

## French monetary policy: some implementation issues

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### Introduction

As a consequence of the sweeping movement of financial deregulation, the instruments and procedures of French monetary policy and their financial environment underwent drastic changes in the mid-eighties. These changes have already been described in depth.<sup>2</sup> They included:

- the demise of direct quantitative control and a substantial decrease in the share of subsidised credit in overall banking credit;
- the modernisation of the management of public debt through the creation of a range of negotiable instruments accessible to all investors, covering all maturities and issued through competitive tenders;
- the reform of the money market through the creation of two compartments. One is the interbank market, which is only open to financial institutions and on which central bank operations are focused. The other is open to all economic agents; instruments such as certificates of deposit, commercial paper and Treasury bills are traded on it. Another aspect of the reform of the money market was improved security through the promotion of repurchase transactions with delivery of securities;<sup>3</sup>
- the creation of financial derivatives markets, the development of short-term mutual funds that gave non-financial agents easy access to money market-related remuneration for their liquid assets and the removal of all capital controls as part of the move towards the creation of the Single European Market; and
- the reform of the Banque de France's money market intervention techniques. The central bank continues to use two kinds of repurchase agreements that normally define the upper and lower limits for money market rates: the first kind of repurchase agreement – repurchase tenders – is conducted at the discretion of the central bank; it constitutes the lower limit for money market rates and is used to supply the bulk of reserves; the second kind of repurchase agreement – the five-to-ten-day repurchase window – is a standing facility that provides the upper limit. However, in line with the reform of the money market, from 1986 onwards, the Banque de France started to intervene more frequently on the market. This was done even when the short-term money market rates lay between the two official rates referred to above, either through outright transactions or through very-short-term repurchase and withdrawal transactions for fine tuning purposes, without any formal announcements.

This paper concentrates on some of the consequences of these structural changes for the implementation of French monetary policy, and more specifically on the more recent years.

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<sup>2</sup> See Icard (1994).

<sup>3</sup> See De Lapasse (1994) and Paul and Wilhelm (1996).

It appears that the main changes in the tactical approach to monetary policy were not related to changes in the structure of the money markets, even though the greater integration of these markets has broadened the range of operational instruments at the disposal of the central bank and may also have increased the rapidity and intensity of the pass-through between policy rates and other market rates. Rather, the most relevant changes have stemmed from the opening up of the French financial markets. As will be shown in Section 1, the respective roles of the various monetary policy instruments and procedures have evolved towards an increasing reliance on open market operations, and especially fine tuning operations. This change took place in a context where convergence of French economic fundamentals towards price stability, free movement of capital and financial innovation increased the substitutability between domestic and foreign assets and where the stability of the French franc vis-à-vis the most credible currencies participating in the Exchange Rate Mechanism (ERM) was pursued as a way of increasing the credibility of French monetary policy and facilitating the domestic disinflationary process. A tentative assessment of this change in the Banque de France's tactical approach to monetary policy is made in Section 2. The final section offers some remarks concerning the future and a model of the diffusion of changes in the intervention rate to money market rates is estimated and discussed in an Appendix.

## **1. The changing roles of the various monetary policy instruments and procedures**

Against the background of its monetary policy objectives and growing capital mobility, the Banque de France has increasingly come to rely on open market operations, and especially fine tuning, to implement its monetary policy.

### **1.1 Monetary policy objectives**

Since the mid-eighties, French monetary policy has pursued price stability as its final objective using two intermediate objectives one of which is domestic and the other external.

The domestic objective is based on a growth target for a money aggregate, the definition of which has somewhat varied over time – essentially M2 till 1990, M3 thereafter – as a consequence of financial innovation and deregulation. Both factors, and the fact that the external objective is more binding in the short-term conduct of monetary policy, led from 1993 onwards, to the monetary target being assigned a medium-term objective.

Indeed, the external objective of keeping the exchange rate of the franc stable vis-à-vis the most credible currencies – i.e. those that have the lowest yield curves – in the ERM has been the greatest constraint on the use of monetary policy instruments and procedures as inflationary pressures were kept under control, the prospect of European monetary unification approached and capital mobility improved.

### **1.2 Growing capital mobility**

The complete liberalisation of capital movements and the availability in France of a full range of financial instruments, traded on liquid and secure markets, have made French financial markets increasingly sensitive to external developments. As far as the consequences for the use of monetary policy instruments and procedures are concerned, greater capital mobility led to a heightened risk of the relocation of certain financial activities, to efforts to try to "disconnect the

domestic impact of monetary policy from its external effects"<sup>4</sup> in situations of tension on the foreign exchange markets, and to the need to create "two-way risk" on the foreign exchange market.

(i) Mainly in order to prevent domestic funds from shifting to Euro-markets, the reserve requirements on time liabilities were eased from 3 to 0.5% in October 1990 and to 0% on time liabilities over one year in December 1991.

(ii) Moreover, as the markets and the central bank have occasionally followed different lines of reasoning,<sup>5</sup> there were situations in which the exchange rate was under pressure and there was a need to shield domestic borrowers as far as possible against higher interest rates. This was achieved temporarily in two ways:

- reserve requirements were lowered on several occasions, by decreasing reserve ratios on sight deposits and passbook savings (in October 1990, January 1991, December 1991 and May 1992) and including vault cash (from October 1990, 75% of vault cash was included and from January 1991, 100%); on one occasion in December 1991, reserve requirements were alleviated as the repurchase tender rate was raised; in the other cases, the repurchase tender rate was kept unchanged and the fall in reserve requirements acted to some extent as a substitute for lower intervention rates; and
- from the second part of 1992, when there was tension on the foreign exchange market, the link between money market rates and the repurchase tender procedure was loosened as the latter rate was kept unchanged and the five-to-ten-day repurchase window was closed and replaced temporarily by an overnight facility to tighten control over the overnight rate. Keeping the repurchase tender rate unchanged also helped to signal that there was no need to change the medium-term orientation of monetary policy (see 2.2).

(iii) Finally, an important measure affecting the operating environment of monetary policy was the widening of the ERM fluctuation bands in August 1993 from  $\pm 2.25\%$  to  $\pm 15\%$ , in order to fight speculative pressures by creating "two-way risk" in the ERM.

The perception among certain market participants that the exchange rate commitment was not credible was probably at the root of the speculative attacks that led to that decision. Also, after the widening of the ERM fluctuation bands, there were expectations that there would be more exchange rate flexibility, in contradiction to the goal set in the original arrangement, the fact that central rates had been kept unchanged as well as the orientation of policies pursued thus far.

As a consequence, in order to dissipate any lingering doubts about the exchange rate commitment, it may be considered that the widening of ERM fluctuation bands increased the need for caution in adjusting money market interest rates towards their "baseline" levels in the wake of speculative attacks. This means that very short-term money market interest rates might have to be more tightly controlled.

### **1.3 An increasing reliance on open market operations, especially fine tuning operations**

The greater use of open market operations, as well as the wider use of repurchase agreements by the central bank, can be seen as a step towards convergence in monetary policy instruments and procedures in EU countries.<sup>6</sup>

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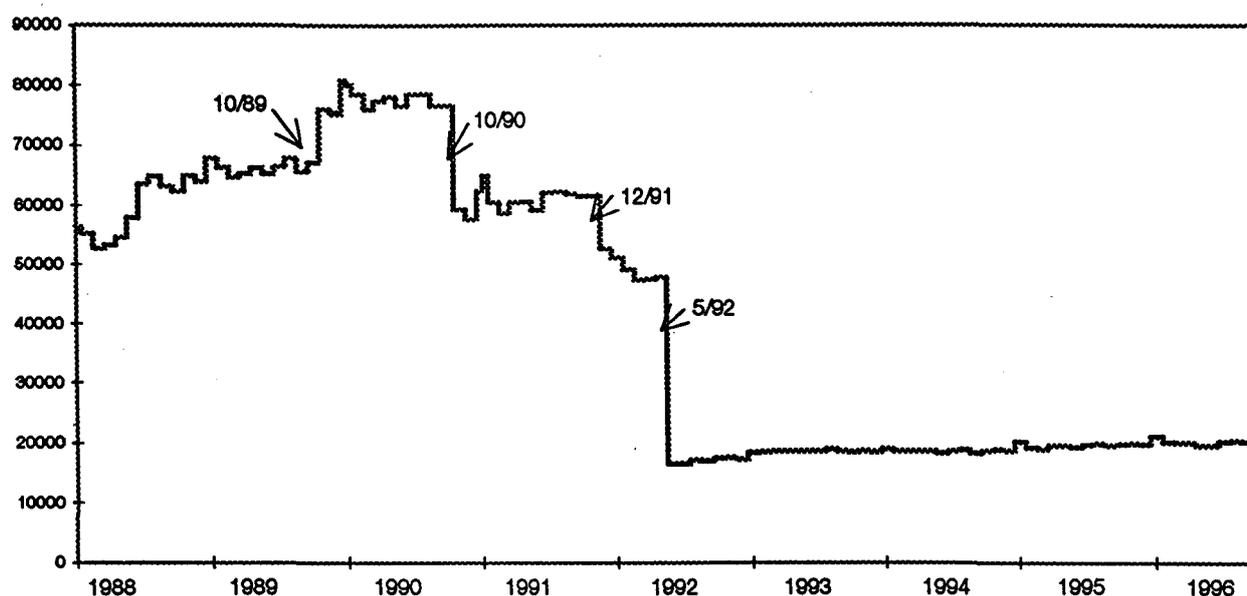
<sup>4</sup> See Icard (1994). It is also worth noting that French private non financial agents were "de facto" protected to a large extent against a rise in short-term interest rates insofar as more than 60% of their debt was referenced on long-term interest rates in 1994. See Grunspan (1995).

<sup>5</sup> See Raymond (1994).

<sup>6</sup> See Aspetsberger (1996).

It is also consistent with a reduced role for reserve requirements that can itself be viewed as a general trend in industrialised countries.<sup>7</sup> In France, as mentioned above, reserve requirements have been lowered drastically since 1990. Today, reserves held with the Banque de France for reserve requirement purposes represent less than 0.1% of GDP, as compared with 1.2% of GDP in 1990 (see Graph 1), and it has been estimated that reserve holdings absorbed only 5% of liquidity shocks in 1994.<sup>8</sup> Moreover, as required reserves are considered to be very close to the level of settlement balances, their stabilising effect on very short-term interest rates has sharply decreased, in spite of averaging provisions over one month.

Graph 1  
Reserve requirements\*



\* Includes vault cash since October 1990.

Since the last reserve requirement reduction, which was decided in May 1992 and which has not been reversed since, open market operations have had to bear the brunt of the Banque de France's money market management. Since 1992, fine-tuning open market operations have been conducted virtually every day, both on overnight and longer maturities.

## 2. A tentative assessment

Among the main functions of an operational framework for monetary policy, one can distinguish its ability to signal monetary policy intentions, contain the volatility of money market rates and steer these rates.<sup>9</sup> The role performed by open market operations conducted by the Banque de France is first assessed against these three benchmarks<sup>10</sup> and an overall judgement is then made.

<sup>7</sup> See Bank of Japan (1995) and Bisignano (1996).

<sup>8</sup> See Escrivá and Fagan (1996).

<sup>9</sup> See European Monetary Institute (1996). The EMI Report also mentions the roles of the operational target in providing and withdrawing liquidity in the interbank market, helping to control monetary aggregates, allowing adequate information to be extracted from market developments and possibly contributing to the smooth functioning of the payment system.

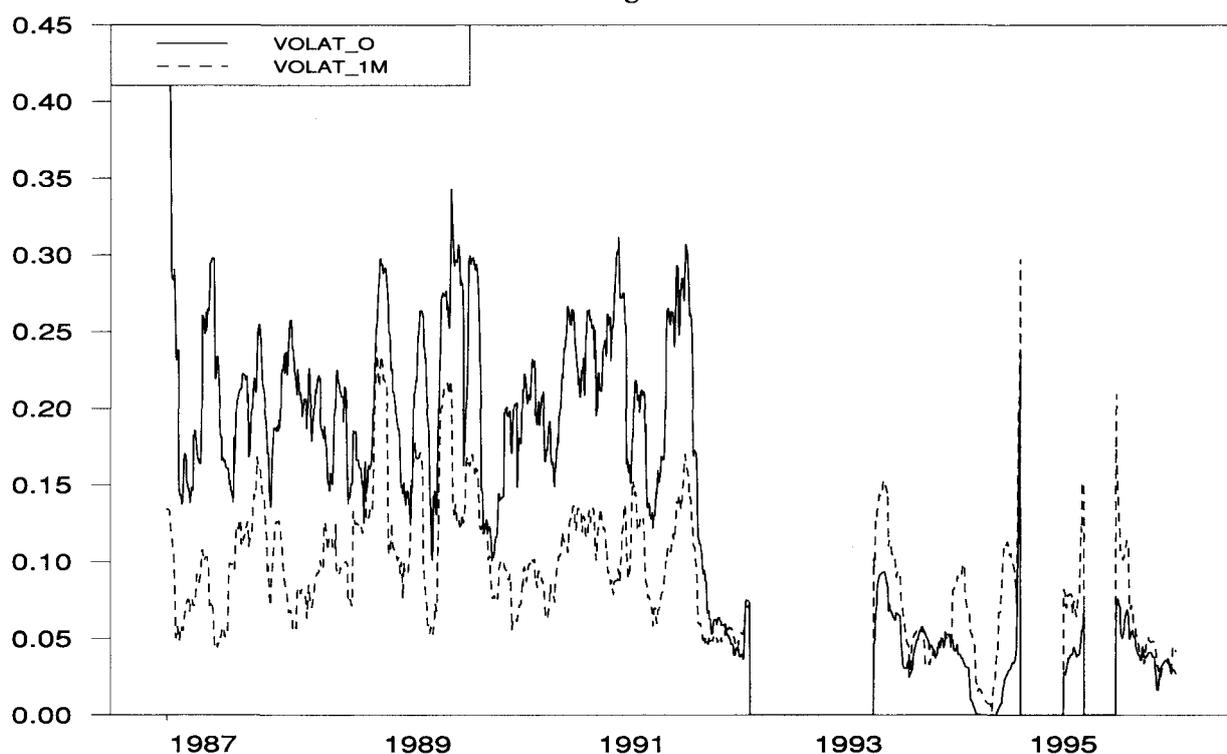
<sup>10</sup> The methodology used is described in the Appendix.

## 2.1 Volatility of short-term interest rates

As in the research conducted at the EMI,<sup>11</sup> the volatility of short-term interest rates is assessed through the standard deviation of the difference between the official rate at which the bulk of liquidity is provided – the repurchase tender rate – on the one hand, and the overnight rate or the one-month rate on the other, so as to eliminate the effect of the trend in money market rates on the level of volatility.

Graph 2 shows that, after 1992, the lower volatility of the overnight rate has not been accompanied, in normal times,<sup>12</sup> by higher volatility in the one-month rate. In fact, average volatility has declined from 0.20 for the overnight rate and 0.11 for the one-month rate before 1992 to, respectively, 0.05 and 0.07 after 1992.

Graph 2  
Volatilities of the overnight and one-month rates



## 2.2 Signalling the monetary policy stance

Granger causality tests reveal that:

- throughout the period, there is causality between the one-month rate and the overnight rate; this may reflect the accuracy of market expectations;
- until 1992, the repurchase tender, five-to-ten-day window and overnight rates had an influence over the one- and three-month rates; and

<sup>11</sup> See Escrivá and Fagan (1996).

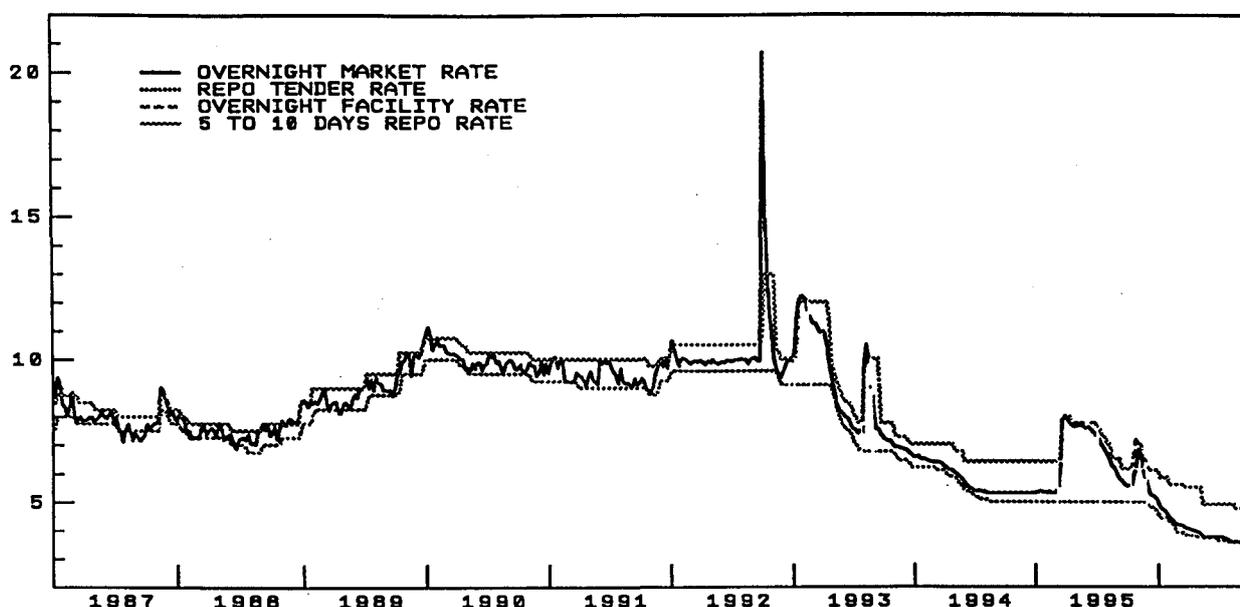
<sup>12</sup> Normal times are defined by excluding periods of exchange rate pressure (from 1st September 1992 to 31st August 1993, 1st March 1995 to 30th June 1995 and 1st October 1995 to 15th November 1995).

- after 1992, and excluding periods of exchange rate tension, only the three-month rate seems to be caused by the overnight rate and the two intervention rates. The absence of a Granger causality between these rates and the one-month rate can be accounted for by the fact that the bulk of the adjustment takes place on the first day, as we will see below, and that this effect is not measured by standard Granger causality tests, due to the absence of contemporaneity.

### 2.3 Steering money market rates

Graph 3 plots the levels of the repurchase tender, five-to-ten-day window and overnight rates since 1987. It can be seen that, before 1992, the overnight rate usually lay within the interest rate corridor, although it was fairly flexible. After 1992, apart from periods of exchange rate pressure, the overnight rate was much more rigid. Although this goes beyond the scope of this paper, one can also note that as the Banque de France was successful in defending the franc, the interest rate rises required to alleviate exchange rate pressure became progressively less important.

Graph 3  
Intervention and overnight rates since 1987



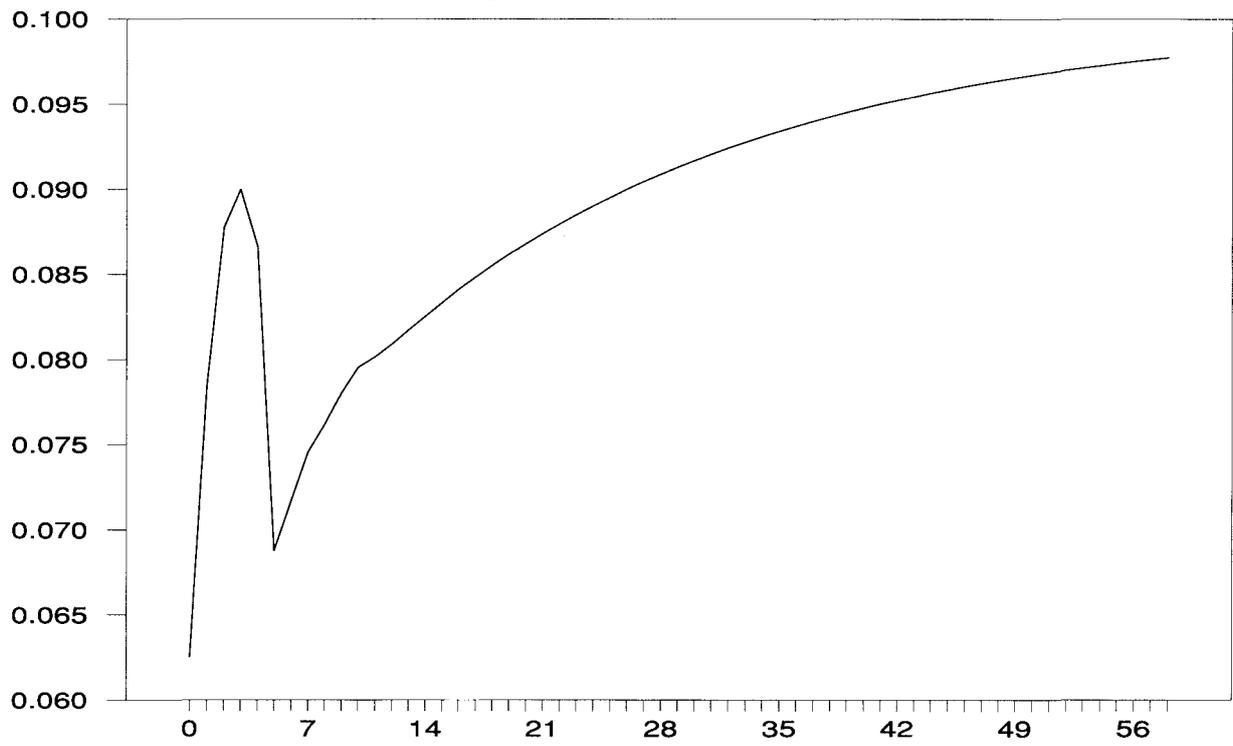
The transmission of monetary policy impulses to the money market is assessed by giving "shocks" to the rates that are relevant for the formation of the one- and three-month rates.<sup>13</sup> The shocks are standardised as a 10-basis-point increase.

Before 1992, it took the one-month rate one month to adjust up to 85% to a shock to the intervention rates and the overnight rate (Graph 4); after the same lapse of time, 80% of the same shock was reflected in the three-month rate (Graph 5).

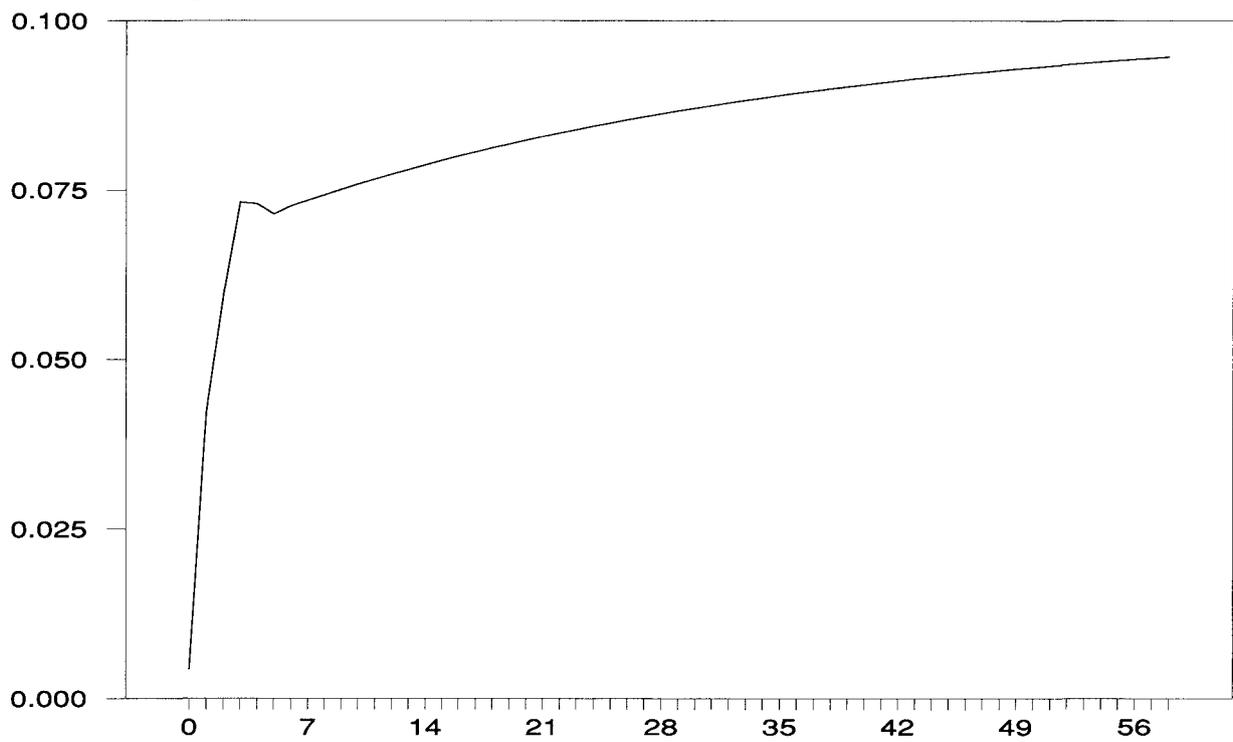
Since 1992, the money market has adjusted much faster: the pass-through of a change in the overnight onto the one-month rate (Graph 6) is completed after one week, with 92% of the adjustment taking place on the first day; the lag is approximately two weeks for the transmission of a change in both the overnight rate and the official rates to the three-month rate (Graph 7). In comparison with the period before 1992, the much more rapid transmission of monetary policy

<sup>13</sup> Although simpler, the approach used here is similar to the one employed in Ayuso, Haldane and Restoy (1994).

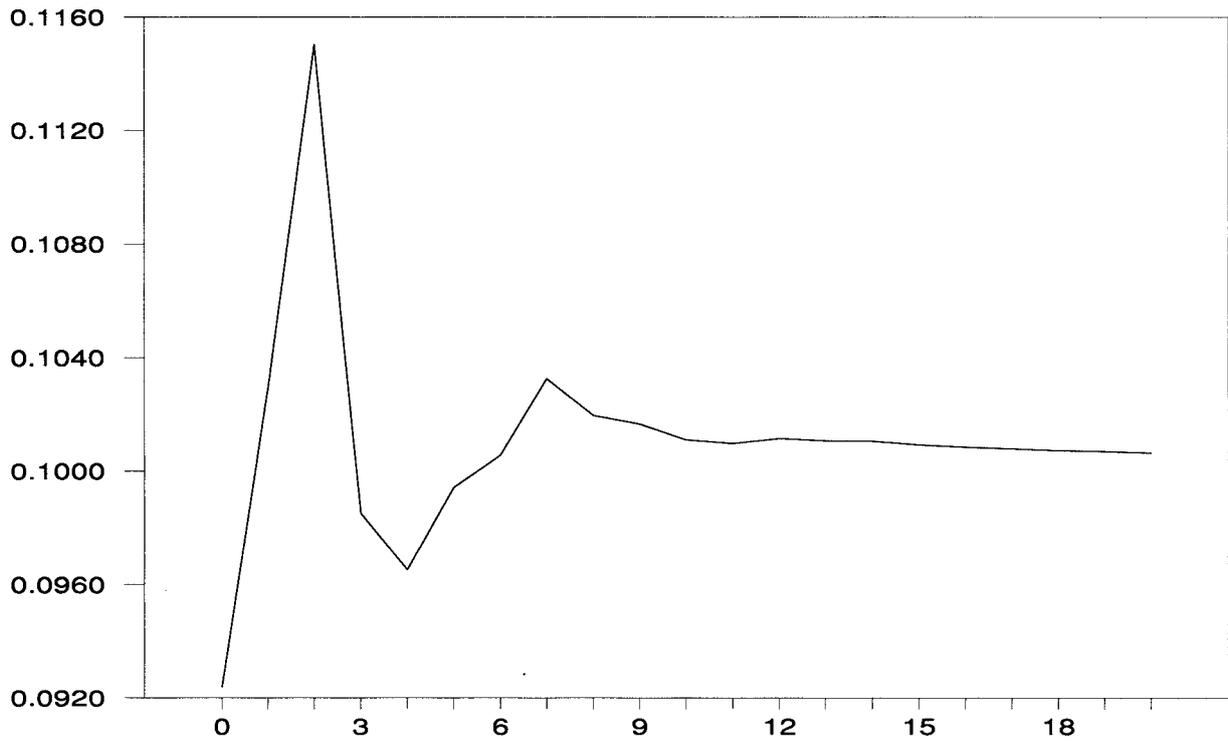
Graph 4  
**Response of the one-month rate to a monetary policy impulse before 1992**



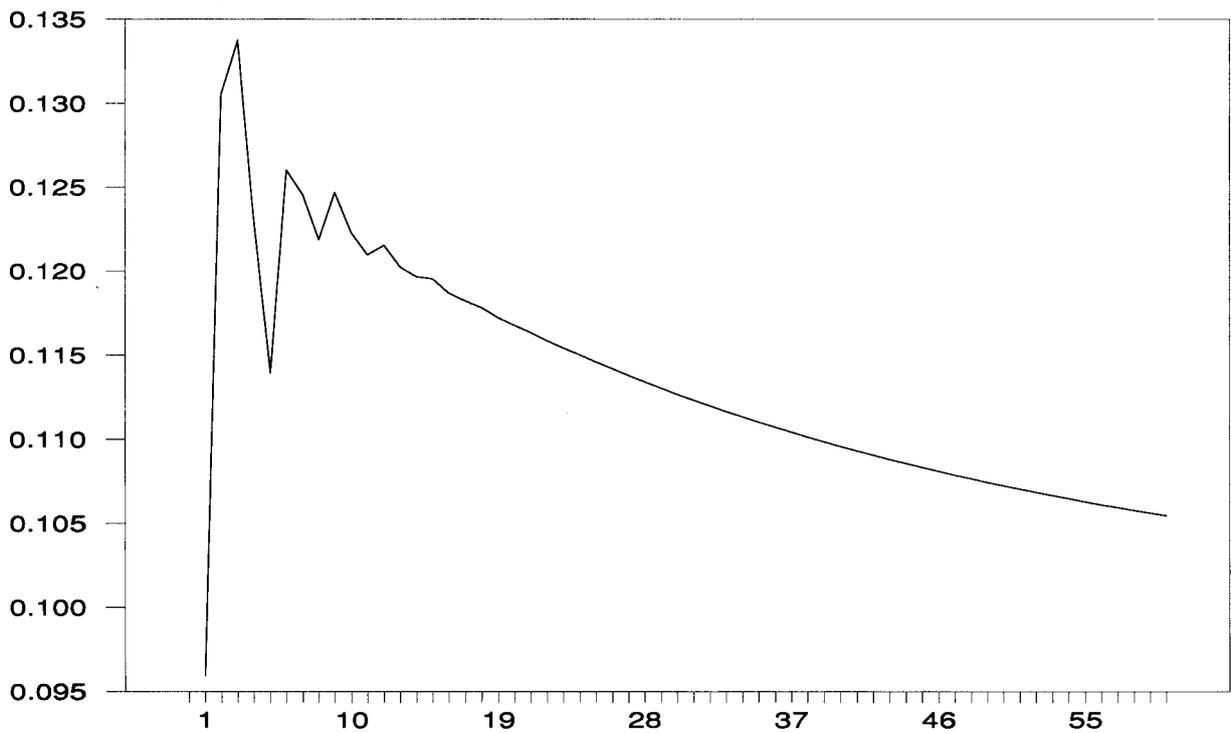
Graph 5  
**Response of the three-month rate to a monetary policy impulse before 1992**



**Graph 6**  
**Response of the one-month rate to a monetary policy shock after 1992**



**Graph 7**  
**Response of the three month rate to a monetary policy shock after 1992**



impulses can be attributed to the market's understanding of the enhanced role played by the overnight rate in the conduct of monetary policy in the short term, and perhaps also to the increased efficiency of the money market resulting from the reforms implemented in the mid-eighties.

## 2.4 Overall assessment

It is clear that the operational framework of French monetary policy has gained in efficiency: apart from periods of exchange rate tension, the volatility of the one-month rate has decreased, in spite of a sharp reduction in reserve requirements, and the transmission of monetary policy impulses is now much more rapid. The enhanced role of the overnight rate can probably be accounted for by the fact that it is more closely monitored. Nevertheless, stability tests tend to show that it took the money market a fairly long time – approximately two years, from May 1992 to June 1994 – to adapt to a situation where the Banque de France kept the overnight rate under control and influenced it in order to convey signals on its monetary policy stance. Concerning the influence that the Bank's intervention rates continue to have over the three-month rate, the repurchase tender rate is still indicative of the medium-term policy orientation, which is consistent with the confidence shown by the Banque de France in not raising this rate in periods of tension on the foreign exchange market, while the five-to-ten-day repurchase window may track the "threat" the Banque de France lets hang over the markets; i.e. the extent to which it is ready to let market rates soar in the event of speculative attacks on the franc.

In these circumstances, the question that arises is to what extent has there been a shift in the Banque de France's monetary policy operating regime after 1992, and how should it be interpreted? Indeed, the emphasis has shifted from the use of an interest rate corridor to steer interbank rates and signal the monetary policy stance on the one hand, and reserve requirements to stabilise the demand for reserves on the other, towards more intensive recourse to open market fine-tuning operations. However, the elements of a "continental" model for the implementation of monetary policy have not been abandoned and the shift towards more intensive fine-tuning took place under the pressure of circumstances, as the increasing substitutability of European currencies made the foreign exchange constraint more binding. In this respect, it is worth noting that the European System of Central Banks (ESCB) is not expected to have an exchange rate target and that the euro will play an anchoring role in the monetary arrangements between countries participating in the euro area from the outset and EU countries with a derogation or an opt-out clause. On the whole, the current method of conducting monetary policy in France can be seen to be transitory.

## 3. Remarks concerning the future

In this Section, two questions are addressed:

- Is the imminent introduction of a Real-Time Gross Settlement (RTGS) system by the Banque de France likely to have consequences for the conduct of monetary policy?
- How might monetary policy instruments and procedures be adapted before the creation of the European Central Bank (ECB)?

### 3.1 Introduction of a Real-Time Gross Settlement (RTGS) System

An RTGS system, known as TBF ("Transferts Banque de France") will come on line at the Banque de France as of April 1997.<sup>14</sup> The introduction of this system is not expected to have any substantial consequences for the conduct of monetary policy.

First, it is quite unlikely that an intraday market for reserves will emerge. There are three reasons for this: there will be broad access to intraday liquidity; the central bank will provide this liquidity free of charge and only demand appropriate collateral; and the range of collateral that will be

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<sup>14</sup> See Banque de France (1996).

accepted will itself be defined rather broadly, which means that the amount of intraday liquidity potentially available from the central bank will be extremely large.

Secondly, even if an intraday market were to emerge, it is very unlikely to "communicate" with the overnight rate since end-of-day overdrafts will be charged at a penalty rate higher than the five-to-ten-day repurchase rate and hence much higher than the overnight rate. More fundamentally, it seems that the separation between a possible intraday market and the money market would disappear only if the central bank were to radically change its operating procedures by intervening on a real-time basis for maturities shorter than one day (in this case, reserve requirements would also have to be computed on a real-time basis). Of course, the question arises as to why central banks should contemplate such a sweeping reform.

Even though no consequences are foreseen for the implementation of monetary policy, the Banque de France is anxious to avoid unduly disturbing market practices, e.g. by requiring participants in TBF to post much higher amounts of collateral than they would expect, which might in turn affect the liquidity of the interbank market. As a consequence, the timing of credits and debits to and from commercial banks' accounts with the central bank will be modified; for example, reserves allocated following repurchase tenders will be credited early in the morning.

### **3.2 Adaptation before the European Central Bank (ECB)**

The ECB will probably be created in early 1998. Once it is created, it is clear that any amendments to existing instruments and procedures, as well as the creation of any new ones, will be inspired by the need to put in place the operational framework for the single monetary policy. This leaves only a year and a half to make "unilateral" changes. Consequently, any such changes will probably be limited in scope.

With regard to reserve requirements, their use for monetary control purposes, i.e. to influence developments in monetary aggregates, has not been abandoned. Nevertheless, there is an awareness of the risks of relocation of activities and disintermediation associated with non-remunerated reserves. In addition, M3 has been growing at an annual pace of 1.5%, on average, since its medium-term growth target was set at 5% at the start of 1994. However, the stabilising properties of reserve requirements could be enhanced, without increasing the reserve burden, by increasing the level of required reserves and remunerating them, especially if the interest paid is partially linked to very short-term market interest rates.<sup>15</sup> Even under such conditions, however, the Banque de France would have to be willing to accept a degree of volatility in very short-term interest rates; otherwise, fine-tuning open market operations might have to be conducted nearly as frequently as today, depriving the remuneration of compulsory reserves of most of its relevance.

Concerning open market operations, conducting variable-rate tenders occasionally, instead of the current fixed-rate repurchase tenders, would help extract information from market developments, but would have the same result as a more active role for reserve requirements; i.e. a degree of volatility in very short-term interest rates.

Finally, as regards standing facilities, creating a marginal lending facility and deposit facility, such as those the European Monetary Institute has suggested preparing for the ESCB,<sup>16</sup> could be contemplated. (In the case of the marginal lending facility, this could be done by shortening the duration of the five-to-ten-day repurchase window in order to use it as an end-of-day facility.) However, in this case also, the usefulness of such decisions may be questioned as long as the overnight rate is kept under control.

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<sup>15</sup> See Vazquez (1995).

<sup>16</sup> See European Monetary Institute (1996).

## Appendix

We wanted to model the process by which monetary policy impulses are diffused to money market rates. Monetary policy impulses are identified with changes in Banque de France intervention rates—repurchase tender rate and five-to-ten-day repurchase rate—as well as changes in the overnight rate. The overnight rate results from the balance of supply and demand on the interbank market and is normally affected by changes in the "autonomous factors" of liquidity. However, the central bank may intervene to clear the market and smooth "ex ante" rate fluctuations. Furthermore, the overnight rate plays an important role on the French money market with over 70% of interbank loans being traded on this maturity.<sup>17</sup> Therefore, in the following, the overnight rate will be included in the range of rates through which the central bank may influence longer money market maturities.

This appendix is divided into five sections: after describing the data used, we construct a volatility indicator for the overnight, one- and three-month rates (Section 1). From this initial examination of the data, we infer the existence of three distinct periods, each one corresponding *a priori* to a specific regime for the diffusion of monetary impulses to money market rates. We then test the causality of various explanatory variables over the three periods (Section 2). In a third section, we describe the features of the selected model and assess its robustness. The fourth section is devoted to testing the stability of the model over the three periods. In the last section, we simulate the diffusion of policy shocks and discuss the results.

### 1. An initial examination of the data

We used daily data, provided by the Capital Markets Division of the Banque de France, on the repurchase tender rate (*AO*), the ceiling rate (*pension*),<sup>18</sup> the overnight rate (*jj*), the one-month PIBOR (*f1m*), the three-month PIBOR (*f3m*) and the Deutsche mark one-month FIBOR (*a1m*). The data span the period 01/01/87 – 10/09/96. The *jj* is the average bid-offer rate quoted at 11.30 a.m. We used five data series per week. Weekends are excluded. For non-working days, we reproduced the data of the previous working day.

A first empirical approach consisted in estimating the volatility of the money market rates, including the overnight rate. In order to eliminate trend effects that may cause the volatility of a variable to be overestimated, we referred to detrended variables. To this end, one can either estimate the variance of the variables minus their moving average or deduce the repurchase tender rate – which is supposed to represent the trend – from each of the variables. By analogy with the work conducted at the EMI,<sup>19</sup> we used the second method. The volatility of variable *X* on time *t* was estimated by computing the variance of *X* on the interval [*t*-15, *t*+15].

Graphs 1 to 3 in the main text suggest that there were three distinct periods, each corresponding *a priori* to a specific regime as regards the reaction of money market rates to changes in the intervention or overnight rates:

- before 1992, the overnight rate appeared much more volatile than the intervention rates;
- after 1992, and excluding periods of exchange rate pressure, the controlled volatility of the overnight rate was accompanied by limited volatility on longer maturities; and

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<sup>17</sup> See Paul and Wilhelm (1996).

<sup>18</sup> The *pension variable* is compiled from the five-to-ten-day window rate under "normal" circumstances and the overnight facility rate in "exceptional" circumstances corresponding to periods of foreign exchange tension. Moreover, the data include a variable that is indicative of the exceptional nature of the overnight facility.

<sup>19</sup> See Escrivá and Fagan (1996).

- foreign exchange crises make up the third period, during which the management of the money market was based on the overnight (and overnight facility) rate, while the repurchase tender rate remained stable.

Empirically, the transition from a regime of moderate overnight rate volatility to a regime of more limited volatility took place in the course of March 1992. From a policy point of view, the closest significant measure was the reduction in reserve requirements on 16th May 1992. Accordingly, we chose that date as a "turning point".

We therefore defined the following three periods:

- period 1 spans 01/01/87 to 15/05/92;
- period 2 spans 16/05/92 to 10/09/96, excluding moments of foreign exchange pressure; and
- period 3 corresponds to moments of foreign exchange tension (from 01/09/92 to 31/08/93, 01/03/95 to 30/06/95 and 01/10/95 to 15/11/95).

## 2. Selection of the appropriate explanatory variables

In order to select the appropriate explanatory variables, we ran Granger causality tests.

The series have been differentiated so as to work in a stationary environment.

The results, as summarised in Table 1, highlight four types of phenomena, of which the last two were not expected *a priori*:

- in period 1, there is a causal relation between the intervention and overnight rates, and the money market rates (one-month and three-month PIBOR);
- excluding periods of exchange rate tension, the Deutsche mark one-month FIBOR displays very limited explanatory power. In this respect, the liberalisation of capital flows does not seem to have resulted in greater interdependence between money market rates. However, the first significant measures in this area were implemented as early as 1986, before the period under review;
- in period 2, only the three-month rate seems to be caused by the two intervention rates and the overnight rate. However, the absence of a Granger relationship of cause and effect between those rates and the one-month rate does not necessarily prove that the former are inefficient in steering the latter. Indeed, this absence of causality can be accounted for by the fact that the bulk of the adjustment takes place on the first day, as we will see below, and that this effect, which expresses increased monetary policy efficiency, is not measured by standard Granger causality tests, due to the lack of contemporaneity; and
- throughout the period under review, there is a causal relationship between the one-month rate and the overnight rate. This may reflect the accuracy of market expectations.

Table 1  
Granger causality tests

Period 1: from 01/01/87 to 15/05/92

Period 2: from 15/05/92 to 10/09/96, excluding periods of exchange rate tension

Period 3: foreign exchange turbulence

**One-month PIBOR – Fischer statistics**

Explanatory variable	Period 1		Period 2		Period 3	
jj	4.5	(0.05)	1.5	(19.8)	10.0	(24.4)
AO	1.5	(17.8)	0.8	(57.5)	0.1	(99.5)
pension	8.0	(0.0)	2.1	(6.2)	3.5	(0.4)
alm	1.0	(42.6)	1.3	(25.2)	4.7	(0.04)

**Overnight rate – Fischer statistics**

Explanatory variable	Period 1		Period 2		Period 3	
One-month PIBOR	5.0	(0.01)	6.3	(0.0)	2.7	(2.1)
AO	2.5	(2.7)	1.2	(32.7)	0.01	(100.0)
pension	7.7	(0.0)	6.3	(0.0)	3.7	(0.3)
Three-month PIBOR	0.41	(84.0)	2.3	(6.1)	1.3	(27.7)

**Three-month PIBOR – Fischer statistics**

Explanatory variable	Period 1		Period 2		Period 3	
jj	25.3	(0.0)	6.0	(0.0)	6.7	(0.0)
AO	4.3	(0.08)	1.4	(23.4)	0.2	(97.3)
pension	18.8	(0.0)	3.8	(0.2)	5.0	(0.02)
One-month PIBOR	139.1	(0.0)	108.7	(0.0)	51.7	(0.0)

Note: Figures in brackets are the p-values (as a percentage).

**3. Selection of a model and assessment of its robustness**

We tried to establish a cointegration relationship between the overnight rate and the money market rates.

Applying the Dickey-Fuller test (see Table 2) led us to reject the null hypothesis of non-stationarity of the spread between the money market rates and the overnight rate.

Table 2  
Results of the Dickey-Fuller test

	Period 1		Period 2	
One-month PIBOR	- 0.19	(- 12.3)	- 0.09	(- 5.7)
Three-month PIBOR	- 0.13	(- 9.9)	- 0.04	(- 3.8)

The table gives the values and t-statistics of the coefficient of  $z(t-1)$  in the regression of  $\Delta z(t)$  over  $z(t-1)$ , where  $z$  is the centred spread of the money market rates vis-à-vis the overnight rate ( $z = fim - jj - E(fim - jj)$ ).

#### Results of the stability test (Chow test)

Over the two periods 01/01/87 to 01/07/90 and 01/07/90 to 15/05/92

	F $\alpha$	P-values
One-month PIBOR	0.85	68.4%
Three-month PIBOR	1.22	20.9%

Over the two periods 15/05/92 to 01/03/95 and 02/03/95 to 10/09/96

	F $\alpha$	P-values
One-month PIBOR	1.725	5.3%
Three-month PIBOR	3.89	0.0%

Consequently, the spreads between the money market rates and the overnight rate converged in the long run and we sought to model the short-term fluctuations of the  $f1m$  and  $f3m$  rates around their long-term target, using an error-correction model with the following form:

$$\Delta fim(t) = Cste + \sum_{i=1}^5 \alpha_i \Delta fim(t-i) + \sum_{j=0}^5 \beta_j \Delta jj(t-j) + \sum_{k=0}^5 \gamma_k \Delta X(t-k) + \sum_{l=0}^5 \delta_l \Delta Y(t-l) + \theta (fim(t-1) - jj(t-1))$$

$i = 1, 3$  [1]

where the  $(fim(t-1)-jj(t-1))$  term corrects any temporary deviation of the variables from their long-term target and the  $\Delta X(t)$  and  $\Delta Y(t)$  terms express the information on changes in the leading rates in time  $t$  that would not already be included in the  $\Delta jj(t)$  term (obviously, one thinks of the repurchase tender rate and the ceiling rate).

In order to avoid problems of colinearity between explanatory variables, we tested for  $X(t)$  and  $Y(t)$  variables that are orthogonal to the overnight rate and contain as much information as possible on the repurchase rate and the ceiling rate. A solution was to use the residuals of the regressions of  $AO$  and  $pension$  over the overnight rate. The  $(pension-jj)$  and  $(AO-jj)$  variables can be considered as good proxies of the residuals.

Table 3  
One-month PIBOR

$$\Delta fim(t) = Cste + \sum_{i=1}^5 \alpha_i \Delta fim(t-i) + \sum_{j=0}^5 \beta_j \Delta jj(t-j) + \sum_{k=0}^5 \delta_k \Delta(pension-jj)(t-k) + \sum_{l=0}^5 \gamma_l \Delta(ao-jj)(t-l) + \theta(f1m-jj)(t-1)$$

	Period 1		Period 2	
R <sup>2</sup>	0.37		0.22	
SEE	0.06		0.07	
DW	2.00		2.01	
Cste	0.01	(3.85)	0.01	(3.13)
$\alpha_1$	-0.10	(-3.79)	-0.04	(-1.11)
$\alpha_2$	-0.10	(-3.63)	0.11	(2.97)
$\alpha_3$	-0.03	(-1.21)	-0.12	(-3.30)
$\alpha_4$	-0.05	(-1.70)	-0.09	(-2.48)
$\alpha_5$	-0.04	(-1.51)	0.05	(1.40)
$\beta_0$	0.63	(12.04)	0.92	(12.20)
$\beta_1$	0.20	(3.66)	0.14	(1.69)
$\beta_2$	0.16	(2.89)	0.02	(0.25)
$\beta_3$	0.06	(1.10)	-0.05	(-0.57)
$\beta_4$	0.01	(0.10)	0.06	(0.69)
$\beta_5$	-0.15	(-3.09)	0.02	(0.23)
$\gamma_0$	0.17	(3.96)		
$\gamma_1$	0.12	(2.58)		
$\gamma_2$	0.12	(2.61)		
$\gamma_3$	0.08	(1.92)		
$\gamma_4$	0.08	(2.09)		
$\gamma_5$	-0.09	(-2.73)		
$\delta_0$	0.18	(5.39)		
$\delta_1$	0.06	(1.45)		
$\delta_2$	0.01	(0.23)		
$\delta_3$	-0.05	(-1.17)		
$\delta_4$	-0.07	(-1.55)		
$\delta_5$	-0.10	(-2.38)		
$\theta$	-0.06	(-6.09)	-0.08	(-4.15)

**Over period 1**, we reject the null hypothesis of non-significance of the coefficients of (*pension-jj*) and of (*AO-jj*): F (12.371) = 7.84 p = 0.00.

**Over period 2**, we accept the null hypothesis of non-significance of the coefficients of (*pension - jj*) and of (*AO- jj*) at the 87% confidence level. The result of the F-test is: F (12.721) = 0.57.

Table 4  
Three-month PIBOR

$$\Delta f3m(t) = Cste + \sum_{i=1}^5 \alpha_i \Delta f3m(t-i) + \sum_{j=0}^5 \beta_j \Delta jj(t-j) + \sum_{k=0}^5 \delta_k \Delta(pension - jj)(t-k) + \sum_{l=0}^5 \gamma_l \Delta(ao - jj)(t-l) + \theta(f3m - jj)(t-1)$$

	Period 1		Period 2	
R <sup>2</sup>	0.16		0.19	
SEE	0.07		0.07	
DW	2.00		2.00	
Cste	0.01	(3.70)	0.01	(2.66)
$\alpha_1$	-0.05	(-1.97)	-0.01	(-0.20)
$\alpha_2$	-0.10	(-3.83)	-0.16	(-4.13)
$\alpha_3$	0.02	(0.93)	0.17	(4.07)
$\alpha_4$	-0.02	(-0.79)	-0.14	(-3.62)
$\alpha_5$	0.00	(0.11)	0.01	(0.15)
$\beta_0$	0.04	(0.71)	0.96	(7.58)
$\beta_1$	0.35	(5.70)	0.35	(2.66)
$\beta_2$	0.17	(2.81)	0.20	(1.46)
$\beta_3$	0.17	(2.75)	-0.20	(-1.47)
$\beta_4$	0.00	(0.07)	0.00	(0.01)
$\beta_5$	-0.01	(-0.13)	0.15	(1.11)
$\gamma_0$	0.00	(-0.02)	0.45	(4.57)
$\gamma_1$	-0.01	(-0.18)	-0.06	(-0.61)
$\gamma_2$	0.07	(1.25)	-0.06	(-0.57)
$\gamma_3$	0.12	(2.34)	-0.15	(-1.50)
$\gamma_4$	-0.01	(-0.29)	-0.08	(-0.84)
$\gamma_5$	-0.01	(-0.25)	0.14	(1.40)
$\delta_0$	0.00	(-0.03)	0.07	(2.65)
$\delta_1$	0.31	(6.74)	0.09	(3.08)
$\delta_2$	0.02	(0.31)	-0.04	(-1.23)
$\delta_3$	0.04	(0.77)	-0.03	(-0.89)
$\delta_4$	0.00	(0.01)	0.00	(0.02)
$\delta_5$	0.00	(0.06)	0.02	(0.82)
$\theta$	-0.04	(-5.03)	-0.03	(-2.78)

**Period 1:** F (12.1370) = 6    p = 0.00.

**Period 2:** F (12.715) = 4.08    p = 0.00.

The results are summarised in Tables 3 and 4. Two distinct regimes clearly appear, in the sense that the values of the model coefficients greatly depend on the period considered.

The fact that the error-correction term ( $\theta$  coefficient) is significant confirms that there is a cointegration relationship between the money market rates and the overnight rate.<sup>20</sup>

After 1992, adding the repurchase tender rate and the ceiling rate does not improve the forecast of the one-month PIBOR (i.e. the HO hypothesis according to which the  $\gamma_k$  and  $\delta_1$  coefficients are all supposed to be equal to zero – see Table 3 – is accepted). It looks as if the overnight rate was implicitly granted the status of a leading rate by the market and supplanted the repurchase tender and ceiling rates. However, the latter retain a predictive power for the three-month rate.

Before 1992, the coefficients of the repurchase tender and ceiling rates were significant and these rates provided the market with information that is not entirely contained in changes in the overnight rate.

The robustness of the model relies on the hypothesis of homoscedasticity of the residuals. Ayuso et al. (1994) seek to estimate a seasonality effect in the volatility of the interbank rates: since reserve requirements are computed over a given period, banks can react to liquidity shocks by adjusting the level of their reserves with the central bank. Consequently, the volatility of interbank rates is supposed to increase as the end of the computation period approaches. As far as Germany is concerned, the seasonality pattern in the variance of the process is brought to light. In the case of France, the seasonality pattern is hardly perceptible. Therefore, the hypothesis of homoscedasticity in our model does not appear especially strong.

#### 4. Stability of the model

The stability of the model over each of the periods considered can be assessed through tests of regime shifts (Chow tests). Over period 1, the results of the tests confirm the stability of the model (see Table 2). After 1992, the hypothesis of stable determinants for the one-month PIBOR is hardly accepted at the 5% significance level. However, the results of the tests are clearly consistent with such a hypothesis after mid-1994.<sup>21</sup> Besides, the hypothesis of stable determinants for the three-month PIBOR after 15th May 1992 is rejected. The regime appears stable only after the last period of foreign exchange tension in October 1995.

It thus looks as though the markets had gradually adapted to a situation where the volatility of the overnight rate was controlled.

#### 5. Diffusion of policy shocks

In period 3, control over the overnight rate was exercised in order to pursue an exchange rate objective and its role as a means of regulating the money market rates appears secondary. Consequently, we will limit our investigations to the diffusion of monetary policy shocks in periods 1 and 2.

By construction, changes in the intervention and overnight rates are entirely passed through to money market rates in the long run, whatever the simulation period: the "one for one" reaction is guaranteed in our model by the error-correction term (see Section 3). Differences between the simulation periods will thus not relate to the size of the adjustment of the money market rates, but to the speed of this adjustment.

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<sup>20</sup> There are at most four cointegration relationships between the 1-month PIBOR, 3-month PIBOR, *AO*, *pension* and *jj* series. We have made an *a priori* selection for the long-term relationships between these variables.

<sup>21</sup> After 1992, Chow tests were conducted with a break on 01/03/95.

Shocks are standardised as a 10-basis-point increase in the "leading" rates. The reaction of money market rates in comparison with the baseline scenario – i.e. that of unchanged "leading" rates – is then observed. The results are plotted in Graphs 4 to 7 in the main text.

Before 1992 (Graphs 4 and 5), the adjustment of money market rates was relatively slow: it took the one-month PIBOR one month to adjust up to 85% to a shock; after the same period of time, 80% of the shock was reflected in the three-month PIBOR. After 1992 (Graphs 6 and 7), the adjustment was very rapid, with more than 92% of it as early as the first day for the one-month PIBOR. After five days, the adjustment was nearly completed. In the case of the three-month PIBOR, there is a slight over-reaction that is unlikely to be statistically significant.

Comparison of Graphs 4 to 7 suggests several conclusions:

- before 1992, the markets were accustomed to a degree of volatility in the overnight rate. As a consequence, any change in the level of this rate was interpreted less as a change in the monetary policy stance than as a sign of historical volatility. Markets adjusted in the long term if they observed that a shock on the "leading" rates was perpetuated, but they only progressively ratified shocks that corresponded to a change in the monetary policy stance. This may be due to the fact that the historical volatility of the overnight rate might have blurred any message that the central bank wanted to send to the market. It may also be due to the absence of regular open market operations conducted within the interest rate corridor, as carried out in Germany, for instance;
- from the beginning of 1992 to the beginning of 1994, the markets became progressively accustomed to limited volatility in the overnight rate. From 1994 onwards, the markets clearly interpret a change in the overnight rate as signalling a tightening or a loosening of monetary policy. One can then speak of greater efficiency in the operational framework insofar as the transmission of monetary policy impulses is much more rapid. However, the repurchase tender rate and five-to-ten-day window rate retain some explanatory power over the three-month rate. In this respect, they anchor medium-term market anticipations. For example, in a situation where a rise in the overnight rate is needed to support the currency, keeping the repurchase tender rate stable can be interpreted by the markets as an indication that the medium-term policy orientation is unchanged. Consequently, this signals the confidence of the central bank in the transitory and limited nature of the foreign exchange turbulence and suggests to the markets that the overnight rate should return to its previous levels in the medium-term. From 1992 to 1994, the markets may have made sure that, as in the past, the repurchase tender rate and the five-to-ten-day window rate were indicative of the medium-term orientation of monetary policy, while changes in the overnight rate could be seen as moves of a more tactical nature.

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