EUROPEAN CENTRAL BANK

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THE ECB MONETARY POLICY STRATEGY AND THE MONEY MARKET

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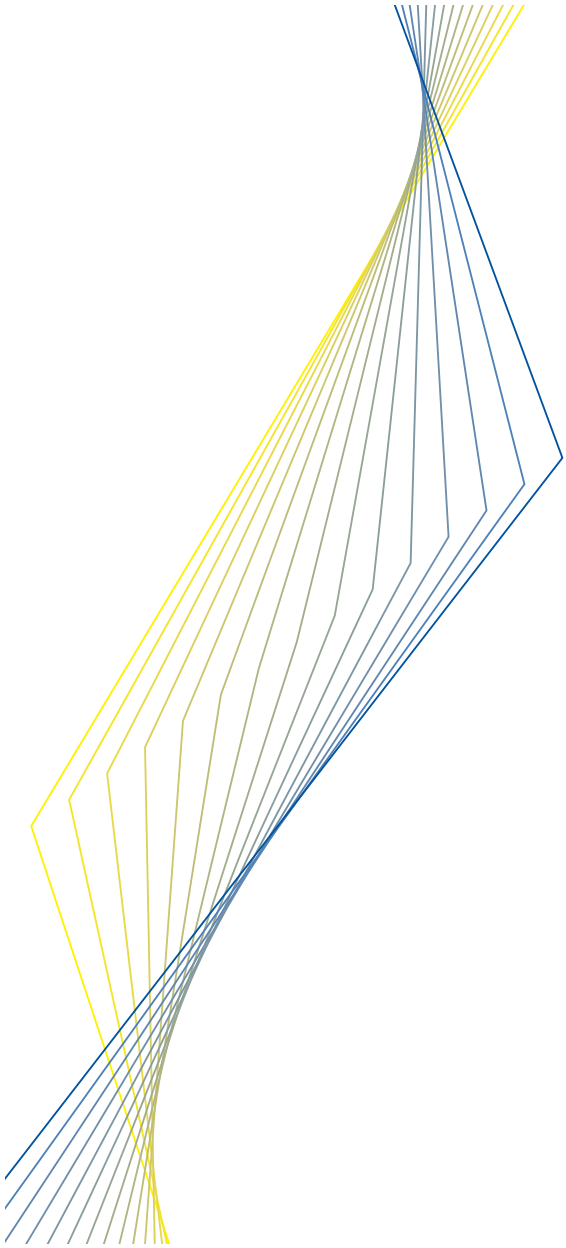

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The views expressed in this paper are those of the authors and do not necessarily represent the view of the European Central Bank or the Eurosystem. This paper has been prepared for the Exchange Rate and Monetary Policy Issues Workshop organised by the Oesterreichische Nationalbank on 19 April 2001. 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-Joaquim 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.

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ISSN 1561-0810

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Non-technical summary

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 covers two different issues. First, it looks at the "learning period" for banks since the Eurosystem started implementing the single monetary policy. It shows that during the first three weeks of 1999 the narrow corridor in place during this period was effective in limiting daily volatility of the money market overnight rates. In addition, the behaviour of banks and market rates during this period provides evidence that learning was taking place. Second, it looks at how well money market participants have anticipated the monetary policy decisions taken by the ECB. To do so, the paper analyses whether the announcements of monetary policy decisions to maintain or change interest rates impact on the stochastic behaviour of interest rates. Looking at the EONIA rates within the reserve maintenance periods, we find that the announcement of monetary policy decisions does not change significantly the level or volatility of overnight rates.

JEL classification system: E52, C22

Keywords: money market; martingale behaviour; operational framework; predictability

1. Introduction

The Eurosystem's operational framework provides the key link between the ECB's monetary policy strategy[1] and the money market. The operational framework is the means to implement policy. Policy implementation 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. In this context it is important to refer to the payments (and settlements) infrastructure. On 4 January 1999 the Eurosystem started operating TARGET (**T**rans-**E**uropean **A**utomated **R**eal-Time **G**ross Settlement **E**xpress **T**ransfer). TARGET is composed of the domestic RTGS (real-time gross settlement systems), one corresponding to each European Union member state, and a network of links between them and the ECB payments node (for a complete account of the Eurosystem's operational framework see ECB (2000)).

At the start of 1999 the introduction of the euro dominated developments in European money markets. Up to the end of 1998 the various national money markets of the euro area displayed significant distinctive features (see Escrivá and Fagan (1996) for a survey). Given the unprecedented historical characteristics associated with European monetary unification the transition was fraught with challenges. Indeed some authors questioned the feasibility of the whole enterprise on both macroeconomic and operational grounds (see, for example, Feldstein (1997) and Obstfeld (1998)).

Almost immediately after the introduction of the euro on 1 January 1999, they integrated smoothly and rapidly. After just a few days a single euro area money market was in place. This illustrates how quickly financial institutions, in particular banks, have adapted to the new operational environment. In fact, when the exceptionally narrow corridor of 50 basis points, defined by the two standing facilities, was lifted, the overnight interest rate (measured by EONIA) kept stable and close to the main refinancing operations rate. This move to a broader corridor (250 basis points at the beginning of 1999) took place on 22 January 1999, as had

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

been previously announced. 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 October 13, 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 engraved in the European Union Treaty itself. Second, an analysis assigning a prominent role to money. Third, a broad based assessment based on a multiplicity of models and indicators (see Issing et al (2001)).[2]

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 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 bank and forward-looking private agents and imperfect knowledge are potentially very intricate and, 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 the price stability, according to the ECB's definition, despite significant shocks pushing headline inflation above 2%.

This paper has very limited and focused ambitions. It aims at contributing to the understanding of how the ECB conducts monetary policy as seen from a money market perspective. More specifically it will cover two different issues. First, it will look at the

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

"learning period" for banks since the Eurosystem started implementing the single monetary policy. It will be shown that during the first three weeks of 1999 the banks learned the new rules of the game remarkably fast. It will be further shown that the narrow corridor in place during this period was effective in limiting daily volatility of the money market overnight rates. However it will also be shown that the behaviour of banks and market rates was, during this period, significantly different from other periods providing evidence that learning was taking place. This provides one example in which the transition to the single monetary policy provides a "real life" approximation to "Experimental Economics"[3].

Second, it will look at how well do money markets predict monetary policy. Here it follows 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 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 (see Krueger and Kuttner (1996), Kuttner (2000) and Poole and Rasche (2000)). 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 interest rates – impact significantly on the stochastic behaviour of overnight rates.

The paper will be structured as follows. In Section 2 the "learning period" which took place at the beginning of 1999 will be examined in some detail. In Section 3 a model for the behaviour of the overnight rate within a reserve maintenance period will be presented. The model will be estimated and the impact of the announcement of monetary policy will be assessed. Some further evidence will be presented. Section 4 will briefly conclude.

[3] In this remark the concept of "Experimental Economics" is used in a loose way (see Davis and Holt (1993), Hey (1991) and Kagel and Roth (1995) for surveys).

2. The "learning period". The first three weeks of Stage Three of EMU

As most central banks, the Eurosystem operates monetary policy through the money market. The first step in the transmission mechanism of monetary policy is, therefore, the control over very short-term interest rates. The operational framework of the Eurosystem includes three main instruments: reserve requirements, standing facilities and open market operations. Table 1 (reproduced from ECB (2000)) provides an overview of the Eurosystem's monetary policy operations.

The Eurosystem operational framework is predicated on a well functioning, self-equilibrating money market. Therefore its operation requires only a limited presence of the central bank in the market. The reserve requirements with an averaging provision over the reserve maintenance period allow banks to spread liquidity shocks over time thereby contribution to smoothen overnight interest rates. Moreover reserve requirements create a structural shortage of liquidity for the banking system as a whole. The two standing facilities: the marginal lending facility and the deposit facilities are used at the discretion of the Eurosystem's counterparties. They define a "corridor" or "band" for overnight rates. Inside the corridor money market rates fluctuate to equilibrate demand and supply for liquidity[4]. Finally, open market operations, normally repurchase agreements, are used to regulate liquidity conditions in the market.

[Please insert Table 1 about here]

Up to the end of 1998 the euro area was characterised by distinct money markets reflecting different monetary policy operational frameworks, diverse legal structures and standard practices and a variety of market microstructures. Escrivá and Fagan (1996), for example, point out differences in the frequency of open market operations, averaging provisions for reserve requirements, eligible collateral for open market operations, rules applicable to standing facilities and so on. Cecchetti (2001) documents differences in legal structures and traditions in Europe building on the research of La Porta et al (1998, 1999). Furthermore the start of Stage Three of EMU would likely coincide with sizeable portfolio shifts and sizeable cross border payment flows. This applies both within the euro area and between the euro area and the rest of the world. Last, but not least, TARGET started operating on 4 January 1999 (the first business day of Stage Three of EMU). TARGET was designed, *inter alia*, to serve

[4] The corridor limits the fluctuation of overnight rates in "normal" circumstances. However, since access to the marginal lending facility requires the ability to pledge a sufficient amount of eligible collateral , the market for unsecured operations, occasionally, may clear at rates above the marginal lending facility.

the needs of the single monetary policy by providing a safe and reliable mechanism for the settlement of cross border payments.

The preceding paragraph describes the magnitude of the adjustment required to operate in this new market environment. In order to contribute to smoothen the "learning period" period the Governing Council made a number of decisions (on 22 December 1998, see Annex) concerning the rules which would apply in the early period of the single monetary policy. The most important, for our purposes, were:

1. The first reserve maintenance period would be from 1 January to 23 February 1999. This period is longer than the standard one-month reserve maintenance period lasting from the 24th calendar day of any given month to the 23rd calendar day of the following month. This longer maintenance period allowed banks to postpone the pressure associated with the end of the maintenance period[5].

2. The corridor between the rate of the marginal lending facility and the deposit facility was temporarily narrowed (from 4 January to 21 January) to 50 basis points only. The width of the corridor at the start of 1999 was defined to be 250 basis points (this was the difference between the marginal lending facility rate of 4.5 per cent and the deposit facility rate of 2 per cent – see Figure 1). The purpose of this narrow corridor was to limit the volatility of money market rates that might have derived from the transition to the new regime.

Looking at developments in the first three weeks it is remarkable how normal they look (see Chart 1 and 2). It suggests that banks seem to have adapted quickly and easily to the new environment.

[Insert Charts 1 and 2 about here.]

If one looks at the Charts (Charts 1a and 2a), covering a period of broadly two years, one is hard pressed to detect any abnormal pattern during the first weeks. Indeed both the time profile of interest rates during this period and even the dispersion of interest rates look well within the patterns that characterise the period as a whole. The changeover period does not stand out when examining the period as a whole.

[5] On the last day of a reserve maintenance period the ability to spread the impact of liquidity shocks over time, which is allowed for by the averaging provision, is no longer possible.

During the first days of January monetary conditions were tight and the money market interest rate (measured by EONIA) was close to the rate of the marginal lending facility. When the exceptionally narrow corridor was removed – as previously announced – after three weeks (22 January 1999) the width of the corridor went back to 250 basis points. At this point EONIA continued to be stable and close to the main refinancing operations rate (of 3 per cent). Money market participants were able to adapt within three weeks to the new money market environment. The operational framework seems to have been flexible enough to foster adjustment towards the efficient functioning of the market mechanism in a smooth way. After more than two years since the introduction of the euro it seems relevant to ask: Did markets participants go through a learning phase at all? Were there significant deviations from efficient market behaviour?

To answer these questions one has to look deeper into the evidence coming from the first month. As already mentioned money market conditions were tight with EONIA rates very close to the marginal lending facility. Therefore it may seem as no surprise that there was intense use of the marginal lending facility (the daily average recourse to the marginal lending facility was EUR 15.6 billion during the first week). The recourse on 4 January alone was above 25 billion (see Chart 3). However it is interesting to point out that, at the same time, there was significant recourse to the deposit facility (EUR 6.3 billion, daily average during the first week). On the one hand, it is fair to say that the intense use of both standing facilities during the first week vindicated their role in limiting the behaviour of EONIA rates. Indeed during the first week the amounts involved were much above the "normal" use of the standing facilities at the beginning of a reserve maintenance period (see Chart 3). On the other hand, the simultaneous use of both standing facilities shows that the money market was unable to allocate liquidity efficiently inside the corridor defined by the standing facilities.. The use of the two standing facilities declined rapidly (see Chart 3). During the second week the use of the marginal lending facility declined to EUR 6.3 billion and the use of the deposit facility went down to EUR 1.3 billion.

[Insert Chart 3 about here]

It is worth commenting further on the use of the deposit facility at the beginning of the reserve maintenance period. Such use departs sharply from standard behaviour. This is because funds available at the beginning of the reserve maintenance period can always be used to meet the reserve requirements. Such behaviour was never observed again in any subsequent reserve maintenance period.

One can also look at the distribution of interest rates across banks. Chart 4 plots the range of interest rates reported by banks contributing to the EONIA panel.[6] The horizontal scale identifies the calendar days of January 1999. The solid horizontal line is at the level, fixed by the ECB, for operations under the marginal lending facility. The solid line disappears from the graph on 22 January. On this day, when the interest rates on the standing facilities went back to its pre-announced level, it was raised to 4.5 per cent. It is clear from the Chart that during the first business week of 1999, banks contributing to the EONIA panel lent at rates above the marginal lending facility[7]. It should be recognised that EONIA rates correspond to unsecured transactions while access to the Eurosystem's marginal lending facility requires the ability to pledge eligible collateral. It is clear, however, that this cannot explain a difference like 25 bp as observed on January 5!

[Insert Chart 4 about here]

From Chart 4 it is also possible to see that the range of interest rates reported by the banks contributing to the EONIA panel narrowed rapidly. After January 22 the range observed had become significantly narrower.

One last remark: Perez-Quiros and Rodriguez (2001) have documented the pattern of volatility of daily interest rates within reserve maintenance periods. They find that, as a rule, volatility is very flat during the first weeks of the reserve maintenance period. Afterwards it increases sharply toward the end of the reserve maintenance period. The distinctive feature of the "learning period" is that volatility declined significantly over time in sharp contrast to the standard pattern (see Section 3).

All in all the effect of the transition to the new operational framework does not seem to have had a significant impact on the behaviour of money market rates. For example if one looks at volatility or dispersion of overnight interest rates one finds effects which are significantly smaller than those associated with well-known recurring effects like those associated with end of the maintenance period or end of the month. In this section evidence has been provided showing that learning did take place. The adjustment was not instantaneous. A sufficiently significant number of deviations from normal behaviour or inefficiencies can be identified during the first few days. However the evidence in this section also shows that banks seem to have adapted quickly and easily to the new environment. This learning process took place

[6] The EONIA rate is a weighted average overnight lending rate of, initially, 57 banks (51 now) organised by the EBF and the ACI Euribor Association. Data are collected and calculated by the ECB which ensures its confidentiality.

[7] This abnormal behaviour was observed just twice after the "learning period", and never with more than one day in a row.

without significant disturbances in the behaviour of money market interest rates. The evidence suggests that the exceptional measures announced by the Governing Council on December 22, particularly the narrow corridor for interest rates effectively contained possible volatility in market interest rates[8].

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

This section looks at the question: how well do money market participants predict interest rates? More specifically how well do market participants predict monetary policy decisions and their impact on market interest rates? It follows Poole and Rasche (2000). The main idea is that if the market usually anticipates the 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 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[9] (see Krueger and Kuttner (1996), Kuttner (2000) and Poole and Rasche (2000)). However, following Perez-Quirós and Rodriguez (2001), this paper follows 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. The interest rates on the main refinancing operations (MRO) play a pivotal role in pursuing the aims 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 the monetary policy in the euro area since January 1999.

Notwithstanding the fact that the interest rates that best signal the monetary policy stance has 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 system". As argued in Manna et al (2001), the smooth functioning of the payments system 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 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 complimented by the existence of a corridor on standing facilities

[8] This experience is not unique. For example Michael Woodford reports (Woodford (2000)) the success of a narrow corridor system, applied in New Zealand, in containing interest rate volatility despite sharp fluctuations in the demand for settlement cash.

[9] This indicator is available since the Fed's futures market was set up by the Chicago Board of Trade in 1989.

which, besides signalling the general stance of monetary policy, provide and absorb liquidity overnight and act as bounds to overnight market 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 Chart 5.

[Insert Chart 5 about here]

The visual perception suggests that these series have moved together reasonably closely suggesting that markets are able to predict the process generating money market interest rates fairly accurately. Is this first perception correct?

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

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

This section will focus 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, inside a reserve maintenance period, the end of such period approaches. As banks accumulate reserves through the reserve maintenance period the likelihood that they will find themselves with excess reserves increases as well.[10] 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

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

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 the liquidity demand. Supply of liquidity is in their model 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 may 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 interest rates – impact 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[11].

Based on this idea it is possible to test whether the ECB is predictable. Specifically if the market is able to predict accurately ECB moves then the transformed martingale behaviour of overnight rates inside a reserve maintenance period should not be significantly affect 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 for the meeting days (and monetary policy announcements) and day after meeting. The model may be written as:

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

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

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

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

where i_t is the EONIA rate[12]. X_t and V_t are vectors of dummy variables which may affect martingale behaviour.

With:

$X_{1t} = Cons\tan t$
$X_{2t} = End\ MP\ Dummy$
$X_{3t} = Begining\ MP\ Dummy$

$V_{1t} = Cons\tan t$
$V_{2t} = End\ MP\ Dummy$
$V_{3t} = Beginning\ MP\ Dummy$
$V_{4t} = End\ Year\ Dummy$
$V_{5t} = EndMonthDummy$
$V_{6t} = Friday$

The key variables for our analysis are going to be:

$V_{7t} = Meeting\ DayDummy$
$V_{8t} = Day\ after\ Meeting\ Dummy$

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)).

[Insert Table 2 about here]

The first important result to report is that meeting dummies 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

[12] 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 re-financing 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.

monetary 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 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 twenty times smaller than volatility associated with the end of the reserve maintenance period.

This result on the variance is remarkable. Indeed before the Governing Council meetings market participants may only have 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. Chart 6 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 takes place on day 9. As the day of the meeting approaches, the probability of an interest rate change increases by 0.04. At 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 at the announcement due to the realisation of the expectations. Such a jump creates an increase in volatility on meeting days.

[Insert Chart 6 about here]

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 an insignificant impact relative to the fundamental determinants of market volatility.

3.2. Have money markets anticipated interest rate decisions within reserve maintenance periods: some insight of further intuition.

The aim of this section is to complement the previous analysis with a different, more heuristic approach. Looking at all the monetary policy decisions on interest rates taken since the beginning of Stage Three, this section analyses to what extent the market has anticipated the interest rate changes (or decisions to keep interest rates unchanged) in the ECB. Short-term interest rates contain information about the expected future path of monetary policy interest 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 to the extraction of market expectations from financial instruments, see Soderlind, P. and L.E.O. Svensson (1997))

It could be argued that the desirable way of reckoning interest rate expectations of a move in ECB's interest rate would be through the derivation of forward rates that correspond to future ECB's two-week reverse transaction rates. However, from a practical point of view, there are no instruments that quote forward two-week collateralised rates in 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 them yet the best tool for analysing expectations in the euro area. This view is further reinforced 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 expectation 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 change expectations, the expectations on ECB's interest rates should be reflected in the overnight interest rates at the beginning of the maintenance period. Due to its 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). However, as money market instruments, a well-known difficulty arise, which is the need to take into account credit, financing, or term-premia factors in order to compare them to MRO rates.

The money market data used is EONIA rate from 1 January 1999 to 23 March 2001 (the results are notwithstanding 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 (ß, 1-ß) of two events. The results provided are calculated using as the two events either a no move or a 25 basis point move in interest rates.

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

ß can be interpreted as the probability of *at least* a 25 basis point change, against the alternative of no change in ECB interest rates. Actually, the value for ß 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 have been done with different magnitudes: a spread of 3,5 and 7 basis points between the EONIA rate and MRO rates has been used[13].

(Insert table 3a about here)

As maintenance periods are considered as a unity, the calculations have been done with the EONIA rates (although the results have been cross-checked using the EONIA one-week swap rate) at the beginning of the maintenance periods. Table 3a shows the results for different spreads.

As it can be seen, at the beginning of the maintenance periods, markets anticipated between 81-88% of the times ECB's decision on interest rates. However, 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. To do so, we replicate the same calculations for the day before the meeting of the Governing Council (to avoid the liquidity effects, if those days correspond to the last four days of the maintenance period, they are taken out of the sample). The results show that the rate of success of the market in predicting ECB's interest rate movements increases to 86-91%. More precisely, table 3b shows how many times the market has anticipated the central bank decision one day in advance of the meeting, distinguishing between the times where the ECB has moved interest rates, and when it has announced that its interest rates were not changed. As seen, of the 8 times the ECB decided to change its interest rates (none of these meetings were held the last four days of a maintenance period), only 12% of them (once) did the market not anticipate the move, namely the April 1999 move. Of the times the ECB decided to keep its interest rates unchanged, only 8% of the times a change in rate was expected by the market.

[Insert table 3b about here]

[13] The medium average of the spread in the sample used has been 7 basis points (6 basis points during fixed MROs and 10 basis point 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 moves 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).

4. Conclusion

The transition to the new operational framework does not seem to have had a significant impact on the behaviour of money market rates. For example if one looks at volatility or dispersion of overnight interest rates, one finds effects which are significantly smaller than those associated with well-known recurring effects like those related with end of the maintenance period or end of the month. If one looks at the path of interest rates in the single monetary policy period as a whole, the first few weeks do not stand out.

Evidence has been provided showing that learning did take place in particular during the first days of Stage Three of EMU. The adjustment was not instantaneous. A sufficiently significant number of deviations from normal behaviour or inefficiencies can be identified during the first few days. However the evidence in this section also shows that banks seem to have adapted quickly and easily to the new environment. This learning process took place without significant disturbances in the behaviour of money market interest rates. The evidence suggests that the exceptional measures announced by the Governing Council on 22 December 1998, particularly the narrow corridor for interest rates, effectively contained possible volatility in market interest rates.

On the predictability of monetary policy moves our research suggest that looking at the behaviour of EONIA rates within a reserve maintenance period provides an interesting starting point. Our empirical results show that monetary policy announcements, after Governing Council meetings, do not affect 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 2, that neither the meeting day dummy nor the day after meeting dummy has a statistically significant impact on the variance of overnight rates. The interpretation suggested is that the announcement of ECB monetary policy decisions has 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 ECB's interest rate decisions quite accurately.

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ANNEX: ECB PRESS RELEASE

The ECB interest rates to be applied at the start of Stage Three

22 December 1998

On 1 January 1999 the ESCB will assume responsibility for defining and implementing the single monetary policy of the euro area. At today's meeting, the Governing Council of the ECB took a decision on the interest rates that will apply to the monetary policy instruments of the ESCB as from the start of Stage Three of EMU. These ECB interest rates will play a key role in signalling the monetary policy stance of the ESCB.

In this context, the Governing Council recalled that on 3 December 1998, in a co-ordinated decision, all the national central banks participating in the single monetary policy lowered their key central bank interest rates to 3% (with the exception of the Banca d'Italia, which reduced its discount rate to 3.5%). As explained by the ECB at that time, these decisions were based on a consensus reached in the ECB's Governing Council following a common assessment of the economic, monetary and financial situation in the euro area. The joint reduction in central interest rates had to be seen as a de facto decision on the level of interest rates with which the ESCB will start Stage Three and which it intends to maintain for the foreseeable future.

Against this background, the Governing Council decided today to conduct the first main refinancing operation of the ESCB as a fixed rate tender and to set the level of the interest rate for this operation at 3%, in line with the key central bank rates prevailing at the end of Stage Two.

With respect to the interest rates on the ESCB's standing facilities, which are designed to form a corridor for movements in short-term money market rates, the Governing Council decided that the interest rate for the marginal lending facility will be set at a level of 4.5% and the interest rate for the deposit facility at a level of 2%. These are the rates of the ESCB's standing facilities at the start of Stage Three, i.e. 1 January 1999.

However, as a transitory measure, between 4 January 1999 and 21 January 1999, the interest rate for the marginal lending facility will be set at a level of 3.25% and the interest rate for the deposit facility at a level of 2.75%. This measure aims at smoothing the adaptation of market participants to the integrated euro money market during the initial days of Monetary Union. The Governing Council intends to terminate this transitory measure following its meeting on 21 January 1999.

***

Further details of relevance for the submission of bids by counterparties to the first main refinancing operation will be announced on 4 January 1999. The allotment decision of the operation will be made public on 5 January 1999 and settlement will take place on 7 January 1999.

The first longer-term refinancing operation will be announced on 12 January 1999. The allotment decision of the operation will be made public on 13 January 1999 and settlement will take place on 14 January 1999. The Governing Council decided today that this operation will be conducted as a variable rate tender, using the single rate auction procedure.

In order to guide financial market participants to the new euro money market situation prevailing in Stage Three, some further technical information concerning the liquidity conditions expected at the start of Stage Three is annexed to this press release.

ANNEX

Information relating to the liquidity conditions at the start of Stage Three

To contribute to a smooth reserve management by credit institutions and to a smooth functioning of the euro area-wide interbank money market at the beginning of Stage Three, the Governing Council of the ECB wishes to draw attention to some features of the liquidity situation prevailing in the first days of Stage Three:

- The transition to the reserve requirement system of the ESCB is expected to imply that the aggregate reserve holdings of credit institutions might be lower on the first three days of Stage Three than the aggregate reserve requirements to be fulfilled on average within the first maintenance period ending on 23 February 1999. However, the ESCB intends to provide sufficient liquidity in its first regular refinancing operations to allow credit institutions (on aggregate) to neutralise the reserve deficits accumulated in the first days of Stage Three. It should be noted that the precise aggregate reserve requirements relevant in the maintenance period of 1 January 1999 to 23 February 1999 will not be known from 1 January 1999 on, but only in the course of the first maintenance period.
- The initial distribution of liquidity within the euro area might be uneven. For that case, interbank flows of reserves are anticipated to level the liquidity situation in the euro area from 4 January 1999 on.

As a general measure to give orientation to credit institutions in their reserve management, the Governing Council of the ECB has also taken the decision to publish regularly in Stage Three the following information regarding the liquidity conditions in the euro area:

- the aggregate current account holdings (mainly consisting of minimum reserve holdings) of euro area credit institutions with the ESCB on the preceding ESCB business day;
- the aggregate use of the standing facilities on the preceding ESCB business day;
- the aggregate minimum reserve requirement for the current maintenance period; (This figure will be published after the publication of monetary statistics for the same month. In effect, this will be a few days after the start of the maintenance period.)
- the average aggregate current account holdings (including minimum reserves holdings) of euro area credit institutions in the current maintenance period up to (and including) the preceding ESCB business day.

The ECB intends to publish this information by 9.30 a.m. on every ESCB business day. Since the reserve requirements in the first maintenance period will not be known until the end of January 1999, the ECB will provide, in this special case, tentative estimates of the aggregate reserve requirements.

European Central Bank

Press Division

Table 1

Monetary policy operations	Types of transactions		Maturity	Frequency	Procedure
	Provision of liquidity	Absorption of liquidity			
OPEN MARKET OPERATIONS					
Main refinancing operations	Reverse transactions		Two weeks	Weekly	Standard tenders
Longer-term refinancing operations	Reverse transactions		Three months	Monthly	Standard tenders
Fine-tuning operations	Reverse transactions	Foreign exchange swaps	Non-standardised	Non-regular	Quick tenders
	Foreign exchange swaps	Collection of fixed-term deposits			Billateral procedures
		Reverse transactions			
	Outright purchases	Outright sales		Non-regular	Billateral procedures
Structural operations	Reverse transactions	Issuance of debt certificates	Standardised/non-standardised	Regular and non-regular	Standard tenders
	Outright purchases	Outright sales		Non-regular	Billateral procedures
STANDING FACILITIES					
The marginal lending facility	Reverse transactions		Overnight	Access at the discretion of counterparties	
The deposit facility		Deposits	Overnight	Access at the discretion of counterparties	

Table 2

The estimated model is:

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

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

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

with:

$X_{1t} = Cons\tan t$
$X_{2t} = End\ MP\ Dummy$
$X_{3t} = Begining\ MP\ Dummy$

$V_{1t} = Cons\tan t$
$V_{2t} = End\ MP\ Dummy$
$V_{3t} = Beginning\ MP\ Dummy$
$V_{4t} = End\ Year\ Dummy$
$V_{5t} = End Month Dummy$
$V_{6t} = Friday$

Mean Parameters		
X_{1t}	-0.203	(0.094)
X_{2t}	-0.970	(1.163)
X_{3t}	5.747	(0.968)
Variance Parameters		
V_{1t}	-10.930	(0.394)
V_{2t}	3.797	(0.260)
V_{3t}	1.369	(0.347)
V_{4t}	4.995	(1.261)
V_{5t}	2.221	(0.332)
V_{6t}	0.184	(0.229)
V_{7t}	0.422	(0.373)
V_{8t}	0.598	(0.348)
Other Variance Parameters		
d_{11}	0.256	(0.046)
d_{21}	0.079	(0.022)
d_{31}	0.219	(0.044)
d_{12}	0.099	(0.089)
d_{13}	0.195	(0.075)
p	0.677	(0.306)
σ	3.671	(0.306)

The model has been estimated by maximum likelihood. Standard errors are displayed in parenthesis.

Table 3.a

Have Money Markets anticipated ECB's decisions?

	Spread		
	3bp	5bp	7bp
At the beginning of the MP	81%	88%	85%
One day before the meeting	86%	91%	86%

Note: The table presents the number of times in which markets have anticipated correctly the ECB's decisions for different values of the "natural spread" between the Eonia and the MRO rates. Meetings held in the last four days of the maintenance period are not considered

Table 3.b
Have Money Markets anticipated ECB's decisions?

		Market Expectations		Number of Observations
		Move	No Move	
ECB	Move	88%	12%	8
	No Move	8%	92%	36

Note: The table presents the number of times in which markets have anticipated correctly the ECB's decisions for a spread of 5bp between the Eonia and the MRO rates. Meetings held in the last four days of the maintenance period are not considered

Chart 1.a
Eonia and Key ECB Rates Full Sample

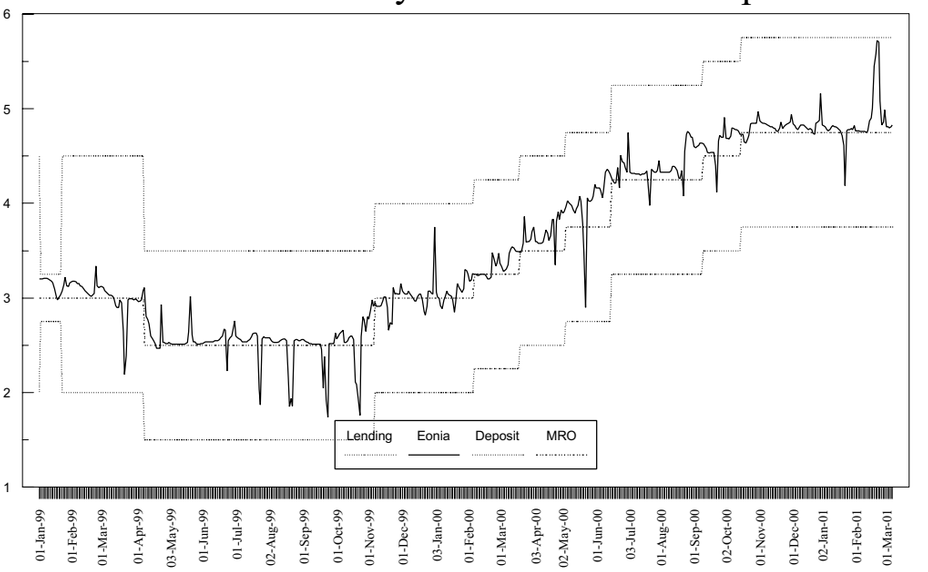
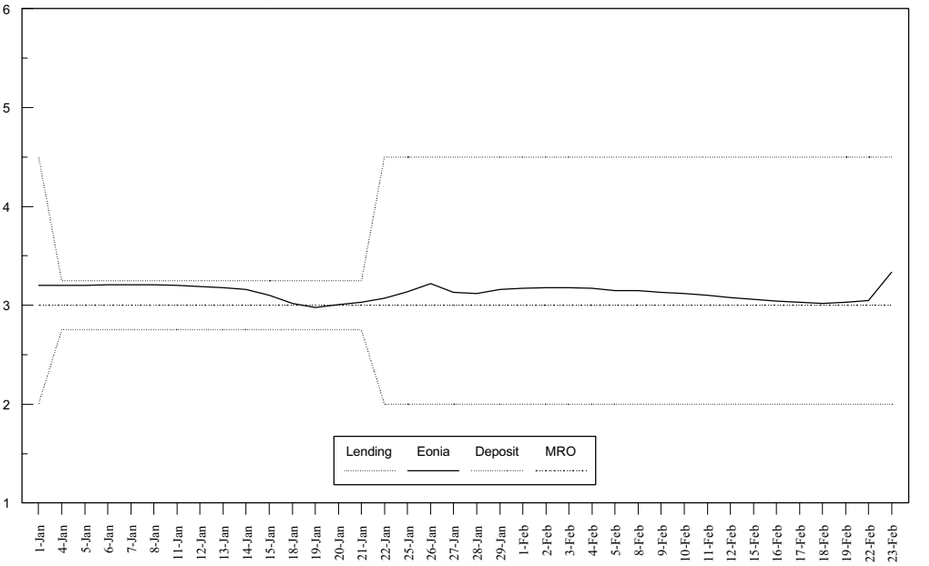


Chart 1.b
Eonia and Key ECB Rates. First Maintenance Period



Source: ECB.The solid line represents the EONIA rates. The dotted line represents the rates associated with the marginal lending and deposit facilities. The broken line represents the rates of the MRO before June 2000 and the rates for the minimun rate tenders after that date

Chart 2.a

Difference between first and third quartile rates. Full Sample

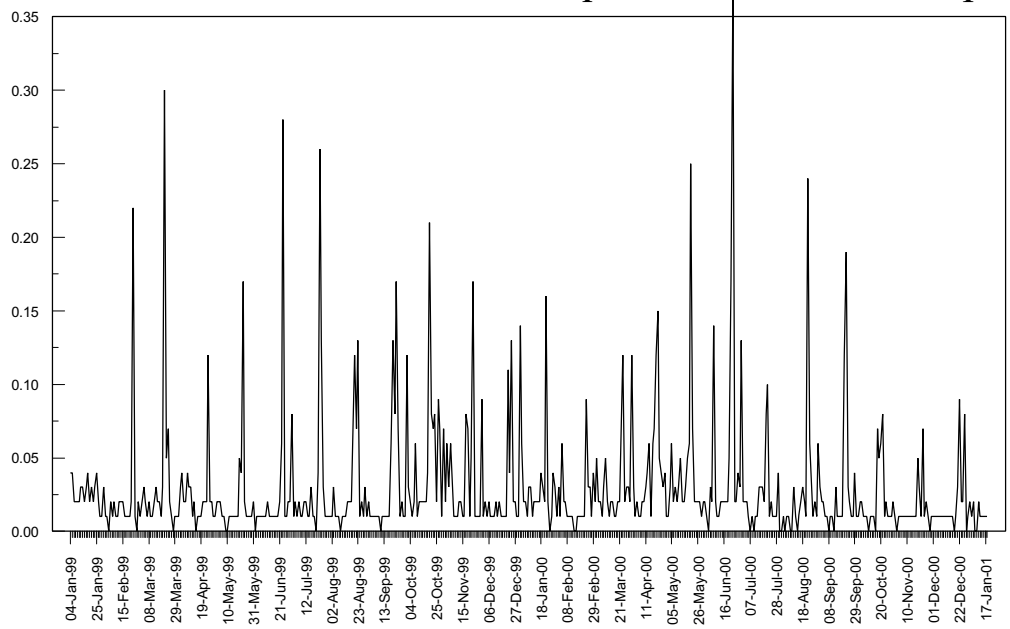
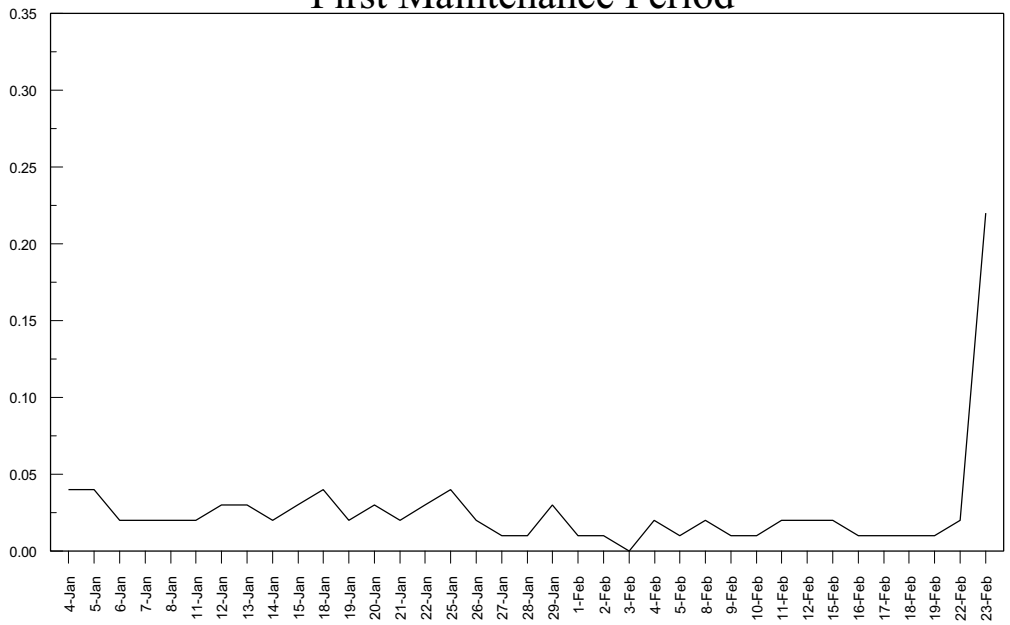


Chart 2.b

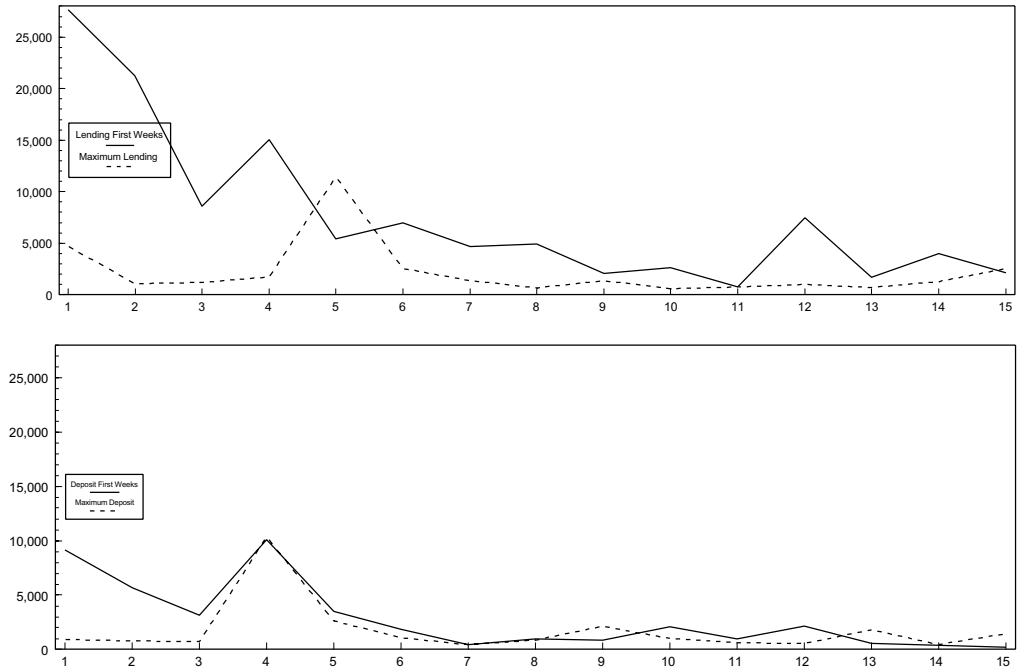
Difference between first and third quartile rates.

First Maintenance Period



Source: EBF.The graph plots the difference between the rate paid by the Euro that represent the 25% cheaper and the one that represent the 25% more expensive. Thisdifference represents a robust measure of dispersion.Data come from the EONIA panel

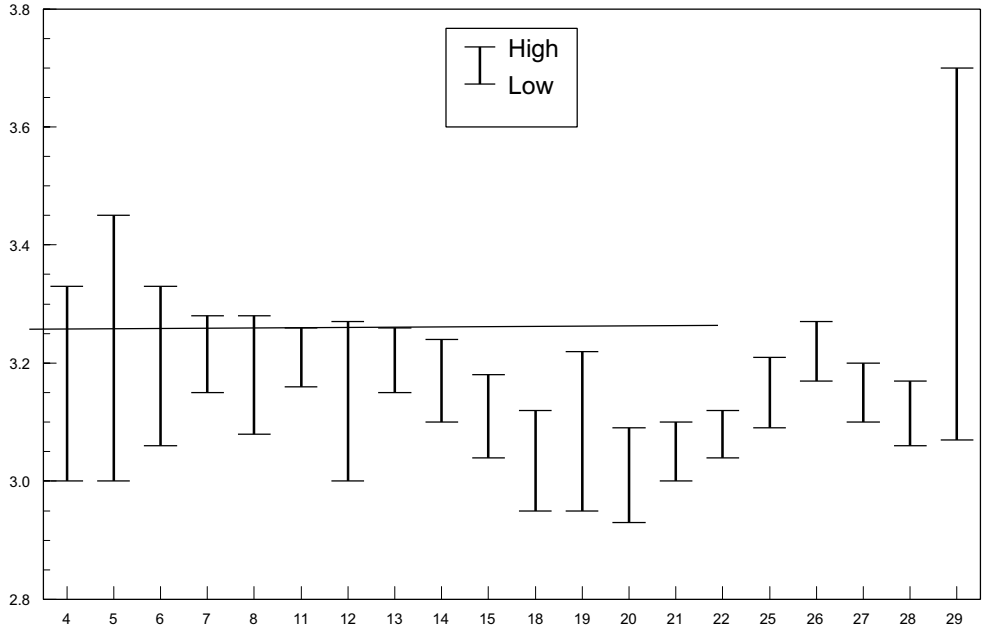
Chart 3
Use of Marginal Lending and Deposit Facilities



Source: ECB The graph plots the use of the marginal lending and deposit facilities in millions of Euros for the period comprising the first three weeks of the first maintenance period and the maximum of the first three weeks of the other maintenance periods.

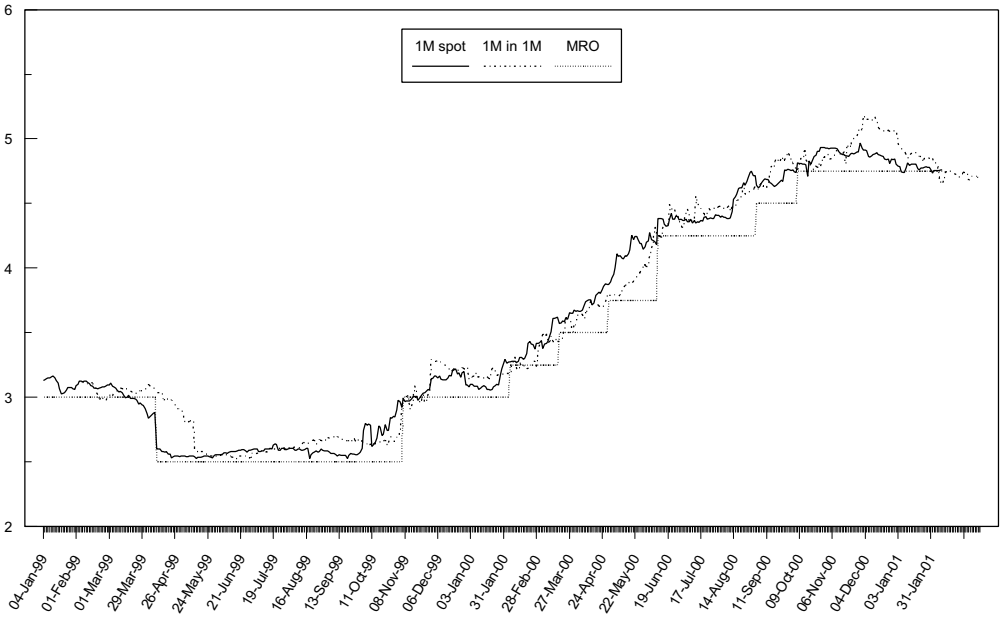
Chart 4

Maximum and minimun transaction rates. First 4 weeks



Source: EBF.The graph plots the minimum and the maximun rates paid to the banks that contribute to the Eonia rates. The horizontal axis represents the days of the month of January 1999. The solid horizontal line reppresent the lending rate fixed by the ECB. After January 22nd, this lending rate is no longer in the graph because it goes up to 4.5. The deposit rate for this period was 2.75 before January 22nd and 2 after this day.

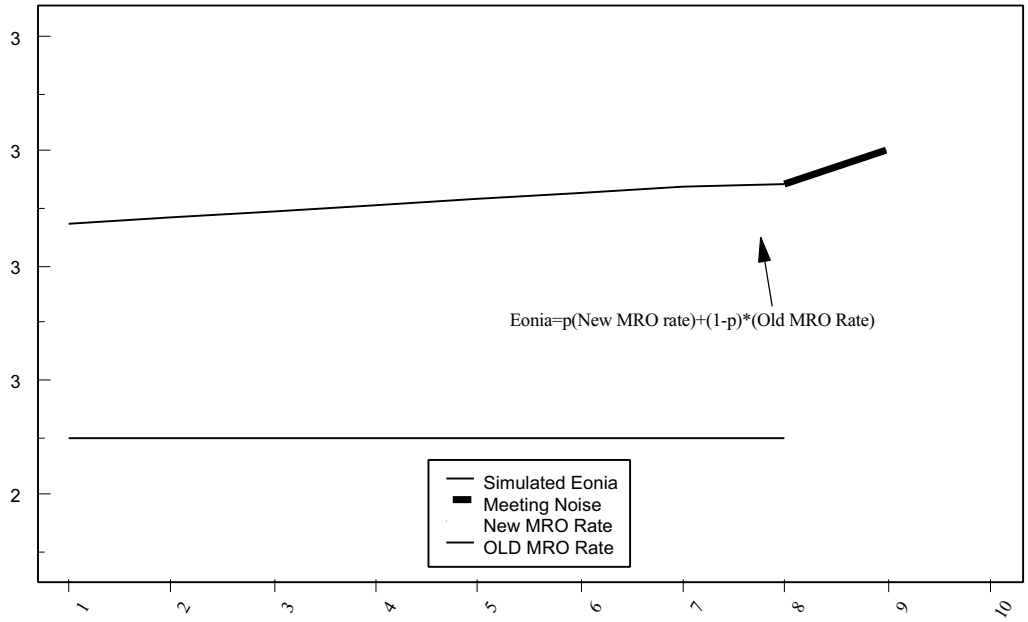
Chart 5
One month rates and MRO rates



Source: ECB. The solid line represents the one-month EONIA - swap rate. The dotted line represents the rate of the MRO before June 2000 and the rate for the minimun rate tenders after that date. The brolen line represents the one moth in one month ex-post rate as calculated with the EONIA swap curve.

Chart 6

Volatility associated with expected changes in rates



The chart illustrate a change in the MRO 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 an increase of .04 each day in the probability of a change in rates. The bold line represents the associated volatility to the realization of the expectation.

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