The monetary policy decisions of the ECB and the money market

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1. Introduction

The Eurosystem's operational framework provides the key link between the ECB's monetary policy strategy[2] and the money market. The operational framework is the means to implement policy, which is based on the control of very short-term money market interest rates. The same applies in most industrial economies. For the European single monetary policy, it was recognised already in 1997 (see EMI (1997a)) that very short-term interest rates were to be regarded as the first step in the transmission mechanism of monetary policy.

The operational framework of the Eurosystem is based on three main instruments: reserve requirements, standing facilities - a marginal lending facility and a deposit facility - and open market operations. Open market operations are mainly conducted through repurchase agreements, through which the Eurosystem provides liquidity to the market in exchange for eligible collateral assets.[3]

Almost immediately after the introduction of the euro on 1 January 1999, the money markets in the euro area integrated smoothly and rapidly. After just a few days a single money market in the euro area was in place. This illustrates how quickly financial institutions, in particular banks, have adapted to the new operational environment. For a systematic account of the performance of the operational framework see Hartmann et al (2001), Manna et al (2001) and Perez-Quirós and Rodriguez (2001).

The ECB announced the stability-oriented monetary policy strategy on 13 October 1998 (ECB (1998b)). The strategy includes three main elements: first and foremost, a precise definition of price stability - this makes clear the ECB's commitment to maintaining price stability, which is enshrined in the European Union Treaty itself; second, analyses assigning a prominent role to money; third, analyses based on a multiplicity of models and indicators (see Issing et al (2001)).[4]

The strategy is used to structure the internal decision-making process. It is also used for external communication. It induces a systematic pattern of policy responses compatible with the maintenance of price stability over the medium term. This may be regarded as rule-like behaviour. Allan Meltzer (1993) defined a policy rule as "nothing more than a systematic decision process that uses information in a consistent and predictable way." Gaspar et al (2001) argued that the announcement of the stability-oriented monetary policy strategy aimed at reducing *strategic uncertainty*.

The increasing importance of forward-looking behaviour has important methodological consequences for macroeconomic modelling, in general, and for the monetary transmission mechanism, in particular (see McCallum (1999, 2001)). The issue is made more complicated when one recognises that knowledge about the economy is necessarily imperfect. The patterns of interaction between a central

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[1] The views expressed in this paper are those of the authors and do not necessarily represent the views of the European Central Bank, the Bank of Spain or the Eurosystem. The paper was presented at the Autumn Meeting of Central Bank Economists at the BIS and is a shorter version of the authors' paper "The ECB monetary policy strategy and the money market", published in the *International Journal of Financial Economics* 6 (2001), pp 325-42. It is reproduced here by permission of the copyright owner John Wiley & Sons. The authors would like to thank the EBF (European Banking Federation) for permission to use the data from the individual banks reporting to the EONIA panel. The authors also thank Peter Bofinger, Hans-Joachim Klöckers, Casper de Vries, Roberto Schiavi, Lars Svensson and seminar participants at Erasmus University and the Exchange Rate and Monetary Policy Issues Workshop for helpful comments and suggestions.

[2] See Issing et al (2001) and also ECB (2001) for a complete account of monetary policy strategy of the ECB.

[3] For a complete account of the Eurosystem's operational framework see ECB (2001) and ECB (2000a).

[4] See ECB (1999, 2000b), Angeloni et al (1999) and Gaspar et al (2001) as complementary references.

bank, forward-looking private agents and imperfect knowledge are potentially very intricate and therefore potentially costly. The public (and detailed) announcement of the strategy is meant to foster the understanding of the objectives, decision-making and instruments of the central bank. In this way the possibility of monetary policy becoming an independent source of uncertainty is prevented.

The ECB's strategy is therefore seen as a means to bolster the *credibility* and *predictability* of the single monetary policy. On *credibility* it may be worth just pointing out that medium-term expectations have been consistently in line with price stability, according to the ECB's definition, despite significant shocks pushing headline inflation above 2%.

This paper aims at contributing to the understanding of how the ECB conducts monetary policy as seen from a money market perspective. More specifically, it will look at how well money markets predict monetary policy. Here it tries to answer the question posed by, among others, Poole and Rasche (2000). If the market usually anticipates the systematic behaviour of the central bank then the market should adjust to news (that is information innovations) but not to the central bank's announcements of monetary policy decisions. In the United States the issue has been investigated using Fed funds futures prices. However, following Perez-Quirós and Rodriguez (2001), this paper follows a different approach. It starts from a simple model of interest rate behaviour inside a reserve maintenance period. These authors have found that the time-series behaviour of overnight interest rates may be properly modelled as a modified martingale. This paper looks at whether the announcement of monetary policy decisions - to maintain or change the key ECB interest rates[5] - impacts significantly on the stochastic behaviour of overnight rates.

2. How predictable are money market interest rates within reserve maintenance periods?

This section looks at the question of how well market participants predict monetary policy decisions and their impact on short-term market interest rates. The main idea is that if the market usually anticipates the behaviour of the central bank then the market rates should adjust to news (that is information innovations) but not to the central bank's announcements of monetary policy decisions. In the US the issue of how well the markets are able to anticipate the Fed's monetary policy moves has been investigated using Fed funds futures prices[6] (see Krueger and Kuttner (1996), Kuttner (2000), Poole and Rasche (2000) and Roley and Sellon (1998)). However, building on the model developed in Perez-Quirós and Rodriguez (2001), this paper takes a different approach to address the questions about predictability in the very short run in order to take advantage of the characteristics of the institutional framework for the implementation of monetary policy in the euro area.

The interest rates on the main refinancing operations (MRO) play a pivotal role in pursuing the aim of steering interest rates and signalling the stance of monetary policy. The fixed rate of these tenders until June 2000 and the minimum bid rate thereafter, both with a maturity of two weeks, have played the role of signalling the stance of monetary policy in the euro area since January 1999. Notwithstanding the fact that the interest rates that best signal the monetary policy stance have a two-week maturity, it should be noted that the overnight rate plays a pivotal role in the modus operandi of the ECB. Among the basic tasks of the Eurosystem, the Treaty establishes the need to "promote the smooth operation of payment systems". As argued in Manna et al (2001), the smooth functioning of the payment systems requires, inter alia, the existence of an equilibrium between the demand for and the supply of funds at the time the daily clearance takes place. As the ECB does not have an official operating target for the overnight rate (or any type of interbank rates), the main refinancing operations ensure this equilibrium by satisfying demands for central bank balances in a smooth fashion over the course of each maintenance period. This smoothness is complemented by the existence of a corridor on standing facilities which, besides signalling the general stance of monetary policy, provide and

[5] The interest rate on the main refinancing operations and the interest rates on the marginal lending facility and the deposit facility are the key ECB interest rates, ie the interest rates which determine the stance of the monetary policy of the ECB and which are set by the Governing Council of the ECB.

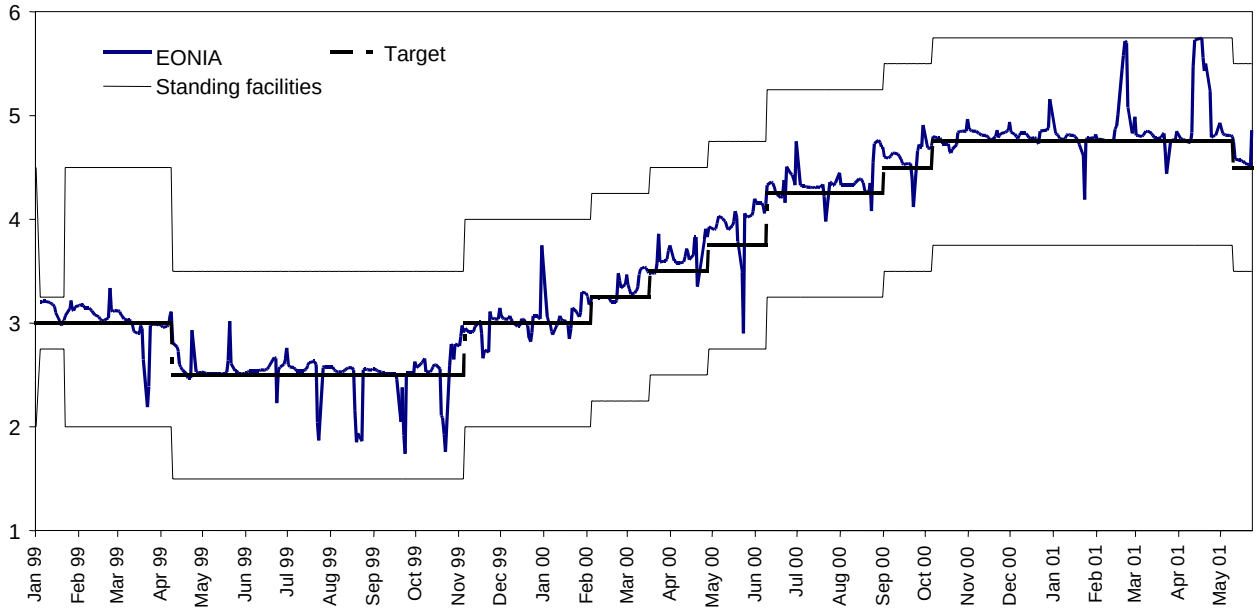
[6] This indicator has been available since the Fed funds futures market was set up by the Chicago Board of Trade in 1989.

absorb liquidity overnight and act as bounds to overnight market interest rates. Graph 1a depicts the evolution of the EONIA and of the key ECB interest rates.

Before trying to explore the evidence in a more systematic way it is useful to take a cursory look at the available evidence on the path of money market rates and the forward rate of the one-month interest rate in one month. This is plotted in Graph 1b.

Graph 1a

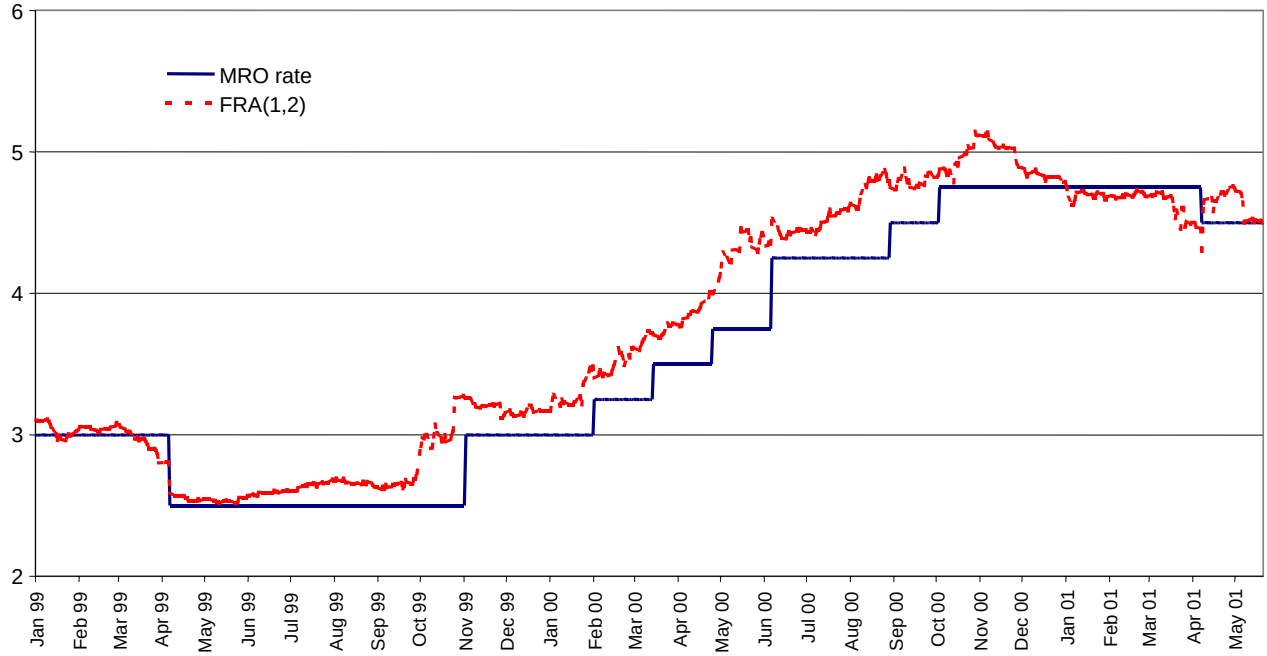
EONIA and key ECB interest rates



The solid line represents the EONIA rates. The thin lines represent the rates on the marginal lending and deposit facilities. The broken line represents the rates for fixed rate tenders up to June 2000 and minimum bid rates since. Source: ECB.

Graph 1b

MRO rates and one-month rates



The FRA(1,2) is the one-month in one-month rate as calculated with the EONIA swap curve. Source: ECB.

It appears from Graph 1b that markets are able to predict the process generating money market interest rates fairly accurately. Is this first impression correct?

This question may be approached in different ways. In the first subsection, the paper analyses formally whether the announcements of monetary policy decisions to maintain or change interest rates impact on the stochastic behaviour of the EONIA. The second part of this section will simply try to calculate using short-term money market rates to what extent the market has anticipated interest rate decisions taken by the Governing Council of the ECB.

2.1 Measuring the impact of ECB monetary policy decisions on money market rates

This subsection focuses on the behaviour of overnight rates inside a reserve maintenance period. The basic idea is that the existence of a reserve maintenance period with an averaging provision makes funds to be very close substitutes for days within the same maintenance period. If funds were perfect substitutes then overnight interest rates would have to follow a martingale. If this were not the case, banks would arbitrage away any expected difference between the current and future cost of funds.

However, as time goes on, the reserve maintenance period gradually nears its end. As banks accumulate reserves through the reserve maintenance period the likelihood that they will find themselves with excess reserves increases as well.[7] This induces banks to be cautious; more specifically, banks will reduce the demand for funds at the beginning of the reserve maintenance period. Given the need to comply with the reserve requirement on average this, in turn, leads to an increasing demand profile for reserves within the maintenance period. This leads, ceteris paribus, to an increase in overnight rates as banks approach the end of the reserve maintenance period.

Perez-Quirós and Rodriguez (2001) have explored this basic idea. They consider a model of identical, risk neutral banks which exchange reserves in a perfect and competitive money market. Perfect markets rule out asymmetric information, transaction costs, credit limits, etc. For this purpose, it is sufficient to assume a passive management of liquidity on the part of the central bank in the sense of abstaining from intervening to deliberately change the total liquidity of the system. This allows the authors to concentrate on the modelling of liquidity demand. The supply of liquidity in their model is driven by autonomous factors that constitute a shock to the aggregate level of reserves (in their model this is equivalent to a shock to the level of reserves of *each* bank).

For the purpose of this paper the only point of relevance is that it may be important to allow for the possibility that overnight interest rates follow a modified martingale. Again Perez-Quirós and Rodriguez (2001) provide empirical evidence using such a model. In what follows we will be using their model in order to look at whether the announcement of monetary policy decisions - to maintain or change key ECB interest rates - impacts on the stochastic behaviour of overnight rates. The basic idea is to model the reserve maintenance period as a unit. Expectations about overnight interest rates within the maintenance period should affect spot overnight rates from the beginning of the reserve maintenance period. For example, if an interest rate reduction is expected nobody will be willing to borrow above the expected future rate. So if the current rate were above the expected future rate, banks would try to postpone satisfying reserve requirements to later in the reserve maintenance period while lending their available funds in the market.[8]

Based on this idea it is possible to test whether the ECB is predictable. Specifically, if the market is able to predict ECB moves accurately then the transformed martingale behaviour of overnight rates inside a reserve maintenance period should not be significantly affected by monetary policy announcements following ECB Governing Council meetings. In order to test this hypothesis it is necessary to extend the Perez-Quirós and Rodriguez (2001) model by including dummies that capture the monetary policy announcements of the Governing Council of the ECB (meeting days and the days after the meeting of the Governing Council). The model may be written as:

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[7] Excess reserves means here liquid funds held for purposes other than compliance with reserve requirements.

[8] For simplicity of argument a simple martingale for overnight rates is assumed (see above for qualifications following Perez-Quirós and Rodriguez (2001)).

$$i_t = i_{t-1} + \beta' X_t + \varepsilon_t$$

$$\frac{\varepsilon_t}{\sqrt{h_t}} \sim pN(0,1) + (1-p)N(0,\sigma^2)$$

$$\ln(h_t) = \lambda' V_t + \sum_{j=1}^{n}\left[\delta_{j,1}(\ln(h_{t-j}) - \lambda' V_{t-j}) + \delta_{j,2}\frac{\varepsilon_{t-j}}{\sqrt{h_{t-j}}} + \delta_{j,3}\left(\frac{|\varepsilon_{t-j}|}{\sqrt{h_{t-j}}} - E\left(\frac{|\varepsilon_{t-j}|}{\sqrt{h_{t-j}}}\right)\right)\right]$$

where i_t is the EONIA rate.[9] X_t and V_t are vectors of dummy variables which may affect the martingale behaviour.

In particular:

X_{1t} = constant

X_{2t} = end MP dummy

X_{3t} = beginning MP dummy

V_{1t} = constant

V_{2t} = end MP dummy

V_{3t} = beginning MP dummy

V_{4t} = end-year dummy

V_{5t} = end-month dummy

V_{6t} = Friday

The key variables for our analysis are:

V_{7t} = meeting day dummy

V_{8t} = day after meeting dummy

The sample used for the estimation is from 1 January 1999 to 23 May 2001. The specified model is an EGARCH to capture the dynamics of volatility transmission from one day to the other. For the distribution of the error term a mixture of two normal distributions is used. This allows modelling fat tails and excess kurtosis (see Perez-Quirós and Rodriguez (2001) for details and also Hamilton (1996)).

The first important result to report (see Table 1) is that the dummies capturing the meetings of the Governing Council are not included in the "mean" equation because they are not statistically significant. This means that monetary policy announcements do not affect the level of overnight money market interest rates. This is consistent with a view that the market does not make systematic errors with respect to monetary policy decisions. This perception is confirmed by looking at the results for the variance. It can be seen, from Table 2, that neither the meeting day dummy nor the day after meeting dummy has a significant impact on the variance of overnight rates. If one looks at the magnitude of the point estimate for the parameters one sees that the effect on volatility associated with monetary policy announcements is less than 20 times smaller than volatility associated with the end of the reserve maintenance period.

This result on the variance is remarkable. Indeed, before the meetings of the Governing Council market participants may have only an ex ante distribution of possible outcomes from the Governing Council meeting. To take the simplest possible case, imagine that there are only two possible outcomes from the meeting. After the policy announcement one of the possibilities has been confirmed and the other one excluded. This will be reflected in the market overnight rate. So some impact on volatility had to be expected. Graph 2 illustrates this point. Starting from day 1, when it is assumed that markets were anticipating even odds of interest continuing at the current level and being raised by 25 basis points, we assume that the Governing Council meeting takes place on day 9. As the day of the meeting approaches, the probability of a change in key ECB interest rate increases by 0.04. On the day of the meeting the new interest rate is announced to the market. As shown in the graph, despite a very high likelihood of the rate change it is clear that there is a "small jump" in the interest rate on the

[9] At the beginning of the reserve maintenance period the interest rate variable on the right-hand side of the equation is replaced by the Eurosystem's main refinancing operations (MRO) interest rate. This means that at the beginning of each reserve maintenance period the daily change in the EONIA interest rate is replaced by the spread between EONIA and MRO rates.

announcement due to the realisation of the expectations. Such a jump creates an increase in volatility on meeting days.

Table 1

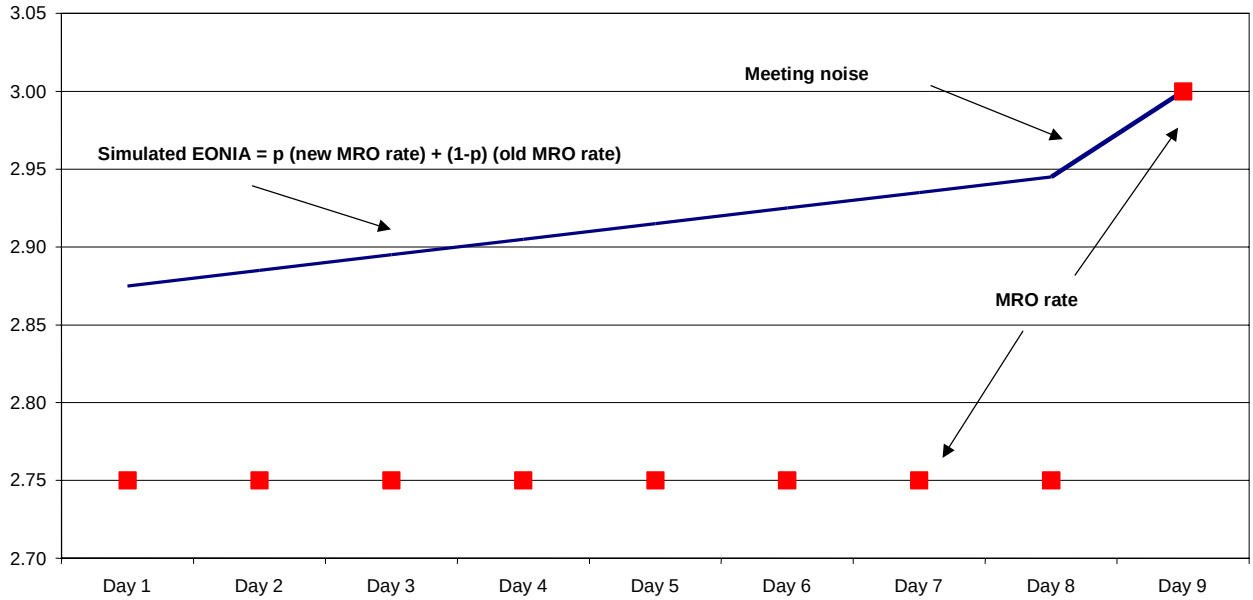
Mean parameters		
X_{1t}	– 0.217	(0.090)
X_{2t}	– 1.689	(1.245)
X_{3t}	5.092	(0.869)
Variance parameters		
V_{1t}	– 11.048	(0.375)
V_{2t}	3.806	(0.247)
V_{3t}	1.446	(0.301)
V_{4t}	4.726	(1.126)
V_{5t}	2.507	(0.360)
V_{6t}	0.082	(0.243)
V_{7t}	0.212	(0.405)
V_{8t}	0.732	(0.385)
Other variance parameters		
d_{11}	0.264	(0.045)
d_{12}	0.093	(0.023)
d_{13}	0.235	(0.043)
d_{21}	0.032	(0.079)
d_{23}	0.211	(0.067)
p	0.700	(0.013)
σ	3.660	(0.068)

Sample: 1 January 1999 to 23 May 2001. The model has been estimated by maximum likelihood. Standard errors are displayed in parenthesis.

The argument, however, is that there are many other sources of disturbance which impact on EONIA rates. Obvious examples are liquidity shocks or economic data releases. Our results show that the announcement of ECB monetary policy decisions has had an insignificant impact relative to the fundamental determinants of market volatility in the sample analysed.

Graph 2

Volatility associated with expected changes in rates



Note: The chart illustrates a change in the MRO rate from 2.75% to 3%. The simulated EONIA rates have been calculated using a sequence of probabilities "p" that started in 0.5 and were adjusted by a daily increase of 0.04. The bold line represents the associated volatility to the realisation of the expectation.

2.2 Have money markets anticipated interest rate decisions within reserve maintenance periods? Some insight of further intuition

The aim of this subsection is to complement the previous analysis with a different, more heuristic approach. Looking at all the monetary policy decisions on key ECB interest rates taken since the beginning of Stage Three, we analyse to what extent the market has anticipated the interest rate changes (or decisions to keep interest rates unchanged) taken by the Governing Council of the ECB.

Short-term interest rates contain information about the expected future path of policy rates. Among other interesting uses for monetary policy purposes, the extraction of interest rate expectations can provide information on whether an interest rate decision taken by a central bank has been anticipated or not by financial markets. To pursue this analysis, different interest rates (or prices) of market instruments can be used, either through spot rates or with a calculation of forward rates. (For a general overview on the extraction of market expectations from financial instruments, see Soderlind and Svensson (1997).)

It could be argued that the desirable way of determining interest rate expectations of a move in key ECB interest rates would be through the derivation of forward rates that correspond to future ECB two-week reverse transaction rates. However, from a practical point of view, there are no instruments that quote forward two-week collateralised rates on the dates where the MROs take place, so they would have to be derived. Although the repo market could be a good candidate to perform such role, at least for certain maturities, the existence of different institutional frameworks and several segmented repo markets coexisting in the euro area do not make it yet the best tool for analysing expectations in the euro area, all the more so as this market is not as deep and liquid as the euro area money markets (see Santillan et al (2000)).

However, as already argued, if banks are risk neutral, the existence of the reserve maintenance period in a world without market frictions should drive funds to be substitutes among days of the same maintenance period. In that framework, banks would arbitrage away any expected differences between the current and future costs of funds. In addition, according to the expectations hypothesis of the term structure, any interest rate can be derived as an average of expected future overnight rates. As the overnight interest rate is the rate at which the payment system clears, any financial transaction between two agents, irrespective of its maturity, ultimately has an impact on the overnight interest rate. In other words, it could be argued that within maintenance periods, in the absence of unforeseen liquidity shocks or news that modify expectations, the expectations of changes of the key ECB interest

rates should be reflected in the overnight interest rates at the beginning of the maintenance period. Due to their euro area representativity and liquidity, EONIA interest rates have become an appropriate tool to extract market expectations (as is also the case with EONIA swaps). Given that there are money market instruments, there is a need to take into account credit, financing or term premia factors in order to compare money market rates (non-collateralised) to MRO rates, which are collateralised.

The money market data used are, as before, EONIA rates from 1 January 1999 to 23 May 2001 (the results are nonetheless practically unchanged when using one-week EONIA swap rates). In order to homogenise information in an easily interpretable way, we consider that the EONIA overnight rate is a linear combination (β, 1–β) of two possible events. The results provided are calculated using as the two events either a "no move" or a "25 basis point move" in key ECB interest rates.

$$i_t = \beta i_{25} + (1-\beta) i_0$$

β can be interpreted as the (linear) probability of ***at least*** a 25 basis point change, against the alternative of no change in key ECB interest rates. Actually, for our purposes, the value for β will become the benchmark: if it is above 50% (in absolute value) it will be considered that the market expected the ECB to change interest rates.

To take account of different estimations of the "natural" or "structural" spread between the EONIA rate and the MRO rate, the calculations were done with different magnitudes: a spread of 3, 5 and 7 basis points between the EONIA rate and MRO rates.[10]

As maintenance periods are considered as a unity, the calculations were done with the EONIA rates (although the results were cross-checked using the EONIA one-week swap rate) at the beginning of the maintenance periods.[11] Table 2a shows the results for the different "natural" spreads considered.

Table 2a

Have money markets anticipated ECB decisions?

Spread	3 bp	5 bp	7 bp	Observations
At the beginning of the maintenance period (in %)	79	82	79	28
One day before the meeting (in %)	85	85	81	48

Note: Percentage of occasions on which markets correctly anticipated the ECB's last decisions for different values of "natural spread" between the EONIA and the MRO rates. Meetings held in the last four days of the period are not considered, nor are where underbidding was present.

Sample from 1 January 1999 to 23 May 2001.

As can be seen, at the beginning of the maintenance periods, markets anticipated the ECB's decision on interest rates 79-82% of the time. However, one should also consider that it might be important to take into account the possible arrival of information between the beginning of the maintenance period and the day of the meeting, which could potentially change market expectations. To do so, we replicate the same calculations for the day before each meeting of the Governing Council (although we gain more observations, to avoid the potentially distorting liquidity effects, if those days correspond to the last four days of the maintenance period they are taken out of the sample). According to the results obtained, the rate of success of the money market in predicting the ECB's interest rate changes increases slightly to 81-85%. More precisely, Table 2b shows how many times the market anticipated

[10] The average of the spread in the sample used was 7 basis points (6 basis points during fixed MROs and 10 basis points during variable rate tenders). However, these results might be an overestimation of the actual spread, as the sample is dominated by a cycle of expectations of interest rate increases. One approach within this sample (apart from estimating the risk premia) is to calculate this spread in a period where expectations of an interest rate move were non-existent. This was the case after the interest rate cut in April 1999. Taking the first three working days of the two maintenance periods following that decision, the spread turns out to be on average 3 basis points (and never higher than 4 basis points).

[11] In particular, an average of the "β" obtained for the first three days of each maintenance period was used.

the central bank decision one day in advance of the meeting, distinguishing between the times when the Governing Council changed interest rates, and those when it announced that its key interest rates were not changed. As can be seen, of the nine times the ECB decided to change its interest rates (none of these meetings were held the last four days of a maintenance period), only on two occasions (22%) did the market fail to anticipate the move, namely the decision to change key ECB interest rates in April 1999 and May 2001. As regards the meetings in which the Governing Council decided to keep the key ECB rates unchanged, only on five out of 39 occasions did the market expect a change in interest rates.

Table 2b

Have money markets anticipated ECB decisions?

	Market expectations		**Observations**
	Change	No change	
ECB changed rates (in %)	78	22	9
ECB did not change rates (in %)	13	87	39

Note: Percentage of occasions on which markets correctly anticipated the ECB's decisions for a "natural spread" between the EONIA and the MRO rates of 3 basis points. Meetings held in the last four days of the maintenance period are not considered.

Sample from 1 January 1999 to 23 May 2001.

3. Conclusion

Our research suggests that the behaviour of EONIA rates within a reserve maintenance period provides an interesting starting point for analysing the predictability of monetary policy decisions of the ECB. Our empirical results show that the monetary policy announcements after the meetings of the Governing Council have not affected the mean interest rates in a statistically significant way. This is consistent with markets not making systematic mistakes in anticipating the announcements. This perception is confirmed by looking at the results for the variance. It can be seen, from Table 1, that neither the meeting day dummy nor the day after meeting dummy has a statistically significant impact on the variance of overnight rates. Moreover, the effect on volatility associated with monetary policy announcements is significantly smaller than the volatility associated with the end of the reserve maintenance period. The interpretation suggested is that the announcement of ECB monetary policy decisions has had an insignificant impact on the volatility of market interest rates relative to fundamental determinants of market volatility. In addition, using a more heuristic approach it is shown that markets are able to predict the ECB's interest rate decisions quite accurately.

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