delta_{12}ipc_{t-1}|]+g_3(.) \quad (6)$$

where $g_1(.)$, $g_2(.)$ and $g_3(.)$ reflect the set of reaction function determinants, in accordance with the specification of Table 3, other than the variable to which the non-proportionate effect is applied in each case. Verification as to the hypothesis of non-proportionality from equations 4 to 6 arises immediately testing the significativeness of the parameters γ_1; note that if the null hypothesis that $\gamma_1=0$ is not rejected, equations 4 to 6 are equivalent to the equation in Table 3. If γ_1 differs significatively from 0 and is positive, then we would be faced with an intervention rate response that were more than proportionate to the values the related reaction variable takes; alternatively, if γ_1 is negative, the response will depend inversely on the scale the reaction variable takes.

Table 6 presents the results of these tests. The second column presents the value of the parameter corresponding to each of the variables of the basic specification; as in the previous section, for the case of alp-alp$^{\infty}$ it is the sum of the parameters comprising its response function that is provided. The third and fourth columns furnish the values of γ_0 and γ_1 obtained in the estimation of equations 4 to 6. Lastly, the fifth and sixth columns present, respectively, the value of the tests -an F for alp-alp$^{\infty}$ and a t for the other two values- and their related critical values at 5%.

Table 6

NON-PROPORTIONATE RESPONSE TESTS

	ß	γ_0	γ_1	Value of the statistic	Critical value at 5%
alp-alp$^{\infty}$	0.71	0.35	0.40	F(2,48) 3.60	3.19
alp-alp^{01}	0.20	0.13	0.13	t(49) 1.12	2.01
ipc	0.27	0.13	0.07	t(49) 0.37	2.01

The non-proportionate response hypothesis can be seen to be rejected in the case of deviations from the long-term ALP targets and deviations from the annual rate of inflation. By contrast, the hypothesis for deviations from the short-term ALP targets is not rejected, it being detected that the degree of response of the rates will depend positively on the scale of the deviations. This result would indicate that the Bank of Spain has given little importance to small-scale deviations from monthly ALP targets that might be the outcome of relatively irrelevant transitory disturbances. Further, the larger these deviations, the greater the intensity of the Bank of Spain's response.

3.4.3 Response to the behaviour of real-sector variables

In the mid-seventies, the main response by most western countries to the inflationary pressures triggered by the oil crisis was to pursue tight monetary policies. Thereafter, the use of monetary control tools as a systematic instrument for boosting economic activity has become progressively more infrequent owing to the belief that they have an essentially transitory effect. This does not mean that at specific junctures, when recessionary risks appear patent, the economic authorities have made financing to the private sector largely and relatively cheaply available.

The belief that this type of conduct prevailed in the monetary policy measures pursued by the Spanish authorities in the eighties led to the discarding of variables measuring real-sector results as arguments of the reaction function of section 3.2. In the Spanish case a second factor supports the exclusion of this type of variable from the aforementioned function: key data on the real sector become available at considerable delay, whereby it is unlikely that they can play a systematic role in a monthly decision-making process.

That said, a test has been performed on the possible influence of this type of economic variable in changes to the Bank of Spain intervention interest rate, taking as a reference the most relevant real-sector variables for which monthly information is available.

First among these is the industrial production index (IPI), published monthly by the Spanish National Statistics Office. Since this series is subject to frequent revisions of some scale, the same procedure as that for other variables used in previous sections is adopted,taking the values observed by the authorities at each moment in time.

The second variable selected is officially registered unemployment, figures for which are published by the Ministry of Labour. This variable has been taken in original form (PR) -the number of people unemployed- and in terms of the unemployment rate (TP), using the quarterly data from the Spanish labour force survey as a denominator.

Lastly, the third variable used for this test was the current-account balance, based on the Bank of Spain's foreign transactions cash-basis data. The correction of the external deficit is undoubtedly one of the main goals of economic policy. It is unlikely, however, that it should be a reaction mechanism for short-term monetary policy decisions. In any event, there may be grounds for considering that the information furnished by the current-account balance is relevant for a monetary policy concerned with the behaviour of inflation and the exchange rate. A persistently high external deficit is a sign of the pressure of domestic demand, above and beyond the economy's production capacity, which may result in upward pressure on the level of prices; in parallel, the course of the current account, if not offset by changes in the non-bank resident private sector's financial position vis-à-vis the external sector, ultimately exerts pressure on the exchange rate and affects the growth of liquidity. The data for the current-account balance have been taken both in terms of monthly flow (BCC) and accumulated flow since the beginning of the year (SBCC).

Table 7

TESTS OF RESPONSE TO REAL-SECTOR VARIABLES

	Tranformation of the variable	**Significativeness**		
		1 lag t(49)	**1-3 lags F(3,47)**	**1-5 lags F(5,45)**
IPI	$\Delta\Delta_{12}\ln IPI$	0.21	0.12	0.12
BCC	$\Delta\Delta_{12}BCC$	0.32	0.04	0.36
SBCC	$\Delta\Delta_{12}SBCC$	0.63	0.21	0.55
PR	$\Delta\Delta_{12}PR$	0.82	0.34	0.41
TP	$\Delta\Delta_{12}TP$	0.04	0.30	0.38
Critical value 5%		2.01	2.80	2.42

Table 7 reports the findings of the tests. The first and second columns present the related variables and the transformations applied thereto on incorporating them into the reaction function[26]. The third column presents the t-significativeness test for the parameter of response to each of the variables, which lag by a period[27]. The fourth and fifth column report a test of the F of overall significativeness of the first to third lags and first to fifth lags, respectively.

As can be seen, the results of the tests coincide with the initial formulation whereunder none of the real-sector variables considered have had systematic incidence on the monthly process of monetary policy decision making in terms of the Bank of Spain intervention interest rate.

3.4.4 Response to the behaviour of public-sector variables

The economic and financial activity of the State may serve as a weighty conditioning factor for monetary policy decision-making. Indeed, in countries with relatively undisciplined monetary systems, central banks habitually have to subordinate their monetary control measures to the task of financing budget deficits. In principle, such conduct cannot be said to be generally applicable to the case of Spain in the period under study (1984-88). In view of the strong growth of the State borrowing requirement in the early eighties, the economic authorities decided to create mechanisms enabling budget deficits to be financed and the growing outstanding balance of government debt to be absorbed without excessive interferences for monetary control. This underlay the decision, in early 1984, to create an obligatory requirement for the banking system to invest in Treasury notes and to ratchet up the level of the cash reserve requirement. Additionally, the range of liabilities eligible for reserve requirement purposes was extended. Along these lines was the decision to grant a privileged tax treatment to Treasury

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[26] These transformations convert these variables into stationary series, which is necessary given that the endogenous variable of the reaction function, ΔTM, is stationary. Moreover, these transformations generally coincide with the form in which it appears logical that the economic authorities should observe these variables.

[27] In the case of the IPI, the variable lags by two periods given the greater lapse before these data become available.

notes in relation to the other financial assets as from May 1985. All these measures introduced considerable dysfunctions and inefficiencies into the Spanish financial system; however, the economic authorities opted for this strategy, with its ensuing costs, to preserve monetary policy from the expansive nature of budgetary policy so that the former could be used as the main instrument to control inflation and, at the same time, ensure cheap financing of the budget deficit.

The aforementioned measures reflect the economic authorities' intentions; yet the possibility (prevalent throughout the period under study) that the Treasury might resort to borrowing unrestrainedly and at no cost from the Bank of Spain entailed at certain junctures a distortion -at least in the short term- for the implementation of monetary policy. Further, the State has, during the period under study, essentially financed itself through short-term borrowing on domestic markets. This, combined with the fact that the monetary aggregate subject to control in Spain is a broad definition of liquidity, has meant that a large portion of budget deficits have been monetised. The raising of public finance on the short-term markets has required concertation by the Treasury and the Bank of Spain -whose field of action is also centred on the short-term markets- as to interest rate decisions; whenever such co-ordination has proven insufficient, it has been difficult to ensure stable market activity.

All these factors suggest that the financial activity of the State has conditioned the Bank of Spain's monetary policy decisions. This section purports to check whether these conditioning factors have become so persistent that they may be viewed as a systematic response factor within the Bank of Spain's intervention rate reaction function. Accordingly, variables reflecting different aspects of the State's financial activity have been constructed.

First, a synthetic indicator of the interest rate applied by the State at its government debt auctions (TD) was constructed. This indicator is defined as the weighted average of the marginal interest rates at which the auctions of the government-debt instruments (bonds, debentures and Treasury bills and notes) have been allotted. The weighting factor is the volume of the related gross issues. As from June 1985, Treasury notes -the rate on which drew progressively away from the ruling money market rates after such date- have been excluded from the calculation of the indicator.

Second, variables measuring the volume of financing for the State have been considered. To assess the behaviour of the State from the standpoint of the budget deficit and its means of financing, the Bank of Spain makes monthly projections in which the State borrowing requirements accumulated in the period elapsed during the year, and its financing structure, are extended with forecasts for the rest of the year. The datum thus obtained is evaluated in terms of its deviation from the target for the whole year which resulted from the Budget and which was duly used in the Annual Monetary Targeting exercise by the Bank of Spain[28]. Specifically, information on deviations in terms of the State's net borrowing requirement (DONF) and of borrowing by the Treasury from the Bank of Spain (DORE) was taken from these monthly projections. Given the strongly normative nature that the references set for these magnitudes often present, the variables of net State borrowing requirements accumulated during the year and Treasury borrowing from the Bank of Spain have been taken into equal consideration without expressing them as a deviation from a target (NF and RE); they have simply been posited in relation to the behaviour recorded in the same period of the previous year.

The results of the tests with all these variables are reported in Table 8. The method applied was the same as in the previous section.

[28] A detailed description is given in Fernández de Lis (1988) of how the forecasts of the State deficit and its related financing mechanisms are integrated into the set of intersectorial financial flows comprising the Annual Monetary Targeting exercise performed by the Bank of Spain.

Table 8

TESTS OF RESPONSE TO PUBLIC-SECTOR VARIABLES

	Transformation of the variable	Significativeness		
		1 lag t(49)	1-3 lags F(3,47)	1-5 lags F(5,45)
TD	ΔTD	1.15	2.16	1.76
DONF	ΔDONF	1.35	0.73	0.99
DORE	ΔDORE	1.63	4.00	3.28
NF	$\Delta\Delta_{12}$NF	1.95	1.23	1.55
RE	$\Delta\Delta_{12}$RE	0.46	0.62	0.89
Critical value 5%		2.01	2.80	2.42

Having considered the foregoing results as a whole, there can be said to be signs that the financial behaviour of the State was a relatively persistent conditioning factor for Bank of Spain interest-rate decisions. Nonetheless, the results are by no means conclusive: the values the statistics take are close in several cases to the critical value at 5%, but it is only in the case of the DORE variable that they amply exceed it.

3.4.5 Response to the behaviour of money supply counterparts

This last section addresses other money supply counterparts which, at very specific junctures, may have furnished additional information to that provided by the variables previously included in the reaction function.

First, the adjusted domestic credit variable measuring financing granted by the credit system to households and firms (CEF) was taken. Given the frequent revisions to this series, the same procedure as for previous cases was used, drawing on the historical data observed at each moment by the authorities.

Second, the behaviour of foreign reserves was considered, which may be viewed as an indicator of the pressure exerted on the peseta on foreign exchange markets. However, it should be highlighted that for this variable to provide accurate information on such pressure, the authorities must pursue a high degree of exchange-rate stability; it would not seem, in principle, that this was the case for the period under study. The central bank foreign reserves variable has been taken in terms both of monthly flow (RC) and accumulated flow since the beginning of the year (SRC).

Table 9 shows the test performed with these variables following the same methodology as in previous sections.

Table 9

TESTS OF RESPONSE TO MONEY SUPPLY COUNTERPARTS

	Tranformation of the variable	Significativeness		
		1 lag t(49)	1-3 lags F(3,47)	1-5 lags F(5,45)
CEF	$\Delta\Delta_{12}\ln CEF$	0.51	0.95	1.22
RC	ΔRC	0.42	0.14	0.48
SRC	$\Delta\Delta_{12}SRC$	0.05	0.11	0.26
Critical value 5%		2.01	2.80	2.42

The results clearly demonstrate that these variables would not appear to have had a systematic effect on the Bank of Spain's interest-rate decisions during the period analysed.

4. Conclusions

This research shows that in Spain in the mid-eighties there was a change in the instrumental variable of monetary control. From a system of quantities, represented by a liquidity creation process based on the money multiplier outline, there was a switch to an interest-rate system.

Section 2 furnishes empirical evidence of the unsuitability of the liquidity creation equation since the mid-eighties. It is not possible in this section to obtain a stable functional form as from 1984 despite experimenting with alternative formulations with which it was attempted to detect the incidence of new factors on fluctuations of the money multiplier.

These instabilities have been prompted by changes in the behaviour of private agents -banking institutions and the public alike. The distortions introduced by these phenomena when instrumenting bank reserves paths, together with other more general considerations on the design of monetary policy, have ultimately moved the Bank of Spain towards a new instrumental system.

In short, there has been a more or less gradual shift from control of quantities to control of interest rates. Given these circumstances, the determination of a reaction function in relation to an interest rate on which the authorities can exert direct control is one means of restoring an equation that summarises the behaviour of the central bank. In Section 3 of this paper, a reaction function has been estimated for the marginal interest rate on monetary regulation (discount window) loans for the period from 1984 to 1988. In 1989 Spanish membership of the ERM, the subsequent setting of ceilings on the growth of bank credit and changes in the monetary control instruments in early 1990 all led to far-reaching changes in the overall design of Spanish monetary policy (see Malo de Molina and Pérez, 1990 and Escrivá and Malo de Molina, 1991). Unquestionably, such changes must have altered the reaction function of the monetary authorities in relation to the specification presented in this paper. Once a sufficiently lengthy timespan is available, then will it be time to assess the scale of these alterations and the effect of the credit restrictions in force during the second half of 1989 and 1990.

The arguments of this function are the main variables that have triggered the Bank of Spain's reactions to modify the degree of intensity in monetary control: deviations from money-supply targets and changes in the inflation rate and in the exchange rate of the peseta. The results elicited may be considered acceptable in terms of the stability and interpretability of the parameters obtained, taking account of the limitations of the sample size.

During the 1984-1988 period, the Bank of Spain reacted systematically to deviations from its ALP targets, changing the level of its basic intervention interest rate. This reaction to the behaviour of the quantitative targets has been determined by both the evaluation of deviations in relation to the annual reference path of ALP and by deviations in relation to the annual reference path of ALP and by deviations from shorter-term targets likewise established by the Bank for this aggregate.

In parallel, the monetary authorities have also drawn on the observed course of the economy's inflation rate. Thus, in the reaction function of the Bank of Spain's intervention rate, it is estimated that changes in this rate correspond to the behaviour of price levels.

Lastly, the exchange rate of the peseta is the third variable that appears as an argument of the reaction function. Nonetheless, the estimations made reveal that the exchange rate did not constitute a specifically systematic reaction factor for the monetary authorities prior to 1986. Thereafter, with Spanish EC membership, the nominal exchange rate of the peseta vis-à-vis the Community countries began to play a major role in monetary policy decision making. Thus, in the estimation of the reaction function, it is possible to detect as from 1986 a systematic pattern of response by the interest rate in the presence of movements by the exchange rate of the peseta against the EC. And, subsequently, since mid-1987, the authorities' response has been governed essentially by the behaviour of the D-Mark.

The results of the estimated reaction function have been used to characterise period-by-period the different episodes in the behaviour of the Bank of Spain's intervention interest rate during the five years under study.

It becomes clear that the function fits better periods of interest-rate stability and rises than interest-rate falls. Equally noteworthy, the episodes marked by intense interest-rate rises are usually accompanied by strong deviations from ALP targets, while episodes marked by falls occur in periods when the behaviour of the CPI is favourable.

Lastly, possible extensions to the reaction function were experimented with, taking into consideration factors whose introduction into the function is, in principle, uncertain. First, the existence of asymmetrical or non-proportionate responses was analysed. Signs of an asymmetrical response in the case of inflation and of a non-proportionate response in the case of deviations from short-term ALP targets were obtained. Next, it was tested whether variables not incorporated in principle into the reaction function might have had a systematic influence on the Bank of Spain's decisions. Positive results were not obtained for real variables (industrial production index, unemployment, current-account balance), for money supply counterparts (domestic credit to households and firms) or for counterparts of bank reserves (foreign reserves). By contrast, signs were obtained that certain variables measuring specific aspects of the State's financial policy may have had more or less systematic influence on the Bank of Spain's interest-rate decisions.

Appendix 1: derivation of the ALP multiplier

The following formulation of the multiplier is analogous to that for the case of M3 in the research by Mauleón, Pérez and Sanz.

It is based on the following definitions:

ALP : Liquid assets held by the public
E : Cash held by the public
DBE : Bank of Spain deposits
DC : Deposits at mutual credit institutions
PC : Eligible liabilities
AE : Eligible liabilities not included in ALP
TP : Government securities
OS : Insurance transactions
OANC : Other non-eligible liquid assets

Accordingly, the definition of ALP is given by the expression:

$$ALP = E + DBE + DC + PC - AE + TP + OS + OANC\ .$$

Dividing the above equation by PC and rearranging terms gives

$$ALP = (1 + k + h + n - a + t + o + s)\ PC\ ,$$

where

$$k = \frac{E}{PC}\ , \quad h = \frac{DBE}{PC}\ ,$$

$$n = \frac{DC}{PC}\ , \quad a = \frac{AE}{PC}\ ,$$

$$t = \frac{TP}{PC}\ , \quad o = \frac{OS}{PC}\ ,$$

and

$$s = \frac{OANC}{PC} .$$

Additionally, if

$$m = \frac{AC}{PC} ,$$

is taken, the basic expression of the multiplier is obtained:

$$ALP = \frac{1 + k + h + n - a + t + o + s}{m} AC .$$

If the subindex α is used to refer to the entities subject to compliance with the reserve requirement, and the subindex ß to highlight entities which, owing to their particular status, are exempt from this requirement, we could write:

$$m = \frac{AC_\alpha + AC_\beta}{PC} = r_\alpha \theta + r_\beta (1 - \theta) , \text{ where}$$

$$r_\alpha = \frac{AC_\alpha}{PC_\alpha},$$

$$r_\beta = \frac{AC_\beta}{PC_\beta}, \; y,$$

$$\theta = \frac{PC_\alpha}{PC} .$$

For entities in group α, i.e. subject to compliance with the reserve requirement, their legal-cash and excess-reserves ratios can be distinguished, whereby

$$m = (q + e_{\alpha}) \theta + r_{\beta} (1 - \theta) .$$

Substituting the above equation into that of the multiplier, taking logarithms, differentiating and approximating in discrete time, the following expression is arrived at:

$$\Delta \ln(ALP) = \frac{\Delta k + \Delta h + \Delta n - \Delta a + \Delta t + \Delta o + \Delta s}{1 + k + h + n - a + t + o + s} -$$

$$- \frac{\theta (\Delta q + \Delta e_{\alpha}) + (q + e_{\alpha} - r_{\beta}) \Delta \theta + (1 - \theta) \Delta r_{\beta}}{m} +$$

$$+ \Delta \ln(AC) .$$

Since bank reserves can be held in deposits at the Bank of Spain or in cash (currently, cash is not an eligible asset), the following expression can be obtained for entities not subject to the reserve requirement:

$$r_{\beta} = re_{\beta} + rd_{\beta} = \frac{E_{\beta}}{PC_{\beta}} + \frac{DE_{\beta}}{PC_{\beta}}$$

where E_{β} and DE_{β} are the cash of these entities and the deposits held at the Bank of Spain while re_{β} and rd_{β} are their cash and deposits coefficients, respectively.

Differentiating the above expression and approximating in discrete time gives

$$\Delta r_\beta = \Delta re_\beta + \frac{\Delta DE_\beta - rd_\beta \, \Delta PC_\beta}{PC_\beta}$$

and, finally

$$\frac{1 - \theta}{m} \Delta r_\beta = \frac{1 - \theta}{m} \Delta re_\beta + \frac{1}{AC} \Delta DE_\beta - \frac{1}{AC} rd_\beta \, \Delta PC_\beta ,$$

Using this last expression and rearranging the terms accordingly, the final expression of the money multiplier is arrived at:

$$\Delta \ln(ALP) = \frac{\Delta k + \Delta h + \Delta n - \Delta a + \Delta t + \Delta o + \Delta s}{1 + k + h + n - a + t + o + s} -$$

$$- \frac{q + e_\alpha - r_\beta}{m} \Delta\theta - \frac{1 - \theta}{m} \Delta re_\beta + \frac{1}{AC} rd_\beta \, \Delta PC_\beta - \frac{\theta}{m} \Delta e_\alpha +$$

$$+ \Delta \ln(AC) - \frac{1}{AC} \Delta DE_\beta - \frac{\theta}{m} \Delta q ,$$

where the change in adjusted bank reserves is given by the expression:

$$\Delta \ln(ACC) = \Delta \ln(AC) - \frac{1}{AC} \Delta DE_\beta - \frac{\theta}{m} \Delta q .$$

Appendix 2: list of variables used in the research.

A2.1 Variables of the liquidity-creation equation.

	ALP	ACC	I1D	I1M	DIF	VOL	COCA
74 I	3798.7	188.2	7.88	11.69	-7.11	1.07	5.91
74 II	3962.1	202.9	13.20	14.28	-7.58	0.57	6.08
74 III	4142.2	215.9	12.19	12.88	-7.60	0.60	6.10
74 IV	4300.4	233.8	5.17	8.50	-8.00	0.10	6.08
75 I	4523.5	243.2	6.82	9.86	-8.15	0.36	6.01
75 II	4677.0	247.5	6.01	9.87	-8.04	5.03	6.05
75 III	4946.3	260.0	6.27	10.04	-7.77	0.52	6.07
75 IV	5136.1	266.5	7.68	10.89	-7.66	0.94	6.03
76 I	5389.0	280.1	10.73	12.85	-7.33	6.72	5.97
76 II	5565.7	289.6	8.44	10.94	-7.10	3.17	6.01
76 III	5854.0	303.7	13.23	15.39	-7.15	6.47	5.83
76 IV	6090.3	316.4	7.46	15.00	-6.49	1.71	5.68
77 I	6413.3	331.3	14.54	15.04	-6.38	7.39	5.46
77 II	6650.3	344.9	9.14	12.39	-6.38	5.84	5.15
77 III	7025.5	360.0	15.90	17.12	-5.47	7.58	5.01
77 IV	7258.5	369.0	12.91	16.83	-5.92	1.66	5.13
78 I	7582.1	386.9	9.95	13.76	-5.80	1.22	5.23
78 II	7916.1	401.5	10.57	14.54	-5.36	1.80	5.39
78 III	8408.6	422.3	11.99	15.33	-4.60	15.54	5.74
78 IV	8706.8	436.9	11.81	16.11	-5.83	10.57	5.75
79 I	9177.0	461.3	11.34	15.18	-6.56	2.94	5.75
79 II	9534.6	479.2	16.92	19.55	-6.84	19.38	5.75
79 III	9997.4	501.8	14.28	16.85	-6.81	7.61	5.75
79 IV	10328.2	519.4	10.00	12.52	-7.89	1.81	5.75
80 I	10799.1	542.9	13.79	14.11	-9.00	1.10	5.75
80 II	11176.7	559.9	16.95	17.65	-9.03	5.08	5.75
80 III	11744.1	585.1	14.14	14.61	-9.35	0.20	5.75
80 IV	12126.8	604.9	16.94	16.30	-9.83	0.11	5.75
81 I	12558.1	626.8	14.51	15.07	-9.31	1.90	5.75
81 II	12970.6	645.1	16.41	15.70	-8.51	0.05	5.75
81 III	13634.8	674.5	17.16	16.03	-7.95	0.45	5.75
81 IV	14111.6	697.7	18.17	15.53	-8.58	0.29	5.75
82 I	14753.3	729.0	14.96	14.39	-8.31	5.03	5.75
82 II	15401.7	764.2	17.52	16.10	-8.36	5.21	5.75
82 III	16194.0	792.9	15.01	15.45	-8.44	4.66	5.75
82 IV	16728.3	816.6	21.34	17.71	-8.39	1.64	5.98

	ALP	ACC	I1D	I1M	DIF	VOL	COCA
83 I	17418.6	843.1	17.26	16.40	-8.01	2.89	6.75
83 II	17998.5	858.9	20.42	20.41	-8.93	0.75	6.75
83 III	18742.5	886.9	21.73	22.86	-9.64	14.85	7.31
83 IV	19272.7	918.0	18.41	20.32	-9.85	22.53	7.75
84 I	20001.6	993.8	14.46	17.33	-9.05	10.15	16.56
84 II	20462.7	1004.6	11.82	14.39	-9.20	11.55	18.00
84 III	21537.5	1048.6	12.12	12.99	-8.67	4.14	18.00
84 IV	22081.0	1080.5	12.01	12.54	-7.08	0.56	18.00
85 I	22898.4	1119.2	11.89	12.21	-5.76	1.61	18.00
85 II	23677.7	1142.4	12.39	12.95	-6.27	4.36	18.00
85 III	24468.3	1150.8	12.24	12.65	-7.11	1.98	18.00
85 IV	25053.8	1159.8	9.92	10.16	-5.69	1.84	18.00
86 I	25930.6	1160.5	10.10	10.71	-6.00	2.49	18.00
86 II	26659.2	1133.3	12.09	12.10	-5.43	0.03	18.00
86 III	27402.3	1165.2	12.06	12.13	-5.62	0.16	18.00
86 IV	28026.8	1194.2	11.71	11.68	-4.60	0.02	18.00

A2.2 Reaction function variables.

	TM	CPI (1)	alp - alp^{oc}	alp - alp^{ol}	TCPD	TCEE	TMAR (2)
8004	17.62	15.7	0.83	0.44	78.56	76.12	69.43
8005	16.28	15.2	-0.18	0.84	77.04	76.12	69.43
8006	12.71	15.9	-0.13	-0.17	77.02	76.12	69.43
8007	12.61	15.1	0.07	0.29	75.67	76.12	69.43
8008	12.20	15.3	-0.06	0.43	74.99	76.12	69.43
8009	12.88	15.0	0.00	-0.05	73.91	76.12	69.43
8010	13.74	14.4	0.02	0.00	73.72	76.12	69.43
8011	15.24	15.3	-0.32	0.02	73.76	76.12	69.43
8012	16.75	15.2	-0.54	-0.32	72.77	76.12	69.43
8101	15.76	14.4	-0.81	-0.47	71.81	76.12	69.43
8102	12.15	14.0	-1.10	-0.84	70.60	76.12	69.43
8103	11.66	15.6	-0.19	-1.11	70.65	76.12	69.43

	TM	CPI (1)	alp − alp^{oc}	alp − alp^{ol}	TCPD	TCEE	TMAR (2)
8104	12.76	15.6	-0.03	-0.97	70.61	76.12	69.43
8105	15.19	15.4	0.34	-0.93	70.65	76.12	69.43
8106	16.34	13.7	-0.08	-0.49	70.09	76.12	69.43
8107	14.62	14.3	-0.27	-0.84	69.47	76.12	69.43
8108	15.42	14.4	-0.10	-0.96	69.04	76.12	69.43
8109	16.32	14.1	-0.04	-0.72	69.54	76.12	69.43
8110	14.58	14.4	0.12	-0.52	68.66	76.12	69.43
8111	18.40	14.3	0.38	-0.40	68.25	76.12	69.43
8112	16.04	14.4	0.32	-0.38	67.74	76.12	69.43
8201	11.27	14.5	0.09	0.21	67.61	76.12	69.43
8202	13.80	14.8	-0.09	0.09	67.69	76.12	69.43
8203	14.76	13.6	0.47	-0.09	66.24	76.12	69.43
8204	16.71	14.0	0.62	0.47	66.18	76.12	69.43
8205	16.49	15.1	1.29	1.00	66.42	76.12	69.43
8206	18.97	16.1	0.99	1.68	65.77	76.12	69.43
8207	15.03	15.3	-0.44	1.44	65.60	76.12	69.43
8208	14.22	14.7	-0.13	0.83	65.67	76.12	69.43
8209	11.53	14.0	0.43	0.69	65.86	76.12	69.43
8210	18.32	13.8	0.61	1.13	65.55	76.12	69.43
8211	19.77	13.2	0.10	1.31	64.17	76.12	69.43
8212	17.72	14.0	0.08	0.83	58.61	76.12	69.43
8301	12.80	13.6	0.29	0.05	57.77	76.12	69.43
8302	15.32	13.3	0.16	0.34	57.23	76.12	69.43
8303	15.64	12.9	-0.10	0.20	56.28	76.12	69.43
8304	19.08	12.9	0.43	-0.08	55.83	76.12	69.43
8305	21.61	11.8	0.54	0.36	55.34	76.12	69.43
8306	20.39	11.3	-0.28	0.55	54.46	76.12	69.43
8307	22.19	10.3	0.37	-0.28	53.48	76.12	69.43
8308	24.23	11.0	0.61	0.45	53.54	76.12	69.43
8309	22.91	11.8	0.93	0.70	53.34	76.12	69.43
8310	22.63	12.2	1.43	1.64	52.93	76.12	69.43
8311	21.83	13.0	0.48	2.21	52.79	76.12	69.43

	TM	CPI (1)	alp − alp^{oc}	alp − alp^{ol}	TCPD	TCEE	TMAR (2)
8312	20.57	12.2	0.00	2.70	52.69	76.12	69.43
8401	20.39	12.1	0.15	0.00	53.00	76.12	69.43
8402	18.82	11.9	-0.02	0.15	53.69	76.12	69.43
8403	18.61	12.1	0.42	-0.08	53.90	76.12	69.43
8404	18.63	11.2	0.16	0.34	54.35	76.12	69.43
8405	16.46	11.3	-0.70	0.03	54.55	76.12	69.43
8406	13.46	11.4	0.02	-0.72	54.28	76.12	69.43
8407	12.63	12.7	1.42	-0.26	53.73	76.12	69.43
8408	13.00	12.0	1.07	1.16	53.17	76.12	69.43
8409	13.00	11.4	0.58	1.09	53.26	76.12	69.43
8410	13.06	10.5	0.58	1.26	53.29	76.12	69.43
8411	12.72	10.0	-0.26	1.32	53.68	76.12	69.43
8412	12.50	9.0	0.46	0.97	53.88	76.12	69.43
8501	12.50	9.4	-0.34	0.00	53.96	76.12	69.43
8502	12.38	9.7	0.48	-0.26	53.57	76.12	69.43
8503	12.29	9.5	0.45	0.29	53.33	76.12	69.43
8504	12.69	10.2	0.64	0.45	53.65	76.12	69.43
8505	12.91	9.9	0.92	0.87	52.97	76.12	69.43
8506	13.93	8.9	1.25	0.93	52.45	76.12	69.43
8507	14.26	7.9	0.15	2.05	52.41	76.12	69.43
8508	13.51	7.3	-0.59	1.00	52.37	76.12	69.43
8509	11.49	8.3	0.22	0.39	51.57	76.12	69.43
8510	11.00	8.2	0.04	0.61	51.06	76.12	69.43
8511	10.69	8.5	-0.40	0.42	50.91	76.12	69.43
8512	10.50	8.2	0.26	-0.20	51.18	76.12	69.43
8601	10.50	9.3	0.01	0.00	51.18	76.06	69.43
8602	10.50	9.0	1.04	0.07	51.18	76.10	69.43
8603	10.98	8.6	0.66	0.77	51.18	76.22	69.43
8604	11.95	7.8	0.49	1.37	51.18	76.22	69.43
8605	11.90	7.8	-0.05	1.10	51.18	76.10	69.43
8606	11.80	8.9	1.00	1.03	51.18	75.79	69.43
8607	12.21	9.4	-0.87	1.89	51.18	76.53	69.43

	TM	CPI (1)	alp − alp^{oc}	alp − alp^{ol}	TCPD	TCEE	TMAR (2)
8608	12.25	9.5	-1.02	0.85	51.18	76.26	69.43
8609	11.93	9.5	0.09	-0.17	51.18	75.91	69.43
8610	11.68	9.3	0.13	0.08	51.18	75.58	69.43
8611	11.63	8.2	0.17	0.22	51.18	74.67	69.43
8612	11.70	8.3	0.11	0.18	51.18	74.45	69.43
8701	12.11	6.0	0.40	0.28	51.18	72.94	69.43
8702	12.52	6.0	0.65	0.00	51.18	72.24	69.43
8703	13.68	6.3	0.97	0.63	51.18	72.02	69.43
8704	15.03	6.3	0.71	1.32	51.18	72.03	69.43
8705	18.95	5.8	1.33	1.76	51.18	72.23	69.43
8706	19.13	4.9	1.12	2.00	51.18	72.90	69.43
8707	18.61	4.9	0.23	1.77	51.18	72.90	68.70
8708	17.58	4.6	0.89	1.69	51.18	72.90	67.65
8709	17.38	4.4	0.27	1.06	51.18	72.90	66.95
8710	16.56	4.7	0.82	1.18	51.18	72.90	65.79
8711	14.50	4.7	0.28	1.86	51.18	72.90	67.28
8712	13.91	4.6	0.16	2.00	51.18	72.90	67.80
8801	13.26	4.5	0.49	0.27	51.18	72.90	67.95
8802	12.26	4.3	-0.22	0.69	51.18	72.90	67.41
8803	11.35	4.5	-0.09	0.47	51.18	72.90	67.05
8804	11.00	3.9	0.45	0.38	51.18	72.90	66.27
8805	10.86	4.0	0.00	0.64	51.18	72.90	66.17
8806	10.50	4.4	0.14	0.64	51.18	72.90	66.13
8807	10.50	4.7	-0.20	0.78	51.18	72.90	66.26
8808	10.47	5.8	-0.38	0.58	51.18	72.90	65.75
8809	10.65	5.7	0.02	0.19	51.18	72.90	66.57
8810	11.38	5.2	0.29	0.14	51.18	72.90	66.05
8811	11.40	5.4	0.23	0.35	51.18	72.90	65.79
8812	12.04	5.8	0.56	0.50	51.18	72.90	64.74

(1) This variable is presented in terms of the annual rate of growth of the CPI.

(2) The inverse of this variable -the DM/PTA exchange rate- is used in the model to maintain homogeneity with the other two exchange-rate variables.

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