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Abstract

The objective of this paper is to examine the predictability of the monetary policy decisions of the Governing Council of the ECB and the transmission of the unexpected component of the monetary policy decisions to the yield curve. We find, using new methodologies, that markets do not fully predict the ECB decisions but the lack of perfect predictability is comparable with the results found for the United States Federal Reserve. We also find that the impact of monetary policy shocks on bond yields declines with the maturity of the bonds, and that this impact is significantly lower when the shock stems from a monetary policy meeting of the ECB. Using implicit rates instead of bond yields, we find evidence that the market views the ECB as credible.

Keywords: Predictability, monetary policy shocks, principal components, transmission of monetary policy, yield curve.

JEL classification: C22, E52

Executive Summary:

The objective of this paper is to examine the predictability of the monetary policy decisions of the Governing Council of the ECB and the transmission of the unexpected component of its monetary policy decisions to the yield curve. With respect to the first goal, the predictability analysis, we apply a battery of tests and we conclude that the markets have predicted the monetary policy decisions of the ECB rather well. However, the results do not accept the hypothesis of perfect predictability. To evaluate the magnitude of the deviations from this hypothesis, applying the same battery of tests, we draw a comparison of these results and those obtained on the predictability of the monetary policy decisions of the United States Federal Reserve during the same period. We provide evidence that the predictability of both central banks is broadly similar.

With respect to the second objective, we analyse the impact of the unexpected component of the monetary policy decisions on the term structure of interest rates in the euro area. We use series of daily monetary policy shocks in the euro area in which the observations on the days of the monetary policy meetings of the ECB are the unexpected component of the monetary policy decisions. This allows us to identify the impact of the surprise part of a monetary policy decision on the yield curve and compare it to the normal response of the yield curve to other daily shocks. We show that the impact of the daily monetary policy shocks on bond yields declines with the maturity of the bonds, and that this impact is significantly lower when the shock stems from a monetary policy meeting of the ECB. Using implicit rates instead of bond yields, we find evidence that the market views the ECB as credible.

In addition to the former contributions, the paper presents a new methodology to approach the problem of measuring monetary policy shocks and predictability of central bank decisions. The contributions can be summarise as follows:

First, as a difference to other standard papers in the literature, we use daily data and consider all days, not only meeting days "T" days before the meetings. Our purpose with this approach is twofold. First, to have daily series of monetary policy shocks which can be interpreted as how market participants change the expected path of monetary policy interest rates on a daily basis (at different horizons) as new information becomes available. Second and taking advantage of this series, to test for the significance of the shocks associated with the monetary policy meetings compared to the shocks produced on any other day.

Second, we gather information about the shocks from different money market interest rates, avoiding the liquidity (and potentially other) consideration(s) unrelated to monetary policy expectations that affect the individual series. We comprise the information of the different rates by using principal components. This approach allows us to get a rich variety of conclusions on how the new daily information affects the expected path of monetary policy rates at different horizons. For example, we show that the impact of monetary policy decisions (either to change the key ECB interest rates or to maintain them unchanged) can be considered surprises when we use very short-term rates but not so when using longer-term rates. We see this as evidence showing that the surprises on monetary policy decisions might be more related to the timing of the decisions than to the decision itself.

Third, we measure the predictability of the monetary policy decisions of a central bank from different points of view by using different techniques in order to check the robustness of our findings. These techniques go from a graphical intuition to an EGARCH specification for the principal components of the series, going through an heuristic approach based on a weighted average of the possible outcomes, an analysis of the probabilities of change based on a probit specification and linear regressions for the transmission mechanism.

Finally, to our knowledge the paper presents the most comprehensive approach to compare the euro area and the US in terms of the amount of information used, a preliminary analysis of the series in order to take into account the differences due to maturity, liquidity, etc., the variety of techniques used and the robustness of the results.

1. Introduction

Not so long ago central banks gave little weight to being transparent; providing timely, open and clear information on their mandate, strategy, assessment and decisions to the public. [3] This has changed significantly in the recent past for good reasons and today transparency is viewed as a very important component of the monetary policy framework of a central bank.

One of these reasons is related to the notion of credibility. Credibility is ultimately driven by the ability and track record of the central bank in fulfilling its mandate, and can be defined as the belief on the side of the public that price stability will be maintained over the medium term. Transparency helps central banks to foster their credibility.

Another important reason stems from the finding that that forward-looking economic agents have relevant methodological consequences for the monetary transmission mechanism (see McCallum, 1999, 2001). If the market[4] fully understands the role of a central bank, the belief in the commitment to maintaining price stability over the medium term should anchor inflation expectations and induce a 'rule like' behaviour on the part of market participants. This would lead the market to react to the new information changing their expected path of monetary policy rates in a way consistent with the monetary policy strategy of the central bank. By being transparent, expectations on the path of future monetary policy decisions are formed more efficiently and accurately.

The policy makers understand this and have stressed their commitment to stand up to the challenge. For example, in the words of a monetary policy maker in the euro area, "*when the markets correctly anticipate that a new piece of information will lead to a change in official interest rates they will do much of the work themselves through a change in the term structure*", Issing (1999).

Has this been the case? Ideally, it could be considered that the relevant question to be answered is to what extent the market expectation on the future path of monetary policy rates is broadly in line with the view of the central bank at every point in time. However, it is not possible to know

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3 There are many definitions of transparency in the literature. In King et al (1998) it is defined it as a "*process by which information about existing conditions, decisions, and actions is made accessible, visible, and understandable*". This definition is broadly in line with Winkler (2000), where transparency is ("*broadly and loosely*") defined as the "*degree of genuine understanding of the monetary policy process and policy decisions by the public*". Several authors (Eijffinger and Geraats (2002), Gerbach and Hahn (2002)) have useful discussions about the different aspects of transparency.

4 While the distinction between market participants and the public at large is relevant for the communication of a central bank, given the empirical nature of the paper, we will concentrate on market participants.

the view on the expected path of monetary policy rates that a central bank has in mind at every point in time.

Instead, we turn our attention to a closely related concept, the predictability of a central bank. We can define predictability as the ability of the public to correctly anticipate the monetary policy decisions of a central bank. By becoming more predictable, a central bank gains the ability to influence interest rates before the announcement of its monetary policy decisions.

Predictability is sometimes viewed as a necessary consequence of transparency. In this vein, the degree of predictability of a central bank is thus sometimes seen as a way of measuring whether it is transparent. [5] For example, Poole and Raasche (2001) argue that with complete transparency, the monetary policy decisions of a central bank should be fully predictable. In fact, they test the predictability of the Fed by checking to what extent monetary policy decisions affect market rates, as their view is that policy announcements should not provide information to market participants, and thereby should not trigger any reaction of asset prices.

It is clear that a higher degree of transparency should be connected to a higher degree of predictability. However, it can also be argued that perfect predictability might not be fully attainable in a world of uncertainty. The decision making process of monetary policy is a complex one in which all relevant pieces of information have to be assessed in the light of their implications for the monetary policy mandate. Given that the outcome of the process of mapping all the information on the state and the functioning of the economy (which is inherently uncertain) to take monetary policy decisions is based on judgement and is not done mechanically, it could be argued that a certain lack of predictability might not necessarily be related to a lack of transparency. Some authors also argue that when the decision is a collective one, as in the case of the European Central Bank (ECB), full transparency (in fact, operational transparency) may not be reached. [6] In this same vein, the precise timing of monetary policy decisions may be hard to anticipate perfectly, especially if monetary policy meetings are held very frequently, as was the case for the Governing Council of the ECB before November 2001. [7]

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[5] Other considerations are important determinants of predictability, such as gradualism in interest rate decisions (Lange, Sack and Wicksell (2001)).

[6] See Cuikerman (2000). In addition, Winkler (2001) holds the view that as the monetary policy in the euro area is a relatively new event the level of common language and understanding between the central bank and market participants still needs to be fully tuned.

[7] Until 8 November 2001, the Governing Council of the ECB held monetary policy discussions at all of its meetings, generally every two weeks. Since then, it has discussed monetary policy issues only once a month.

Whilst in a world of uncertainty policy actions will most likely never be fully predictable, from the point of view of central bank it is important to avoid being unpredictable (or perhaps more importantly, to avoid that market uncertainty increases because of an incorrect interpretation of its own behaviour). This calls for the need for a continuous effort to be transparent, communicate effectively and provide active guidance to the markets explaining its policy decisions.[8] In fact, central banks care about predictability. This paper analyses to what extent the markets have anticipated the monetary policy decisions of the ECB.

There is not one single approach to measure predictability in the empirical literature. A great deal of work has been done to measure the predictability of monetary policy decisions in the United States and some European countries prior to the Monetary Union.[9] However, the predictability of the monetary policy decisions of the ECB has not been tested extensively, partly due to the relatively short period of time in which the ECB has been conducting the single monetary policy in the euro area. To our knowledge, two papers, Gaspar, Perez-Quiros and Sicilia (2001), Hartman, Manna and Manzanares (2001) have analysed it and found evidence indicating that financial markets have generally understood and predicted the monetary policy decisions of the ECB. [10]

Interpreting the results is not easy. While perfect predictability is the clearest benchmark that comes to our mind, given the above arguments it might not be too realistic. For this reason, we also provide some evidence on the predictability of the United States Federal Reserve (Fed), which allows for a rouge comparison between the two central banks. However, as the literature has typically found that predictability is an evolving process, and that the market has improved its ability to predict the monetary policy decisions over time,[11] perhaps not enough time has passed yet for the ECB.

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8 Not surprising the markets cannot be an objective itself of monetary policy, following what market participants expect, regardless of the view the central bank holds on its assessment of the likelihood of reaching its objective. As Blinder puts it: "*markets tend to overreact, are susceptible to fads and speculative bubbles, and seem to be have more short-term horizons than central bankers.*" While central banks should not have any interest in surprising the markets, it might be unavoidable on some occasions.

9 For example, for the Fed, among others, Roley and Sellon (1998), Poole and Raasche (2001), Kuttner (2001), Poole, Raasche and Thornton (2002), Cochrane and Piazzesi (2002); For the Bank of England, Haldane and Read (1999); for a series of European countries prior to the Monetary Union and the United States, see Favero *et al* (1998) and Buttiglione *et al* (1998).

10 Ross (2002) extends the analysis of Gaspar, Perez Quiros and Sicilia (2001) for the ECB and compares the predictability of the ECB with the one of the Bank of England and the Federal Reserve. Bernhardsen and Kloster (2002) also compare the predictability of several central banks using changes in the three-month interest rates.

11 For the United States (see references in footnote 9) a common finding is that the predictability of Fed's actions increased after the decision to announce changes in Fed policy rates immediately after FOMC meetings. In turn

As regards the second objective, we analyse the transmission of the unexpected component of the monetary decisions of the ECB to the term structure of interest rates. The reaction of the yield curve to the unexpected component of the monetary policy decisions at the Federal Open Market Committee (FOMC) has been used in the literature (Roley and Sellon (1998), Poole and Raasche (2001), Kuttner (2001), Cochrane and Piazzesi (2002)) to analyse the predictability of the Fed. Besides applying this analysis to the monetary policy decisions of the ECB, taking advantage of the series of daily monetary policy shocks estimated to assess predictability, our contribution is to study how the unexpected component of the monetary policy decisions has affected the term structure of interest rates compared to the normal impact of shocks on other days with no monetary policy decisions.

The paper is structured as follows: In section 2, we present a simple heuristic approach to assess how well market participants have predicted the monetary policy decisions of the ECB before the meeting of the Governing Council. In section 3 we define series of daily monetary policy shocks in the euro area applying principal components to an array of daily money market data. We consider this approach a good way of summarising all the information contained in the money market and we present it in a way in which the predictability can be analysed. These series will be of particular importance, as they will allow us to measure to what extent monetary policy decisions have moved short-term money market rates (i.e. how have they surprised the markets), as compared to the normal behaviour of these rates. Section 4 analyses, using an EGARCH, how the monetary policy meetings of the Governing Council have changed the volatility pattern of these monetary policy shocks. Throughout these sections, to find a benchmark with which to compare the predictability results for the ECB, we apply (the same battery of) measures of predictability to the Fed. In Section 5 we analyse the reaction of the term structure of the euro area to the daily shocks and to the unexpected component of the monetary policy decisions of the ECB (the shocks on the days of the monetary policy meetings of the ECB). Section 6 sums up and concludes.

2. Heuristic approach to measure the predictability of the monetary policy decisions

A rather intuitive approach is to analyse to what extent market participants have predicted the monetary policy decisions taken shortly before the meeting. Gaspar, Quiros and Sicilia (2001)

Haldane and Read (1999) show that the introduction of inflation targeting in the Bank of England improved the predictability of its monetary policy decisions.

used the EONIA[12] to calculate the probability attached to a change in the key ECB interest rates before the meetings of the Governing Council. However, the high volatility of the EONIA and the impact of liquidity considerations in its pattern of behaviour, like when underbidding episodes occur (Bindseil 2002), argue in favour of using other short-term interest rates to assess market expectations. The very short end of the money market curve, and in particular the EONIA swap rates, are good candidates.

The money market data used in the remainder of this section for the euro area is the one-month and the two-week EONIA swap rate from 1 January 1999 to 7 June 2002. Following Gaspar, Quiros and Sicilia (2001), we consider that the short-term market rate can be seen as a linear combination (β, 1-β) of two events, a decision not to change interest rates from their prevailing level (i_0) or to change them by 25 basis points (i_{25}).

$$i_t = bi_{25} + (1 - b)i_0 \qquad (1)$$

β can thus be interpreted as the probability of at least a 25 basis point change (positive when the expectation is of an increase and negative otherwise), against the alternative of not changing the key rate.[13] At these maturities there seems to be no need to control for the risk premia, as it is estimated to be zero.[14] However, to take account of the "natural" spread between the market rate and the MRO rate (which is a collateralised rate with lower credit risk than the interbank market rate), we apply a spread of 5 basis points (bp) between the market rate and the MRO rates.[15]

We impose a (rather arbitrary) benchmark for ß to assess the extent to which the market has predicted the monetary policy decisions taken by the ECB. We assume that if ß is above 12.5 bp in absolute value, which corresponds to a probability of 50% attached to a change of 25 bp in the key rates, the market expected the ECB to change its key interest rates.

We calculate ß for each meeting of the Governing Council using the two-week and one-month EONIA swap money market rates one day before the meeting. We then evaluate the percentage of times in which financial markets have anticipated the monetary policy decisions of the ECB.

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12 The EONIA is an overnight index average rate (see Annex 1).

13 The ECB considers as key ECB interest rates the MRO rate (the fixed rate under fixed rate tenders and the minimum bid rate under variable rate tenders) and both the marginal and lending facility rates. For the sake of clarity, in the remainder of the paper we use MRO rate or key rate interchangeably.

14 It cannot be rejected that the risk premia is significantly different from zero in the short-term interest rates in the EONIA swap market. See Durre, Evjen and Pilegaard (2002) for a thorough analysis on estimates for the risk premia across the maturity spectrum for the euro area EONIA swaps.

15 Alternative estimations applying a natural spread of 3 and 7 basis point yield similar results.

Similar to the graphic analysis in Robertson and Thornton (1997) and Ross (2002), Figures 1 and 2 show the results for all the meetings of the Governing Council.

[Insert Figures 1 and 2 about here]

The monetary policy decisions of the ECB have been accurately predicted 87% (94%) of the times when the one-month rate (two-week rate) is used to assess the expectations of market participants. The two-week rate is better than the one-month rate for assessing the predictability of the monetary policy decisions in the euro area before November 2001, when the ECB discussed monetary policy decisions bimonthly. Given that it then switched to monetary policy discussions once a month, it is probably more accurate to use since then the one-month rate. In any case, the results since November 2001 are similar using both rates.

The decisions are analysed in more detail in Table 1. Using the two-week rate, the market has anticipated with a similar probability the decisions to change interest rates (92%) and to maintain them unchanged (94%). On the slightly more negative side, the reliability of changes, defined as the percentage of times in which the model signals a rate change and it actually happens, has been 80%. Given the frequent meetings of the Governing Council of the ECB before November 2001, the markets may have found some difficulties anticipating the decision on a particular day. Figure 1 shows how the majority of occasions in which a monetary policy decision was expected and did not occur are mostly concentrated on the meetings shortly before the ones in which the actual change was implemented. While it may be considered that the decision to switch to monthly discussions of monetary policy may have affected for the better the predictability of the monetary policy decisions of the ECB, it is too soon to tell.

[Insert Table1 about here]

The results fall short of the "perfect predictability" benchmark. As already noted, this may however be too an extreme benchmark by which to judge a central bank. To see to what extent this result is comparable with other similar central banks we apply the same analysis to the monetary policy decisions in the United States, using the one-month Libor dollar rate in a sample spanning from 4 January 1999 to 6 June 2002. [16] [17]

Figure 3 (and also Table 1) presents the results for the Fed. As can be seen, the similarities are large. The percentage of times in which the decisions were anticipated was 90%. While the number of changes anticipated is lower than for the ECB (81%), the Fed changed rates on a larger number of occasions than the ECB. The percentage of hits for the cuts (82%) and increases (100%) in interest rates implemented are also similar. The main difference is that, in the sample, markets have never anticipated a change that the Fed failed to deliver and thereby the high score in the reliability of changes (100%). This could be due to the fewer meetings held by the FOMC in the sample, or perhaps to the fact that markets may have had better guidance, e.g. through speeches. Moreover, there are many more announcements of changes than times when the FOMC decided to keep the Fed Fund rate unchanged. As Figure 3 shows, on two of the three occasions in which the markets failed to anticipate a move from the Fed in the sample, interest rates were changed at unscheduled meetings.

[Insert Figure 3 about here]

To sum up, using a very simple approach to assess the predictability one day before the monetary policy meetings, we find that the monetary policy decisions of the Governing Council of the ECB have been very predictable. These results are broadly comparable to the ones obtained for the United States Federal Reserve.

3. Monetary policy shocks, surprises and monetary policy decisions of the ECB.

3.1. What do we mean by monetary policy shocks?

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16 While the results cannot be completely comparable as the operational framework in which the two central banks operate are different, the use of the one-month rate to measure the predictability of the monetary policy decisions of the Fed minimise the lack of comparability, as the FOMC hold scheduled meetings approximately every six weeks. Yet, some important caveats need to be considered. The FOMC met on fewer occasions than the Governing Council of the ECB in that period, so the market had fewer opportunities to bet on the outcome of a meeting. In addition, three monetary policy decisions in the sample were taken at scheduled meetings (3 January, 18 April, and 17 September 2001), for only one for the ECB. While the model could have been applied to a longer sample for the US, we would rather not draw comparisons from different samples.

17 An estimation or $i_{t,t+1} = \alpha + \beta * E_{t-1}(i_{t,t+1}) + \varepsilon_t$, where $i_{t,t+1}$ is the one-month dollar Libor rate at time t and $E_{t-1}(i_{t,t+1})$ is the expected one month rate for at time t calculated at t-1, which are cointegrated variables, yielded a risk premia of 13 basis points with a standard deviation of 4.4 basis points. Differing from the calculations carried for the euro area, the risk premia is significantly different form zero.

Market rates summarise the vast amount of information used by the central bank to reach the monetary policy decisions. In fact, these rates change as a reaction to the information that arrives to the market. [18] In this section, we define the daily changes of a set of short-term interest rates as monetary policy shocks. These daily changes, if devoid of liquidity considerations, are almost ideal measures of how unexpected news changes market's expectations of future monetary policy decisions during the maturity of the interest rate considered. On the days of monetary policy meetings, these shocks reflect the surprise associated with the monetary policy decision. Very short-term interest rates (from instruments which mature before the next meeting of the central bank) will reflect the short-term surprises of the monetary policy decision, that is if the decision was expected to take place at that precise meeting. Daily changes in other longer-term money market rates (from instruments which mature only after the next meeting of the central bank) allow for analysis if the surprise has also changed the short-term expected path of monetary policy rates.

This definition of monetary policy shocks is not new in the literature. Roley and Sellon (1998) Kuttner (2001), Poole and Raasche (2001), Cochrane and Piazzesi (2002) have used the daily change in some money market interest rates as a measure of the monetary policy shocks (the surprise or unexpected component of the monetary policy decision). [19] Most of the previous papers, however, define the monetary policy shocks as daily changes in market rates on the days in which the central bank took a monetary policy decision (and only as a previous step to analysing the impact of these shocks on the yield curve). In our view, defining the shocks on a daily basis, rather than only on monetary policy meeting days makes sense, as it permits the comparison of the shocks on the days of the meetings to other news or events that have affected the perspective of future monetary policy decisions. It allows the quantifying of the normal noise in the market due to monetary policy or any other kind of news other than the decisions of the monetary authority.

Besides extending the definition of shocks to daily changes in market interest rates, what is new in this paper is the way we calculate monetary policy shocks in the euro area. The institutional framework matters a lot in the analysis of what the changes in money market rates mean. While

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[18] Daily changes in risk premium can be considered very low at these short horizons. In any case, the risk premia in the euro area is estimated not to be significantly different from zero. See footnote number 14.

[19] Favero *et al* (1998) define the movement in the overnight rate as policy shocks and define monetary policy surprises as the difference between observed overnight rates and expected overnight rates.

in the United States there is a strong consensus in the literature that the Fed Fund rates should be used to assess expectations[20], it is not easy to find such a consensus in the euro area.

3.2. Monetary policy shocks in the euro area: which rates could we use?

Every interest rate may have its own advantages and disadvantages. Using daily changes in EONIA, for example, provides a measure of shocks highly influenced by liquidity issues, rather than (solely) by monetary policy considerations. EONIA swap rates (which span out to one year) might be a better alternative as they are not as affected as the EONIA by liquidity issues, especially for maturities larger than two weeks. However, they are not completely free of the characteristics of the specific operational framework.

Let us take a (rather) extreme example to clarify this. Assume that we use the two-week EONIA rate to gauge market expectations. If at the beginning of a maintenance period market participants receive a piece of news that changes the expectation of interest rates movements by the ECB only for a meeting taking place in the next maintenance period, the two week rate may not change at all. If, however, this same event occurs less than two weeks before the end of a maintenance period, the effect will be partially covered by the two-week rate, and the more so as the end of the maintenance period approaches.[21] All this suggests that, to the extent that this type of effects exists, by measuring shocks with the short-term money market rates we could be underestimating the monetary policy shock if the shock occurs that day. In addition, we may also be measuring as a shock the impact of information that became available at the beginning of the maintenance period.

While longer-term money market rates provide a picture of how the market view the path of key ECB interest rates, they might not be devoid of these specific problems either. Take the monthly rate. While its changes are clearly more related to monetary policy expectations over longer horizons, some liquidity considerations, such as the end-of-month and end-of-year effects may also matter. Other long-term instruments, such as EURIBOR future contracts, while they are not affected by these considerations and form a very deep market, may have other problems. As the

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[20] See Thornton (1995). The fact that the US monetary policy implementation implies daily open market operations allows the Fed Funds rate to have more information about market expectations than the information contained in the EONIA where weekly and monthly patterns exist due to bank's liquidity management considerations. For a recent comparison on the appropriateness of the different rates to measure expectations of monetary policy, see Gürkaynak, Sack and Swanson (2002).

[21] The behaviour of daily rates in the maintenance period is explained in Perez Quiros and Rodriguez (2001).

contracts apply to a fixed period of time, the maturity of the instrument changes as times passes, which does not happen with EONIA swap rates.

All in all, there are reasons to use an array of interest rate data to measure the monetary policy shocks in the euro area.

Obviously, there is a wide pool of rates from which we can extract the information. Before that decision, however, we should test if, on average, all the variables contain the same amount of information, abstracting from the impact of liquidity considerations in very short-term money market rates. It is of particular interest to test if implicit or forward rates and the actual realisation of rates present a long-term relation showing a stable behaviour of the spreads. If this were the case, mixing information from implicit rates and actual rates would be appropriate to solve the problem of "contamination" of the information that comes from different liquidity considerations. The best way of testing for the long-term relation between actual and implicit rates is to check if these variables present a unit root but that a linear combination between the actual and the implicit rates are stationary, i.e. a cointegration relation exists between them. In particular we check for cointegration in the following set up:

$$i_t = \alpha + \beta^j * E_{t-j}(i_t) + \varepsilon^j_{t+k} \quad (2)$$

where i_t is the one month interest rate, and $E_{t-j}(i_t)$ represent the one-month rate in one, two and three months as indicated by the value of j=1,2,3.

In all cases, for both, the euro area and the US, the series show cointegration and the β^j can be accepted to be equal to one. In this set up, the ε^j_{t+k} represent, not only the spread but also the shock to the information set in t-1.

It seems that there is a long-term equilibrium (markets do not make mistakes on average) and that deviations from this equilibrium are stationary. We can therefore widen our set of money market interest rate rates and combine them in order to achieve a better specification for the monetary policy shocks. [22]

3.3. Monetary policy shocks in the euro area: applying principal components (PC)

[22] While an approach using this line has been proposed in the literature to measure predictability over long-horizons, and our analysis show that overall the decisions have been predicted on average up to three-months in advance, it has the problem that the information set is not the same. While the expectations are calculated with the set of information at t-j (for j=1, 2, and 3 months), the actual realisation of the one-month rate uses information up to t. Results are available upon request.

We propose to use the daily changes of several money market interest rates and add them up daily. However, instead of assigning ad hoc weighs to each of the interest rates used, we let the data speak by extracting their principal component, without doing any type of intervention in the series. The objective is to capture the main common component that shapes the evolution in all these rates. The particular considerations that might affect only one series (and that should not be related to monetary policy considerations) would in the majority of cases not play an important role in the series obtained through the principal component.

We are also interested in measuring shocks with rates of different maturities. Daily changes in longer-term interest rates will reflect better how the expected short-term path of official interest rates changes. For example, if after a monetary policy decision of the ECB market participants are only surprised by the timing, say because they expected the change a fortnight after, longer-term interest rates might not change much. However, we do not want to use very long money market rates, as their liquidity, and therefore their information content diminishes progressively. [23]

We use daily changes in the EONIA, changes in the EONIA-swap with maturities of 2 weeks, one, two and three-months, and the change in the closest three-month EURIBOR futures. [24] We define different measures of monetary policy shocks using principal components (PCj), according to the maturities of the interest rates. PCall is calculated applying principal components to the daily changes of all the above mentioned money market rates. PCshort uses the market instruments up to and including the one-month rate (EONIA, the two-week and the one-month rate). PClong uses the two and three-month EONIA swap rate and the three-month EURIBOR future. Finally, PCnoe is PCall without the EONIA rate, which is very volatile and could affect the results.[25] While we would expect that PCshort could still be influenced by liquidity considerations (due to the weight of EONIA), we would expect that the other definition of shocks to be devoid of liquidity considerations.

3.4. An analysis of the monetary policy shocks and the monetary policy decisions of the ECB (and the US Federal Reserve)

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23 See ECB (2001a).

24 Annex 1 presents a detailed description of all the interest rates used in the paper. We did not use longer-term rates, as those rates might reflect other considerations different other than the expectations of monetary policy.

25 Annex 2 analyses in detail the principal component technique used and the calculated weights for each definition of shock.

We now have daily series of monetary policy shocks for the euro area in which the shocks generated by the monetary policy decisions of the ECB are only observations of that series. These daily shocks (at different maturities) provide a benchmark with which we can compare the monetary policy announcements of the ECB. We define a monetary policy surprise as a shock bigger than two times its standard deviation.

Of the 78 meetings of the Governing Council (in a sample of 878 observations) only between 7 and 10 (depending on the definition of the shock used) were surprises. [26] That is, only between 18-24% of the surprises in the sample have been caused by monetary policy decisions of the ECB (including decisions to change rates and to keep them unchanged). That is, other pieces of information have an important affect on the expected path of key interest rates. Of all the meetings of the Governing Council the markets have not been surprised in 87% of them (using the shocks measured by PCshort). The percentage increases slightly to 90-91% when the other measures of shocks are used. These results, together with the meetings of the Governing Council of the ECB in which a surprise occurred (according to the four measures of shocks), are presented on Table 2. Table 3 in turn lists the shocks on the other days of the sample, and points to possible determinants.

[Insert Tables 2, 3a-3b about here]

In turn, Figure 4 plots for all the monetary policy meetings of the ECB the changes in the key ECB rates and the monetary policy shocks on those days.

[Insert Figure 4a-4d about here]

By definition, these shocks capture the surprise associated with the timing of the monetary policy decisions. In fact, it is easy to see why this holds. For every shock, we can define the expected change in the key ECB rates one day before the meeting as

$$E_{t-1}(\Delta k_t) = \Delta k_t - PC_t \qquad (3)$$

where k is the level of the MRO or key interest rate.

As a major difference to the approach taken in Section 2, the size of the changes in the key ECB interest rates now matters. For example, if the market expects a cut in key ECB rates of 50 basis points and rates are only lowered by 25 basis points, the shock would adjust by some 25 basis

[26] The total number of surprises oscillated between 32 and 55, depending on the shock (see Table 2).

points [27]. In fact, Figure 4 shows how some of the changes of 50 basis points that were not considered surprises in the analysis conducted in Section 1, now appear as surprises.

This same analysis can be applied to the United States Federal Reserve. Following Poole and Raasche (2001), we use the change in the one-month-ahead federal fund future rate as our measure of shocks (PR from now on). [28] We also use the two-month-ahead change in the Fed fund future (PR1) as a shock, to see if the results are sensitive to the horizon (its maturity ranges between 2 and 3 months, while PR spans only between 1 and 2 months depending on the day of the month).

For the 877 observations in the sample, and the 30 meetings of the Fed in that period [29] only 8 of the surprises (both according to the measure of PR and PR1) were on days in which the FOMC met. That is, only between 22-23% of the surprises in the sample (again, defined as 2 times the standard deviation of each series) have stemmed from the meetings of the FOMC, a similar ratio to the one obtained for the euro area. However, given the lower number of meetings, the percentage of times in which the market has not been surprised by the monetary policy decisions is 73%. Table 4 shows these and also lists the meetings of the FOMC in which a surprise was estimated to have occurred (according to the two measures of the shocks which provide very similar results). Similar to the euro area, an indicative (and non-comprehensive) table which lists all the shocks and the events which happened those days is provided in Table 5.

[Insert Table 4 and Tables 5a-5b about here]

Figure 5 plots for all the meetings of the FOMC the change in the Fed Funds rate and the corresponding shock PR on that day (the results with PR1 are very similar).

[Insert Figure 5 about here]

Overall, this section has shown that using a more demanding measure of the predictability of the monetary policy decisions of a central bank, the markets have not been surprised on 87-91% of the monetary policy meetings of the ECB, a result which is slightly better than for the FOMC.

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[27] Care needs to be taken when interpreting these results as the shocks are constructed with rates that span more than one meeting. These expected rates, however, are good signals of the monetary policy expectations. Annex 3 exploits these series of expected rates to show, estimating a Probit, that this is a good measure of expectations of changes in the key ECB interest rates.

[28] Poole, Raasche and Thornton (2002) show that this measure of shock is broadly similar to the measure used by Kuttner (2001), that uses the change in the Fed Fund rate of the current month.

[29] There is no need to take out the meeting on 29 December 2001, as our measure of shock is not affected by the end-of-year effect.

4. Has the daily pattern of the variance of these shocks changed with the announcements of monetary policy?

In this section we analyse to what extent the volatility pattern of the series of shocks change on the days of the meetings. This is a good measure of how the monetary policy decisions have surprised the markets. Tables 3a-3b (5a-5b) list all the surprises in the euro area (in the United States) in the sample. The last column indicates the pieces of news that were cited from market sources (Bloomberg) to be the major movers that day. As already analysed in the previous sections, besides the monetary policy meetings, the information that arrives to the market on a daily basis changes the expected path of monetary policy rates. After an examination of the list, the natural variables to check seem to be related to releases of money data, inflation and leading indicators for activity.

We use an EGARCH specification for the analysis of the different factors on the volatility. The EGARCH model, introduced by Nelson (1991) and widely used in the finance literature allows a flexible dynamic specification for the variance that easily solves the nonnegative constraint associate with the GARCH models. The estimated model is:

$$\mathrm{PCj}_t = c + e_t$$

where $e_t \approx N(0, h_t)$

$$\ln(h_t) = l'V_t + \sum_{j=1}^{n}\left[d_{j,1}(\ln(h_{t-j}) - l'V_{t-j}) + d_{j,2}\frac{e_{t-j}}{\sqrt{h_{t-j}}} + d_{j,3}\left(\frac{|e_{t-j}|}{\sqrt{h_{t-j}}} - \sqrt{\frac{2}{p}}\right)\right] \tag{4}$$

where PC_j represents the principal component (the change in a set of money market interest rates). The rest of the variables are:

$V_{1t} = Constant$

$V_{2t} = End\ MP\ Dummy$

$V_{3t} = Beginning\ MP\ Dummy$

$V_{4t} = M3\ Publication\ Dummy$

$V_{5t} = End\ Year\ Dummy$

$V_{6t} = EndMonthDummy$

$V_{7t} = IPC\ PublicationDummy$

$V_{8t} = IFO\ PublicationDummy$

$V_{9t} = Meeting\ DayDummy$

We can rewrite the volatility equation as:

$$\ln(h_t) = l'V_t + \sum_{j=1}^{n} -\left[d_{j,1}(l'V_{t-j})\right] + \sum_{j=1}^{n}\left[d_{j,1}\ln(h_{t-j}) + d_{j,2}\frac{e_{t-j}}{\sqrt{h_{t-j}}} + d_{j,3}\left(\frac{|e_{t-j}|}{\sqrt{h_{t-j}}} - \sqrt{\frac{2}{p}}\right)\right] =$$
$$l_1 X_t + \sum_{j=1}^{n}\left[d_{j,1}\ln(h_{t-j}) + d_{j,2}\frac{e_{t-j}}{\sqrt{h_{t-j}}} + d_{j,3}\left(\frac{|e_{t-j}|}{\sqrt{h_{t-j}}} - \sqrt{\frac{2}{p}}\right)\right] \quad (4a)$$

where X_t include the variables in V_t and n lags of those and l_1 is a vector that includes the k coefficients of V_t and (k-1)*n coefficients that affect the lags of the dummy variables. We do not impose the non-linear restrictions implied by (5) allowing a different transmission of the volatility associated to the "special days" but not constraining (as would be the case if we did not consider the lagged dummies) that these "special days" transmit the variance in full as if the increase or decrease variance associated to a calendar or meeting effect was due to a shock. Finally, we test for the optimal value of the number of lags obtaining n=1.

Looking at Table 6, the results of the different principal components specifications and the EONIA confirm that short-term rates are affected by liquidity needs and that this is not true in the case of the long term rates. Dummy variables related with periods associated with excess demand or supply of liquidity are clearly significant in the volatility equation for the shorter-term shocks and not significant for the longer-term shocks. Also, a principal component model that includes both short and long term rates seems to also avoid this liquidity problem. This result gives us some motivation for the use of the principal component methodology. It allows us to, incorporating some information on the short rates, avoid the liquidity problem that could hide important volatility movements.

[Insert Table 6 about here]

What are the results that we obtain for the volatility associated to the meeting? To start with from all the events tested, the meetings are the main drivers of the volatility of the series. Interestingly, economic variables do not seem to play a major role in the pattern of volatility. This could be due to the fact that when euro area data comes out, data for individual countries has already been published, reducing its information content. While we use CPI and the IFO for Germany (other euro area data has been found to be not significant), other country data (in the case of the IFO) and provisional data for inflation for the German Länder (in the case of the CPI) which are published in advance of the data incorporated in V might explain this result.

Second, there is a greater variance on the days of the meetings of the Governing Council compared to the days in which no meetings took place. In particular, the variance on the days of the meeting is between 1.6 and 2 times bigger on meeting days. As the volatility is higher the shorter the horizon, this result could be seen as indicating that the market is less surprised over longer horizons after a meeting of the Governing Council. However, as in the previous sections, we want to compare these results with the ones obtained for the FOMC to analyse how much that volatility is.

Table 7 compares it with the results of the euro area. As with other measures of predictability, we obtain indications that the variance added on days of the meetings of the monetary authority has similar values in the United States and the euro area for the sample checked.

[Insert Table 7 about here]

The results of this section indicate that the monetary policy decisions of the ECB increase the volatility of interest rates, compared to the normal volatility of the series. This increase is similar to the one observed to the one associated in the United States to the meetings of the FOMC. At the same time, the results seem to indicate that the market is less surprised over longer-term measures of shocks.

5. Impact of the shocks on the term structure of interest rates

As noted in the introduction, several papers have analysed the impact of the monetary policy shocks from the days of the monetary policy meetings of the central bank to the yield curve. This allows to measuring how the unexpected component of the monetary policy decision is transmitted to the term structure of interest rates. Differently from these papers, however, we are not only interested in the impact of these monetary policy shocks on the days of the meetings on the term structure of interest rates, but also in the impact of these specific shocks compared to the shocks on any other day.

Monetary policy is conventionally viewed as running from short-term interest rates managed by central banks to longer-term rates. Abstracting from default risk considerations, the expectation theory of the term structure of interest rates implies that (unexpected) monetary policy decisions affect the prices of bonds to the extent that they lead investors to revise their expected path of the monetary policy rate. The impact of the surprise change in the key ECB interest rates on longer-term bond yields will depend on the perception of the persistence of the surprise. According to the expectation hypothesis, a surprise change in the key rates that is expected to last for the term of the bond will increase the yield on this bond by the same amount. However, if monetary policy decisions are perceived to have only a temporary effect, the impact of a change in the key ECB interest rates would be smaller the longer the maturity horizon of the bond.

The expectation hypothesis might not be the only force shaping the move in the term structure. Given the commitment of modern central banks to keep inflation low over the medium term, a credible monetary policy affects long-term bond yields by anchoring inflation expectations over the long run (the Fischer effect). [30] If a central bank is credible, its actions should be seen as compatible with the maintenance of price stability over the medium term.

We can see the movement in the term structure of interest rates as the net effect of two forces, the expectation theory and the Fisher effect. The impact of a monetary policy decision on the term structure depends on the impact of such a decision on the future path of short-term interest rates and on the expected effect of the monetary policy decision on expected inflation over long horizons. The former effect is likely to dominate the short-to-medium term of the yield curve, while the latter is likely to dominate the medium to long-end of the term structure.

5.1. Monetary policy shocks and the yield curve

An extensive stream of the literature has measured the impact of monetary policy decisions on the yield curve. An early work of Cook and Hahn (1989) examined the one-day response of bond rates in the United States to changes in the target Fed Funds rate from 1974 to 1979.[31] They regressed the change in the Treasury Bill and several bond rates (ΔR_i, where i stands for the maturity of the bond) on the change in the target Fed funds rate (target rate or key rate, Δk). The sample consists only of the days in which the Fed changed the Fed Funds target rate.

$$\Delta R_{it} = a_i + b_i \Delta k_t + e_{it} \tag{6}$$

30 The primary objective of the monetary policy of the ECB is the maintenance of price stability over the medium term. Price stability is, in turn, defined, as “year-on-year increases of the HICP of below 2%”.

31 An updated estimation of the approach of Cook and Hahn (1989) is developed in Roley and Sellon (1998) and Kuttner (2001).

In more recent papers Kuttner (2001), Poole and Raasche (2001) and Poole, Raasche and Thornton (2002) have perfected this approach, using the Fed Funds Futures to identify the expected and unexpected component of the monetary policy decision (the shock) [32]. Once identified, they estimate the response of market rates to the expected and unexpected shocks on days in which the Fed funds rate was changed. In these studies, the change in the rate of the current (Kuttner) or the one-month ahead (PR and PRT) federal funds futures contract after the decision is the measure of the unexpected change in the funds rate (PR).[33] In turn, the expected change in the official monetary policy rates ($E_{t-1}(\Delta k_t)$) is defined as the difference between the actual change in the key rate Δk_t minus the monetary policy shock, PR_t. They then estimate

$$\Delta R_{it} = a_i + b_{1i} PR_t + b_{2i} E_{t-1}(\Delta k_t) + e_{it} \tag{7}$$

As in Cook and Hahn (1989), these authors typically find that bond yields respond systematically to policy decisions. However, they show that the coefficient on the anticipated component of the funds change is generally small and statistically insignificant. In addition, comparing his results with estimations *a-la* Cook and Hahn, Kuttner (2001) indicates that the response of market rates to surprise changes in the target is considerably larger than the response to raw changes in target rates. These results pinpoint the importance of using monetary policy shocks rather than changes in official monetary policy rates to study the response of market rates to a surprise generated by the decision to change the official rate.

With a similar approach, Roley and Sellon (1998) estimate (7) on the days in which the Federal Reserve decided to maintain interest rates (with β_{1i}-0 only when the FOMC met and decided to maintain the Fed Funds unchanged). They find that there are statistically significant effects of the Fed’s decision to maintain interest rates up to the intermediate-end of the yield curve, but beyond three years, the effects turn out to be non-significant. Comparing these results with other studies, they observe that the response of long-term yields is larger to decisions to change official rates than to the decision to maintain them unchanged.

The purpose of this Section is to analyse how the monetary policy decisions of the ECB (both to change and to maintain the key ECB interest rates unchanged) have affected the yield curve in the euro area. To do so, we depart slightly from the previous papers and we study the impact of

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[32] See Favero *et al* (1996) and Buttiglione *et al* (1996) for further work on the impact of monetary policy decisions on the term structure of interest rates conducted for several countries in Europe, and also for the United States.

[33] See Kuttner (2001) and Poole, Raasche and Thornton (2002) to find a detailed explanation on the definitions of these shocks.

the unexpected component of the decisions over the official monetary policy rates on the yield curve compared to what was the transmission of other monetary policy shocks not related to monetary policy decisions. We thus estimate the daily reaction of the yield curve to our (daily) measure(s) of monetary policy shocks (PC_j), and we study if the surprises generated on days in which the Governing Council met are significantly different to the impact on the yield curve of the other daily monetary policy shocks. Failing to do this would prevent the analysis of the impact of the shock associated to a monetary policy decision, from a daily shock not generated by the decision of the ECB. We estimate:

$$\Delta R_t^i = a^i + b^i PCj_t + d_{1a}^i D_{meet} PCj_t + e_t^i \quad (5a)$$

$$\Delta R_t^i = a^i + b^i PCj_t + d_{1b}^i D_{meet} PCj_t + d_2^i D_{move} PCj_t + e_t^i \quad (5b)$$

where ΔR^i is the change in the 1-year EONIA swap, and the daily change in the 3-year, 5-year and 10-year bond yields in the euro area, [34] PCj_t the series of monetary policy shocks obtained with the principal component analysis in Section 3, D_{meet} is a dummy which takes value 1 on days of Governing Council meetings and 0 otherwise. D_{move} is a dummy with value 1 when key ECB rates were changed and 0 otherwise. A dummy distinguishing a rise and a decrease in key rates was introduced and found to be not significant due to the lack of observations. The estimations were conducted with a lagged operator for the dependent variables. [35] For the parameters to be consistently estimated we require that the shocks are true measures of the monetary policy shocks, and that there be no contemporaneous policy feedback from the adjustment in the bond yields to the monetary policy decisions. This restriction is satisfied as daily movements in long term bonds do not impact the monetary policy decisions on that day.

As a quick guide to interpreting the results, the estimate of the impact of the shocks on the days of the meetings (or announcements) should be close to 1 if market participants revise permanently (during the life of the bond) their expectation for the key rates. It should be less than 1 if market participants believe that the change will last for a period that is shorter than the maturity of the instrument. It could also be greater than 1 if market participants believe that the shock may lead to further (permanent) changes in the same direction. In turn, if the market

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[34] See Annex 1 for a description the data used.

[35] Lagged values of the independent variables were also used, although the estimated results did not change significantly.

correctly anticipated the change but missed the timing the size of the response would hinge on how big the surprise was. [36]

The estimations are presented for PCnoe (the results using PCall are similar) and PClong. The results for PCshort were not significant, although the sign and sizes of the effects were similar to the other measures of shocks. This could be interpreted as if the surprises on the timing did not have any impact on the yield curve in the euro area. However, it could also be related to the higher importance of EONIA in PCshort (which in turn makes that the estimated value of ß is low). As movements in rates due to liquidity considerations should not translate to the yield curve, this result might not be too surprising. Table 8a presents the estimation of (5) using PCnoe.

[Insert Table 8a about here]

The results need to be interpreted carefully. The impact of monetary shocks on the yield curve is significant, albeit lower the longer the yield, as the expectation theory would suggest. On average, around 80% of the shocks not related to the meetings is transmitted to the 1 year rate, while 70%, 63% and 43% are transmitted to the 3, 5 and 10 year bond yield respectively.

The dummy for the meetings of the Governing Council is significantly negative for all maturities, smoothing out on average the effects of the impact of other shocks on the yield curve. A monetary policy shock caused on the days of the Governing Council meetings is around 30% less than any other monetary policy shock. A similar result applies for the dummies capturing the 12 occasions in which the key rates were changed (D_{move}). Overall, an unexpected surprise associated to the meeting of 100 basis points would typically increase by 59, 37, 31, and 14 basis points the 1, 3, 5 and 10-year yield respectively. [37] In other words, the shocks caused by the meetings of the Governing Council have a lower impact on the yield curve than the impact of other monetary policy shocks. In turn, a surprise change in rates of 100 basis points would on average have an impact of 54, 28, 23 and 7 basis points on 1, 3, 5 and 10-year yield respectively. [38]

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[36] As already argued, over longer-term horizons, given the lags with which monetary policy operates, one should also see the Fisher affecting interest rates.

[37] These results are common to other similar studies for the US (see Poole, Raasche and Thornton (2002), Kuttner (2001)). Cochrane and Piazessi (2002), estimate higher impacts for β.

[38] Given that the days of the meetings are days where the average shock was higher, it could be argued this smoothing of the meetings is not more than the normal smoothing of a large shock in the money market. To test whether this is true, we have estimated (8) with dummies on the days in which the (12) largest shocks different from shocks at meetings occurred. The impact of these large shocks on the yield curve was found to be not significant.

Table 8b presents the results for PClong. Overall, the impact of the monetary policy shocks and the effects of the meetings are slightly larger. This could be due to the fact that the maturity (the duration) of the instruments used to calculate PClong are larger than in PCnoe.

[Insert Table 8b about here]

5.2. Monetary policy shocks and the implicit interest rates at long horizons

The shocks generated on the days of the meeting of the Governing Council do have an impact on the yield curve, although smaller than the impact of a monetary policy shock on any other day. It is however difficult to disentangle from the previous analysis to what extent the Fisher effect holds, and whether it compensates or not for the expectation theory effect.

In the main, the answer boils down to obtaining an interpretation of the impact of these shocks on the term structure. This can be facilitated by the study of the impact of the shocks on the implicit yields, a more accurate representation of the term structure. Haldane and Read (1999) try to fill this gap between the theory and the applied work through a model where the transmission mechanism, a reaction function of monetary policy authorities and the (market's) expectation theory are present. In this framework, the agents face two types of uncertainties, the uncertainty about the central bank's (interpretation of) economic indicators and uncertainty about their policy objectives. Solving the model, they find that the interest rate surprise is a combination of two components, the (market's) uncertainty about the central bank's interpretation of the economy and the uncertainty on the monetary policy objective. In short, due to the monetary transmission lags, the latter has no impact on short-maturity forward rates, while the reverse is true at long maturities. Shocks on the long end of the implicit curve could thus be interpreted as uncertainty as regards the objective of the central bank. Through a numerical example on their model for plausible values of the parameters, they find that the credibility effect dominates over the longer part of the sample. We therefore estimate as in (5)

$$\Delta r_t^i = a^i + b^i PCj_t + d_{1a}^i D_{meet} PCj_t + e_t^i \qquad (6a)$$

$$\Delta r_t^i = a^i + b^i PCj_t + d_{1b}^i D_{meet} PCj_t + d_2^i D_{move} PCj_t + e_t^i \qquad (6b)$$

where Δr^i is now the change in the implicit rates[39]. The rest of variables are like in equation (8). We only report the results obtained using PCnoe.

The first thing to report is that lagged variables of the shocks matter in (6). Table 9a reports the estimates for equation (6). The low end of the table reports both the impact of the meetings if we were only to consider the contemporaneous effects, and the overall impact, taking care of all the lagged variables (one lag).

[Insert Table 9a about here]

Daily monetary policy shocks have a significant impact up to the fifth-year implicit rate (the one-year rate in four years). The impact on the days of the meeting of the Governing Council is however lower. The longer two-year implicit rates show that both the impact of the shocks and of the meetings (this one only for the ninth year) are also significant. It might however be more intuitive to use averages of the implicit rates for the medium and the long end of the curve. To this end, we define a series named "medium" which is the average of the one year rate expected by the market at day t to prevail 4, 5 and 6 years ahead, a horizon from which the expectation theory effect should no longer be relevant. The series named "long" is an average of the longer implicit rates (one-year rate in 7, 8 and 9 years). The estimated results are shown in Table 9b.

[Insert Table 9b about here]

For Δr^i = "medium" we find that the impact of the shock (PCnoe) is significant and positive. 29 bp of a monetary policy shock is transmitted to the medium section of the term structure. The impact is however much lower for meeting days (8 bp) and on meetings in which the key rates are changed (3 bp). The impact of the lagged shocks is not significant.

Important things happen on the long end of the term structure of interest rates. Of a shock of 100 bp, 23 bp impact the longer implicit rates, although this impact is almost totally reversed one day afterwards (and the overall effect drops to 4bp). This indicates that the market does not typically expect an increase in inflation over longer horizons on account of monetary policy shocks. As regards the shocks generated by the meetings of the Governing Council, the bottom of Table 9b shows that the impact on the yield curve of a change of 100 bp changes the long-term implicit rates by 1 bp and turns negative when one lag of the dependent variable is used. That is, a positive shock typically reduces long term implicit rates while a negative shock tends to increase

[39] The rates are taken from an estimation of the term structure of interest rates using daily data of the one-year EONIA swap and the interest rate swaps spanning from 2 to 10 years. The estimation is done with the bootstrapping technique.

them. These results indicate that a surprise increase in official rates reduce the expectation for inflation over the medium term, while a surprise reduction in official rates typically increases it. The lack of significance of dummies capturing increases and decreases in rates prevents us from reaching further conclusions.

The fact that the impact of monetary policy decisions on long term implicit rates is of limited size (and negative) has been seen in other papers as pointing to a credible monetary policy. A previous paper, Buttiglioni et al (1998), claims that this reaction of market rates is indicative of credible (or “text-book”) central banks, as inflation expectations typically tend to decrease when monetary policy is tightened and to increase when it is eased. In fact, the results obtained here for the euro area match those obtained in that study for Germany, the Netherlands and Belgium. This could provide evidence that the ECB has maintained the credibility that some of the most credible central banks in the European Union countries had prior to the Monetary Union.

Overall, in this section we find evidence that the impact of the monetary policy shocks on bond yields declines with the maturity of the bond, as the expectation hypothesis would suggest. In addition, we show that the impact on the yield curve of a given monetary policy shock is significantly lower when that shock comes from a meeting of the Governing Council. Using implicit rates instead of bond yields, a better measure of the term structure, we find evidence that the market views the ECB as credible.

6. Conclusions

It is often argued that a central bank should lead financial markets by signalling its intentions, more than surprising with its decisions, as monetary policy can be more effective when financial markets understand how the central bank assesses economic developments in relation to the policy objectives, and anticipates its decisions. If the market knew perfectly how the monetary authority filtered every piece of information relevant for the conduct of monetary policy, monetary policy decisions would be predictable. That is, the decisions on interest rates of a central bank should provide no significant information to market participants and should trigger little reactions in financial markets. A necessary condition for this to happen is a high level of transparency on the side of the central bank.

This paper has first examined the predictability of the monetary policy of the ECB and has analysed the impact of monetary policy decisions on the yield curve.

As regards predictability, we have provided evidence, using a battery of tests that the markets have not been overall surprised by the monetary policy decisions of the ECB, that is that markets have been able to predict the Governing Council's decisions on key ECB interest rates fairly accurately. While the benchmark of perfect predictability is not reached, similar results are obtained for the Federal Reserve, a central bank with a long track record of transparency and credibility. This is to be seen as proof that despite its youth, the ECB has been as predictable as the Federal Reserve throughout the period analysed.

As regards the transmission of the (unexpected component of the) monetary policy decisions to the yield curve, we provide evidence that the meetings smooth out the impact of the monetary policy shocks (daily changes in short-term interest rates) generated outside meeting days. We also find that the impact of the monetary policy shocks outside meeting days on the longer section of the implicit yield curve is significant, although it weakens significantly the next day. This could be evidence pointing to the markets belief that inflation will be stable in the long run, as the daily shocks do not have an impact on longer-term yields. As regards the impact of the shocks generated on the days of the meeting of the Governing Council of the ECB, we find evidence showing that the impact is limited. This could provide evidence that the ECB has maintained the credibility that some of the most credible central banks in the European Union countries had prior to the Monetary Union.

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Annex 1. Description of the data

1. Data for the euro area

The set of data used spans from 4 January 1999 to 6 June 2002. Some observations had to be interpolated due to implausible values (a list of those days still has to be added). The characteristics of the series are the following:

EONIA: It is a measure of the effective interest rate prevailing in the euro interbank overnight market. It is calculated as a weighted average of the interest rates on unsecured overnight contracts on deposits denominated in euro, as reported by a panel of contributing banks.

EONIA swap rates: An EONIA swap rate is an agreement between two parties to exchange a set of variable daily payments at the EONIA rate with a set of payments at a fixed rate over an agreed period of time. The interest rate on the fixed leg of this swap is referred to as the EONIA swap rate and it reflects the expected average level of the EONIA over the maturity of the swap. EONIA swaps are offered at maturities of one, two and three weeks and from one to twelve months. They are traded over the counter (OTC), bilaterally and not at an exchange. The liquidity is high at the shortest maturities. The data collected are mid rates (average between bid and ask rates) at the end-of-day. The forward rates used in the text (the one-month in one, two and three months are derived from EONIA swaps and assuming perfect arbitrage.

Three-month EURIBOR futures: It is a contract to engage in a three month loan or deposit of a set amount, starting on a specific future date. By buying or selling this contract, an investor can fix the effective rate for borrowing or lending a set amount of money over a future three-month period. At horizons up to 18 months, EURIBOR futures are very liquid and the implied rates are likely to reliably reflect the expected future level of the three-month EURIBOR. The data collected are mid prices (average between bid and ask prices) at the end-of-day. The contracts mature in March, June, September and December.

Euro area bond yields: Yields on the benchmark bonds of euro-11 countries from January 1999 to December 2000 and for euro-12 countries since January 2001 onwards. The data collected are mid yields (average between bid and ask yields) at the end-of-day.

Interest rate swaps: The yield on a swap (maturity i) can be seen as the yield of a par bond with a coupon equal to the yield at maturity i. The risk of this instrument is the risk associated to the interbank market.

Monetary policy shocks

The series of monetary policy shocks are constructed applying principal components to the series of daily changes in several money market rates (see Annex 2). Two peculiarities are worth mentioning here however as regards the use of the series. First, the ECB has changed the time at which it announced its monetary policy decisions. Until 8 April 1999 the ECB announced the decision of the Governing Council at around 18:00 or later, while since 22 April 1999 onwards, the decision started to be announced at 13,45. To address this, the dummy that catches the effect of the meeting on the money market interest rates is placed one day after the meeting until 8 April 1999 and the same day of the meeting since 22 April 1999. Second, different money market rates incorporate information at different times: while the EONIA rate is a weighted average, and therefore incorporates information of what happens in the course of the day, the rest of the data incorporates the information available at the end of the day (at around 17,30). To take these two issues into account, the change in the money market series that enter the definition of the shocks are the following.

EONIA: The "shock" from the EONIA on day t is measured as $EONIA_t$- $EONIA_{t-1}$ until 21 April and as $EONIA_{t+1}$- $EONIA_t$ since 22 April onwards.

EONIA swaps: The "shock" from these rates on day t is measured as R_t- R_{t-1}

Three-month EURIBOR: The "shock" from these rates on day t is measured as R_t- R_{t-1}. The contract used is always the "next contract". However, due to the nature of the futures contracts we need to merge the data when the contract expires. For the changes in the three-month EURIBOR, we use the daily change of the most proximate contract until the first working day of the month in which the contract expires (March, June, September and December). As at these dates the volume of transaction typically drops, we switch to the next contract (of June, September, December of the same year and March of the following year respectively). For example, on 1 March 1999 we switch from daily changes in the March future contract to daily changes in the June contract.

2. Data for the United States

The data used for the United States are the one month Libor dollar (close of business data) and the one-month and two-month ahead Fed Fund Futures. Please refer to Kuttner (2001) and Poole, Raasche, Thornton (2002) for an analysis of the futures data used. We make the same corrections to the series than these authors do.

Annex 2. Principal components

Using principal components can solve the problem of summarising in one variable the information context of a set of variables. The question to answer is which is the best linear combination of the variables that provides the best fit to explain the movements of all of them?

We use the following interest rates: daily changes in the EONIA, the EONIA-swaps (with a maturity of 2 weeks, one, two and three-months, and the daily change in the closest three-month EURIBOR futures. For the changes in the three-month EURIBOR, we use the daily change of the most proximate contract. We change to the next contract 15 days before its expiration, a time where the volume of transactions typically drops.

Let us denote by X $X = (X_{1t}, X_{2t}, X_{3t}, X_{4t}, X_{5t}, X_{5t})$ where all the variables are in differences, and

$$
\begin{aligned}
X_{1t} &= Eonia\, rate \\
X_{2t} &= One\, week\, rate \\
X_{3t} &= One\, month\, rate \\
X_{4t} &= Two\, month\, rate \\
X_{5t} &= Three\, month\, rate \\
X_{6,t} &= 3 Months\;\; future\, rate
\end{aligned}
$$

We are looking for a (6X1) vector C such that: $PCj = XC$ where PCj is the combination that best explains (maximises the R-Squared) the behaviour of the individual series. Obviously, before doing the analysis, all the series have to be normalised in order to avoid that the most volatile series dominate the weight of the estimation.

The problem to solve in order to calculate the value of the vector C is just a maximisation problem subject to the fact that the weights have to add to one. The result in our case is a vector $C = (c_1, c_2, c_3, c_4, c_5, c_6)$ that will be the characteristic vector associated with the highest eigenvalue of X´X.

We consider that in this case, principal component is a good approach to capture the unobserved component that describe the comovements among all these rates because, as a difference to other unobserved component techniques (Kalman filter, Markov switching, etc.) the law of motion of the unobserved component should not be relevant in the determination of its value and we prefer to give more weight to the actual observations of the different rates.

In PCj, j stands for the four principal components used (short, long, all, noe).

The four series of the shocks are homogenised to have the variance of the daily changes in the one-month EONIA Swap (0.038 basis points). In particular, the estimated weighs are:

C_{short}= (0.230, 0.391, 0.379, 0.000, 0.000, 0.000)

C_{noe}= (0.000, 0.156, 0.213, 0.221, 0.215, 0.195)

C_{all}= (0.056, 0.150, 0.201, 0.208, 0.203, 0.183)

C_{long}= (0.000, 0.000, 0.000, 0.326, 0.347, 0.327)

Annex 3: estimation of a Probit

Using an ordered probit model, we test if the expectations of monetary policy changes from equation (3), $E_{t-1}(\Delta k_t) = \Delta k_t - PC_t$ is a good measure of the expectations of the market for changed in the key ECB interest rates. The range of values to test are the set of responses {up, maintain, down}. We define $d_t^{meet}=1$ if t falls on the day on which the Governing Council of the ECB announces a monetary policy decision.

In addition to assessing their predictive ability, we consider the impact of liquidity (measured by dummies capturing end and start-of-maintenance period effects), to see if the shocks are devoid of liquidity considerations. We define $d_t^{emp}=1$ if t falls in any of the last three business days of the maintenance period, 0 otherwise. $d_t^{bmp}=1$ if t falls in the first business day of the maintenance period and 0 otherwise. To check to what extent the liquidity considerations are out of the new measure, we also apply this probit to the analyses for the EONIA.

As in Demiralp and Jorda (2002), we hypothesise the existence of an unobserved latent variable s_{t+1} such that

$$s_{t+1} = \omega E_{t-1}(\Delta k_t) + \omega_m d_t^{meet} E_{t-1}(\Delta k_{t+1}) + \omega_e d_t^{emp} E_{t-1}(\Delta k_t) + \omega_b d_t^{bmp} E_{t-1}(\Delta k_t) + u_t$$

where u_{t+1} i.i.d. N(0,1). The discrete changes in the target are related to the latent process according to:

$$E_{t-1}(\Delta k_t) = \begin{cases} -1 & if \quad s_{t+1} \leq c_1 \\ 0 & if \quad c_1 < s_{t+1} \leq c_2 \\ +1 & if \quad s_{t+1} > c_2 \end{cases}$$

Table A contains the maximum likelihood estimates of this ordered probit model for the EONIA, the one month swap rate, Pcshort, Pclong, PCall, and PCnoe. The estimations suggest that the days when the Governing Council of the ECB met strengthened the signal provided by $E_{t-1}(\Delta k_t)$. With respect to the liquidity dummies, as expected, they are only significant in the estimation with the EONIA.

[Insert Table A]

Table 1: Predictability of the monetary policy decisions of the ECB and the Fed

$$i_t = bi_{25} + (1-b)i_0$$

Central bank	Interest rate maturity	Number of meetings	Overall hit rate (1)	Interest rate changes		Interest rate no-changes		Cuts anticipated		Increases anticipated		Reliability of changes (2)
ECB	**2-week**	(78)	**94%**	(12)	**92%**	(66)	**94%**	(5)	**80%**	(7)	**100%**	**80%**
ECB	**1 month**	(78)	**87%**	(12)	**92%**	(66)	**86%**	(5)	**80%**	(7)	**100%**	**60%**
FED	**1 month**	(29)	**90%**	(16)	**81%**	(11)	**100%**	(11)	**82%**	(6)	**100%**	**100%**

Note: Calculations for the ECB conducted with the one-month and the two-week EONIA swap rates. No risk premium and a natural spread of 5 basis points

The calculations for the Fed are conducted with the one-month dollar Libor rate with a risk premium of 13 basis points (see text).

The meeting on 29-Dec-99 in the United States is taken out of the sample due to impact of the end-of-year effect.

Note: Numbers in parentheses represent numbers of the corresponding meetings or changes (depending on the header)

(1) Percentage of correct signals

(2) Percentage of time the model signals rate change and one actually happens

Table 2: Monetary policy surprises on Governing Council's meeting days

Date of the meeting	Change in key ECB rates	Shocks (in percentage points) (1)				Comments
		PCshort (2)	PClong (3)	PCall	PCnoe	
8-abr-99	-0,50	**-0,23**	**-0,28**	**-0,31**	**-0,32**	Higher cut than expected
7-oct-99	0,00	**-0,12**	**-0,10**	**-0,14**	**-0,14**	An increase was expected
27-abr-00	0,25	0,04	**0,08**	0,07	0,07	Increase came as a surprise only for PClong
8-jun-00	0,50	**0,15**	**0,26**	**0,25**	**0,26**	Higher increase than expected
5-oct-00	0,25	0,07	**0,07**	**0,09**	**0,09**	Increase was partly a surprise
4-ene-01	0,00	-0,03	**-0,12**	**-0,09**	**-0,10**	Due to the cut in the Fed Fund rates on 3 January
11-abr-01	0,00	**0,12**	**0,17**	**0,17**	**0,16**	A cut was expected and not fulfilled
10-may-01	-0,25	**-0,14**	**-0,22**	**-0,22**	**-0,23**	The cut was not expected
17-sep-01	-0,50	**-0,28**	**-0,30**	**-0,36**	**-0,36**	Concerted interest rate cut. Unscheduled meeting.
% of shocks associated to monetary policy meetings of the ECB compared to:						
All the shocks in the sample		18%	24%	20%	22%	
The meetings of the ECB (4)		87%	90%	91%	91%	
Total number of surprises in the sample		55	34	35	32	

(1): In bold if the shock is a surprise (defined as a shock larger than twice the normalised standard deviation of 0.038 bp)
(2): Due to jumps in EONIA (and to a lesser extent in the 1-week rate), this measure considers that shocks also occurred on 22 April 1999, 20 May 1999, 23 Sept 1999 and 21 June 2001
(3): According to this measure a surprise also occurred on 3 Feb-2000 of 9 bp
(4): On 4 January the shock is associated with the unexpected cut in the Fed Funds rate and not to the decision itself of the ECB
Note: Bimonthly meetings until November 2001, monthly meetings (where monetary policy is discussed) since then.

Table 3a: Main monetary policy surprises in the euro area in 1999 and 2000

Date	Meeting	Shocks (in percentage points) (1)				Comments	Explanation
		PCshort (2)	Pclong(3)	PCall	PCnoe		
18-ene-99	NO	-0,04	**-0,07**	-0,07	-0,07	Speech President at the European Parliament	Communication
8-abr-99	NO	**-0,23**	**-0,28**	**-0,31**	**-0,32**	Higher cut than expected	Meeting
13-ago-99	NO	-0,01	**-0,11**	**-0,07**	**-0,08**	Euro area producer prices	Economic data
1-oct-99	NO	0,07	**0,21**	**0,17**	**0,19**	Speech: President warning on money and Issing on inflation	Communication
7-oct-99	NO	**-0,12**	**-0,10**	**-0,14**	**-0,14**	An increase in key rates expected	Meeting
14-oct-99	NO	0,02	**0,08**	0,06	0,07	MB (inflation risks rising) and Issing (strong growth)	Communication
25-oct-99	NO	0,06	0,07	**0,07**	0,06	German CPI	Economic data
29-oct-99	NO	0,05	**0,10**	**0,10**	**0,11**	Issing, Noyer (rates historically low), Domingo (growth)	Communication
29-dic-99	NO	-0,03	**-0,03**	**-0,07**	**-0,13**	End of year effect	Liquidity
27-ene-00	NO	**0,07**	**0,19**	**0,15**	**0,15**	HICP (26 June) and comments on the need to increase rates	Economic data
3-feb-00	NO	0,02	**-0,09**	-0,04	-0,05	Reassessment on interest rate expectations	Meeting
18-feb-00	NO	0,03	**0,11**	**0,09**	**0,09**	Issing ("ECB will react on a timely manner")	Communication
10-mar-00	NO	0,05	**0,09**	**0,09**	**0,10**	Market talks about higher growth	Market
24-mar-00	NO	0,02	**0,08**	0,06	0,06	German import prices (first data Länder)	Economic data
20-abr-00	NO	**0,10**	0,05	**0,08**	0,05	High shock to the EONIA	Liquidity
27-abr-00	NO	0,04	**0,08**	0,07	0,07	Increase came as a surprise for Pclong	Meeting
28-abr-00	NO	0,01	-0,02	**-0,01**	**-0,01**	Correction after the GC meeting	Market
2-may-00	NO	0,06	**0,09**	**0,09**	**0,10**	Unexpectedly high M3 data and PMI	Economic data
3-may-00	NO	-0,01	**0,08**	0,04	0,04	Lower exchange rate of the euro	Market
4-may-00	NO	**0,11**	**0,10**	**0,14**	**0,15**	Lower exchange rate of the euro	Market
17-may-00	NO	0,03	**0,15**	**0,11**	**0,13**	HICP	Economic data
23-may-00	NO	**0,19**	-0,01	**0,07**	-0,01	High shock to the EONIA	Liquidity
30-may-00	NO	0,04	**0,09**	**0,08**	**0,07**	High M3 growth (29 May) and speech Issing	Economic data / Communication
8-jun-00	NO	**0,15**	**0,26**	**0,25**	**0,26**	Higher increase than expected	Meeting
11-ago-00	NO	0,05	**0,12**	**0,11**	**0,12**	HICP FR and SP high after the Monthly Bulletin (10 Aug)	Economic data
24-ago-00	NO	**0,08**	0,05	**0,07**	0,07	Producer prices in Germany and liquidity	Economic data / liquidity
5-oct-00	NO	0,07	**0,07**	**0,09**	**0,09**	Increase was partly a surprise	Meeting
19-dic-00	NO	-0,03	**-0,08**	-0,07	-0,07	HICP (high) / talks of general expectation of falling rates	Economic data / Markets

(1): In bold if the shock is a surprise (defined as a shock larger than twice its standard deviation of 0.038 bp)
(2): Due to jumps in EONIA (and to a lesser extent in the 1-week rate), this measure considers that shocks also occurred on
1999: 24 Mar, 22 Apr, 19-20 May, 21-23 July, 17-18-23 Aug, 17-23 Sep,18-22 Oct, 22 Nov, 22-30 Dec
2000: 19-20 April, 22-23 May, 23-24 Aug, 22 Sep, 21 Dec
Note: a monetary policy surprise is defined as a shock higher or lower than two standard deviations. The last two columns has been elaborated checking in Bloomberg the news which have been considered to be the main movers of the markets on that day.

Table 3b: Main monetary policy surprises in the euro area in 2001 and 2002

Date	Meeting	Shocks (in percentage points) (1)				Comments	Explanation
		PCshort [2]	Pclong	PCall	PCnoe [3]		
4-ene-01	NO	-0,03	**-0,12**	**-0,09**	**-0,10**	Surprise increase in the Fed Fund rates and euro weakness	Market
9-ene-01	NO	0,02	**0,08**	0,06	0,07	producer prices and (to a lesser extent) retail sales	Economic data
10-ene-01	NO	0,01	**0,07**	0,05	0,05	Issing ("Fed decision has no impact on the ECB")	Communication
20-feb-01	NO	**0,12**	0,03	**0,09**	**0,09**	Welteke ("inflation risks have not vanished")	Communication
23-feb-01	NO	**-0,13**	-0,02	**-0,09**	**-0,08**	German producer prices and market talks	Economic data / Market
21-mar-01	NO	-0,05	**-0,09**	**-0,08**	-0,07	IFO decline and Duisenberg ("risks more balanced")	Economic data / Communication
10-abr-01	NO	**0,22**	0,06	**0,15**	**0,12**	Welteke ("steady hand approach") and market talks	Communication / Market /Liquidity
11-abr-01	NO	**0,12**	**0,17**	**0,17**	**0,16**	Expectation of increases in the long run	Meeting
18-abr-01	NO	**-0,09**	**-0,08**	**-0,10**	**-0,10**	Fed cut rates	Fed Meeting
10-may-01	NO	**-0,14**	**-0,22**	**-0,22**	**-0,23**	The cut was not expected (distortion in M3)	Meeting
29-jun-01	NO	-0,01	**0,08**	0,05	0,06	M3 data higher than expected	Economic data
11-sep-01	NO	0,00	**-0,17**	**-0,10**	**-0,11**	Terrorist attack to the US	Terrorist shock
17-sep-01	NO	**-0,28**	**-0,30**	**-0,36**	**-0,36**	Concerted cut of 50 basis points	Meeting
19-sep-01	NO	**-0,14**	**-0,09**	**-0,13**	**-0,11**		Terrorist shock
20-sep-01	NO	**0,08**	0,03	**0,08**	**0,09**		Terrorist shock
21-sep-01	NO	**0,08**	**-0,11**	-0,05	**-0,10**	IFO lower than expected	Terrorist shock / Economic data
9-oct-01	NO	**0,12**	0,06	**0,11**	**0,12**	Industrial production in Germany (?)	Economic data
15-oct-01	NO	-0,04	-0,07	**-0,07**	**-0,08**	Speeches EU officials (need to cut rates) and ECB members (need to wait and assess the situation)	Communication
16-oct-01	NO	**0,16**	0,01	**0,10**	**0,07**		
7-nov-01	NO	**-0,12**	**-0,09**	**-0,13**	**-0,13**	Euro area business confidence	Economic data
5-dic-01	NO	-0,01	**0,08**	0,04	0,04	NAPM-ISM high and fall of the euro	Economic data/ Market
21-may-02	NO	0,01	**-0,07**	-0,04	-0,05	EP Hearing Duisenberg (slow recovery)	Communication

(1): In bold if the shock is a surprise (defined as a shock larger than twice its standard deviation of 0.038 bp)
(2): Due to jumps in EONIA (and to a lesser extent in the 1-week rate), this measure considers that also shocks occurred on
2001: 23 Jan, 16-22 Feb, 23 April, 21 June, 23 Oct, 13-20 Nov, 21-28 Dec
2002: 23 Jan, 21 March, 22-23 April, 21 May
(2): This measure signals also a shock on 27 Dec 2001 due to the end of year effect
Note: a monetary policy surprise is defined as a shock higher or lower than two standard deviations. The last two columns have been elaborated checking in Bloomberg the news which have been considered to be the main movers of the markets on that day.

Table 4: Monetary policy shocks on FOMC's meeting days

Date of the meeting	Change in the Fed Fund Rates	Shocks (percentage points) [1] PR	PR1	Comments
16-nov-99	0,25	**0,08**	**0,07**	Partly unexpected increase
3-ene-01	-0,50	**-0,29**	**-0,26**	Unexpected 50 bp cut. Unscheduled meeting
18-abr-01	-0,50	**-0,42**	**-0,35**	Unexpected 50 bp cut. Unscheduled meeting
15-may-01	-0,50	**-0,08**	**-0,12**	Partly unexpected cut
27-jun-01	-0,25	**0,08**	**0,09**	Cut slightly lower than expected
17-sep-01	-0,50	**-0,13**	**-0,14**	Concerted interest rate cut. Unscheduled meeting
2-oct-01	-0,50	**-0,08**	**-0,11**	Partly unexpected cut
6-nov-01	-0,50	**-0,11**	**-0,11**	Partly unexpected cut
% of shocks associated to monetary policy meetings of the ECB compared to:				
All the shocks in the sample		23%	22%	
The meetings of the FOMC		73%	73%	
Total number of surprises in the sample		35	37	

(1): In bold if the shock is a surprise (defined as a shock larger than twice its standard deviation)

Note: a monetary policy surprise is defined as a shock higher or lower than two standard deviations

Table 5a: Main monetary policy surprises in the United States in 1999 until 2000					
Date	**Meeting**	**Shocks (percentage points) (1)**		**Comments**	**Explanation**
		PR	**PR1**		
14-may-99	NO	0,04	**0,06**	HICP (higher) and inventories (higher)	Economic data
22-jul-99	NO	0,02	**0,06**	Greenspan Testimony	Communication
6-ago-99	NO	**0,06**	**0,06**	Payrolls / Employment report	Economic data
16-nov-99	YES	**0,08**	**0,07**	Partly unexpected increase	Meeting
4-abr-00	NO	-0,06	**-0,08**	Leading indicators and retail sales	Economic data
27-abr-00	NO	0,04	**0,09**	Real GDP first quarter (high) and HICP (high)	Economic data
2-jun-00	NO	**-0,10**	**-0,10**	Payrolls / Employment report	Economic data
19-dic-00	YES	**0,06**	0,01	Slight expectation of a cut	Meeting

(1): In bold if the shock is a surprise (defined as a shock larger than twice its standard deviation)

(2): Due to the end-of-year effect, the measures signal shocks on 26 Nov and 28 Dec 1999 and on 28 Nov 2000

Note: a monetary policy surprise is defined as a shock higher or lower than two standard deviations. The last two columns has been elaborated checking in Bloomberg the news which have been considered to be the main movers of the markets on that day.

Table 5b: Main monetary policy surprises in the United States in 2001-2002					
Date	**Meeting**	**Shocks (percentage points) (1)**		**Comments**	**Explanation**
		PR	**PR1**		
2-ene-01	NO	**-0,09**	**-0,10**	NAPM-ISM slumps	Economic data
3-ene-01	YES	**-0,29**	**-0,26**	Unexpected 50 bp cut	Meeting
4-ene-01	NO	**-0,19**	**-0,24**	Fall in the discount rate and market talks	Meeting / Market
5-ene-01	NO	**-0,09**	**-0,11**	Market talks	Market
9-ene-01	NO	**0,06**	**0,10**	Retail sales (high) and optimism on the recovery	Economic data / Market
15-ene-01	NO	**0,08**	**0,10**		
18-ene-01	NO	**-0,07**	**-0,07**	Speech Gramlich and Phil Fed. Index	Economic data / Communication
30-ene-01	NO	**-0,07**	-0,07	Consumer confidence (drops)	Economic data
2-feb-01	NO	**0,07**	0,03	Payrolls / Employment report	Economic data
23-feb-01	NO	**-0,09**	**-0,08**	Fall stock markets and dollar	Market
28-feb-01	NO	**0,07**	0,04	Greenspan ("Growth better in early 2001 than in 2000")	Communication
14-mar-01	NO	**-0,10**	**-0,11**	OPEC may cut supply of oil (market talk ahead meeting)	Market
23-mar-01	NO	**0,07**	**0,08**	Talks outlook improving	Market
27-mar-01	NO	0,04	**0,09**	March confidence indexes (higher)	Economic data
10-abr-01	NO	**0,08**	**0,09**	Speech on economic growth (Poole) and market talk	Communication / Market
11-abr-01	NO	**0,06**	**0,07**	Market talks	Market
18-abr-01	YES	**-0,42**	**-0,35**	Unexpected 50 bp cut	Meeting
4-may-01	NO	**-0,08**	**-0,13**	Payrolls / Employment report	Economic data
10-may-01	NO	0,04	**0,06**	Jobless claims	Economic data
11-may-01	NO	0,04	**0,08**	Retail sales and producer prices	Economic data
15-may-01	YES	**-0,08**	**-0,12**	Partly unexpected cut	Meeting
27-jun-01	YES	**0,08**	**0,09**	Cut slightly lower than expected	Meeting
4-sep-01	NO	0,09	0,13	NAPM-ISM	Economic data
6-sep-01	NO	-0,03	**-0,07**	NAPM-ISM (non manufacturing)	Economic data
7-sep-01	NO	**-0,12**	**-0,13**	Payrolls / Employment report	Economic data
12-sep-01	NO	**-0,07**	-0,07		Terrorist shocks
13-sep-01	NO	**-0,25**	**-0,24**		Terrorist shocks
14-sep-01	NO	**-0,07**	**-0,08**		Terrorist shocks
17-sep-01	YES	**-0,13**	**-0,14**	Concerted cut of 50 basis points	Meeting
18-sep-01	NO	**-0,07**	**-0,08**		Terrorist shocks
19-sep-01	NO	**-0,15**	**-0,14**	Beige book and Greenspan to Congress	Terrorist shocks /Economic data
20-sep-01	NO	**0,07**	**0,06**	Greenspan testimony	Communication
2-oct-01	YES	**-0,08**	**-0,11**	Partly unexpected cut	Meeting
6-nov-01	YES	**-0,11**	**-0,11**	Partly unexpected cut	Meeting
5-dic-01	NO	**0,06**	**0,08**	NAPM-ISM (non manufacturing)	Economic data
7-dic-01	NO	**-0,08**	**-0,09**	Payrolls / Employment report	Economic data
11-ene-02	NO	**-0,09**	**-0,09**	Greenspan Speech and producer prices	Communication / Economic data
29-mar-02	NO	-0,01	**-0,11**		
1-abr-02	NO	**0,12**	**0,10**	NAPM-ISM	Economic data

(1): In bold if the shock is a surprise (defined as a shock larger than twice its standard deviation)

Note: a monetary policy surprise is defined as a shock higher or lower than two standard deviations. The last two columns has been elaborated checking in Bloomberg the news which have been considered to be the main movers of the markets on that day.

Table 6 EGARCH Specification (including Meeting Days)

$\rho_t = \beta_0 + \varepsilon_t$

$\varepsilon_t \sim N(0,h_t)$, $\ln(h_t)=\lambda_0 + \lambda_1 X_t + \delta_1 \ln(ht\text{-}l)+\delta_2[(|\varepsilon_{t-1}|/(h_{t-1})^{1/2})] +\delta_3[(\varepsilon_{t-1}/(h_{t-1})^{1/2}-(2/\pi)^{1/2})]$

Mean Parameters	Europe. Principal Components (PCNOE)		Europe. Principal Compon (PCSHORT)		Europe. Principal Compon (PCLONG)		Europe. Eonia	
b_0	-0,001	(0,445)	-0,001	(0,033)	0,000	(1,000)	0,000	(1,000)
Variance Parameters								
l_0	-0,802	(0,005)	-0,818	(0,002)	-0,731	(0,008)	-0,628	(0,008)
l_1								
Meeting Dummy	1,331	(0,001)	1,607	(0,001)	1,148	(0,001)	-0,100	(0,731)
Lagged Meeting Dummy	-1,664	(0,000)	-2,237	(0,000)	-1,172	(0,000)	-1,266	(0,000)
d_1	0,9082	(0,000)	0,9017	(0,000)	0,9176	(0,000)	0,9257	(0,000)
d_2	0,3683	(0,000)	0,4525	(0,000)	0,3102	(0,000)	0,9818	(0,000)
d_3	0,0021	(0,969)	0,0168	(0,770)	-0,0043	(0,922)	0,1178	(0,306)
Log of Variance is X times bigger on Meeting days	1,6606		1,9644		1,5702			
Other Dummy Variables								
M3	-0,1960	(0,650)	0,4092	(0,438)	-0,5376	(0,253)	0,5443	(0,586)
Lagged M3	-0,3222	(0,594)	-0,6932	(0,208)	-0,2806	(0,535)	2,1370	(0,033)
CPI	0,1160	(0,741)	-1,0640	(0,017)	-0,0725	(0,842)	-4,1952	(0,000)
LaggedCPI	0,2119	(0,602)	-0,7530	(0,027)	0,3120	(0,547)	0,4615	(0,644)
End of MP	0,0726	(0,797)	1,2322	(0,000)	-0,1420	(0,589)	8,7056	(0,000)
Lagged End of MP	-0,2887	(0,340)	-1,0923	(0,000)	-0,0416	(0,878)	-7,2286	(0,000)

Note: P-values of the null hypothesis that the coefficeint is equal to 0 appear in parentheses to the right of the parameter estimates.

Table 7: comparison of volatility in the US and the euro area

$\rho_t = \beta_0 + \varepsilon_t$

$\varepsilon_t \sim N(0,h_t)$, $\ln(h_t)=\lambda_0 + \lambda_1 X_t + \delta_1 \ln(ht\text{-}l)+\delta_2[(|\varepsilon_{t-1}|/(h_{t-1})^{1/2})] + \delta_3[(\varepsilon_{t-1}/(h_{t-1})^{1/2}-(2/\pi)^{1/2})]$

Mean Parameters	Europe. Principal Components (pcnoe)		US. Poole y Raasche (PR)	
b $_0$	-0,001	(0,775)	0,000	(0,670)
Variance Parameters				
l $_0$	-0,802	(0,010)	-1,392	(0,002)
l $_1$				
Meeting Dummy	1,331	(0,000)	2,297	(0,000)
Lagged Meeting Dummy	-1,664	(0,000)	-2,779	(0,000)
d$_1$	0,9082	(0,000)	0,8670	(0,000)
d$_2$	0,3683	(0,000)	0,5470	(0,000)
d$_3$	0,0021	(0,902)	-0,1050	(0,087)
Log of Variance is X times bigger on Meeting days	1,6606		1,6501	

Note: P-values of the null hypothesis that the coefficeint is equal to 0 appear in parentheses to the right of the parameter estimates.

Table 8a. Measuring the impact of monetary policy surprises in bond yields with Pcnoe

	$\Delta R_t^i = a^i + b^i PCj_t + d_{1a}^i D_{meet} + e_t^i$			$\Delta R_t^i = a^i + b^i PCj_t + d_{1b}^i D_{meet} + d_2^i D_{move} + e_t^i$			
	intcpt (1)	**beta** (1)	**delta1a** (1)	**delta1b**(2)	**delta2**(2)	**R^2** (1)	**DW** (1)
	(a)	(b)	(c)	(d)	(f)		
1 year	0,00	0,82	-0,23	-0,06	-0,22	0,40	2,14
	(0,95)	(12,14)	-(2,13)	-(0,35)	-(1,18)		
3 years	0,00	0,69	-0,32	-0,04	-0,37	0,24	2,00
	(0,93)	(9,74)	-(2,90)	-(0,21)	-(1,97)		
5 years	0,00	0,63	-0,32	-0,05	-0,36	0,18	2,01
	(0,99)	(9,22)	-(2,66)	-(0,26)	-(1,85)		
10 years	0,00	0,43	-0,29	-0,08	-0,28	0,10	2,01
	(1,02)	(7,47)	-(3,21)	-(0,48)	-(1,73)		

Impact on the respective yield from the following dummies

	No meet (s)	**Meeting (s)**	**Move (s)**	**No move (nos)**
	(b)	(b+c)	(b+d+f)	(b+d)
1 year	**0,82**	**0,59**	**0,54**	0,77
3 years	**0,69**	**0,37**	**0,28**	0,65
5 years	**0,63**	**0,31**	**0,23**	0,59
10years	**0,43**	**0,14**	**0,07**	0,35

The intercept was not signficant. t statistics in parenthesis

(1) Equation 5a, (2) Equation 5b

(s) stands for significant (in bold) and (nos) for not-significant at 95%

Estimates incorporates 1 lag of the dependant variable. Estimation with LS and Newley West (NW) adjusted errors

Estimates of 5a substituting D_{meet} by D_{move},D_{nomove} showed that all were significantly different from 0

Table 8b. Measuring the impact of monetary policy surprises in bond yields with Pclong

	$\Delta R_t^i = a^i + b^i PCj_t + d_{1a}^i D_{meet} + e_t^i$			$\Delta R_t^i = a^i + b^i PCj_t + d_{1b}^i D_{meet} + d_2^i D_{move} + e_t^i$			
	intcpt (1)	**beta** (1)	**delta1a** (1)	**delta1b**(2)	**delta2**(2)	**R^2** (1)	**DW** (1)
	(a)	(b)	(c)	(d)	(f)		
3 years	0,00	0,83	-0,36	0,05	-0,56	0,24	2,00
	(1,06)	(12,10)	-(3,20)	(0,30)	-(3,22)		
5 years	0,00	0,76	-0,36	0,06	-0,57	0,18	2,01
	(1,09)	(11,79)	-(2,92)	(0,30)	-(2,71)		
10 years	0,00	0,54	-0,32	0,03	-0,47	0,10	2,01
	(1,07)	(9,66)	-(3,31)	(0,16)	-(2,68)		

Impact on the respective yield from the following dummies

	No meet (s)	**Meeting (s)**	**Move (s)**	**No move (nos)**
	(b)	(b+c)	(b+d+f)	(b+d)
3 years	**0,83**	**0,46**	**0,31**	0,88
5 years	**0,76**	**0,41**	**0,26**	0,82
10years	**0,54**	**0,22**	**0,09**	0,56

The intercept was not signficant t-statistics in parenthesis

(1) Equation 5a, (2) Equation 5b

(s) stands for significant (in bold) and nos for not-significant at 95%

Estimates incorporates 1 lag of the dependant variable. Estimation with LS and Newley West (NW) adjusted errors

Estimates of 5a substituting D_{meet} by D_{move},D_{nomove} showed that all were significantly different from 0

Table 9a. Measuring the impact of monetary policy surprises on implicit rates with Pcnoe

	$\Delta R_t^i = a^i + b^i PCj_t + d_{1a}^i D_{meet} + e_t^i$				$\Delta R_t^i = a^i + b^i PCj_t + d_{1b}^i D_{meet} + d_2^i D_{move} + e_t^i$			
Implicits	**beta (1)**	**beta$_{t-1}$ (1)**	**delta1a (1)**	**delta1a$_{t-1}$ (1)**	**delta1b(2)**	**delta1b$_{t-1}$(2)**	**delta2(2)**	**delta2$_{t-1}$(2)**
	(b)	(b1)	(c)	(c1)	(d)	(d1)	(f)	(f1)
1 year	**0,82**	**0,14**	**-0,23**	0,01	-0,04	0,14	-0,24	-0,18
	(12,70)	**(2,54)**	**-(2,10)**	(0,07)	-(0,30)	(0,92)	-(1,31)	-(1,05)
2 year	**0,69**	**0,23**	**-0,50**	-0,04	-0,37	0,10	-0,16	-0,17
	(8,47)	**(2,60)**	**-(3,26)**	-(0,34)	-(1,91)	(0,63)	-(0,65)	-(1,13)
3 year	**0,70**	-0,09	**-0,49**	0,01	-0,35	0,23	-0,17	-0,29
	(7,24)	-(0,88)	**-(2,61)**	(0,08)	-(1,71)	(1,60)	-(0,72)	-(1,56)
4 year	**0,74**	-0,06	**-0,79**	-0,05	-0,38	-0,60	-0,54	0,71
	(6,67)	-(0,54)	**-(2,98)**	-(0,26)	-(1,38)	-(2,44)	-(1,45)	(2,52)
5 year	**0,53**	-0,05	**-0,38**	-0,11	-0,37	0,00	-0,16	0,00
	(6,11)	-(0,70)	**-(3,75)**	-(1,03)	(0,00)	(0,00)	-(0,99)	(0,00)
6 year	0,19	0,05	-0,11	-0,01	0,18	0,00	-0,34	-0,06
	(1,28)	(0,46)	-(0,55)	-(0,09)	(0,00)	(0,00)	-(1,11)	-(0,26)
7 year	0,14	0,05	-0,16	-0,33	0,07	-0,53	-0,30	0,26
	(1,03)	(0,44)	-(0,98)	-(2,45)	(0,34)	-(1,79)	-(1,56)	(0,88)
8 year	0,13	-0,28	-0,11	-0,09	0,02	-0,27	-0,17	0,23
	(1,03)	-(1,90)	-(0,61)	-(0,55)	(0,06)	-(1,11)	-(0,50)	(0,86)
9 year	**0,23**	-0,08	**-0,32**	0,02	-0,16	0,20	-0,21	-0,24
	(2,11)	-(0,71)	**-(2,23)**	(0,13)	-(0,69)	(0,77)	-(0,97)	-(0,89)
10 year	**0,27**	-0,05	-0,16	-0,19	-0,13	-0,29	-0,04	0,13
	(2,60)	-(0,36)	-(1,04)	-(1,05)	-(0,40)	-(1,12)	-(0,13)	(0,47)

Impact on the respective yield from the following dummies

	$\Delta r_t^i = a^i + b^i PCj_t + d_{1a}^i D_{meet} + e_t^i$				$\Delta r_t^i = a^i + b^i PCj_t + d_{1b}^i D_{meet} + d_2^i D_{move} + e_t^i$			
	With no lags				**With one lag**			
	No meet	**Meeting**	**Move**	**No move**	**No meet**	**Meeting**	**Move**	**No move**
	(b)	(b+c)	(b+d+f)	(b+d)	(b)	(b+c)	(b+d+f)	(b+d)
1 year	0,82	0,59	0,54	0,78	0,96	0,74	0,64	1,06
2 year	0,69	0,19	0,16	0,32	0,92	0,38	0,31	0,64
3 year	0,70	0,21	0,17	0,35	0,61	0,13	0,03	0,49
4 year	0,74	-0,05	-0,18	0,36	0,68	-0,16	-0,12	-0,29
5 year	0,53	0,15	0,01	0,17	0,48	-0,01	-0,05	0,11
6 year	0,19	0,08	0,03	0,37	0,24	0,12	0,03	0,42
7 year	0,14	-0,01	-0,09	0,22	0,20	-0,30	-0,31	-0,26
8 year	0,13	0,02	-0,02	0,15	-0,15	-0,35	-0,34	-0,40
9 year	0,23	-0,09	-0,14	0,07	0,15	-0,15	-0,25	0,20
10 year	0,27	0,11	0,10	0,14	0,22	-0,13	-0,11	-0,20

t statistics in parenthesis. The constant is not significant

(1) Equation 5a, (2) Equation 5b

(s) stands for significant (in bold) and nos for not-significant at 95%

Estimates incorporates one lag of the dependent varialble. Estimation with LS and Newley West (NW) adjusted errors

Table 9b . Measuring the impact of monetary policy surprises on implicit rates with Pcnoe

	$\Delta r_t^i = a^i + b^i PCj_t + d_{1a}^i D_{meet} + e_t^i$				$\Delta r_t^i = a^i + b^i PCj_t + d_{1b}^i D_{meet} + d_2^i D_{move} + e_t^i$			
Averages	**beta (1)**	**beta$_{t-1}$ (1)**	**delta1a (1)**	**delta1a$_{t-1}$ (1)**	**delta1b(2)**	**delta1b$_{t-1}$(2)**	**delta2(2)**	**delta2$_{t-1}$(2)**
	(b)	(b1)	(c)	(c1)	(d)	(d1)	(f)	(f1)
medium(3)	**0,29**	-0,02	**-0,21**	-0,12	-0,04	-0,19	-0,23	0,09
	(4,67)	-(0,38)	**-(2,31)**	-(1,42)	-(0,24)	-(1,53)	-(1,36)	(0,64)
long (4)	**0,23**	**-0,19**	**-0,22**	-0,02	-0,12	-0,08	-0,13	0,07
	(3,24)	**-(2,64)**	**-(2,27)**	-(0,22)	-(0,60)	-(0,52)	-(0,72)	(0,39)

Impact on the respective yield from the following dummies

	With no lags				**With one lag**			
	No meet	**Meeting**	**Move**	**No move**	**No meet**	**Meeting**	**Move**	**No move**
	(b)	(b+c)	(b+d+f)	(b+d)	(b)	(b+c)	(b+d+f)	(b+d)
medium(3)	0,29	0,08	0,03	0,25	0,27	-0,06	-0,10	0,04
long (4)	0,23	0,01	-0,03	0,11	0,04	-0,21	-0,23	-0,16

t statistics in parenthesis. The constant is not significant

(1) Equation 5a, (2) Equation 5b

(3) Average of implicit rates from the fourth to the sixth year (both included)

(4) Average of implicit rates from the seventh to the ninth year (both included)

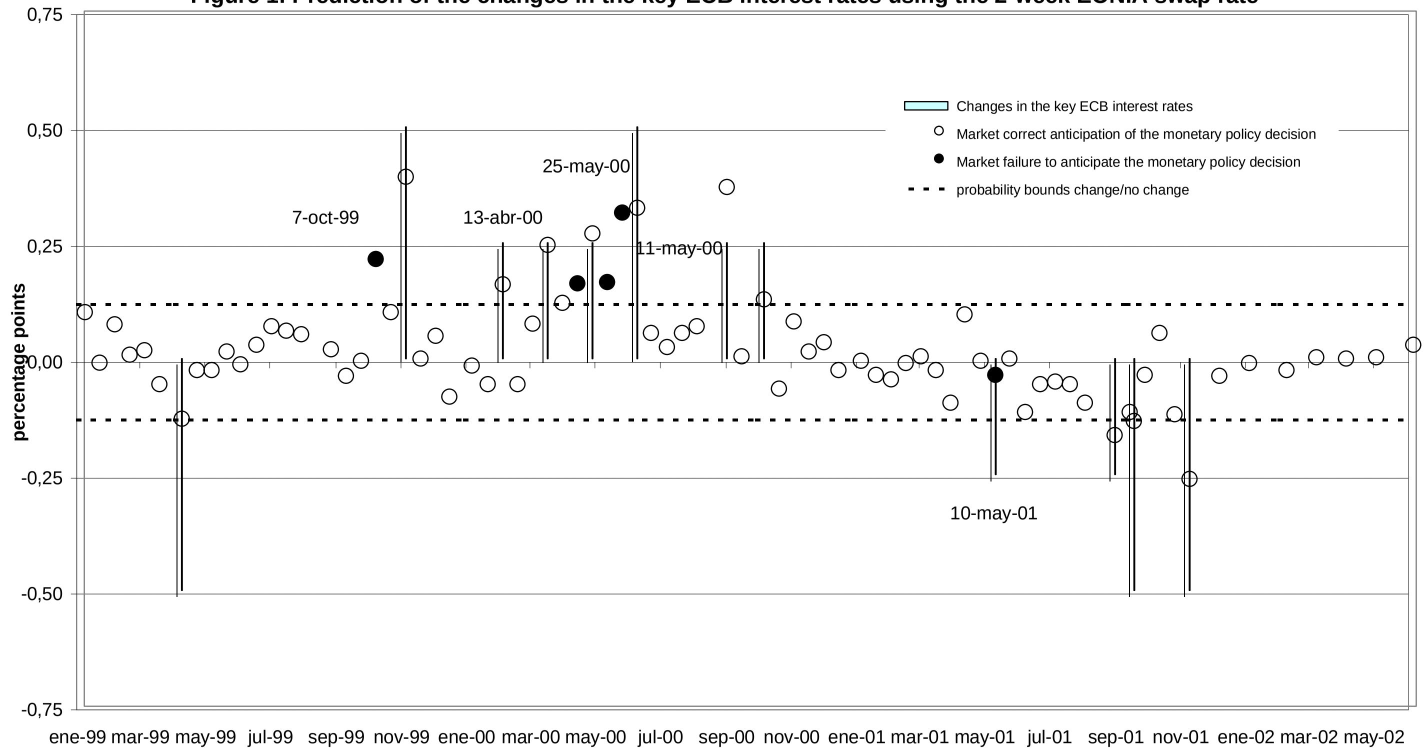
(s) stands for significant (in bold) and nos for not-significant at 95%

Estimates incorporates one lag of the dependent varialble. Estimation with LS and Newley West (NW) adjusted errors

Table A. Ordered probit estimates					
Coefficient	**EONIA**	**PCshort**	**PCnoe**	**PCall**	**PClong**
Et(Akt+1)	4,11	12,19	0,54	1,61	0,12
	(4,28)	(0,51)	(0,04)	(0,12)	(0,01)
At meeting	7,88	34,96	24,35	23,48	23,89
	(5,93)	(1,10)	(1,73)	(1,72)	(1,61)
End maintenance period	-6,54	-24,93	-3,55	-5,10	-1,25
	-(3,87)	-(0,27)	-(0,13)	-(0,22)	-(0,04)
Beginning maintenance period	-6,24	-28,04	-0,55	-8,19	0,34
	-(4,74)	-(0,87)	-(0,01)	-(0,25)	(0,01)
Avg. Log likelihood	-0,03	0,00	-0,01	-0,01	-0,01
Pseudo R2	0,59	0,97	0,85	0,86	0,87

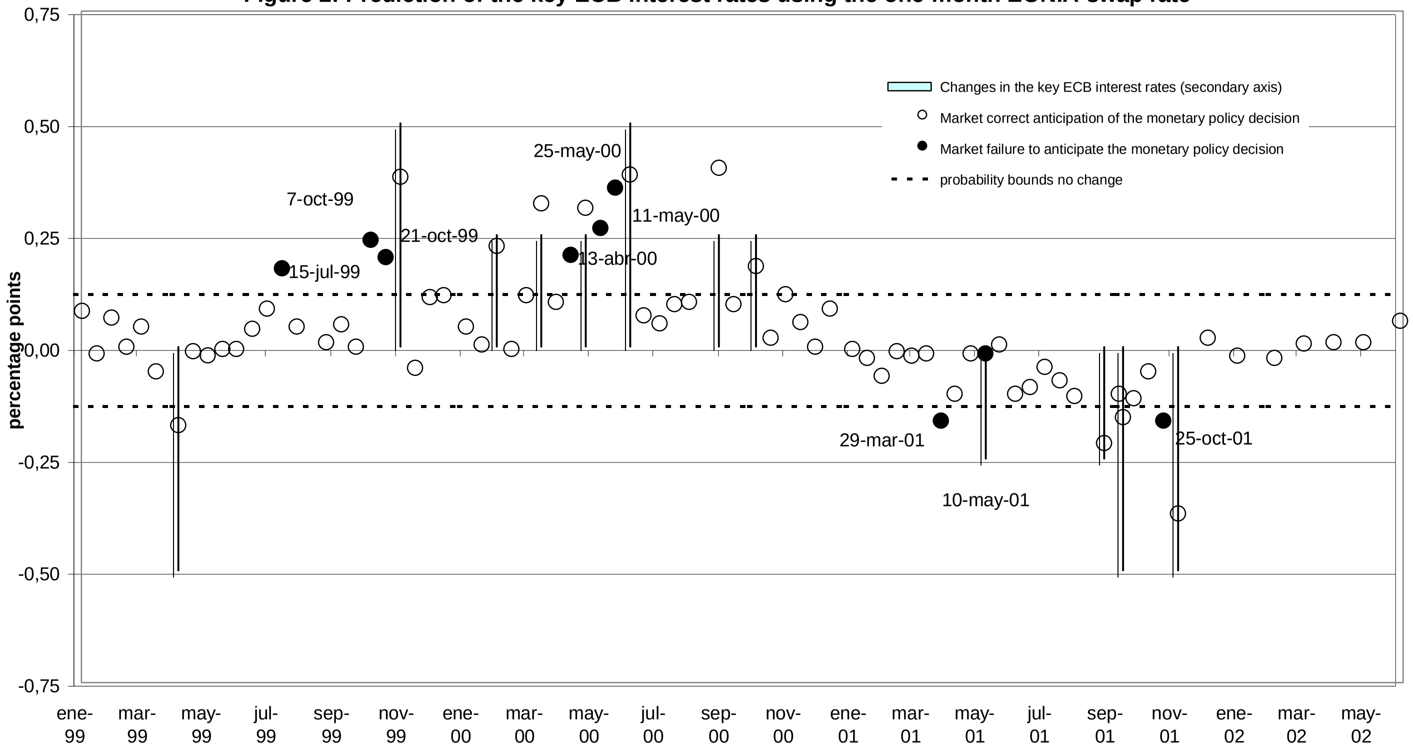
Note: z-statistics in parentheses.

Figure 1: Prediction of the changes in the key ECB interest rates using the 2-week EONIA swap rate



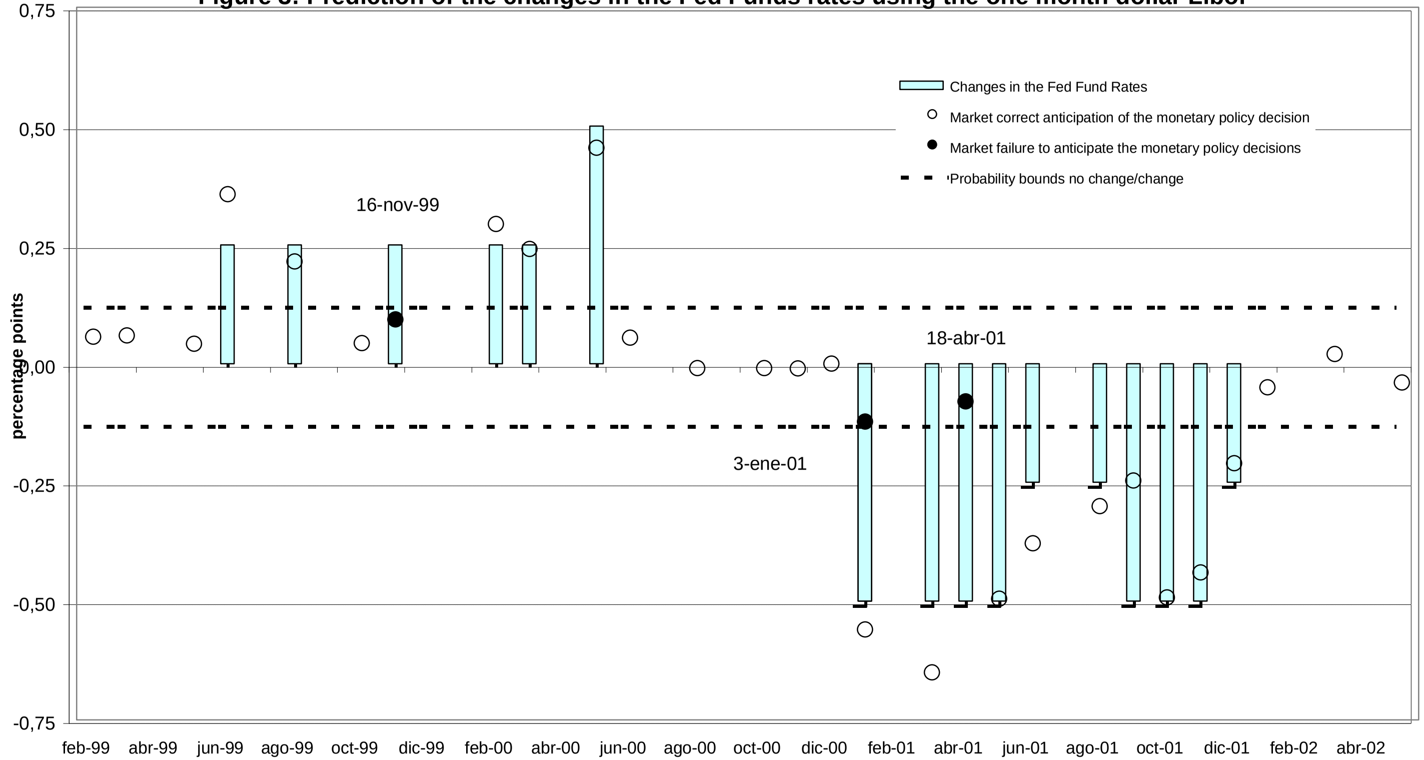
Bars represent changes in the key ECB interest rates. Circles represent the probability calculated with the two-week EONIA swap rate market of a change in the MRO rate (fixed rate since June 2000 and the minimum bid rate thereafter) one day before the Governing Council meeting. Since November 2001, the Governing Council discuss monetary policy once a month, instead of bimonthly (see text). The two-week EONIA swap is lowered by 5 basis points to reflect the natural spread between the market rate and the MRO rate. Clear (dark) circles represent cases in which the prediction of the market was correct (incorrect). Dotted lines are drawn at +/-12.5 basis points and represent the boundary of the 50% probability assigned to a change in the MRO rate (see text). Only the dates in which the monetary policy decisions were nor predicted (dark circles) are labelled in the Figure.
Source: Reuters and own calculations.

Figure 2: Prediction of the key ECB interest rates using the one-month EONIA-swap rate



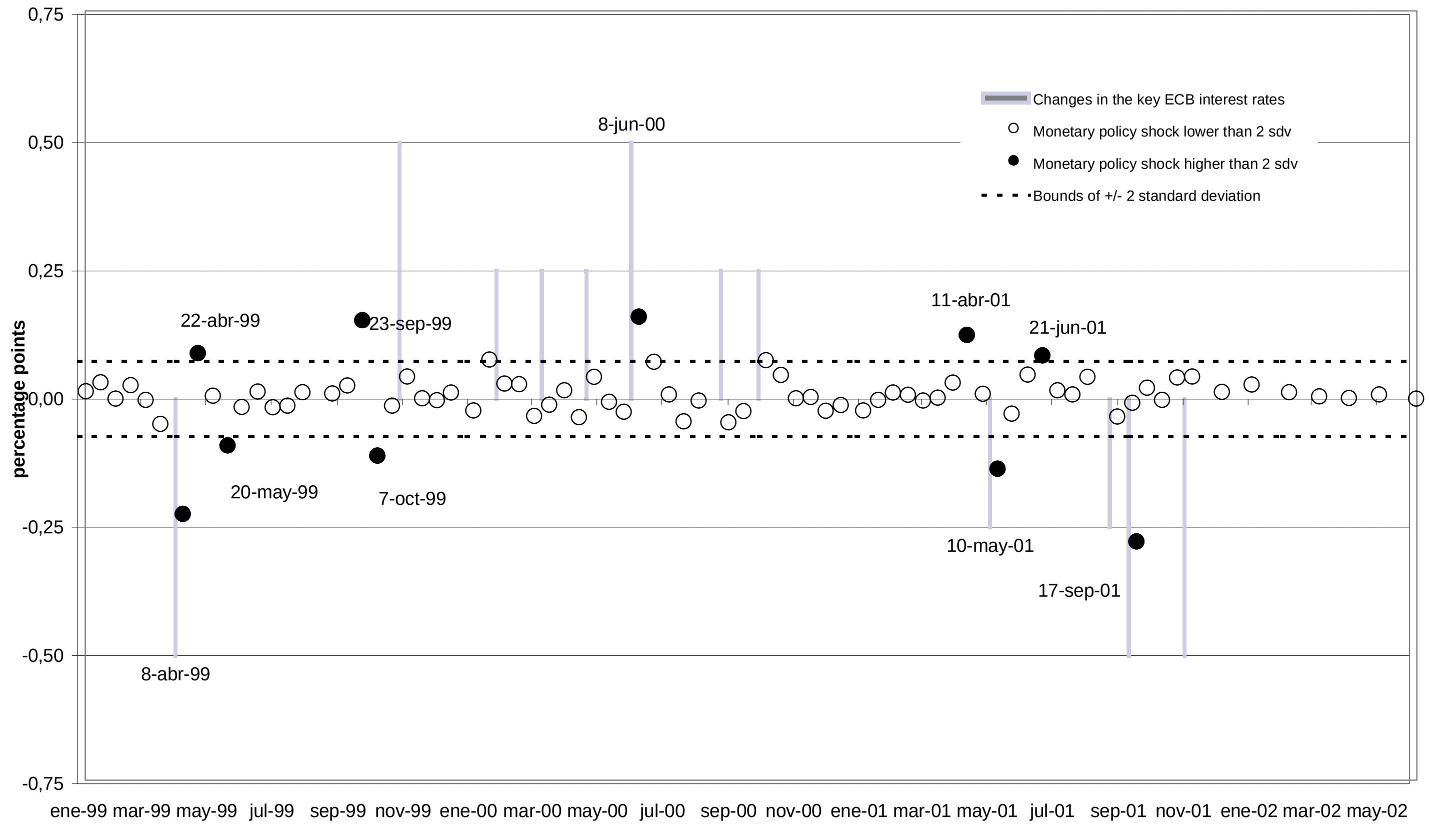
Bars represent changes in the key ECB interest rates. Circles represent the probability calculated with the one-month EONIA swap rate market of a change in the MRO rate (fixed rate since June 2000 and the minimum bid rate thereafter) one day before the Governing Council meeting. Since November 2001, the Governing Council discuss monetary policy once a month, instead of bimonthly (see text). The two-week EONIA swap is lowered by 5 basis points to reflect the natural spread between the market rate and the MRO rate. Clear (dark) circles represent cases in which the prediction of the market was correct (incorrect). Dotted lines are drawn at +/-12.5 basis points and represent the boundary of the 50% probability assigned to a change in the MRO (see text). Only the dates in which the monetary policy decisions were not predicted (dark circles) are labelled in the Figure.
Source: Reuters and own calculations.

Figure 3: Prediction of the changes in the Fed Funds rates using the one month dollar Libor



Bars represent changes in the Fed Fund rates. Circles represent the probability calculated with the one-month dollar Libor of a change in the Fed Fund rate one day before the FOMC meeting. The one-month market rate is lowered by 13 basis points to reflect the risk premia embedded in this one-month rate. Clear (dark) circles represent cases in which the prediction of the market was correct (incorrect). Dotted lines are drawn at +/-12.5 basis points represent the boundary of the 50% probability assigned to a change in the Fed FUnd rate. Only the dates in which the monetary policy decisions were not predicted are labelled in the Figure.
Source: Reuters and own calculations.

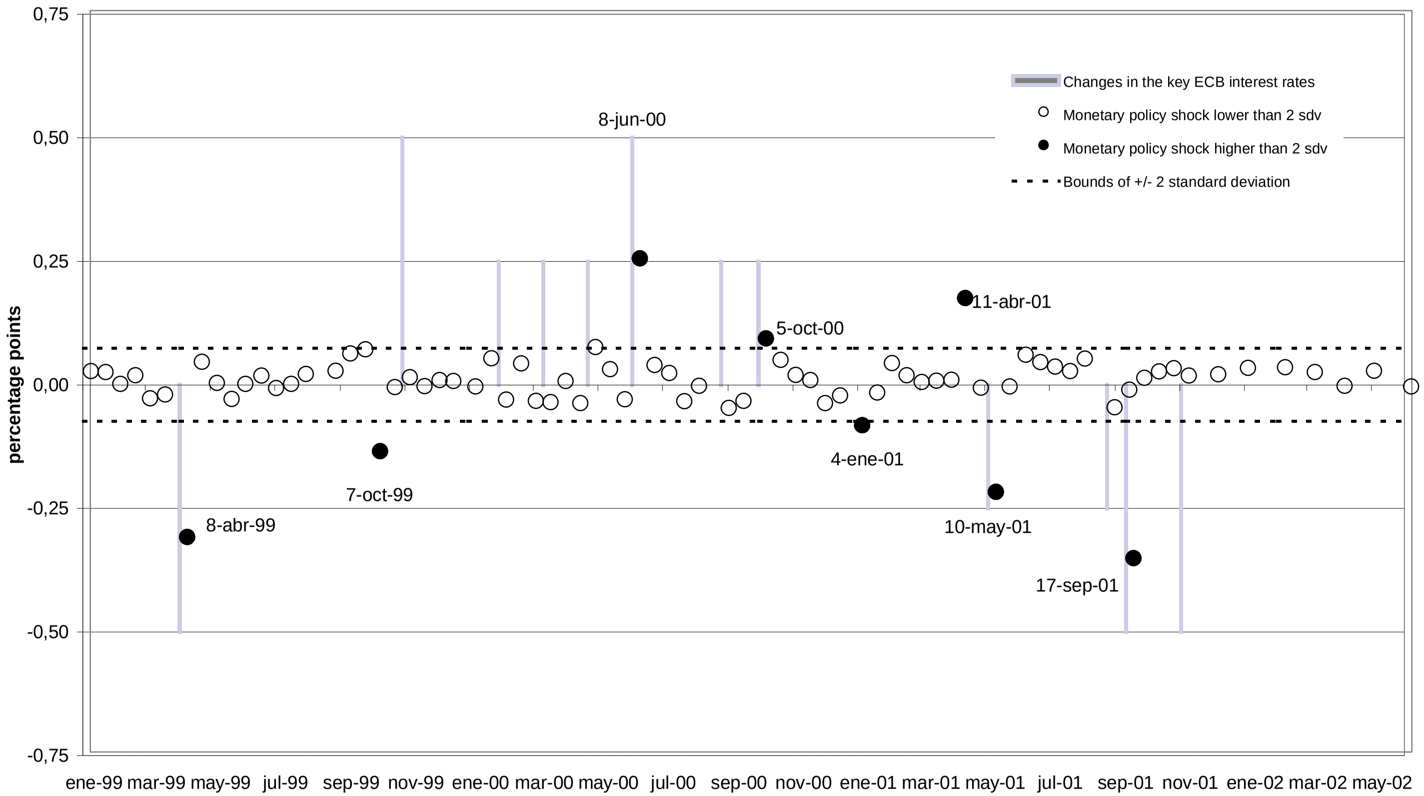
Fig 4a. Change in the key rates and monetary policy shocks (PCshort)



Note: Bars represent the change in the key ECB interest rates. Circles represent the monetary policy shocks on the days of the meeting of the Governing Council in which monetary policy is discussed (bimonthly meetings until 8 November 2001, monthly meetings thereafter. Dotted lines are drawn at the +/- 2 standard deviations (normalised at .038)

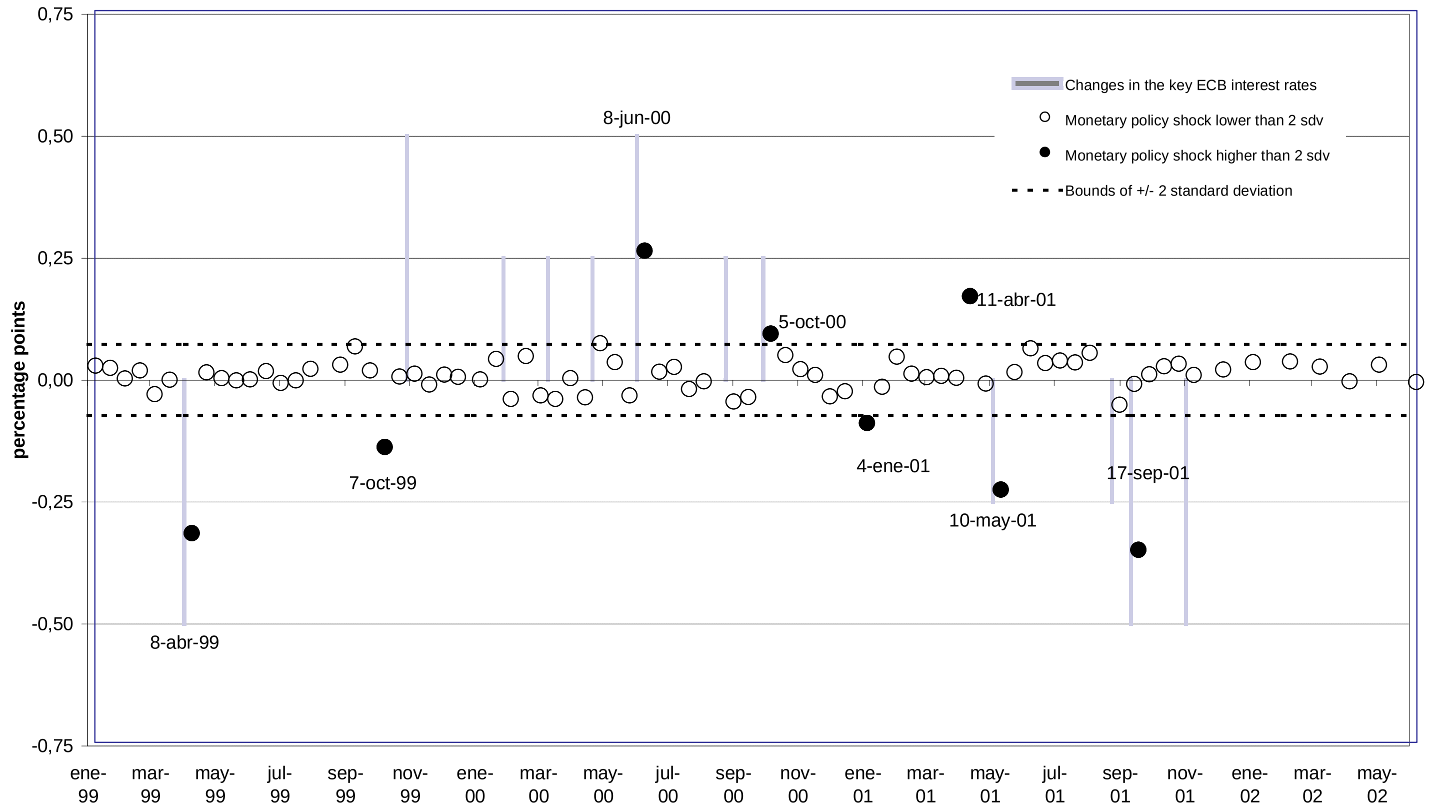
Source: Reuters and own calculations (see text).

Fig 4b. Change in the key rates and monetary policy shocks (PCall)



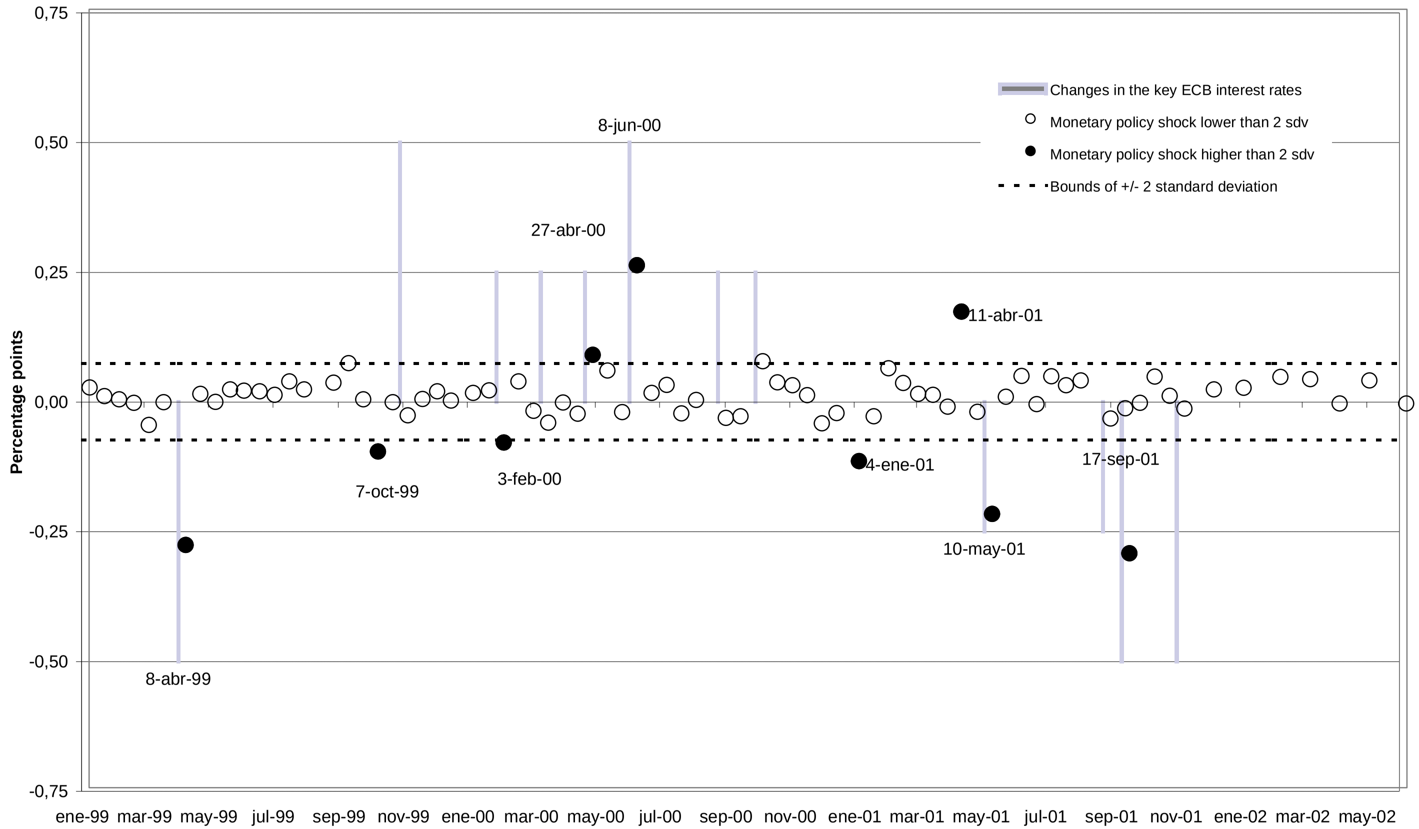
Note: Bars represent the change in the key ECB interest rates. Circles represent the monetary policy shocks on the days of the meeting of the Governing Council in which monetary policy is discussed (bimonthly meetings until 8 November 2001, monthly meetings thereafter. Dotted lines are drawn at the +/-2 standard deviations (normalised at .038)
Source: Reuters and own calculations (see text).

Fig 4c. Change in the key rates and monetary policy shocks (PCnoe)



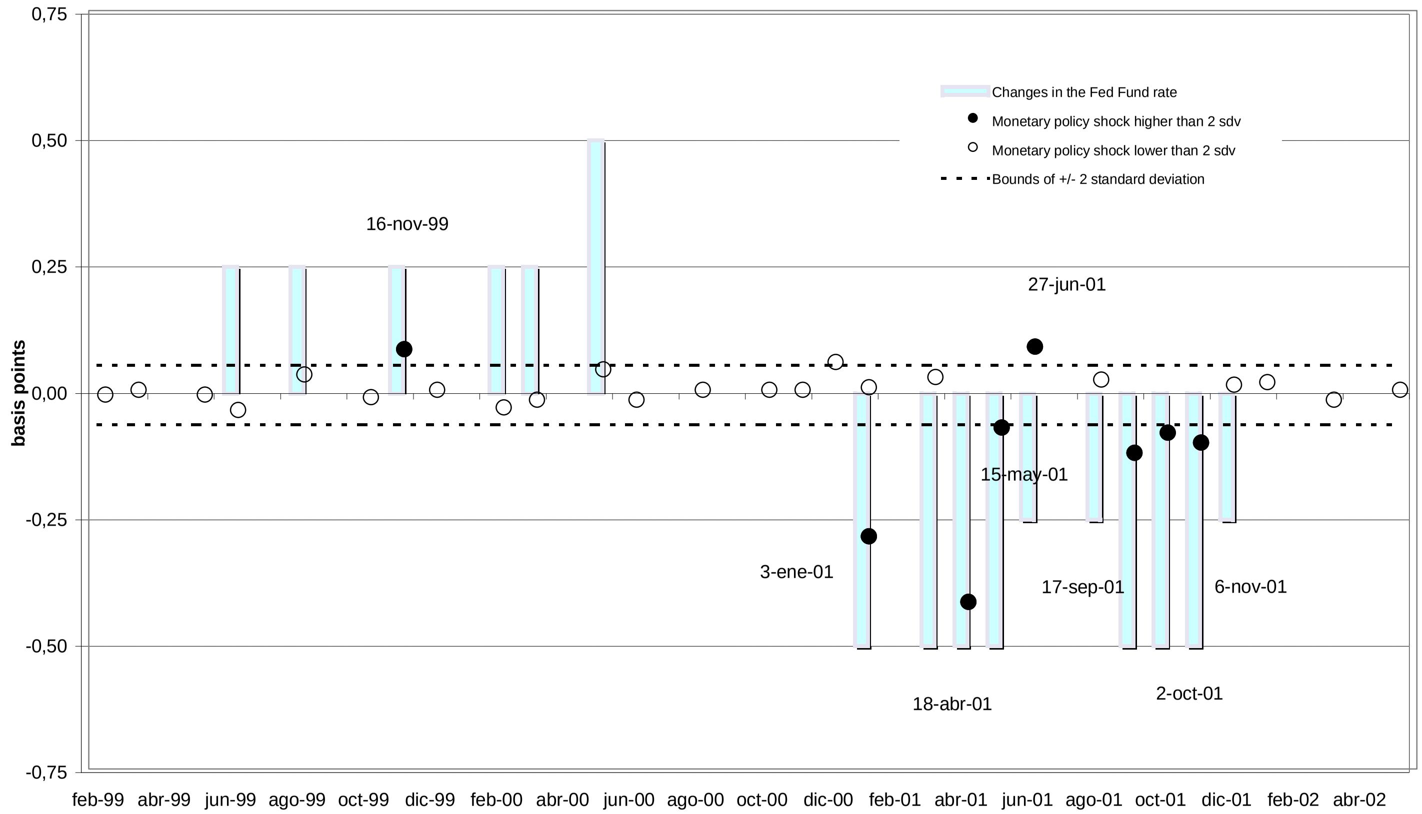
Note: Bars represent the change in the key ECB interest rates. Circles represent the monetary policy shocks on the days of the meeting of the Governing Council in which monetary policy is discussed (bimonthly meetings until 8 November 2001, monthly meetings thereafter. Dotted lines are drawn at the +/-2 standard deviations (normalised at .038)
Source: Reuters and own calculations (see text).

Fig 4d: Change in the key rates and monetary policy shocks (PClong)



Note: Bars represent the change in the key ECB interest rates. Circles represent the monetary policy shocks on the days of the meeting of the Governing Council in which monetary policy is discussed (bimonthly meetings until 8 November 2001, monthly meetings thereafter. Dotted lines are drawn at the +/- 2 standard deviations (normalised at .038)

Fig 5: Change in the Fed Fund rates and monetary policy shocks (PR)



Note: Bars represent the change in the Fed Fund rates. Circles represent the monetary policy shocks on the days of the meetings of the FOMC (scheduled and unscheduled). Dotted lines are drawn at the +/- 2 standard deviations.
Source: Reuters and own calculations (see text).