Monetary policy execution in Spain: key features and assessment[1]

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Introduction

The model used by the Banco de España to execute its monetary policy over the past ten years has evolved in line with the type of changes made at other central banks. Thus, since the late eighties, the Banco de España has oriented its market interventions towards using the overnight interbank rate as the operational target to guide short-term monetary policy actions. At the same time, open market operations have progressively gained in importance over this period, becoming the dominant procedure in monetary implementation techniques, while the relative significance of the reserve requirement has tended gradually to diminish.[2]

The reasons behind these changes are largely common to a number of countries, and are related, above all, to the liberalisation, integration and globalisation of financial markets at the international level. Nonetheless, the Spanish model displays certain particularities which are in response to the conditioning factors of the Spanish operational framework. Notable among these idiosyncratic features are the non-existence of credit and deposit facilities, a relatively high degree of activism in intervention by the Banco de España and the use of the principle of liquidity (and obviously, of quality as well) in selecting the collateral that is valid for financing operations with the Banco de España.

The aim of this paper is to present the Spanish monetary implementation model, to explain its conditioning factors and particularities and to evaluate its degree of effectiveness in fulfilling the functions assigned to it. Hence, the following section describes the operational framework used by the Banco de España for monetary policy implementation. In connection with its conditioning factors, there is discussion, first, of the changes in the economic and financial framework and, second, of some of the characteristics of the Banco de España balance sheet. In this respect, particular regard is paid to the liquidity generating autonomous factors. The second section evaluates the capacity of the Banco de España to steer – with the procedures available to it – short-term interest rates, and it analyses the combination of instruments used to this end. The third section draws conclusions and is followed by an annex in which a theoretical model and some empirical evidence on the functioning of the Spanish overnight interbank market is presented. Particular attention is paid in this annex to the modelling of banks' demand for bank reserves in a setting with compulsory reserve requirement.

1. Monetary policy implementation in Spain

1.1 The operational framework

The operational framework used by the Banco de España for implementing monetary policy is based on a very strict application of market criteria. This gives rise to a relatively straightforward and transparent system in which open market operations are the centrepiece for the

[1] We are grateful to Fernando Gutiérrez for comments to a previous version of this paper and to Miguel Val for providing us information used in the paper. Any errors are our own.

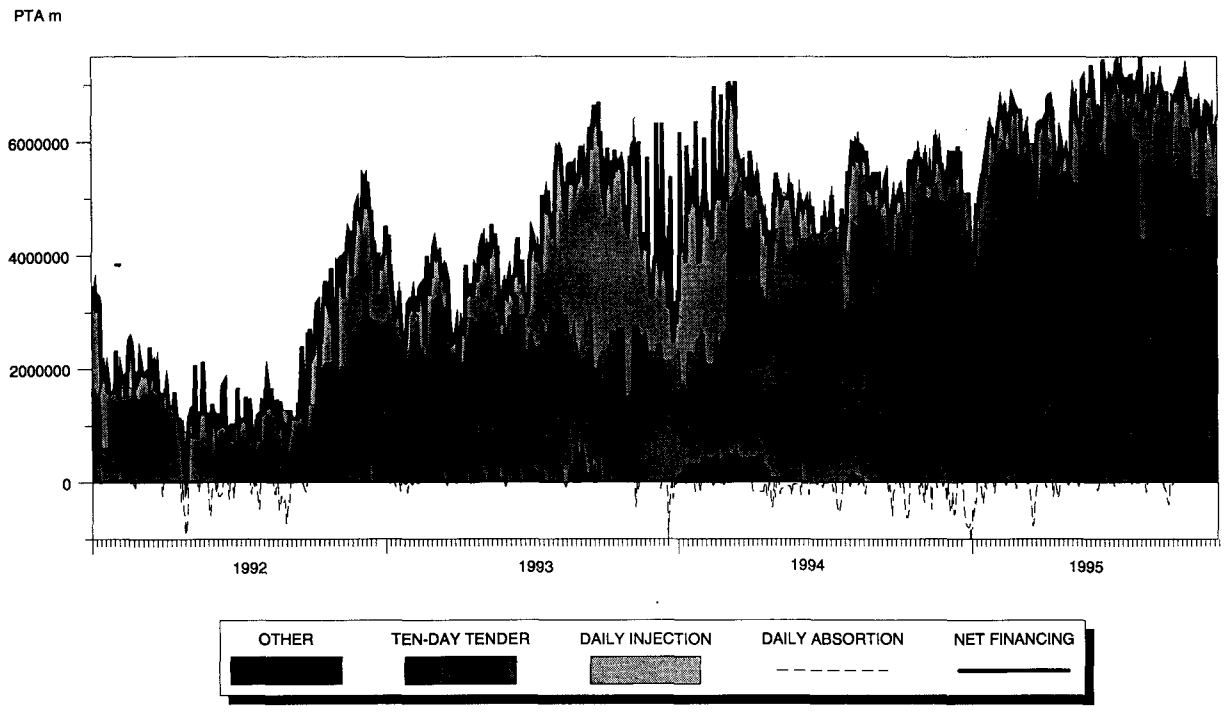
[2] On the use of open market operations in EU countries, see Aspetsberber (1995).

regulation of money market liquidity conditions. In addition, there is a non-remunerated reserve requirement which affects all credit institutions. It is set at a relatively low level (2% in recent years) and is designed with a view to assisting the liquidity management of both the Banco de España and of its counterparties. In principle, the reserve requirements (RRs) contribute to stabilising credit institutions' demand for liquidity and, indirectly, to reducing short-term interest rate volatility.[3]

The Banco de España regulates money market liquidity conditions through the close adjustment of interest rates in the shortest-dated money market terms (between one and ten days). Such intervention is structured around two major types of open market operations. First, via the calling of a ten-day repurchase tender for Banco de España certificates (CEBES by their Spanish name) and government debt in which all entities subject to RRs participate. And second, via a daily presence of the Banco de España in the markets using repo operations to inject and drain off liquidity. The same type of collateral is used as for the ten-day tender, albeit with an overnight maturity and with a limited group of entities.[4]

At the regular tenders held every ten days, the central bank supplies most of the liquidity entities will need for that period, the estimation of which is based on the foreseeable course of the autonomous factors and on the average required reserves (see Chart 1). Indeed, this type of operation is conducted in accordance with a pre-set schedule closely linked to RRs.[5] Moreover, it is in these operations that the official Banco de España interest rate is determined, through which the central bank signals the desired monetary policy stance.

Chart 1
Banco de España financing to the banking system
1992-95



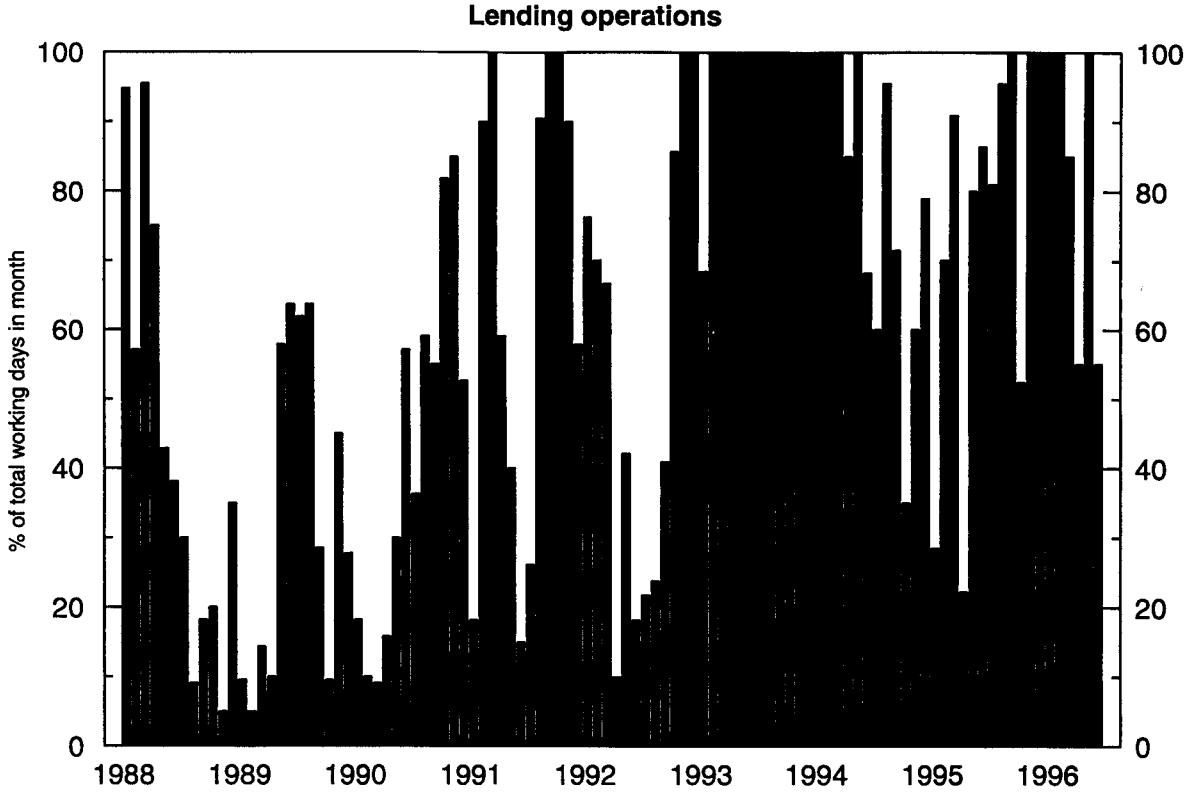
Source: Banco de España.

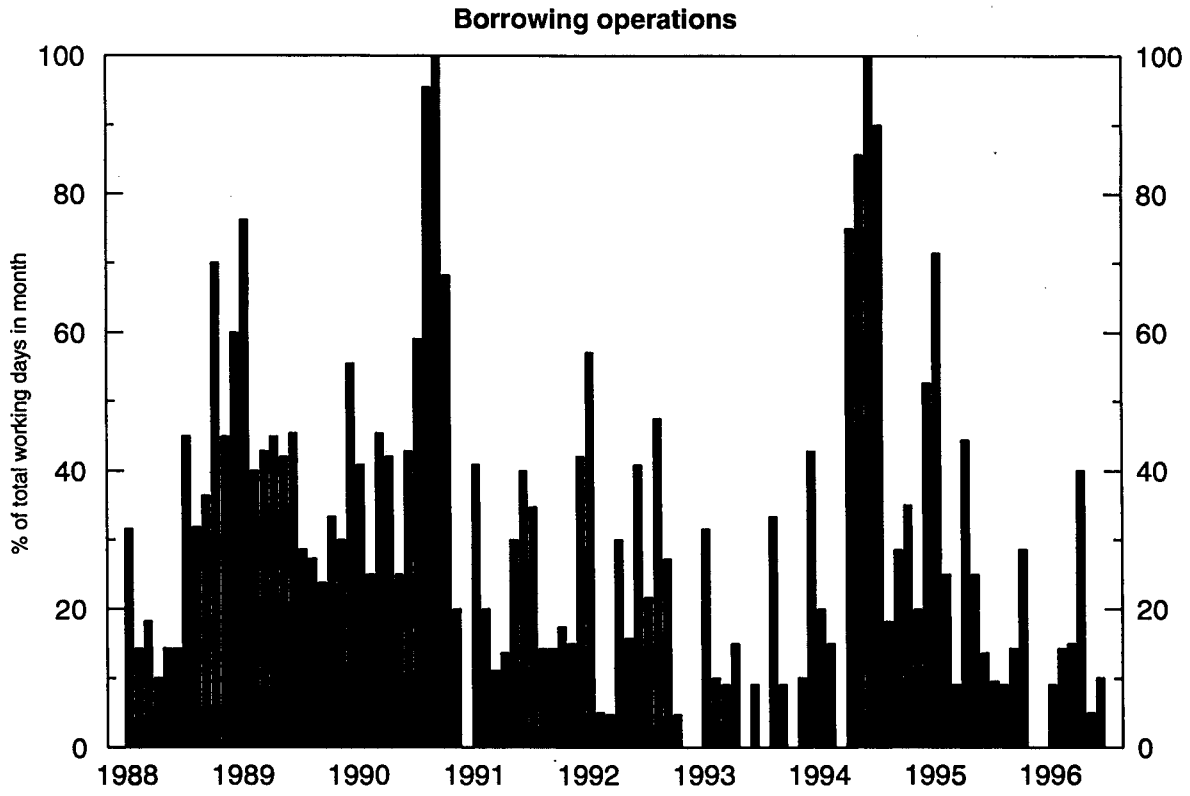
3 A more detailed description of the Banco de España monetary policy execution can be found in Ortega and Quirós (1996).

4 For a more comprehensive explanation, see "Banco de España's replies to the BIS questionnaire on Central Bank monetary policy operating procedures".

5 Ten days is the frequency of the computation and maintenance period of RRs.

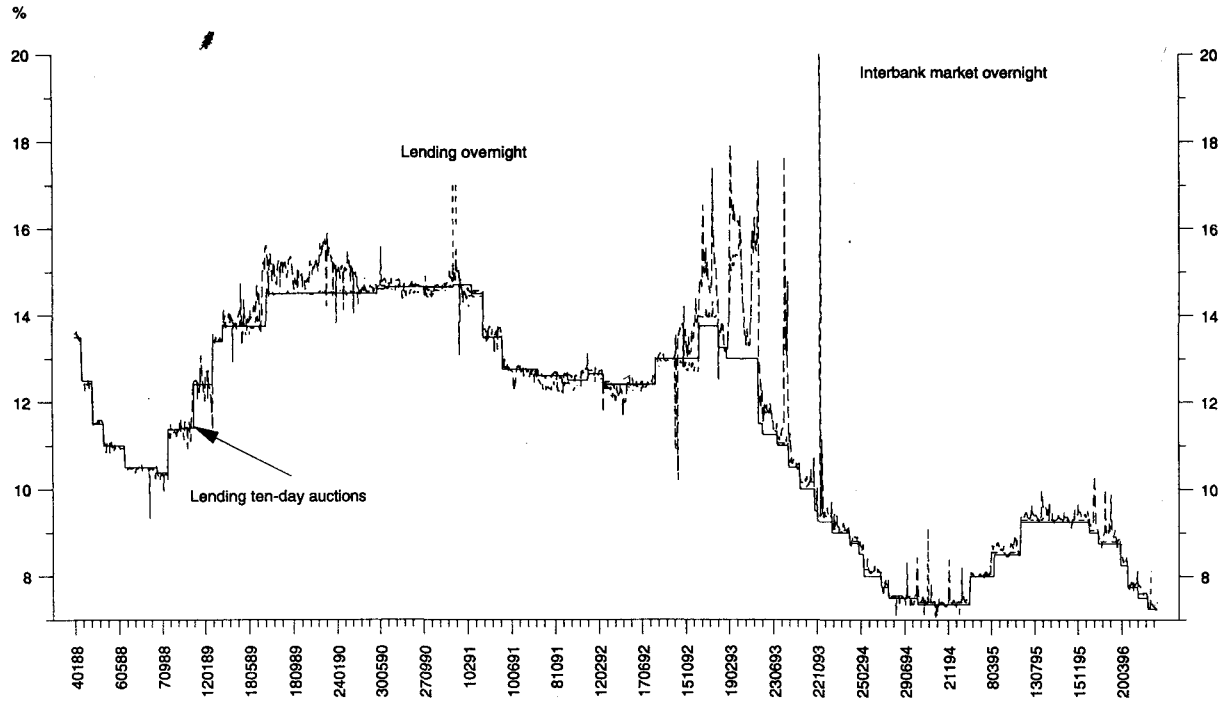
Chart 2
Frequency of Banco de España daily interventions





Daily fine-tuning operations are concentrated in the more liquid segments of the interbank deposit market (normally an overnight maturity). The aim of this type of intervention is to keep the overnight interest rate within a very narrow corridor. However, this entails a very active intervention by the Banco de España in the money markets (see Chart 2). As a result of this strategy the daily intervention rate pivots around the ten-day rate, and only in exceptional circumstances – normally associated with exchange rate tensions – does the Banco de España make differentiated use of daily and ten-day rates (see Chart 3). The volatility of daily rates is, likewise, very low.

Chart 3
Banco de España and interbank deposit market interest rates



RRs are an essential element within the Banco de España's operational framework and play an important role in the functioning of the Spanish money market. However, the functions performed by this instrument have been changing over time. In the eighties, under a quantity operational target, RRs were crucial in defining a stable short-run money multiplier which allowed the Banco de España to pursue reserve paths coherent with the M4 objectives. Moreover, the high reserve ratios prevailing at that time were warranted by the need to enlarge banks' demand for reserves, thereby modifying the sign – from deficit to surplus – of the net financial position of the Banco de España vis-à-vis the banking system. At present, the sharp changes in the structure of the Banco de España's balance-sheet have made this enlargement function of RRs redundant. This issue is discussed in greater detail in Section 1.2.2.

On the other hand, as a result of the gradual shift since the mid-eighties towards an interest-rate-based execution of monetary policy, the use of the money multiplier is being phased out. Nevertheless, under the new operational strategy aimed at reaching a high degree of stability in the short term for money market interest rates, RRs have also proved to be a very useful instrument. This stabilisation function crucially lies in the existence of averaging provisions meaning that banks are obliged to hold at the Banco de España non-remunerated reserves at an average level over a maintenance period of around ten days. Averaging provisions provide an automatic buffer-stock mechanism for controlling the volatility of the interest rates, as the effects of liquidity shocks on money market interest rates are absorbed by variations of reserve holdings which can be rebuilt or

reduced during the remaining of the maintenance period.[6] A more formal presentation and some econometric results of the functioning of the Spanish market for bank reserves and of the repercussion for this market of the existence of averaging provisions can be found in the annex to this paper. In examining these repercussions, it is worth mentioning the fact that the performance of the RRs buffer-stock function is not uniform over time or across different circumstances.

First, in the absence of the Banco de España's fine-tuning operations, interest rate volatility would tend to follow a marked time pattern, rising sharply at the end of the maintenance period.[7] This is so because, as the reserve maintenance period progresses, the constraints posed by the overall reserve requirement and by previous decisions become progressively more binding, leaving banks less leeway to absorb money market shocks. As a result, the banks' demand for reserves becomes less elastic. At the limit, on the last day of the maintenance period, it is totally inelastic, as banks have practically no choice but to meet any unfulfilled portion of the overall reserve requirement. In this respect, it is important to notice that banks are not allowed to carry over reserves to the next maintenance period and that the penalties imposed by the Banco de España on banks incurring reserve deficiencies are extremely high. One implication of this pattern of interest rate volatility is a more active presence of the Banco de España in the money market by means of frequent fine-tuning operations towards the end of maintenance periods. The sign of these end-of-maintenance-period interventions is normally one of injecting liquidity.

Second, while RRs with averaging provisions facilitate the absorption of shocks to the liquidity autonomous factors, they also reinforce a potential source of interest rate volatility, i.e. changes in interest rate expectations. Banks' reserve management over the maintenance period is swayed by the arbitrage between the current overnight rate and the expected overnight rate over the remainder of the maintenance period – the spread between these two variables is the opportunity cost of holding reserves on each particular day. This arbitrage activity means that the overnight rate tends to settle at around the expected level. The implications of this behaviour are manifold. First, episodes of marked changes in interest rate expectations may cause undesired movements in the overnight rate. On these occasions, the existence of RRs reduces Banco de España's ability to offset the shift in the demand for reserves via fine-tuning operations. Second, the Banco de España, by targeting the overnight rate, is in practice targeting an interest rate with a maturity moving in line with the remaining duration of the maintenance period. Further, the information that can be extracted from overnight rate developments is modified by the presence of RRs with averaging provisions, to the extent that actual interest-rate fluctuations tend to respond less to autonomous shocks to the supply of reserves and more to expectations regarding future interest rates. Finally, insofar as the Banco de España influences short-run interest rate expectations according to its signalling strategy, RRs serve not only to smooth interest rates in the face of liquidity shocks, but also to steer the overnight rate through expectations.

1.2 Conditioning factors

This implementation framework has been in place without significant changes since the early 1990s. The change in the operational framework, however, came about gradually, during the second half of the 1980s, given the confluence of a series of factors which highlighted the advisability of making changes to the Banco de España's operational procedures. The culmination of these reforms was the transformation of RRs in 1990[8] complemented by the creation of the ten-day period repo

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6 A discussion of the stabilisation function of reserve requirements can be found in Santos (1994).

7 Some evidence on this pattern is provided in Ayuso, Haldane and Restoy (1993).

8 As a result of this transformation, the reserve requirement was lowered by somewhat more than fifteen percentage points, and the banking assets freed following this reduction were allocated to the subscription of certificates issued by the Banco de España. This allowed a portfolio made up of CEBES (the Banco de España certificates) and

tenders and an increased recourse to daily fine-tuning operations. The presence at that time of a sufficiently developed government debt market, as the Book-Entry System for Government Debt Trading had been running for three years, was no doubt a factor that contributed to the smooth functioning of the new operational framework.[9]

The factors that prompted this transformation can be grouped in two categories: those linked to the changes in the economic and financial framework following Spanish entry into the EU; and those associated with the changes in the Banco de España balance-sheet, reflected in a change in sign of the banking system's liquidity dependence position in relation to that offered by the central bank.

The two groups of factors are not independent, moreover, of a clear attitude on the part of the Banco de España to give priority to market mechanisms as a selection criterion for the operational framework. This attitude has progressively infused the decisions that the Banco de España has taken in this area: the reduction of the RRs, the elimination of mechanisms for subsidised financing to credit institutions, the formulation of open market operations and, lastly, the decision to minimise operations implying bilateral relations between the Banco de España and its counterparties.

1.2.1 Changes in the economic and financial framework

Various changes in the Spanish economy's economic and financial framework since the mid-eighties are at the root of the modifications to the Banco de España monetary implementation framework and, in particular, of the advance in operational procedures to facilitate the close control of short-term interest rates.[10]

First, regard should be had to the implications for the monetary policy transmission channels arising from the modernisation of the Spanish financial system. The period prior to Spanish EU entry was marked by a deep-seated segmentation of Spanish money and financial markets, a stringent regulation of interest rates and limited external openness. Against this background, changes in Banco de España intervention rates were internalised in the markets for interbank funds, with scant propagation to the other markets. This situation was compatible with the pursuit of a monetary policy geared to the strict control of bank reserves via which it was sought to attain the monetary policy objectives, defined in terms of the growth of the money stock, and which, necessarily, entailed high volatility in the Banco de España intervention rate (see Chart 4). Further to Spanish EU accession and against a general backdrop of global liberalisation and deregulation, there was growing integration among the various Spanish money and financial markets, heightened competition and greater prominence for the role of the exchange rate of the peseta as a decisive aspect of the definition of economic policy in general, and of monetary policy in particular.[11]

The combination of all these factors favoured the propagation of the Banco de España's monetary impulses to the various markets, and it strengthened some of the transmission channels that had been scarcely operative in the preceding stage, in particular the exchange rate channel. The change in circumstances advised paying growing attention to the orderly course of interest rates. In this connection it was considered necessary for the Banco de España to use short-term interest rates as an

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government securities to be set up, which entities could use in their liquidity procurement operations. For greater details of the reform of the reserve requirement, see Banco de España (1990).

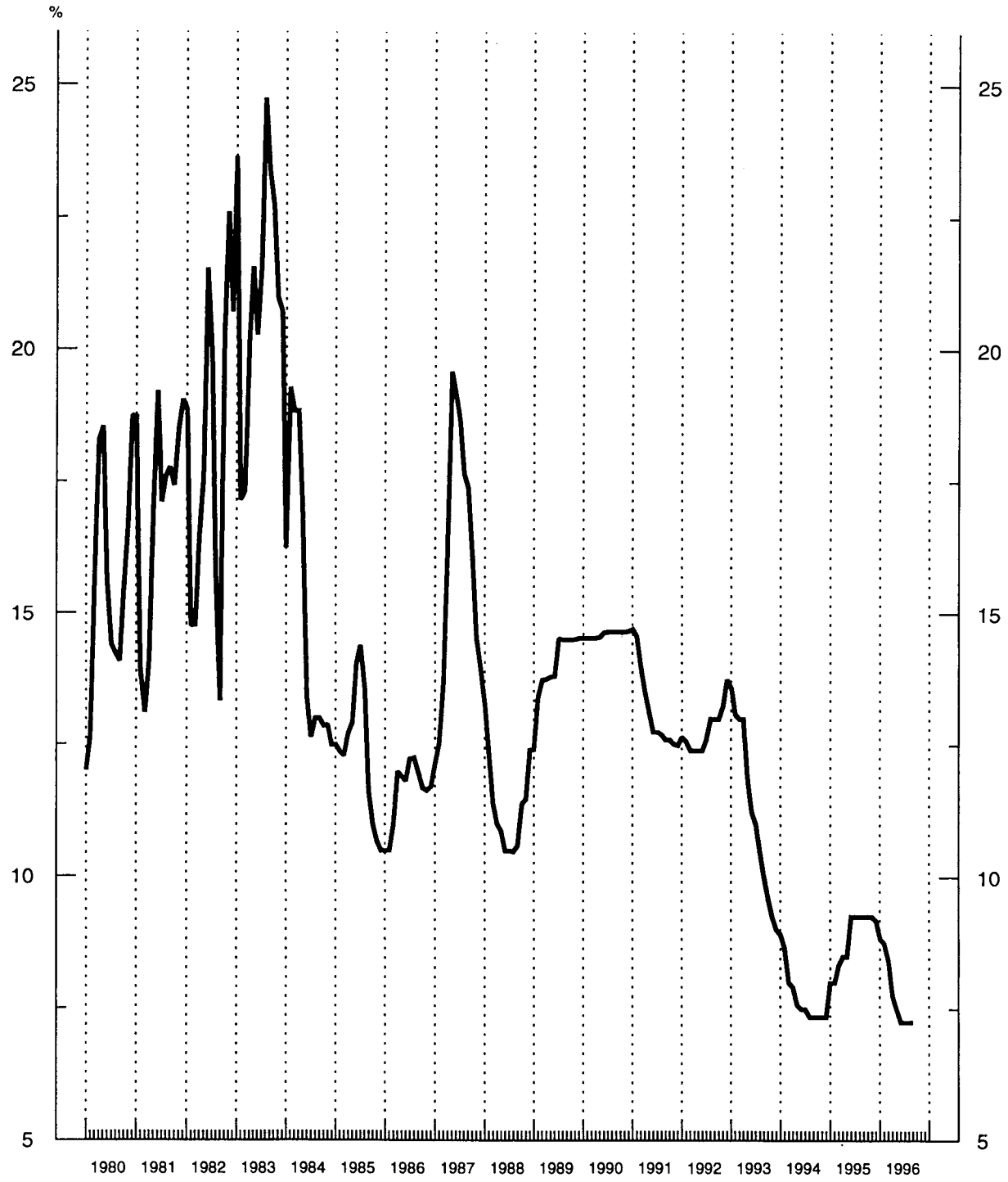
9 On the one hand, it allows entities to have a securities portfolio with which to resort to the Banco de España in search of financing. On the other, the Book-Entry Office provided, along with the Money Market Communication Service, the technical infrastructure needed for the settlement of repos with government securities and CEBES.

10 Some of these aspects are addressed in greater detail in Escrivá and Malo de Molina (1991) and in Ayuso and Escrivá (1996).

11 On the implications of the financial integration and internationalization of the Spanish economy, see Alejano, A. and J.M. Peñalosa (1995).

instrumental variable and to develop the procedures required for fine-tuning them. The peseta's entry into the ERM in June 1989, and the assuming of the related exchange rate commitments, reinforced the role that interest-rate stability had to play in monetary policy implementation in Spain. And this despite the fact that, for a relatively extensive period, to end-1994, intermediate targets in terms of the growth of the money stock continued to be formulated.

Chart 4
Banco de España intervention rate
Monthly average of daily data



Note: Marginal interest rates of daily auctions of monetary regulation loans were used until April 1990. Since May 1990, the interest rate for the ten-day auction of Banco de España certificates has been used.

The need to ensure the proper working of the monetary policy strategy currently pursued by the Banco de España – which, since 1995, involves setting a direct target in terms of the inflation rate – bolsters the positive effect on the monetary policy transmission mechanism of the use of interest rates as an instrumental variable. Justifying the latter decision are the role of the exchange rate in this strategy and the reinforcement of some of the aspects relating to the determination of bank lending and borrowing rates and, in general, to the importance played by expectations in determining interest rates in the various markets.

Regarding the first aspect, the stability of the exchange rate of the peseta is considered an important factor for attaining price stability. As regards the second point, there has recently been a perceptible increase in the intensity and speed with which monetary impulses are transmitted to the various financial markets. It has been proved that in determining the interest rates on their credit operations, institutions, in the long term, completely adjust to movements in interbank overnight interest rates and that, in the process of adjustment, expected future interest rates acquire great relevance. The speed of adjustment is far greater in the case of floating rate loans, which leads to an acceleration in the transmission mechanism since the importance of this type of financing is continuously rising (see, for instance, Sáez, F. (1996)).

1.2.2 Changes in the Banco de España balance sheet and characteristics of the autonomous factors of liquidity generation

The present configuration of the implementation framework – in particular, the maintenance of a low reserve ratio – is also supported by the change in the Banco de España balance sheet and by the financing structure of entities. This change has been manifest in a most substantial increase in the banking system's liquidity requirements and in the consolidation of a sizable net debtor position vis-à-vis the Banco de España. Nonetheless, this increase in the debtor position has highlighted some of the difficulties the current implementation system poses, which are discussed below.

This configuration is a relatively novel one; historically the strongly expansionary nature of the autonomous factors of liquidity generation, and of the public sector in particular, has been a constant in the determination of the Banco de España's intervention requirements and it has meant that only through imposing a high reserve requirement would entities ultimately depend on the liquidity offered by the Banco de España.

To illustrate this aspect a relatively extensive time perspective should be adopted for analysis, and the asset and liability captions of the Banco de España should be grouped in such a way that the system's liquidity requirements may be explained by its two main sources: the first, resulting from the combined effect of the autonomous factors of liquidity generation, and reflecting general monetary conditions; and the second, consisting of the level of RRs.[12]

This decomposition, which is depicted in Chart 5, enables a link to be made between the heavy increase in reserve ratios, as from 1983, and the need of the Banco de España to face up to a situation in which the overall effect of the autonomous factors of liquidity generation, driven by the highly expansionary nature of the public sector, led to a heavy surplus position of liquidity in the banking system and made monetary implementation enormously complicated. As can be seen in the chart, this was reflected in the assumption by the Banco de España of a debtor position vis-à-vis the banking system.

Following the heavy rise in the reserve requirement after 1983, the Banco de España managed to reverse the sign of the banking system's liquidity dependence in a setting in which the autonomous factors of liquidity generation continued to be highly expansionary. Against this

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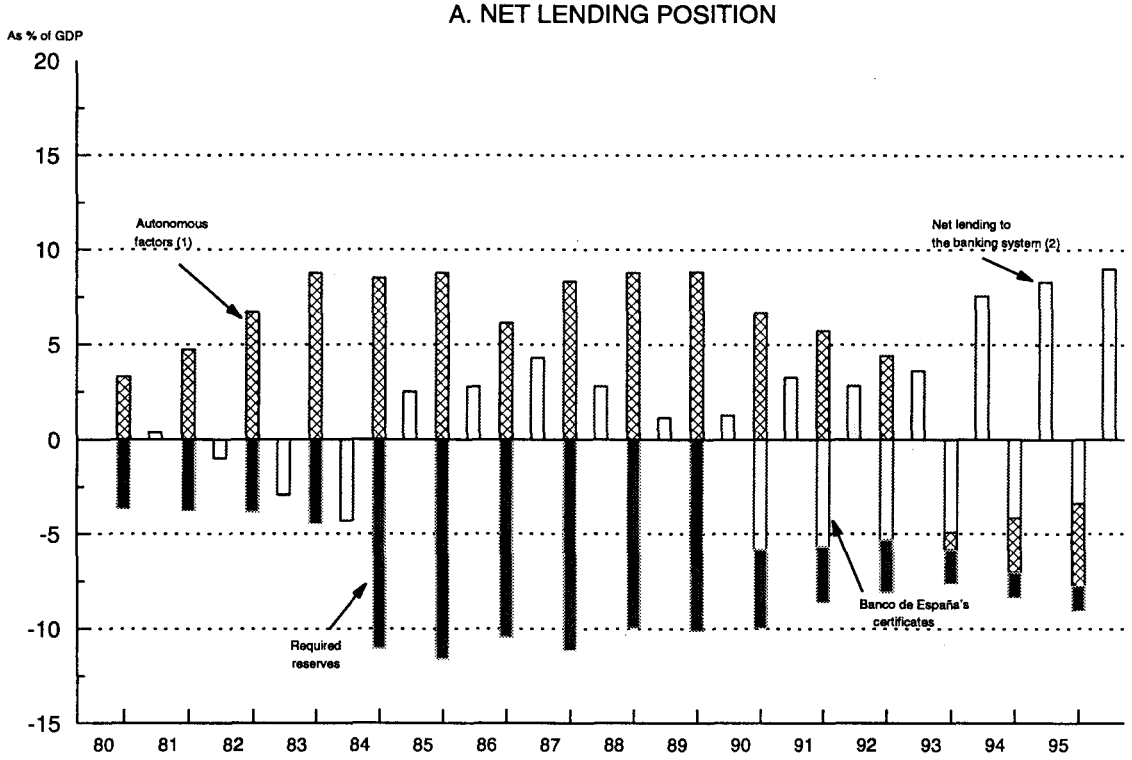
[12] Net credit from the central bank to the banking system (*NCBS*) results from the following identity: $NCBS = BN - FA - CPS + ONL + RR$, where *BN* = banknotes; *FA* = foreign assets; *CPS* = net credit to the public sector; *ONL* = other net liabilities; and *RR* = bank reserves and stock of CEBES.

Chart 5

Determinants of the Banco de España's net lending position to the banking system

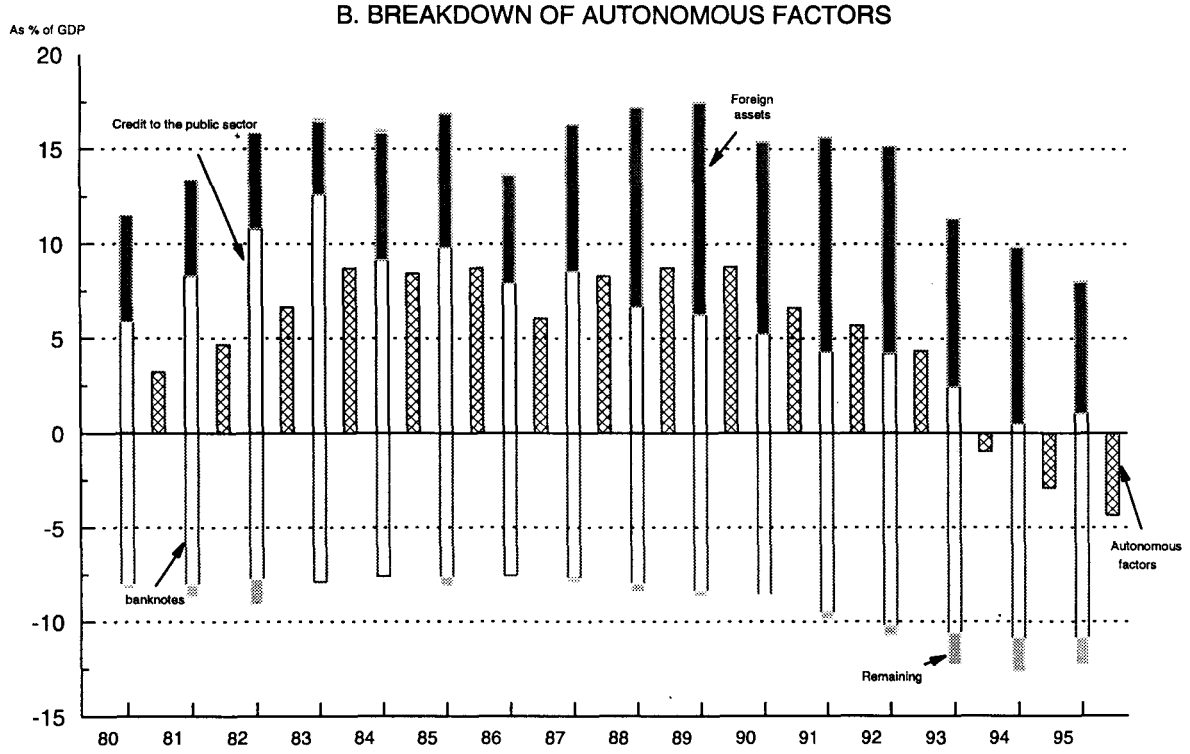
A. NET LENDING POSITION



(1) Autonomous factors= banknotes - net foreign assets -net credit to the public sector + other net liabilities

(2) Net lending= required reserves + atonomous factors.

B. BREAKDOWN OF AUTONOMOUS FACTORS



background, compliance with the reserve requirement was increasing the demand for funds for its coverage and was reversing the sign of the system's net liquidity requirements.[13]

This combination of factors differs radically from that prevailing since 1992. Since that year, the demand for financing by entities has increased enormously, reaching an amount equivalent to 10% of GDP at end-1995. The increase is of a genuine nature: it reflects the widening of entities' deficit liquidity position in the face of the reduction of the expansionary nature of the autonomous factors, which has not been offset by the lesser requirements derived from the reduction of RRs and the partial redemption of CEBES.

Further, the lower part of Chart 5 depicts changes in the various liquidity generating factors during the period under consideration. This allows the reasons for the change in the sign of the entities' liquidity position after 1992 to be specified.

As reflected in the foregoing chart, the expansionary character of the external sector lessened as from late 1992 as a result of the interventions by the Banco de España in defence of the exchange rate of the peseta during the ERM crisis. In addition, as from 1993, the step taken to comply with article 104A of the Treaty of Maastricht – which came into force in January 1994 and prohibits the monetary financing of the Treasury – imposed a permanent reduction in the net credit extended by the Banco de España to the public sector. The break with the expansionary nature of both factors until that point made it impossible to offset, as had been done in previous periods, the contractionary effect of the expansion of the demand for cash by the public, which accounted for somewhat over 10.7% of GDP at end-1995.

These changes are summarised in Table 1. It reflects the contribution of the various factors to the change in the dependence of credit institutions on Banco de España financing in the period 1990-95.

Table 1

Determinants of the change in financing extended to credit institutions by the Banco de España

1990-95, as a percentage of GDP

1.	Reduction in foreign reserves	3.2
2.	Reduction in net debtor position of General Government	4.6
3.	Increase in bank notes	2.3
4.	Reduction in bank reserves	-3.1
5.	Reduction in CEBES	-1.6
6.	Other items	1.2
Net liquidity requirements (1 to 6) = Financing to credit institutions		6.6

The combination of these elements has meant that the Banco de España has had to face up to growing demand for liquidity by entities. Also, on certain occasions over the past few years, tensions have consequently arisen in money markets, caused by the shortage of suitable instruments in entities' portfolios to pledge against the liquidity supplied by the Banco de España.

Along with the changes recorded in the Banco de España balance sheet, it is important to stress the high volatility of the autonomous factors of liquidity generation in the Spanish case. This characteristic has been integral to the functioning of the monetary policy implemented by the Banco de España and has conditioned certain aspects of its operative procedures. In particular, a greater volatility of the autonomous factors may entail greater difficulties in predicting liquidity shocks and, ultimately, entities' actual liquidity requirements. That may then bias monetary implementation towards a more intensive use of fine-tuning operations. Table 2 presents an international comparison

[13] A more detailed analysis of the autonomous factors of liquidity in the period prior to the reform of the reserve requirement can be found in Sanz, B. and M. Val (1993).

of the volatility of overnight interest rates and of the autonomous factors of liquidity generation, measured as the standard deviation of daily variations in relation to GDP. As the table shows, Spain is among the countries with the highest volatility, a feature it shares with other countries in which the public sector is also the highest-volatility autonomous factor (see, in this connection, Escrivá and Fagan (1995)). Furthermore, there is not an automatic link between changes in the autonomous factors and the behaviour of interest rates; on the contrary, as it is explained below and in a more formal fashion in the annex, a number of institutional factors intervene in the relation between these two variables.

Table 2

International comparison between interest rate volatility and liquidity shocks volatility

Countries	Overnight rate volatility[1]	Liquidity shocks volatility[2]
Austria	0.05	0.01
Belgium	0.10	0.09
Denmark	0.47	0.62
Finland	0.63	0.18
France	0.07	0.18
Germany	0.25	0.09
Greece	0.72	0.23
Ireland	0.31	0.20
Italy	0.27	0.39
Netherlands	0.13	0.31
Portugal	0.31	0.51
Spain	0.16	0.38
Sweden	0.03	0.38
United Kingdom	0.54	0.11

[1] Daily standard deviation of overnight market rates from official rates (December 1993 - December 1994). [2] Daily standard deviation of changes in autonomous items as a percentage of GDP (December 1993 - December 1994).

Source: Escrivá and Fagan (1995).

Chart 6 presents, for the Spanish case, the contribution of the various autonomous factors to total volatility over the last ten years, drawing on a variance decomposition of the daily changes in these factors.[14] As can be seen in this chart, the public sector, the most volatile autonomous component, has shown an increasingly irregular behaviour during the period under analysis. This has come about despite the institutional changes made throughout this period, which have tended first to reduce and next to prohibit the monetary financing of the budget deficit. This result is consistent with a highly active management of the Treasury's current account at the Banco de España, and with its use as an alternative financing instrument in the event of exceptional circumstances on the securities markets. The absence of a ceiling on movements in this account (which is the practice in some other European countries) may be contributing to this greater volatility. By contrast, the changes recently made to government debt tender arrangements, with the announcement and undertaking to meet an

[14] To illustrate the variance decomposition approach, consider the following definition of autonomous factors:
$AF = BN - FA - CPS + ONL$, where BN is banknotes; FA = net foreign assets; CPS = net credit to the public sector; and ONL = other net liabilities.

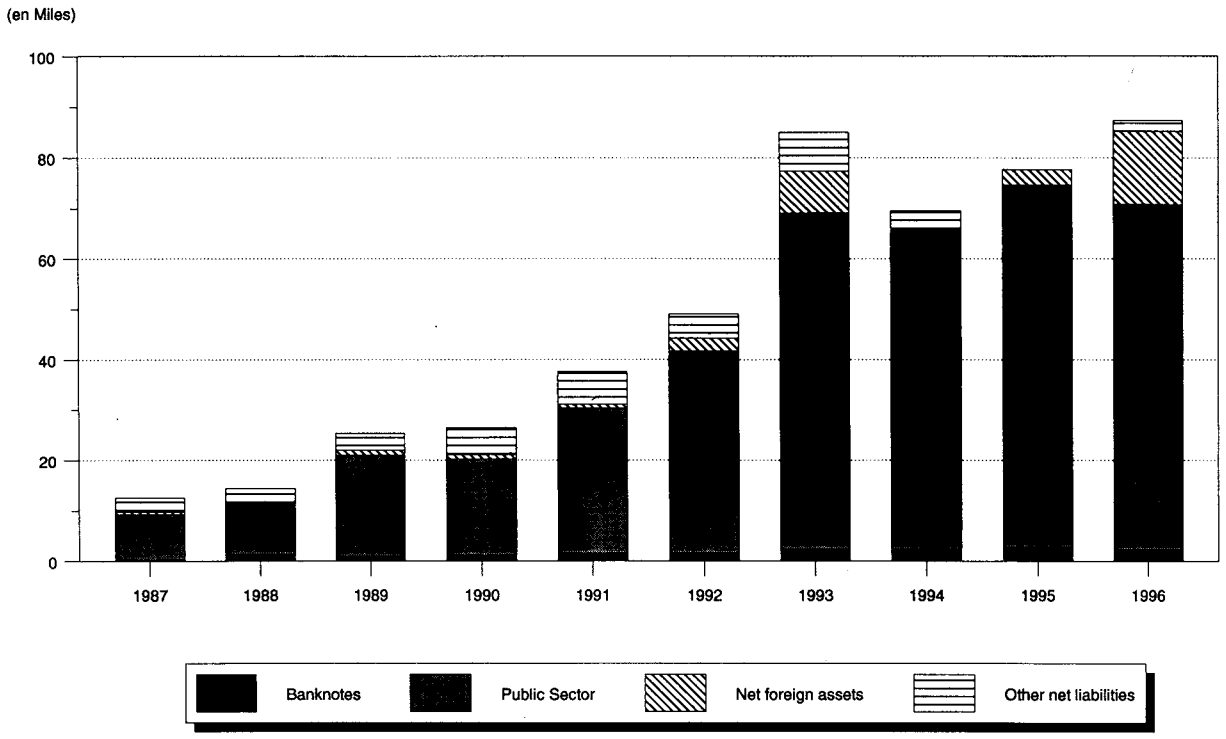
Multiplying across by AF and taking expectations yields:
$\mathrm{VAR}(AF) = \mathrm{Cov}(AF, BN) - \mathrm{Cov}(AF, FA) - \mathrm{Cov}(AF, CPS) + \mathrm{Cov}(AF, ONL)$.

The covariance terms on the right-hand side of this equation show the contribution of each of the elements to the total variance of AF. For example, expanding the term $\mathrm{Cov}(AF, BN)$ yields:
$\mathrm{Cov}(AF, BN) = \mathrm{VAR}(BN) - \mathrm{Cov}(BN, FA) - \mathrm{Cov}(BN, CPS) + \mathrm{Cov}(BN, ONL)$.

Thus, the contribution of banknotes (BN) to the total variance is the sum of its variance plus its covariances with the other terms.

average issuance target, may end up having the opposite effect. The external sector, for its part, has contributed to amplifying this irregular profile in the recent years of the sample, as a result of successive ERM crises.

Chart 6
Contribution to total volatility in autonomous factors



2. Assessment of the functioning of the operational framework

The design of the Banco de España monetary policy implementation model is supported by two pillars. The first is the priority given to market mechanisms. The second is the selection of a set of suitable instruments to exert tight control on the course of short-term interest rates in the interbank deposit market. Assessment of the effectiveness of this operational framework should thus be made in the light of these two considerations.

2.1 Development of money markets

The Banco de España's monetary policy operational framework and the efficient functioning of money markets are closely interlinked. The framework, while aimed at fostering the development of secondary markets, also requires that a high degree of market efficiency be attained to adequately perform its tasks.

The aim to create disciplinary mechanisms for efficient liquidity management is reflected in a number of features of the framework:

- the exclusive reliance on open market operations for the Banco de España's intervention and, consequently, the lack of any lombard, deposit or refinancing facility;

- to cope with banks' end-of-day imbalances, the Banco de España, instead of providing liquidity via a marginal lending facility, usually re-opens the interbank market so that the banks with liquidity needs can find a lending counterpart;
- the lowering of the reserve ratio to 2%, while greatly reducing the implicit tax on banks entailed by this instrument, creates much tougher conditions for liquidity management so that banks must strive to optimise the level of the working balances they hold in their current accounts at the Banco de España to settle their interbank operations;
- all open market operations are conducted via repos so as to avoid the rigidities imposed on banks' portfolio management when collateral is pledged and blocked;
- in the case of fine-tuning operations, liquidity is provided to a small set of primary dealers, who perform the task of distributing it all across the money market; and
- the underlying assets (collateral) for repo operations are restricted to high quality paper traded in very liquid secondary markets.

An operational framework characterised by the above-mentioned features could lead to unwanted developments if the goal of promoting a deep and liquid secondary money markets were to fail. First, in the absence of such a market, difficulties encountered by banks in working off excess liquidity or covering reserve deficiencies, particularly towards the end of the interbank session, would be conducive to greater market instability. This is particularly so since there is a lack of facilities to deal with end-of-day imbalances. Second, if the interbank market were relatively narrow and some institutions were to enjoy a dominant position, certain banks, normally the smallest ones, would have worse conditions to enter and operate in the market. In this situation, the lack of automatic refinancing instruments provided by the central bank would be a serious shortcoming for these institutions. Third, if the market were not sufficiently deep, the fast and even distribution of liquidity across the market by primary dealers might encounter difficulties.

In our opinion, experience over the last few years shows that the trade-off between the potential benefits and risks of the Banco de España's operational framework is favourable on balance. Various pieces of evidence are provided below to support this view.

Table 3
Features of interbank fund transfer systems in EU countries*

Countries	Ratios		
	Number of transactions (thousands)	Depth - transacted value (ECUm)	Breadth - average value (ECUm)
Austria	5.4	2.8	3.2
Denmark	2.8	26.0	74.9
Finland	1.3	12.4	118.4
France	3.7	15.0	3.7
Germany	9.7	50.5	3.0
Ireland	3.6	24.4	152.5
Italy	6.6	26.8	4.7
Netherlands	8.7	32.1	13.3
Spain	6.5	64.0	24.2
Sweden	0.5	27.4	326.5
United Kingdom	13.7	38.7	3.3

* The systems in place in Belgium, Greece, Luxembourg and Portugal jointly process large-value payments and retail transactions. Consequently, they are excluded from this table. Values deflated by GDP; 1994 figures.

In the international sphere, comparison of measures of the depth and liquidity of securities-settlement and fund-transfer systems (see Tables 3 and 4) highlights Spain as one of the

countries with the largest number of recorded transactions and the depth of the related systems – measured as the value of transactions in relation to GDP – is also greatest. In terms of breadth – measured by the average value of transactions – Spain would occupy a less differentiated position compared with the rest of the countries.

Table 4
Features of securities settlement systems in EU countries*

Countries	Ratios		
	Number of transactions (thousands)	Depth - transacted value (ECUm)	Breadth - average value (ECUm)
Austria	0.8	0.8	5.7
Belgium	5.7	8.8	8.0
Denmark	31.7	18.9	4.8
Finland	17.7	4.1	2.8
France	13.6	364.0	23.9
Germany	14.6	2.95	0.1
Ireland	0.7	2.2	77.5
Italy	16.5	7.6	0.5
Netherlands	0.0	0.11	65.7
Portugal	7.8	2.29	3.8
Spain	27.5	44.9	4.0
Sweden	18.4	30.8	10.1
United Kingdom	6.2	13.9	2.6

* Transactions carried out; trends in EU countries. Values deflated by GDP.

Source: Own data based on EMI figures (see EMI 1996a).

Table 5
Efficiency measures of the Spanish money and public debt markets

Markets and efficiency measures	1987-91	1992-96
Interbank money market[1]		
a) Overnight market		
Liquidity (%)	82.5	241.9
Depth (%)	8.2	14.4
Breadth (bn of pesetas)	1.18	3.25
b) Remaining maturities		
Liquidity (%)	14.9	34.9
Depth (%)	1.5	1.9
Breadth (bn of pesetas)	0.78	2.23
Public debt market[2]		
Liquidity (%)	12.4	54.9
Depth (%)	3.2	23.0
Breadth (bn of pesetas)	0.07	0.66

[1] Liquidity measures are calculated as the ratio of turnover to the reserve requirement plus the outstanding amount of CEBES. Turnover takes into account both overnight deposits and repos among market members. Depth is calculated as the ratio of turnover in billions of pesetas to GDP and breadth is turnover per operation. [2] Measures of depth and breadth are calculated as described in footnote 1, with liquidity calculated as the ratio of turnover to the outstanding amount of debt and turnover including outright spot purchases and repos with non-market members.

In the domestic sphere, the development of the overnight interbank market has, in the 1990s, been most noteworthy in showing that some of the characteristics of the operational framework, described above, have fostered the use of this market as the principal alternative to Banco de España financing. In Table 5, various measures of efficiency in the overnight market are shown. Furthermore, the implications of the operational framework have extended beyond the interbank money markets: the public debt market has also grown most forcefully since the constitution of the SACDE and the use of public paper as collateral for repo operations (see, again, Table 5). The efficiency of this market, approximated by various measures of liquidity, depth and breadth, has continuously increased.

2.2 Steering interest rates

Over recent years the Banco de España has progressively increased its capacity for influencing short-term interest rates and affecting agents' expectations about the future course of interest rates. From this standpoint, the operational framework has proven sufficient in attaining its objectives.

For a more complete assessment of this function, it would be advisable to analyse specific features of the instruments available to the Banco de España to regulate monetary conditions, before and after the change in the operational framework. In this respect, an analysis starting in 1988 and ending in 1996 may offer a suitable perspective. Throughout this period, however, significant changes ensued which are worth bearing in mind in the analysis undertaken. For this reason, a division into sub-periods has been made which enables the differentiation between the two implementation regimes, as well as a distinction between different reserve ratios and identification of episodes of instability in the ERM to be isolated. The sub-periods selected are shown in Table 6.

Table 6

Sub-periods	Reserve ratio (%)	Other distinguishing features
1: 4/1/88-2/8/88	18.5	Inception of daily auction of monetary regulation loans
2: 3/8/88-2/2/89	16.5	"
3: 3/2/89-12/7/89	18	"
4: 13/7/89-22/3/90	19-17	"
5: 23/3/90-11/9/92	5	Introduction of CEBES in March 1990 and inception of ten-day repo tenders of CEBES and public debt
6: 14/9/92-3/11/93	4.5-3	ERM turbulences
7: 4/11/93-28/6/96	2	—

The basic information that will be used in this sub-section for relating the behaviour of interest rates to the procedures used by the Banco de España for steering them is given in Table 7. The contents of this table allow conclusions to be drawn with respect to the following questions. To what extent has the greater volatility experienced by the autonomous factors of liquidity generation throughout the period been internalised in the liquidity requirement forecasts made by banks and the Banco de España? If such internalisation is the case, what are the procedures whereby banks have met their unexpected liquidity requirements? And lastly, to what extent has the reduction in the reserve requirements entailed a significant lessening of the role played by this instrument in enabling banks to meet unexpected liquidity shocks?

Regarding the behaviour of short-term interest rates, the change in the operational framework in 1990 prompted a reduction in the volatility of overnight rates. This reduction was only interrupted in the 1992-93 period, when tensions were recorded in Spanish money markets, against the background of exchange rate tensions in the ERM. That said, the volatility of overnight rates has been

systematically higher since 1990 if it is calculated in terms of the daily intervention rate. That might reflect the behaviour at the close of ten-day accounting period for bank reserves where, since the reduction of the reserve ratio, significant – though specific – fluctuations in interest rates in the interbank deposit market have been perceptible.

This diminishing trend in interest rate volatility has come about despite the increased volatility of the autonomous factors of liquidity generation (as seen in the previous section). This may be indicative of a greater capacity of counterparties and/or the Banco de España to foresee liquidity requirements despite such greater volatility, or, alternatively, of a greater degree of activism on the part of the Banco de España.

Table 7
Factors affecting volatility in money market interest rates

Periods	Volatility in interest rates		Liquidity shocks volatility		Reserve requirements			Degree of activism	
	vis-à-vis 10-day inter-vention	vis-à-vis daily inter-vention	defini-tion A	defini-tion B	potential shock: absorp-tion capacity of bank reserves	% of liquidity shocks absorbed by RRs	reserve require-ment level (in %)	frequen-cy of interven-tion	% of liquidity shocks absorbed by FTOs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4/1/88-2/8/88	0.156	0.084	0.065	0.049	0.082	0.902	18.5	0.705	0.047
3/8/88-2/2/89	0.247	0.186	0.171	0.048	0.073	0.376	16.5	0.624	0.521
3/2/89-12/7/89	0.442	0.347	0.147	0.047	0.100	0.771	18.0	0.657	0.117
13/7/89-22/3/90	0.305	0.322	0.337	0.069	0.085	0.378	19.0-17.0	0.509	0.515
23/3/90-11/9/92	0.159	0.197	0.351	0.087	0.024	0.237	5.0	0.722	0.714
14/9/92-3/11/93	1.540	1.247	11.924	3.193	0.030	0.301	4.5-3.0	0.968	0.675
4/11/93-28/6/96	0.186	0.200	0.447	0.118	0.012	0.194	2.0	0.911	0.779

(1) Daily standard deviation of the difference between the overnight rate and the ten-day intervention rate.
(2) Daily standard deviation of the difference between the overnight rate and the rate of fortnightly repo operations.
(3) Daily standard deviation of fine-tuning operations (daily intervention).
(4) Daily standard deviation of the difference between the actual magnitude of autonomous factors and the forecasts made by the Banco de España at the beginning of each maintenance period for the average level over this period.
(5) Reserve requirements as a percentage of the total balance sheet eligible for averaging multiplied by the length of the maintenance period (in days).
(6) Average percent of liquidity shocks absorbed by the reserve requirement, according to the decomposition of variance of total volatility in autonomous factors as shown in Chart 7.
(7) Level of reserve requirement in each of the periods considered.
(8) Ratio between the number of days of fine-tuning intervention and the number of working days.
(9) Average percentage of liquidity shocks absorbed by fine-tuning operations, according to the decomposition of variance of total volatility in autonomous factors as shown in Chart 7.

As to the capacity of banks and the Banco de España to anticipate liquidity requirements, the information in Table 7 shows the absence of significant progress following the change in the operational framework: the increase in the volatility of the autonomous factors has been accompanied by a sustained increase in unexpected liquidity shocks, interrupted only in the last two years of the sample. The course of this variable has been approximated by two alternative measures. The first, in column 3, has been obtained drawing on the daily intervention by the Banco de España.[15] The second,

[15] This variable could be a good proxy for unexpected liquidity shocks if banks confront expected shocks via the financing they obtain from regular operations. However, against a background of expectations of a slowdown, this measure could give misleading information of unexpected shocks.

in column 4, has been constructed on the basis of the deviations between the actual scale of the liquidity derived from the autonomous factors and the estimates made by the Banco de España at the start of each reserve requirement coverage period (the reference period for liquidity management both for the central bank and its counterparties). As both measures show, the scale of the unexpected liquidity shocks was extraordinary in 1992-93, especially in the latter year against the backdrop of the previously mentioned exchange rate tensions.

The lesser volatility of interest rates has arisen in a setting in which the capacity to absorb unexpected liquidity shocks via the reserve requirement has progressively been reduced in step with the lowering of the reserve requirement level. The course of this variable is approximated by two alternative measures which are detailed in columns 5 and 6 of Table 7. The first gives an idea of the liquidity buffer banks have during the reserve requirement coverage period to face up to unexpected liquidity shocks and, from this point of view, is of a potential nature. The second represents the part of liquidity shocks absorbed by the reserve requirements, according to the variance decomposition of total volatility in autonomous factors, which is depicted in Chart 7.[16]

An assessment of the extent to which a level of 2% suffices to provide a liquidity buffer ensuring the stabilising function of the reserve requirement is conditional upon the estimated level of the working balances (the minimum volume of funds required for banks to meet transaction clearance and settlement needs). This level is always difficult to estimate. It ultimately depends on the type of business in which banks engage, on their operational efficiency or on structural aspects inherent in the characteristics of the financial system in which they operate. A relatively straightforward estimate of this variable for the Spanish case indicates that it may, for the banking system as a whole, stand at a level close to 1.5% of eligible liabilities. Nonetheless, a ratio of this type may be perfectly compatible with the existence of banks for which a reserve requirement level of 2% is insufficient to provide a liquidity buffer which is adequate for the clearance and settlement of their transactions. This may condition the optimal fulfilment of the reserve requirement stabilising function and may be one of the determinants of the prominent presence of the Banco de España in the money markets.

Against this background, the increasingly frequent use of daily interventions involving ever greater amounts is the most important stabilising element employed by the Banco de España to reduce interest rate volatility. Columns 8 and 9 of Table 7 offers a measure of the importance fine-tuning operations have acquired in the period under analysis. Frequency of intervention – calculated as the relationship between the number of days of intervention and the number of working days – indicates a sustained increase in the Banco de España's presence in the money markets (over 90% as from 1993 and slightly higher in the years of exchange rate instability).

The importance of fine-tuning operations is also visible from the analysis of the relative significance of the various instruments available to the Banco de España and its counterparties to face daily liquidity shocks. To this end, the decomposition of the variance of daily movements in the autonomous factors of liquidity generation is used again. As Chart 7 shows, the change in the operational framework entailed an uninterrupted increase in the significance of daily interventions as an instrument for tackling daily liquidity shocks. This increase came about progressively as the portion of shocks absorbed by the reserve requirement diminished. Regular operations, aimed at providing the portion of liquidity associated with the habitual refinancing mechanisms, have moved on a constant line.

The information in this chart thus summarises the implementation changes that have arisen as a result of the change in the operational framework: the obligation to hold a relatively high volume of reserves in the late 80s provided an extensive liquidity buffer that enabled banks to cover

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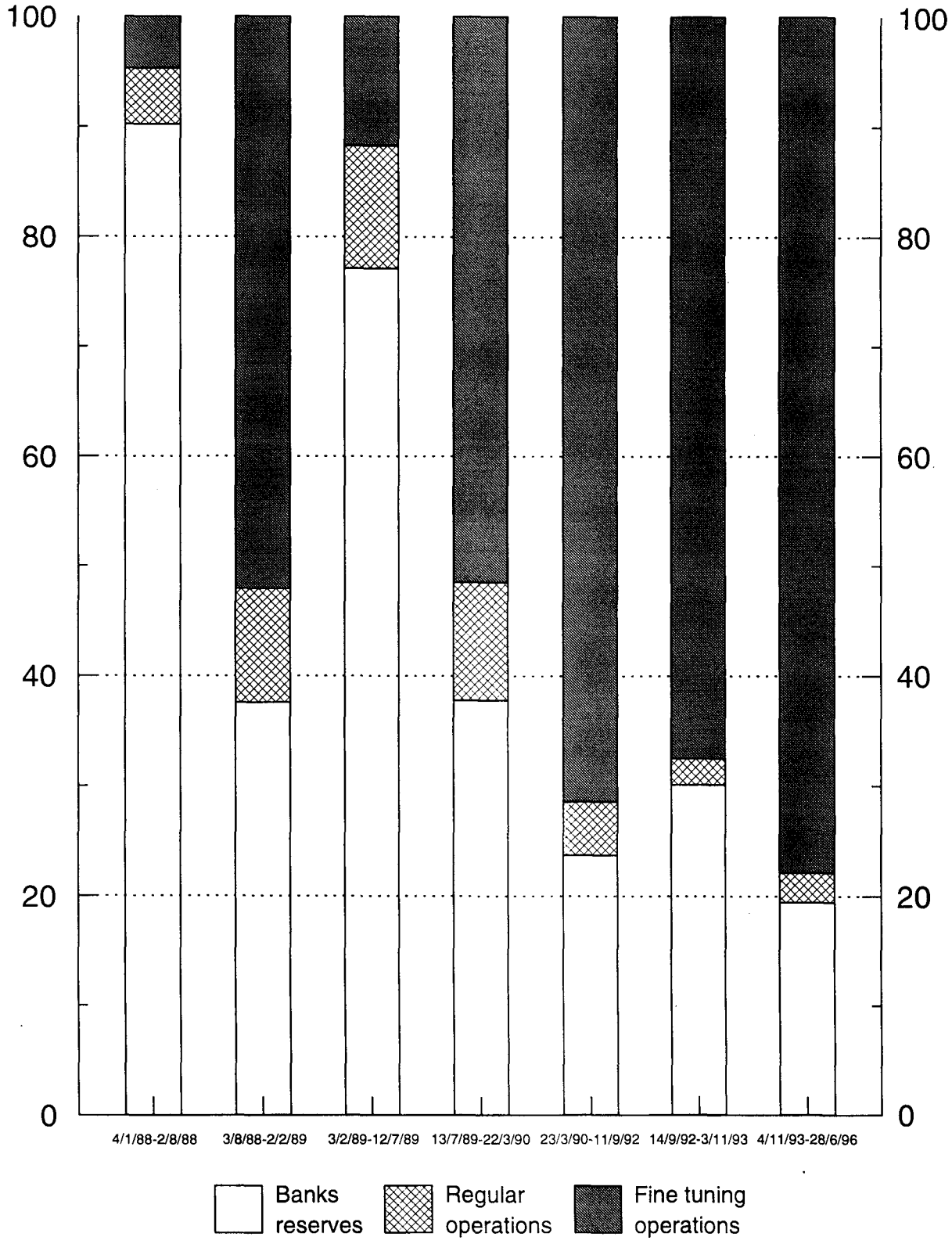
[16] The variance decomposition underlying Chart 7 has been carried out using the same technique as explained in footnote 13. The variance of daily movements in autonomous factors is decomposed by the relative contributions of the three monetary policy instruments used by the Banco de España; note that $AF = RR - FT - RO$, where AF = autonomous factors; RR = reserve requirement; FT = fine-tuning operations; and RO = regular operations. The contributions are presented in percentage of the total variance.

Chart 7

Contribution of monetary instruments to total volatility in autonomous factors

As a percentage of total variance



close to 70% of their daily liquidity requirements. The subsequent reduction of the reserve requirement and the greater tendency towards open market operations prompted, by contrast, greater

resort to the daily financing offered by the Banco de España, to the point where a proportion of over 70% of banks' daily liquidity requirements were covered by this means in the latter years of the period.

Econometric results presented in the annex broadly support the stylised facts presented in this section. These results show that expectations regarding future interest rates become a major determinant of the overnight rate. Conversely, the impact of shocks to autonomous factors, in spite of its size, is very minor, confirming the operation of the buffer-stock function of RRs and the stabilisation action of Banco de España's fine-tuning operations. Both instruments appear to be very important in performing this task. In this respect, econometric results hint that, in the absence of fine-tuning operations, the impact of shocks to autonomous factors on the overnight rate fluctuations would be three times as large as is the case at present; on the other hand, if the buffer-stock function of RRs were to be cancelled, contribution of autonomous factors to interest rate volatility would be six times as large as in the present situation. Therefore, the econometric analysis gives more importance to the stabilisation function of RRs than the evidence provided below based on variance decomposition of the changes in the autonomous factors and their correlations with the various monetary policy instruments. The results also show the loss of importance of the stabilisation function of RRs towards the end of the maintenance period and a parallel strengthening of the contribution of fine-tuning operations to stabilising interest rates.

2.3 Other implications of the operational framework

The operational framework described, which has been visibly effective in interest rate management, has not been fully free from occasional sources of friction. The causes of this have been the lack of collateral accepted in operations with the Banco de España and the difficulty, in certain circumstances, of emitting sufficiently differentiated signals about the optimal monetary policy stance. These problems arose with greater intensity during the period of exchange rate instability in 1992 and 1993, but they point to some of the aspects susceptible to improvement in the future. The reforms needed would, in any event, be consistent with those required to adapt the instruments within the framework of the preparatory work on the single monetary policy in EMU.

The insufficiency of collateral and the resulting tensions in money markets are relatively recent problems. They are closely linked to the increase in liquidity requirements that Spanish banks have undergone since late 1992 and to the relatively restrictive criterion applied by the Banco de España in the selection of collateral for intervention operations. The Banco de España's decision to give priority to the liquidity criterion has entailed the abandonment of securities pledging and the exclusive use of repos executed by the Central Book-Entry System as a procedure for securing the financing provided by the Banco de España. This has meant that the set of collateral instruments demanded by the Banco de España is made up of public securities and CEBES, with the outstanding balance of the latter being subject to a staggered redemption schedule due to end in the year 2000. As earlier indicated, the collateral available under this criterion has proven insufficient, particularly during bouts of selling pressure on the peseta, which have required intervention by the Banco de España in the foreign exchange markets and a decline in the external contribution to liquidity generation. The tensions caused by this lack of collateral have made it necessary to resort to ad-hoc procedures, such as currency swaps and special loans and, from time to time, to tolerate sizable deviations of the overnight interest rate on interbank deposits from the ten-day intervention rate. This may have prompted some confusion about what the degree of monetary tightness wanted by the Banco de España actually was.

Signalling difficulties also arise from other quarters. On the one hand, it may be argued that high degrees of activism by central banks may entail some loss of control over the timing of their market intervention, causing a risk that central banks become associated with any change in market interest rates. On the other, the Banco de España has opted to raise a single intervention rate to the category of official rate, namely the ten-day repurchase tender rate, which is no doubt consistent with

the criterion of straightforwardness governing the configuration of the operational framework. But it implies a clear refusal to arrange more complex signalling systems, such as those in other countries, where the differentiated use of interest rates associated with different instruments allows a greater scaling of the signals emitted.

As earlier indicated, the work to adapt to the implementation of the single monetary policy requires the modification of these two aspects of the operational framework. First, private paper should be accepted as collateral; and further, a credit facility and a deposit facility should be introduced which, along with open market operations, will set up an interest-rate corridor and will broaden signalling potential, in line with the ECB guidelines (see EMI (1996b)).

3. Concluding remarks

1. The operational framework used by the Banco de España to implement monetary policy has evolved over the past ten years in line with general trends in other central banks. The increasing importance of open market operations and successive reductions in the reserve ratio are the main characteristics of this process.

2. Notwithstanding this consideration, monetary implementation in Spain has its own particularities, due partly to its conditioning factors.

   First, there is a group of environmental factors, which advised ensuring stability in money market interest rates. These are closely linked to the transformation in the monetary policy transmission mechanism and the increasing importance of the exchange rate as a key variable for economic policy decisions.

   Second, there is a set of factors relating to changes in the Banco de España balance sheet. Among these, the increase in the banking system's liquidity dependence in relation to the financing offered by the Banco de España allows monetary policy implementation to work with a low reserve ratio, thus making the enlargement function of RRs redundant. At the same time, the high volatility of the autonomous factors of liquidity generation – one of the highest at the EU level – implies that with lower reserve ratios, instability in money markets would have been high in the absence of a frequent intervention by the Banco de España.

   A third conditioning factor is the attitude on the part of the Banco de España to give priority to market mechanisms as a selection criterion for the operational framework.

3. The resulting model for monetary implementation, in which transparency and straightforwardness are the most relevant characteristics, has been successful in its main function: to exert tight control and to minimise the volatility of short-term interest rates. An increasing use of daily interventions has been the most important element employed by the Banco de España to achieve this goal.

   At the same time, the procedures used by the Banco de España have promoted, trough the introduction of disciplinary mechanisms, an efficient functioning of monetary markets. Equal treatment in terms of the access to finance provided by the central bank and an even distribution of liquidity across the market are both characteristics which show this development.

4. In the course of the last years and coinciding with specific episodes of high instability in money markets – normally caused by strains in the ERM – monetary implementation has faced occasional sources of friction. In this regard, two sort of difficulties have been faced by the Banco de España:

   On the one hand, against a background of increasing liquidity needs of credit institutions – aggravated by the restrictive stance of the external sector as a source of liquidity

generation – the collateral accepted in operations with the Banco de España proved to be insufficient.

On the other, some aspects of the operational framework tended to complicate the signalling function of monetary implementation. High degrees of activism may, under specific circumstances, entail loss of control of intervention. Furthermore, although in agreement with an approach based on straightforwardness, using a single official rate for both modifying money market conditions and signalling the monetary policy stance reduces the room for manoeuvre of central banks for scaling signals emitted.

These problems point to some of the aspects susceptible to improvement in the future, in the process of adaptation to the single monetary policy in EMU.

Annex

The functioning of the Spanish market for bank reserves: a simplified model and some empirical evidence

The aim of this annex is to gain further insight into the functioning of the Spanish market for bank reserves. First, a model for the determination of the overnight rate incorporating key institutional features of the Spanish money market is built. Particular attention is paid to the modelling of the banks' demand for reserves under a system of required reserves. Second, empirical work is undertaken whereby some implications of the model are tested. The empirical analysis is designed so as to provide further evidence on the relative importance of the various determinants of the volatility of the overnight rate.

1. Modelling the Spanish market for bank reserves

Money market participants operate in an environment which is defined by the following elements:

a) There is a *reserve requirement system* which includes averaging provisions, whereby banks are obliged to hold at the central bank non-remunerated reserves (R) at an average level $\bar{R}$ over a maintenance period spanning from t=1,.....,T. It is assumed that banks exactly meet the required level $\bar{R}$; i.e. there are neither excess reserves nor reserve deficiencies. This assumption seems reasonable for the Spanish case given that banks maintain an extremely low and fairly stable level of excess reserves and that non-fulfilment of required reserves is a very infrequent situation. Thus, $\bar{R}=\frac{1}{T}\sum_{t=1}^{T}R_t$. Reserve excesses or deficiencies cannot be carried over from one period to the next. Moreover, banks are not allowed to have overdrafts in their accounts with the Banco de España. It is also assumed that the level of required reserves is well above the working balances that banks would normally hold for settlement purposes in the absence of any system of reserve requirements and that the required average level is known in advance over the entire maintenance period.[17]

b) The Banco de España exclusively uses *open market operations* to steer money market rates. These operations can be of two types:

   i) *regular operations* (*RO*), conducted at fixed intervals and aimed at providing regular basic refinancing and conveying policy signals. The interval between regular operations is equal to the length of the maintenance for required reserves. The operations are carried out at the start of each maintenance period.

   ii) *fine-tuning operations* (*FT*), carried out whenever necessary to limit interest rate volatility.

[17] This assumption, which is indisputable when the end of the computation period for the eligible liabilities precedes the start of the maintenance period, appears reasonable for the Spanish case, where there is some overlapping between the two periods, because the banks' margin of error in estimating their eligible liabilities on average over the computation period is relatively low. However, this margin of error tends to fade as the maintenance period progresses.

c) *AF* is the sum of the *autonomous factors* impinging on the money market (i.e. net foreign assets plus net asset position vis-à-vis the government minus banknotes and minus other net liabilities). Thus, the Banco de España's balance-sheet identity can be written as:

$$AF = R + RO + FT \tag{1}$$

d) *Decision-making by the Banco de España's* on whether and how to intervene takes places in two steps, at two different frequencies:

i) *Step 1* (at the time of regular operations). At this frequency, the reserve market equation (1) boils down to:

$$RO = \overline{AF^e} + \bar{R} \tag{2}$$

which assumes that the regular open market operation (*RO*) undertaken at the start of the maintenance period covers the banks' need for reserves to meet the required level $(\bar{R})$ while offsetting the expected value of autonomous factors during the maintenance period $\overline{AF^e} = \frac{1}{T} E_t \sum_{t=1}^{T} AF_t$.

ii) *Step 2* (daily frequency). Between regular operations, there may be variations in the banks' demand for reserves or in reserve supply. Shifts in demand reflect mostly the banks' behaviour in meeting required reserves, changes in desired working balances or expectations on future interest rates over the maintenance period. The supply of reserves may be affected not only by shocks to the autonomous factors, but also by the fine-tuning operations which may be carried out at the discretion of the central bank. All these factors will be examined in greater detail below.

On the basis of equation (2), which implies that the regular provision of liquidity (*RO*) matches banks' average demand for reserves plus the expected autonomous factors, the daily Banco de España balance sheet over the reserve maintenance period (t=1,.....,T) can be rewritten as:

$$RD_t = AF_t^{ne} + FT_t \tag{3}$$

where *RD* is the deviation of daily reserve balances from the average required level $(RD_t = R_t - \bar{R})$ and AF_t^{ne} is the deviation of autonomous factors from their expected average level over the maintenance period $(AF_t^{ne} = AF_t - \overline{AF^e})$.

This second step will be the focus of the remainder of this section and of subsequent empirical analysis, which first specifies behavioral equations for the components of equation (3).

1.1 Behaviour of factors influencing the supply of and demand for reserves

The *supply of reserves* within the maintenance period reflects two factors: the behaviour of autonomous factors and fine-tuning operations carried out by the Banco de España. As regards *autonomous factors*, they can be assumed to be interest-rate-inelastic and just to follow a stochastic process. The behaviour of the Banco de España concerning *fine-tuning operations* can be modelled as follows:

$$FT_t = \beta(or_t - rr) \tag{4}$$

which represents a simple reaction function whereby the Banco de España injects (mops up) liquidity whenever the overnight rate (*or*) tends to rise (fall) relative to the central bank's target rate. Of course,

it provides only of a simplified description of the behaviour of fine-tuning operations. The underlying assumption that the target for the overnight rate coincides with the rate set by the last regular repo operation (rr) should be seen only as a proxy of the actual targeting by Banco de España of the overnight rate. Rather than by a point target, this targeting is characterised by a tolerance band around the marginal rate set at the last ten-day period repo tender. However, the fact that this band is normally very narrow supports the simplified reaction function presented above. On the other hand, equation (4) assumes that the Banco de España reacts to offset interest rate movements regardless of the source of the shock. This properly characterises most of the Banco de España behaviour's concerning fine-tuning operations. However, on certain – though rather seldom – occasions the Banco de España does not accommodate certain shocks (for instance, specific episodes of increased demand for liquidity in the domestic money market resulting from severe exchange rate instability) and accepts relatively persistent deviations (for a few days) of the overnight rate from the official repo rate.

As regards the *demand for reserves,* it is swayed by banks' reserve management over the maintenance period, which, in turn, is fully conditioned by the existence of averaging provisions. The key feature of averaging provisions is that they allow banks to choose when, during the maintenance period, they prefer to meet the reserve requirement, subject to the constraint that their average level is equal to the required one. Every day, banks need to make a decision on what portion of the overall reserve requirements they intend to meet; i.e. on whether they want to hold reserves equal to, below or above the one required level. The banks' decision on the desired level of reserves will be made on the basis of a number of factors:

i) The *expected opportunity cost of holding reserves* on each particular day. Such opportunity cost is given by the difference between the current level of the overnight rate (or_t) and its expected level over the remaining part of the maintenance period

$$(E_t \overline{or} = E_t \frac{1}{T-t} \sum_{i=t+1}^{T} or_t).$$

Banks have an incentive to meet as much as possible of the requirement on those days of the maintenance period when the cost of financing such reserve holdings is lowest. If the current rate is above (below) the expected rate, banks will tend to hold reserves below (above) the average required level. The responsiveness of daily reserve balances to the spread between the current and expected rate ($or_t - E_t \overline{or}$) can be defined by a parameter (η) which measures the buffer-stock stabilising function of averaging provisions: the higher the value of the parameter, the larger the contribution of averaging provisions to stabilising interest rates. The value of this parameter, in turn, depends on certain technical features of the reserve requirement system (such as the length of the maintenance period and the level of working balances relative to required reserves), as well as on structural aspects of the banks' behaviour (degree of risk aversion; degree of uncertainty about the expected average level of overnight rates). These features are not explicitly modelled here.

ii) The *unfulfilled portion of the overall reserve requirement*, which will have to be met over the remainder of the maintenance period. It is bounded by the amount of reserves that a bank could be willing to hold (upper bound) and by the level of working balances that banks need to maintain (lower bound, normally determined by technical and institutional factors).

As a result of this factor, the relative importance of the different parameters in defining the banks' behaviour varies in a significant way during the course of the maintenance period. At the start, the constraint represented by the overall requirements is not very binding, and allows banks considerable discretion. Banks can thus respond to interest rate movements that are perceived as temporary by holding a higher or lower level of

reserves; in so doing, they tend to absorb such interest rate shocks to a large extent. As the end of the maintenance period approaches, the constraints represented by the overall requirement and by previous decisions in fulfilling it become progressively more binding, leaving banks less leeway to absorb money market shocks. At the same time, the relevant time horizon over which interest rate expectations are assessed becomes shorter, reducing the time available for a future reversal of current interest rate movements. As a result, the banks' demand for reserves becomes less elastic. At the limit, on the last day of the maintenance period it is totally inelastic, as banks have no choice but to meet any unfulfilled portion of the overall requirement.

This constraint imposed on banks by a system of required reserves can be modelled as a stochastic seasonal pattern in the daily reserve balances. In response to the behaviour of current interest rates and to their expectations of future interest rates, banks engage in strategies which imply an accumulation of reserve positions either above or below the required average level. Even in a context of constant expectations on interest rates over the remainder of the maintenance period, there may be an incentive for banks to postpone fulfilling the reserve requirement to the end of the maintenance period due to the interest compounding on the tax associated with non-remunerated required reserves. As the maintenance period progresses, this accumulated position tends to become increasingly more binding for the management of reserves in the remaining days of the maintenance period. At the limit, on the last day of the maintenance period, the level of reserves will be fully pre-determined by the accumulated reserve position of the day before. In other words, the pace at which previous decisions during the maintenance period condition current reserve management tends to accelerate as the end of the maintenance period approaches. To model this pattern, let us first define the accumulated reserve position:

$(AR_t = \sum_{h=1}^{t} R_h - t\bar{R})$.

Note that $RD_t = R_t - \bar{R} = \Delta AR_t$. One component of the determination of RD over the maintenance period can be seen as a sort of error correction mechanism, the "error" to be corrected being AR_{t-1} (i.e. the accumulated reserve position lagged by one day) and the error correction parameter (α_s) increasing in value as the end of maintenance period approaches.

As the weight of the error-correction mechanism increases towards the end of the maintenance period, so the role of the expectational variables discussed above lose importance in the determination of reserve demand. This pattern can be modelled by means of time-varying parameters whose values depend on the position within the maintenance period (s), probably in a non-linear fashion. Thus:

$$\Delta AR_t = -\alpha_s AR_{t-1} - \eta_s\left(or_t - E_t\overline{or}\right) \tag{5}$$

where $\frac{\partial \alpha}{\partial s} > 0$; $\frac{\partial \eta}{\partial s} < 0$; $\alpha_T = 1$; and $\eta_T = 0$.

Expression (5) can be rewritten in order to insulate an expectational component regarding future interest rates as follows:

$$\Delta AR_t = -\alpha_s AR_{t-1} - \eta_s\left(or_t - rr\right) + \eta_s\left(E_t\overline{or} - rr\right). \tag{6}$$

1.2 Reduced-form solution

Substituting equations (4) and (6) into (3) and solving out for $\left(or_t - rr\right)$, we obtain:

$$(or_t - rr) = \varepsilon_s AF_t^{ne} + \pi_s AR_{t-1} + \rho_s \left(E_t \overline{or} - rr\right) \tag{7}$$

where $\varepsilon_s = \dfrac{1}{(\eta_s + \beta)}$; $\pi_s = \dfrac{-\alpha_s}{(\eta_s + \beta)}$; and $\rho_s = \dfrac{\eta_s}{(\eta_s + \beta)}$.

Equation (7) is a reduced-form equation whereby the overnight rate is determined. Three variables account for the deviations of the overnight rate from the repo rate: the unexpected autonomous factors, the one-day-lagged accumulated reserve position, and, finally, expectations regarding future rates. The weight of these three variables in determining reserves demand varies over the maintenance period. The three variables can contribute to money market volatility and must be countered by the Banco de España if this volatility exceeds its desired level.

The central bank has at its disposal two devices to neutralise the impact of these factors on the overnight rate. These devices are the two structural parameters of the denominator of the reduced-form parameters of the model: the buffer-stock parameter of the demand for reserves (η); and the steering parameter of the fine-tuning operations (β). The higher the value of these parameters, the lower the impact of the "destabilising" factor on the overnight rate.

2. Estimate of the reduced-form equation for the overnight rate

2.1 Econometric analysis

Empirical work has been carried out to estimate a reduced-form of the overnight rate relative to the repo rate in line with equation (7). The estimated dynamic equation takes the form:

$$(or - rr)_n = \tau_0 + \left(\varepsilon_0 + \varepsilon_1\left(\frac{t}{T}\right) + \varepsilon_2\left(\frac{t}{T}\right)^2\right) AF_n^{ne} + \left(\pi_0 + \pi_1\left(\frac{t}{T}\right) + \pi_2\left(\frac{t}{T}\right)^2\right) AR_{n-1} + \left(\rho_0 + \rho_1\left(\frac{t}{T}\right) + \rho_2\left(\frac{t}{T}\right)^2\right)\left(E_n \overline{or_n} - rr_n\right) + \text{ lags}$$

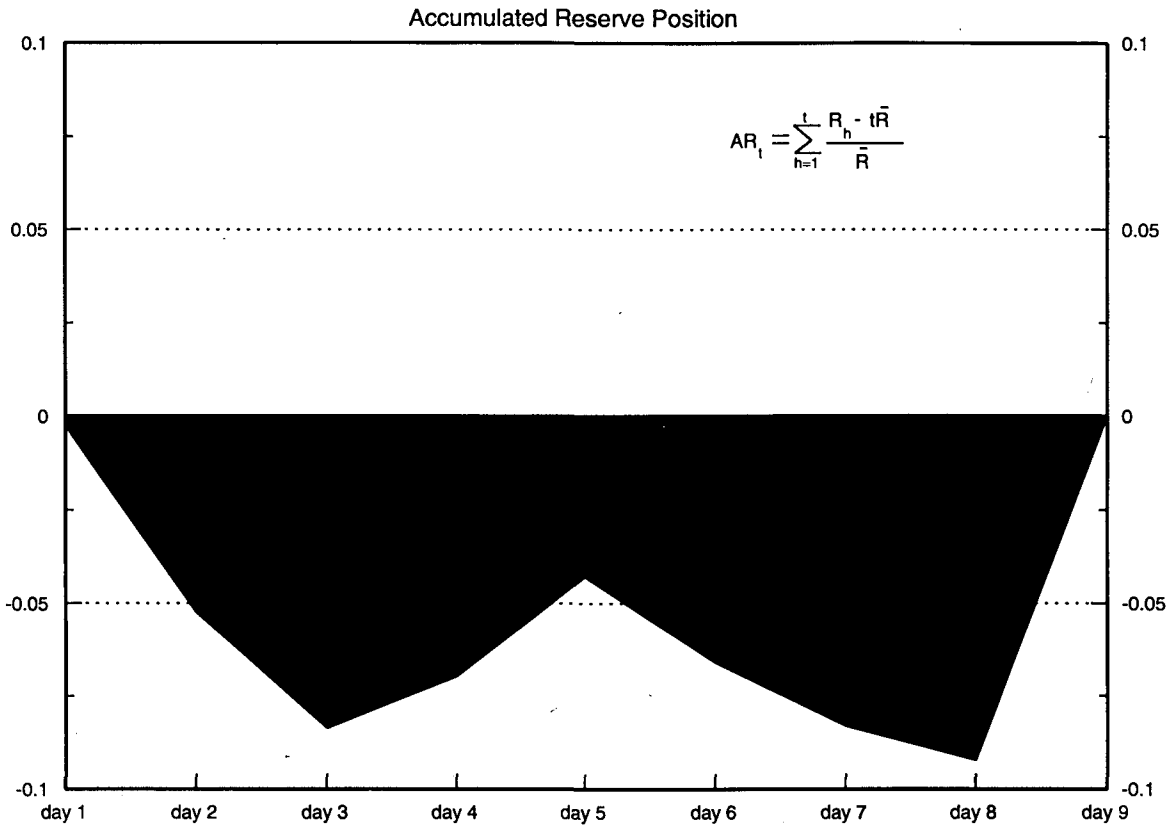
of the left and right-hand side variables.

Compared to equation (7), this testable version of the model incorporates a constant term which chiefly captures deterministic components of the financial spread. Moreover, a dynamic relationship between the overnight rate and the explanatory variables is allowed by including – if statistically significant – one-lagged terms of both the dependent and the right-hand side variables. It should be noted that the left-hand side variable is not the overnight rate itself, but the difference between the overnight and the official repo rate. Therefore, the empirical results explain the deviations of the overnight rate from the repo rate, but do not contain any information on the determinants of the overall level of the repo rate.

This equation is estimated with daily data over a sample (n = 1,..., N) spanning from November 1993 to June 1996. $(or - rr)_n$ and AR_n are observable variables. As regards the latter, in Chart A1, the average time pattern of the lagged accumulated reserve position – as well as daily reserve balances relative to the average requirement – over the maintenance period in the entire sample is plotted. It is apparent from Chart A1 that the dominant time pattern of the accumulated reserve position is one of under-fulfilling over most the maintenance period and a rapid reversal of reserve deficit positions during the last days of the period. This may indicate the closeness of the required reserves to working balances. It could also show that delaying the payment of the implicit tax entailed by the reserve requirement system seems to be an important consideration in the banks' reserve management. The expectational variable regarding future overnight interest rates ($E_n\ or_n$) and the unanticipated component of autonomous factors (AF_n^{ne}) are non-observable. The former has been proxied by longer maturities – between 5 and 10 days – of money market rates. For the autonomous factors, two alternative approaches have been taken. Firstly, it has been assumed that the liquidity

Chart A1

Average time pattern of Bank's reserve position over the maintenance period in the entire sample (November 1993 - January 1996)



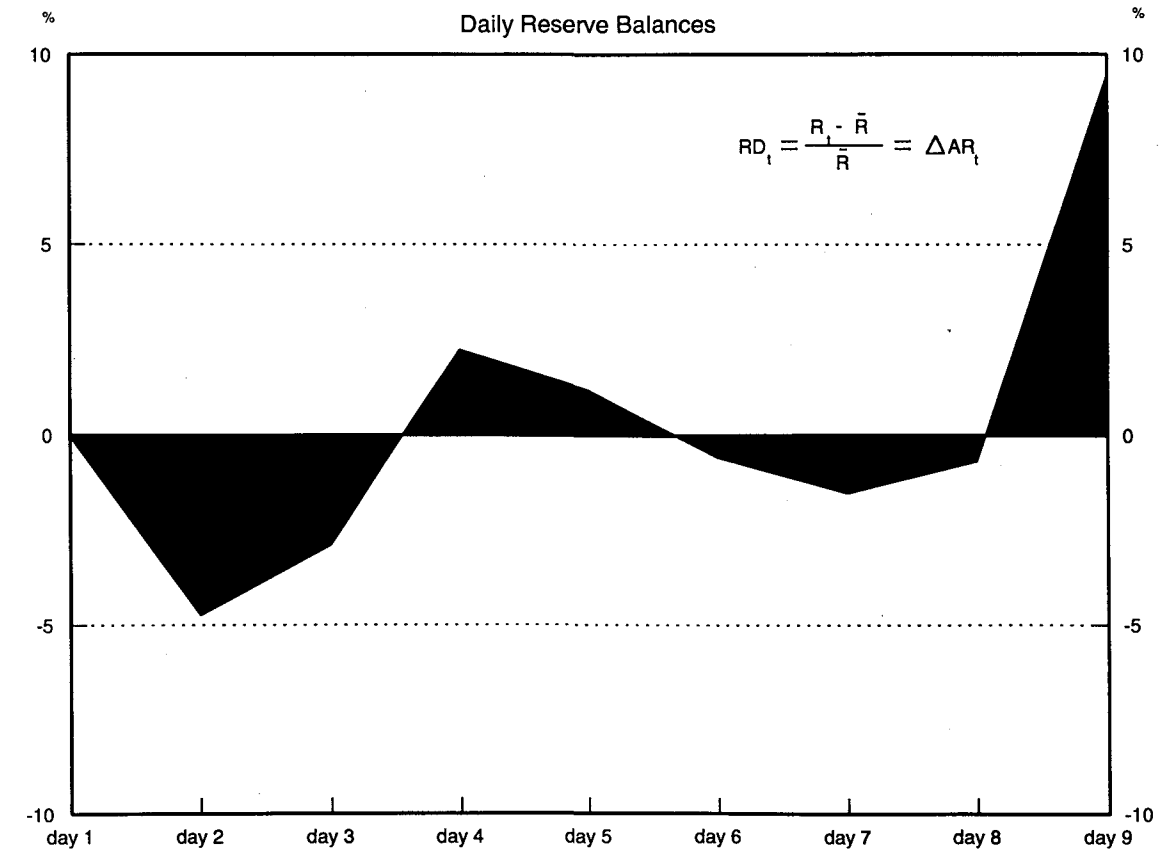


Table A1

Dynamic equation for the overnight rate

$$(or-rr)_n = \left(\varepsilon_0+\varepsilon_1\left(\frac{t}{T}\right)+\varepsilon_2\left(\frac{t}{T}\right)^2\right)AF_n^{ne}+\left(\pi_1\left(\frac{t}{T}\right)+\pi_2\left(\frac{t}{T}\right)\right)^2 AR_{n-1}+$$
$$+\left(\rho_{00}+\rho_{01}\left(\frac{t}{T}\right)+\rho_{02}\left(\frac{t}{T}\right)^2\right)\left(E\overline{or}-rr\right)_n+\delta_0(or-rr)_{n-1}+$$
$$+\left(\rho_{10}+\rho_{11}\left(\frac{t}{T}\right)+\rho_{12}\left(\frac{t}{T}\right)^2\right)\left(E\overline{or}-rr\right)_{n-1}+\varepsilon_n$$

Sample period: 4/11/93 - 28/6/96

ε_0 =	0.027	ρ_{00} =	0.48	ρ_{10} =	-0.83
	(3.3)		(2.5)		(-13.7)
ε_1 =	0.143	ρ_{01} =	1.8	ρ_{11} =	2.72
	(3.5)		(2.9)		(7.3)
ε_2 =	$-\varepsilon_1$	ρ_{02} =	-1.3	ρ_{12} =	$-\rho_{11}$
			(-2.9)		
π_1 =	0.15 (Fixed)	δ_0 =	0.74		
			(30.4)		
π_2 =	-0.30 (Fixed)				

R^2 =	0.81	DW=	1.9	SSR=	4.26
σ_ε =	0.08	F (11,644) =	398.7		

Variance decomposition of the overnight rate by its determinants

Absolute value of the variance of:

$(or-rr)$	$\bar{\varepsilon}AF^{ne}$	$\bar{\pi}AR$	$\bar{\rho}(Eor-rr)$	Residuals	Covariance
0.034	0.0013	0.003	0.024	0.016	-0.01

Relative contribution of variance of $(or-rr)$ (in percentages):

100	4	1	76	52	-33

Residuals

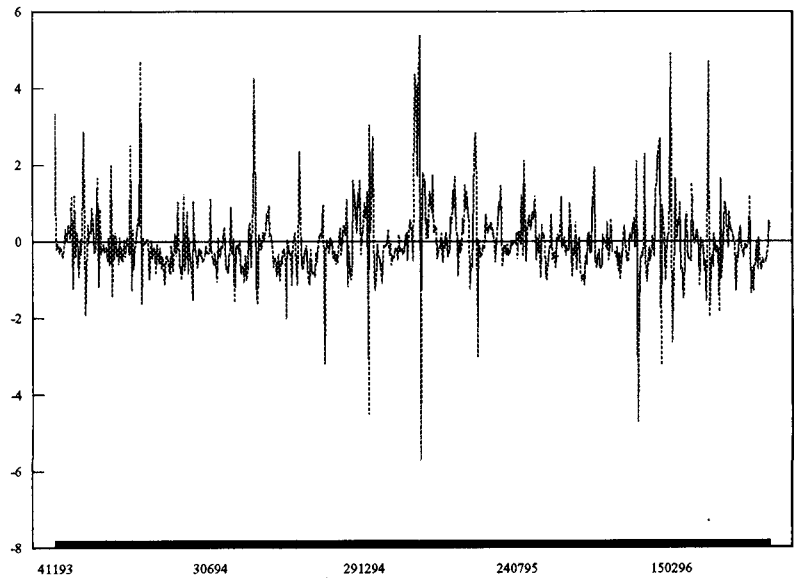


Chart A2

Time pattern over the maintenance period of the parameters of the variables accounting for the overnight rate fluctuations

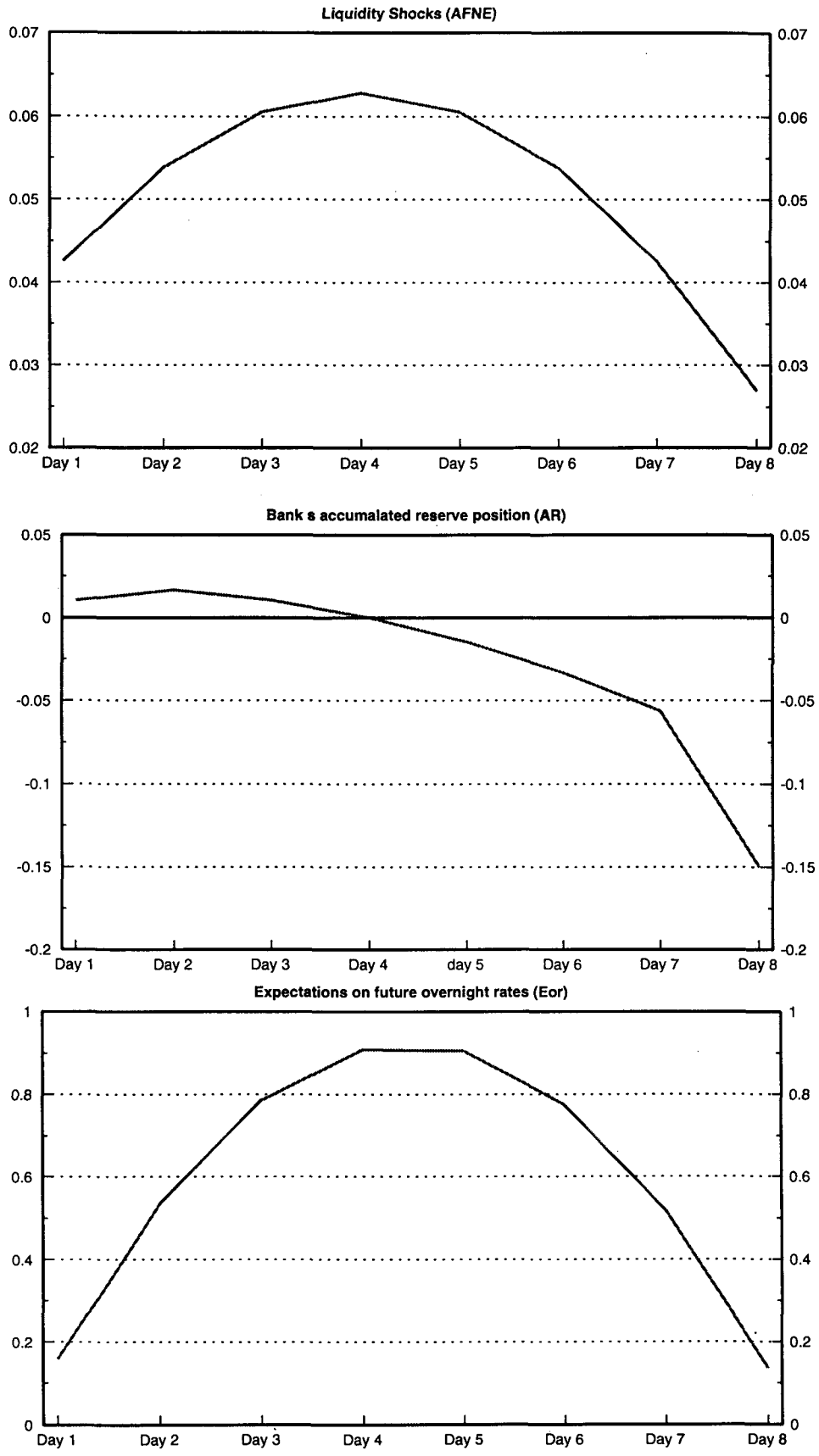


Table A2

Average parameters over the maintenance period		
Reduced-form parameters		
$\bar{\varepsilon} = 0.05$	$\bar{\pi} = -0.027$	$\bar{\rho} = 0.59$
Structural parameters		
$\alpha = 0.54$	$\beta = 8.1$	$\eta = 11.7$

Change in reduced-form parameters under two alternative scenarios			
		Zero degree of activism	Zero buffer-stock effect of RRs
		$(\beta = 0)$	$(\eta = 0)$
$\bar{\varepsilon}$	=	0.085	0.123
$\bar{\pi}$	=	-0.045	-0.066
$\bar{\rho}$	=	1	1.44

provided by regular open market operations matches the observed average of the autonomous factors from this average level, a second estimate of the unanticipated component of the autonomous factors is obtained. It can be advanced that econometric results are not very sensitive to the alternative use of these two variables. The equation reported below includes the second of the two proxies for AF^{ne}, which yielded slightly better results.

The possible non-linear time-varying shape of the parameters is proxied by a second order polynomial in a variable (*t/T*) which measures the position within the reserve maintenance period. In this regard, the specification of the model allows for testing the extent to which this position is determining the value of the parameters. In the case where the only independent terms of the polynomial – those with a zero sub-index – are statistically significant, the hypothesis that variables influence the overnight rate according to a seasonal pattern associated with the reserve requirements maintenance period would be rejected. If the first-order terms are significant, then the parameters are varying over the maintenance period in a liner fashion. Finally, the significance of the second-order terms would be an indication of non-proportional changes in the value of the parameters over the maintenance period.

In Table A1, the econometric results are summarised. The table first provides the estimated parameters of the dynamic equation which gives a first indication of the relative weight of the various factors determining fluctuations in the overnight rate relative to the official repo rate. However, these parameters only provide a rough indication of the relative contribution of the explanatory variables since the actual variance of the latter differs substantially across variables. In this regard, Table A1 also includes – along with some statistics and a plot of the residuals of the model to check its properties – the variance decomposition of (*or-rr*) by the model determinants, which provides a more accurate quantification of the relative contribution of the various variables; given that, by construction, all the variables of the model are stationary, the computation of this variance decomposition is legitimate. Two other pieces of evidence regarding the econometric results are also provided. First, Chart A2 plots the estimated time pattern over the maintenance period of the three explanatory variables on average over the entire sample. Second, Table A2 presents the average reduced-form and parameters over the maintenance period. From the estimated parameters, it is possible to recoup the structural parameters of the model presented in the previous section. Once these paraments were obtained, two simple exercises were carried out. First, it was assumed that $\beta=0$; i.e. a scenario with no fine-tuning operations by the Banco de España (zero degree of activism), while the

other two structural parameters were left unchanged and the average reduced-form parameters were recalculated. Second, this exercise was repeated assuming $\eta=0$, meaning that the buffer-stock function of RRs is cancelled. The results of this exercise are also provided in Table A2.

2.2 Conclusions from empirical results

On the basic of these empirical results, a number of conclusions can be drawn:

a) as a result of the existence of RRs with averaging provisions, expectations regarding future interest rates become a major determinant of the overnight rate;

b) the impact of autonomous factors is very minor, confirming the operation of the buffer-stock function of RRs and the stabilisation action of Banco de España's fine-tuning operations; obtained structural parameters suggest that both instruments are very important in performing this task. In this respect, econometric results hint that, in the absence of fine-tuning operations, the impact of shocks to autonomous factors on the overnight rate fluctuations would have been three times as large as is the case at present; on the other had, if the buffer-stock function of RRs were to be cancelled, contribution of autonomous factors on interest rate volatility would have been six times as large as the present situation; and

c) the impact of the lagged-accumulated reserve position is limited, although increasing as the maintenance period progresses. This shows the loss of importance of the stabilisation function of RRs towards the end of the maintenance period and is an indirect indication of a more active use of fine-tuning operations on those days.

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