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## Market Predictability of ECB Monetary Policy Decisions: A Comparative Examination

*Kevin Ross*

**IMF Working Paper**

European I Department

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Prepared by Kevin Ross<sup>1</sup>

Authorized for distribution by Bankim Chadha

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**Abstract**

The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate.

Many surveys of the ECB's monetary framework emphasize the inability of financial markets to correctly predict monetary policy decisions. At the same time, these surveys of financial market participants have given relatively high marks to the United States Federal Reserve and the Bank of England on their ability to be understood by financial markets. Against this background, this paper examines the ability of financial markets to correctly anticipate these three central bank policy decisions over the first 3½ years of the ECB. The paper relies on calculations that market participants employ in anticipating policy changes and on term structure regressions that provide ex post evidence of market surprises. While the results suggest that all three central banks are broadly predictable, markets have had difficulty anticipating large changes and cuts in ECB policy interest rates. These surprises may be tied to the large number of policy meetings, particular characteristics of the EONIA money market, and the unique circumstances of the ECB. An added factor may be the absence of a consistent policy on communicating the current stance—if any—of the ECB's policy bias on the future direction of interest rates.

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Author's E-Mail Address: [kross@imf.org](mailto:kross@imf.org)

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## I. INTRODUCTION

Particularly during its early history, many surveys and reviews of the European Central Bank's (ECB) monetary framework emphasized the inability of financial markets to fully understand and correctly predict monetary policy decisions.<sup>2</sup> According to these reports, market participants questioned the ECB's degree of policy transparency and had difficulty interpreting how the two-pillar monetary framework was linked to policy actions.<sup>3</sup> At the same time, these surveys of financial market participants gave relatively high marks to the United States Federal Reserve (Fed) and the Bank of England (BoE) on their ability to be understood by financial markets.

In various communications the ECB has highlighted the important linkage between financial markets' ability to understand and predict monetary policy decisions and the effective implementation of monetary policy.<sup>4</sup> In an address to an *ECB Watchers Conference*, Issing (2001) noted that policy "should induce 'rule like' behavior on the behalf of market participants. This leads them to react to new developments in a manner consistent with the monetary policy strategy, thus aiding in the smooth conduct of monetary policy." Similarly, Hämäläinen (2001) stressed that "a credible and predictable central bank can achieve price stability with more stable interest rate movements and at lower interest rate levels than a central bank with lower credibility."

So far, empirical research by the ECB has indicated that financial markets have generally understood and predicted ECB policy decisions since the startup of Stage III of EMU (Box 1). Most of this work, however, has focused on a relatively small number of ECB policy decisions or during a period of generalized expectations of tightening.

Research on the predictability of Federal Reserve and BoE's Monetary Policy Committee (MPC) policy actions has tended to support a view of an evolving process: as transparency and market understanding of policy have increased over the years, the accuracy of market forecast's of central bank policy decisions has improved. For example, Haldane and Read (2001) found that the introduction of inflation targeting in the United Kingdom appears to have coincided with a marked dampening in yield curve responses, suggesting greater transparency and predictability as the BoE monetary framework changed. For the United States, Poole and Rasche (2001) demonstrated that predictability of the Fed's actions increased after the 1994 decision to announce changes in Fed policy rates immediately after Federal Open Market Committee (FOMC) meetings.

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<sup>2</sup> See Begg et. al. (2002), Bini-Smaghi and Gros (2001), Blinder et. al. (2001), and Callow (2001).

<sup>3</sup> Gros et. al. (2002) indicate that predictability may have improved since the second half of 2001.

<sup>4</sup> However, there may be instances of justifiable monetary policy surprises, e.g., during periods of asymmetric information.

### Box 1. Research on Predicting ECB Policy Decisions

Two research studies (Gaspar, Pérez, and Sicilia (2001) (GPS) and Hartmann, Manna and Manzanares (2001) (HMM) have considered the market's ability to predict ECB policy moves.<sup>17</sup> GPS examined the *daily* overnight EONIA market using interest rate data from January 1999 to March 2001. HMM examined *intra-day tick* data (bid-ask spreads and mid-rates) on overnight interbank quotes from 6 voice brokers in four euro-area countries as well as tick data from the Italian electronic trading system (e-MID) from November 1999 to March 2000. Both papers viewed their results as providing positive evidence on the ability of markets to predict ECB policy decisions.

#### *GPS (2001)*

GPS estimated an EGARCH model of the daily change in EONIA overnight interest rates with calendar, reserve maintenance period, and ECB meeting day dummy variables in the mean and variance equations. Meeting dummies were not found to be significant in the mean equation suggesting that monetary policy announcements did not affect overnight rates, i.e., the market did not make systematic errors with respect to monetary decisions. Similarly, the meeting dummies did not have a significant impact on the variance of returns, especially in relation to other fundamental determinates of market volatility (macroeconomic news, liquidity shocks). In addition, GPS used a heuristic approach to show that markets were able to predict a majority (*around 80 to 85 percent*) of the ECB's interest rate decisions.

#### *HMM (2001)*

This paper considered the functioning of the overnight market for funds through a study of *quoting activity* (as well as trading volume where available), *overnight rate volatility* (defined as the average absolute overnight rate change during an intra-day period), and *bid-ask spreads* from broker data.

HMM first examined the intra-week and intra-day behavior of the data, focusing on "normal" days (all business days less the two-reserve maintenance period days and Y2K days). Given the infrequent and irregular pattern of the voice broker data, it is broken up into 3 intervals (8 a.m. to 11 a.m.), (11 a.m. to 2 p.m.) and (2 p.m. to 5 p.m.). The average absolute 3-hour interval change in the overnight rate is about 3-4 basis points. Thursdays are the most volatile (and active) at about 4-7 basis points—but as a whole the market is not very volatile. The main microstructure features are: (i) Mondays—low post-weekend trading and volatility, (ii) Tuesdays—high market activity related to MROs, (iii) Wednesdays—large MID trading volumes related to MRO settlement obligations, and (iv) Thursdays—high volatility potentially related to ECB meeting days. Trading activity took on the usual U-shape—except for Thursdays where the mid-day interval was very high—with lots of activity at the start and end of the day. Volatility and spreads were rather U-shaped as well. Friday was relatively active, as managers tended to close out positions before the long weekend break.

Focusing on *monetary policy related events*, HMM investigated the intra-day patterns of Governing Council Thursdays versus non-Governing Council Thursdays. Activity was (substantially) higher on Council days than on non-Council days. In fact, non-Council days look like post-weekend Mondays. A U-shape trading pattern emerged for the non-Council days, but for the Council days, trading activity picked up in the mid-day period. HMM also look more closely at 45-minute intervals from the Italian MID market. *Activity (volume and quoting)* increased dramatically after the 1:45 p.m. ECB policy announcement; in fact, average volume in the post-announcement period on Council days was 2.5 times larger than on non-Council Thursdays and tick frequency was 4.5 times larger. HMM state that the volumes, however, were not particularly low before the ECB policy announcement—as compared to the non-Council Thursdays. They cited this as evidence that upcoming ECB

<sup>17</sup> See Gaspar, Vitor, Pérez Quirós, Gabriel, and Jorge Sicilia, 2001, "The ECB Monetary Strategy and the Money Market," ECB Working Paper No. 69; and Hartmann, P., M. Manna, and A. Manzanares, 2001, "The Microstructure of the Euro Money Market," Journal of International Money and Finance, Vol. 20, pp. 895-948.

### Box 1. Research on Predicting ECB Policy Decisions (Continued)

interest rate decisions were not preceded by substantial asymmetric information, which would have led to adverse select and hence ceasing volumes.

*Volatility* in both the voice broker and electronic trading system increased on Council days around the 1:45 p.m. announcement period. The finer MID data reveal that most of the increase in volatility was right after the ECB policy announcement. Volatility (mean rate changes) on Council days was on average 3 times higher than the mean 45-minute rate change over a non-Council day, and 10 times larger than the average change on a non-Council Thursday during the same interval. Upon a closer examination of the Italian MID data, the authors concluded that the higher volatility after ECB policy announcements was not a mechanical adjustment to the three ECB rate changes in the data, and that the market was better at anticipating an unchanged ECB policy rate than in anticipating changes in policy rates. In particular, only in one rate increase did the overnight rate move close to the future or post-announcement rate. However, the authors noted that the average 4.6 basis point increase right after the announcement on Council days was relatively small given policy changes. On the other hand, mean returns were probably a lot higher right after the announcement; thus the *average basis point change* would tend to hide this outcome.

*Bid-ask spreads* were higher on Council Thursdays, especially during the mid-day interval. This could be interpreted as asymmetric information increasing trading costs before ECB announcements, however, the authors pointed to the large market activity and volumes, which suggested continuous informational flows. MID spreads were higher—as compared to non-Council Thursdays—both before and after ECB announcements. When compared to all other days (non-Council, non-MRO settlement days) the authors state that the spreads (during pre and post announcement periods) on Council Thursdays were similar. Together with the information on volumes, trading activity, volatility and spreads, the authors stated that overnight market participants were not subject to large uncertainty regarding ECB interest rate decisions, since they could by and large anticipate the decisions.

Against this background, this paper examines the predictability of the ECB, BoE, and U.S. Fed's monetary policy decisions over the last 3½ years. A comparison of policy actions during this period offers a number of advantages, including the ability to examine central bank predictability of two industrial countries and a currency union, each with distinctive monetary frameworks, during a number of large changes in policy rates, and over a period of relatively turbulent shifts in the macroeconomic environment.

The paper will rely on calculations that market participants employ in anticipating policy changes and on regressions that provide ex post evidence of market surprises. For a variety of reasons a *direct* comparison of market predictability of these three central banks' policy actions is not feasible. Monetary policy operations and the market instruments available to ascertain expectations of future policy decisions are markedly different between the three central banks (Figure 1).<sup>5</sup> Therefore, different degrees and types of liquidity, term and risk premia may be affecting the outcomes under the simple techniques employed in this study.

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<sup>5</sup> For example, a futures contract on federal funds—the main policy rate of the U.S. central bank—is available while futures contracts on the euro area's two-week official repo instrument are nonexistent. See Borio (1997, 2001), and Blenck et. al. (2001) for a comparison of monetary policy operating procedures and frameworks.

Other factors, which prevent precise conclusions, are differences in macroeconomic environments and the short period of time under review—with a restricted number of policy decisions—that limit the power of the empirical work undertaken.

The rest of the paper is organized as follows: Section II briefly discusses the recent evolution in how these three central banks communicate their monetary policy stance. Sections III and IV describe the policy decisions undertaken during the period under review and estimate the degree to which each central bank followed a pattern of interest rate smoothing. Section V presents the results of our predictability analysis of central bank policy decisions, while in Section VI, the outcomes of regressions that examine the movement of yield curves at the time of policy rate changes are discussed. Finally, some concluding observations are offered in Section VII.

## **II. THE MOVEMENT TOWARD GREATER TRANSPARENCY OF CENTRAL BANK POLICY ACTIONS**

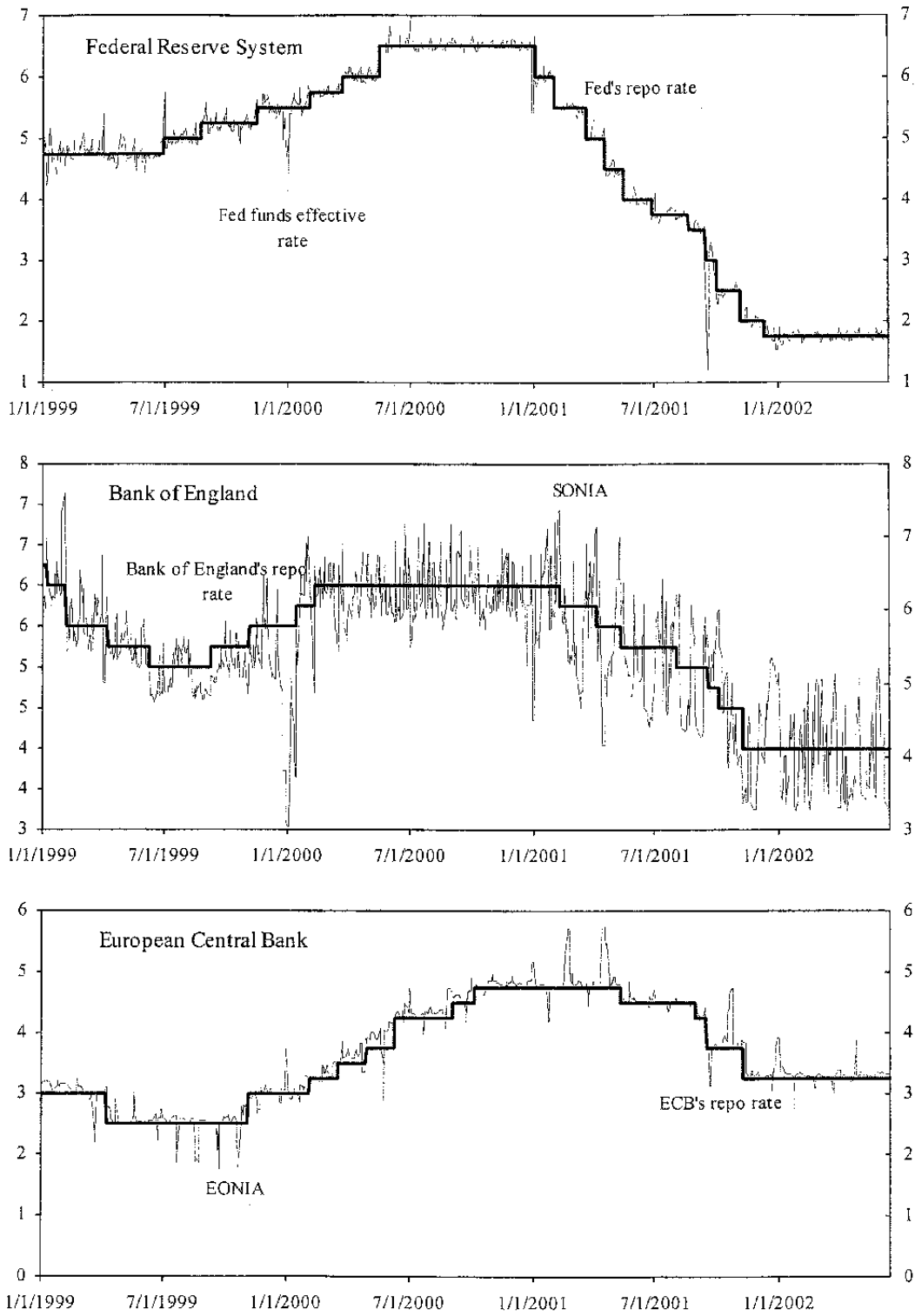
Monetary policy has its greatest impact on current economic conditions and the movement of financial market variables through the formulation of expectations. Indeed, the efficacy of the monetary transmission mechanism—the link between the real economy and policy—depends heavily on the ability of monetary policy to impact the course of interest rates through financial market expectations. With this in mind, many industrial country central banks in the 1990s embraced a greater emphasis on transparency and open communication in order to enhance credibility and improve the effectiveness of policy.

The conduct of U.S. monetary policy has traditionally been viewed as rather opaque. For example, before February 1994 changes in policy rates were not announced but rather left to be gradually discerned by financial markets. However, since then the U.S. Federal Reserve has started to publicly announce FOMC policy changes, with this policy officially enshrined in 1995. In a similar vein, before May 1999, press statements announcing policy decisions were relatively brief, cryptic, and undifferentiated between rate cuts and rate increases. Now, these statements offer greater detail on all policy decisions, and occur after every meeting. In addition, prior to May 1999, the Fed would announce its “policy bias” only after FOMC minutes were published (a few days after the next meeting) thus disabling its signaling function. Since then, the policy bias has been announced immediately after each FOMC meeting making it an effective forward-looking signal. In February 2000, the Fed moved away from the policy bias terminology and instead inserted a formulaic “balance of risks” sentence in order to clarify its asymmetric directives regarding inflationary pressures and economic weaknesses.<sup>6</sup> Finally, in March 2002, the FOMC started to publish a roll call of the votes on the Federal Funds target, including the preferred policy choice of any dissenters.

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<sup>6</sup> In August 1999, the FOMC established the *Working Group on the Directive and Disclosure Policy* to assess the FOMC’s approach to disclosing its view about prospective policy adjustments and to propose procedural modifications. The working group’s January 2000 report recommended that the FOMC statement issue a “balance-of-risks” statement that chose between a set of bracketed words to reflect the Committee’s view about prospective developments. Now risks are explicitly categorized as either: (i) balanced with respect for both goals; (ii) weighted mainly toward conditions that may generate heightened inflation pressures; or (iii) weighted mainly toward conditions that may generate economic weakness.

Figure 1. Policy Determined and Money Market Interest Rates  
(In percent)



Source: Bloomberg.



Most of the changes in communication and transparency at the Bank of England can be linked to the granting of operational independence in May 1997. At that time, the setting of monetary policy was delegated to the MPC, with the power to set the inflation target remaining with the Chancellor. In addition, the BoE's *Inflation Report*—christened in 1993—was retained as the main public communication vehicle that described current MPC thinking. While press statements on policy decisions have shied away from a precisely worded statement on the balance of risks to the inflation target—due in some part to the individualistic nature of the MPC—the quarterly inflation report contains a rather detailed analysis of the balance of risks and highlights financial market's views on these risks. Most of the MPC's analysis is encapsulated in error bands or probability distributions contained in fan charts on the direction of prices and output some two years ahead. Also, these fan charts are published under constant as well as expected market interest rates. For MPC members, one gap in coverage may arise from the fact that these charts are only updated on a quarterly basis versus a monthly MPC meeting. Finally, the BoE publishes the minutes of each MPC meeting with a two-week lag and has outlined in some detail, the models used by the Committee.

In many respects, the ECB has been able to draw upon this new emphasis on transparency and openness when it developed its communication and disclosure policies. Like many other central banks with a defined inflation objective, the ECB issues a *Monthly Bulletin*, which provides a relatively detailed analysis of monetary and economic developments throughout the area. The monthly editorial in the bulletin offers a guide to the Council's assessment of the balance of risks to price stability and the suitability of its monetary policy stance.<sup>7</sup> In addition, after the first meeting of the month, the President and Vice-President preside over a press conference, in which an introductory statement—that will be used as the outline of the editorial of the next bulletin—is read out and the floor opened to questions and answers.

At the same time, the ECB has augmented or modified some aspects of its communication strategy over the last 3½ years. First, since December 2000 the ECB has started to publish biannual staff forecasts on output growth and inflation, which are discussed in the monthly bulletin.<sup>8</sup> However, the models and methods that underlie these forecasts are not explicitly presented in detail, and it is unclear how much weight the Governing Council actually places on them in formulating policy. Second, in November 2001 the ECB moved from bimonthly meetings of the Governing Council, at which time interest rate decisions are undertaken, to

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<sup>7</sup> While the language used in the press statement (and editorial) has generally referenced the “balance of risks to price stability over the medium-term,” the presentation of this assessment has not been uniform since the start of stage III of EMU. For example, in the Fall of 1999 President Duisenberg talked about “creeping biases” during press conferences; beginning in May 2001 editorial statements regarding the “appropriateness” of policy rates over the medium-term were used; in May 2002 the editorial compared the balance of risks to those projected in December 2001; and in June 2002 the editorial noted that there was too much uncertainty to fully assess the balance of risks.

<sup>8</sup> These staff forecasts, however, have been criticized for their lack of precision. The width of forecast error bands have been set at twice the historical mean absolute forecast errors made by euro area central banks.

monthly meetings.<sup>9</sup> At the second meeting of the month, the Governing Council focuses on issues related to other tasks and responsibilities of the ECB and Eurosystem. Finally, since 1999 ECB's Governing Council has actively supported and participated in a unique annual forum for ECB watchers that brings together academics, the media, and financial market participants in a broad discussion on ECB policy.

### III. ECB, FED, AND BOE POLICY DECISIONS

Table 1 displays information on monetary policy decisions of the ECB, U.S. Fed, and BoE over January 1999 to May 2002 period. All three central banks hold frequent, regularly scheduled monetary policy meetings. With bimonthly policy meetings—until the move to monthly meetings in February 2002—the ECB Governing Council has met more often, some 77 times over the 41-month period versus 30 and 42 meetings, respectively, of the U.S. Fed's Federal Open Market Committee (FOMC) and the BoE's MPC. In general, it would appear that the ECB has been the least active central bank with only 16 percent of all meetings resulting in a decision to change policy rates. On the other hand, the U.S. Fed has been the most active, changing the targeted federal funds rate at about 60 percent of the FOMC decision dates, while the BoE's policy activism lies in-between, moving repo rates at about 35 percent of all MPC meetings.

However, the more frequent ECB Governing Council meetings may provide a false sense of inactivity. Excluding the nonscheduled September 17, 2001 meeting, the ECB has tended to change rates at the very end or beginning of the month (9 of the 11 changes) when all available monthly information on activity and prices have been tabulated, suggesting that mid-monthly meetings would not be expected to contain changes in policy stance. Similarly, there have been three U.S. Fed policy changes during unscheduled meetings (through telephone conference calls among the FOMC) that increase the percentage of Fed policy activism.<sup>10</sup> Also, the Federal Reserve was much less active in the preceding 40 policy meetings from 1994-98, changing rates only 30 percent of the time, suggesting the last three years has been a particularly active period in US monetary policy.

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<sup>9</sup> President Duisenberg noted that bimonthly meetings had led to higher volatility in exchange rates and interest rates, and the move to assess monetary policy only at the first meeting of the month may have the effect of calming markets (ECB Press Conference, November 8, 2001).

<sup>10</sup> Eliminating the three change decisions during these nonscheduled meeting days would decrease Fed activism to some 50 percent of all FOMC meetings over this period. The Fed meets eight times a year with the first and fourth meeting held over two days in order to cover the longer-term economic outlook and current state of open market operations. There does not appear to be any pattern regarding the decision to change rates. The BoE's MPC generally meets on the Wednesday and Thursday after the first Monday of the month.

Table 1. ECB, FED and BoE Policy Decisions, January 1999-May 2002

	ECB	U.S. Fed	BoE
Central bank policy decisions	77	30	42
No-change decisions	65	13	27
Percentage of no-change decisions	84%	43%	64%
Number of changes	12	17	15
Increased rates	7	6	4
by 25 basis points	5	5	4
by 50 basis points	2	1	0
Decreased rates	5	11	11
by 25 basis points	2	3	9
by 50 basis points	3	8	2
Minimum	2.50	1.75	4.00
Maximum	4.75	6.50	6.25
Range	2.25	4.75	2.25
Changes in direction	2	2	2
Number of decisions on non-scheduled meeting days 1/	1	3	1

Sources: ECB, U.S. Federal Reserve, and the Bank of England; and IMF staff estimates.

1/ Data include the decisions on September 11, 2001.

#### IV. INTEREST RATE SMOOTHING AND PREDICTABILITY

Generally, the three central banks appear to favor a form of interest rate smoothing, with small movements in interest rates without marked reversals in direction. In fact, including the path of rates in the pre-1999 period, each central bank changed direction of interest rates twice over the last 3½-4 years, with only two of the six directional changes applying rate changes of at least 50 basis points. In addition, the time lag between the last policy move and the new change in direction policy move has usually been about 9-11 months. Interest rate smoothing has typically been explained by uncertainty regarding the current state of the economy, with policymakers undertaking a rather muted reaction to new data since the true structure of the economy is unknown.<sup>11</sup> Interest rate smoothing behavior under this scenario could be uncovered by looking at basic autocorrelations.

An alternative explanation focuses on the use of a systematic and *predictable* monetary policy with low nominal interest rate variability in the context of a forward-looking private sector. In this view, the potency of monetary policy will be enhanced—through the formation of accurate expectations of future policy—if the private sector can expect interest rate changes to persist, allowing agents to better anticipate policy adjustments. This can be accomplished if the central bank commits itself to a rule.<sup>12</sup>

<sup>11</sup> See Brainard (1967).

<sup>12</sup> Given that policy moves are expected to last well into the future, consumers and firms should react more forcefully today to any change in policy rates.

To quantify the extent to which each central bank has followed an interest rate smoothing policy (and therefore tended to improve the probability of accurate market predictions), the following regression on monthly data (1999.1-2001.12) was estimated for each area:

$$i_t = \alpha + \beta\pi_t + \gamma gap_t + \lambda i_{t-1} + \varepsilon_t \quad (1)$$

where  $i_t$  is the overnight interest rate series,  $\pi_t$  is the CPI inflation rate,  $gap_t$  is detrended industrial production, and  $i_{t-1}$  is the one-period lagged overnight interest rate. This type of regression separates out an explicit smoothing coefficient ( $\lambda$ ) from other factors that may have affected the behavior of the monetary authority. Larger values of ( $\lambda$ ) imply a higher degree of smoothing.

Figure 2 shows the behavior of these overnight interest rates and the estimated smoothing coefficient. The smoothing coefficients for the euro area and the United Kingdom are very similar at around 0.8. For the United States, the smoothing coefficient is greater than one, indicating that shocks affecting the setting of interest rates would not eventually fade away, i.e., interest rates would not revert to “trend.” Previous work by Amato and Laubach (1999) estimated an interest rate-smoothing coefficient of about 0.9 for the US using data from the late 1980s to 1997. Thus, our results imply that the Federal Reserve’s view of the economy, perhaps related to the signals emanating from the equity markets, radically changed in 2001, forcing the Fed to abandon the small infrequent changes seen under interest rate smoothing in favor of repeated large reductions in the Fed Funds target.<sup>13</sup> This should make the predictability of U.S. policymakers more difficult in comparison to the U.K. and the euro area.

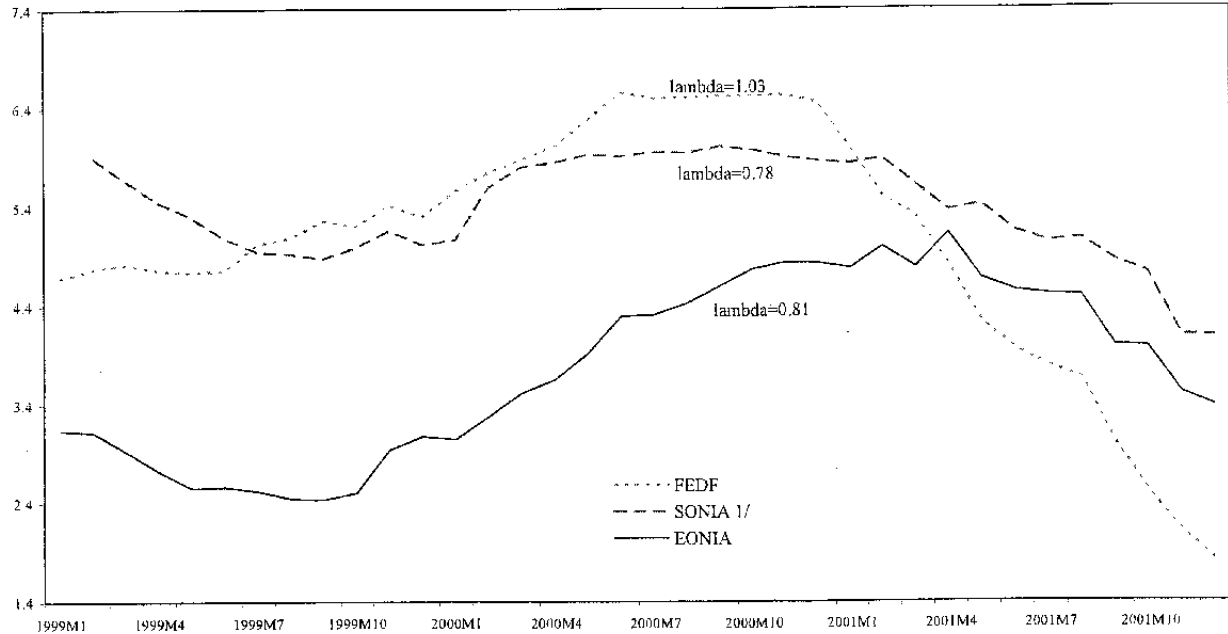
## V. PREDICTABILITY OF CENTRAL BANK INTEREST RATE DECISIONS

Given the paper’s focus on the relative predictability of ECB policy decisions, benchmark calculations on how well financial markets anticipated U.S. Fed and BoE policy actions are undertaken first. The results on ECB policy decisions are then compared to the evidence for these two central banks.

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<sup>13</sup> Approximately 53 percent of the U.S. Federal Reserve changes in interest rates in this 3½-year period were at least as large as 50 basis points. For the ECB and the BoE, these figures are 42 and 13 percent, respectively.

Figure 2. Behavior of Euro Area, U.S., and U.K. Overnight Interest Rates with Estimated Smoothing Coefficients



Source: IMF staff estimates.

1) Due to high volatility the Sterling Overnight Index Average (SONIA) is a two-month

### A. The U.S. Federal Reserve FOMC

This section uses federal funds futures rates to predict changes in U.S. monetary policy. In doing so, we follow the heuristic method employed by Robertson and Thornton (1997). Variants of this method have been used by Poole and Rasche (2001) and Kuttner (2000) in studies of the expected and unexpected changes in federal funds targets.

We start by assuming that the one-month federal funds futures rate is a predictor of the average federal funds rate, with the allowance for a non-zero risk premium  $\alpha_i$  that may vary with the forecast horizon. Specifically,

$$fff_{t,i} = E_t \overline{ff}_{t+i} + \alpha_i \quad (2)$$

where  $fff_{t,i}$  is the  $i$ -month ahead future rate calculated as the rate on the last day of the month,  $E_t$  the expectations operator at time  $t$  and  $\overline{ff}_{t+i}$  is the average of the daily effective federal funds rate for each day of the month. The data are measured on a monthly frequency, and given that our data runs from January 1999 to May 2002, we have 41 observations. The forecast errors are serially correlated, and adjusted estimates reveal a significant positive bias of 8.3 basis points at the one-month horizon. This “hedging premium” results from the fact that banks use the federal funds market to finance their loan portfolios and will hedge their positions against any rate increases in the futures market. The desire to protect against possible spot increases will increase the yield in the futures market.

Using the one-month federal funds futures rate at the end of the month as a barometer of expected changes in the federal funds target over the following month runs into two problems. First, the federal funds futures rate is a forecast of the average of federal funds rates and not the federal funds target. Second, the effect of a target change on the average depends on the timing and the magnitude of any target change.

Assume the market's forecast of the average funds rate is the sum of the average federal funds rate target and deviations of the average federal funds rates from that average target:

$$E_t \overline{ff}_{t+i} = E_t \overline{fftar}_{t+i} + E_t (\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \quad (3)$$

Substituting from equation 2, we get:

$$\overline{fff}_{i,t} - \alpha_i = E_t \overline{fftar}_{t+i} + E_t (\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \quad (4)$$

Thus, the bias adjusted futures rate would deviate from the market's forecast for the average target rate when the market's forecast for the average federal funds rate differs from the average target rate. In order to identify the market's expectation for the target rate, we could assume that the market's expectation of the average federal funds rate will coincide with the federal funds target rate. However, this is unlikely, so identification remains a problem.

Robertson and Thornton consider a "partial identifying assumption," which allows identification on occasions when the market is expecting a change in the target rate. Specifically, assume that  $E_t (\overline{ff}_{t+i} - \overline{fftar}_{t+i})$  falls within a certain interval. If the bias-adjusted  $i$ -month spread between the futures rate and current target rate is outside this interval then they conclude the market expected a change in the target. To see this better subtract  $\overline{fftar}_t$  from both sides of equation 4 to get:

$$\overline{fff}_{i,t} - \alpha_i - \overline{fftar}_t = E_t \overline{fftar}_{t+i} - \overline{fftar}_t + E_t (\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \quad (5)$$

If markets expected no change in the target, the bias adjusted spread between the federal funds futures and the target is equal to the market's expectation of the average federal funds-target spread, i.e., the historical average spread.

$$\overline{fff}_{i,t} - \alpha_i - \overline{fftar}_t = E_t (\overline{ff}_{t+i} - \overline{fftar}_{t+i}) \quad (6)$$

This partial identifying assumption can be made operational by using the min/max bounds of  $(\overline{ff}_{t+i} - \overline{fftar}_{t+i})$  over the whole sample period. In our sample, this has ranged between -20.4 and +5.9 basis points. With the interval determined, we then plot the bias adjusted spread  $(\overline{fff}_{i,t} - \alpha_i - \overline{fftar}_t)$ , with points outside the interval signifying an expectation of a target change (Figure 3, top panel).

To compare against actual changes in the federal funds target, we plot as vertical bars the difference between the current federal funds target and the average of the following month.<sup>14</sup> The results show that futures markets did not emit false signals regarding rate increases and were able to predict most of the rate increases in 1999 and 2000. The two exceptions being the 25-basis point increases of November 1999 and February 2000. Most importantly, the markets were able to predict changes in direction (both the increase in rates in 1999 and the reversal in 2001) and anticipated the majority of the large changes in rates. However, the markets did not anticipate well the last round of sharp cuts starting in September of 2001, perhaps due to the aforementioned deviation from interest rate smoothing. In fact, two-thirds of the errors in market anticipation of Fed policy action can be found in the fall of 2001.

The accuracy of the forecast results can be summarized in a basic tabulation, Table 2. The simple rule correctly predicted 10 out of the 16 (63 percent) federal funds target changes and 100 percent of the no-change months.<sup>15</sup> While the overall hit rate was about 85 percent, with 35 of the 41 months correctly predicted, the reliability of the model's prediction of a policy change was 100 percent or 10 out of 10. However, it is important to remember that this analysis predicts monthly FOMC policy actions (over our 41-month sample), regardless if a meeting had been scheduled. In 11 months, no policy decision meetings occurred within the month. Although the model correctly predicted no target changes during these months, eliminating these dates would bring the overall hit rate to some 80 percent (24 out of 30 decisions).

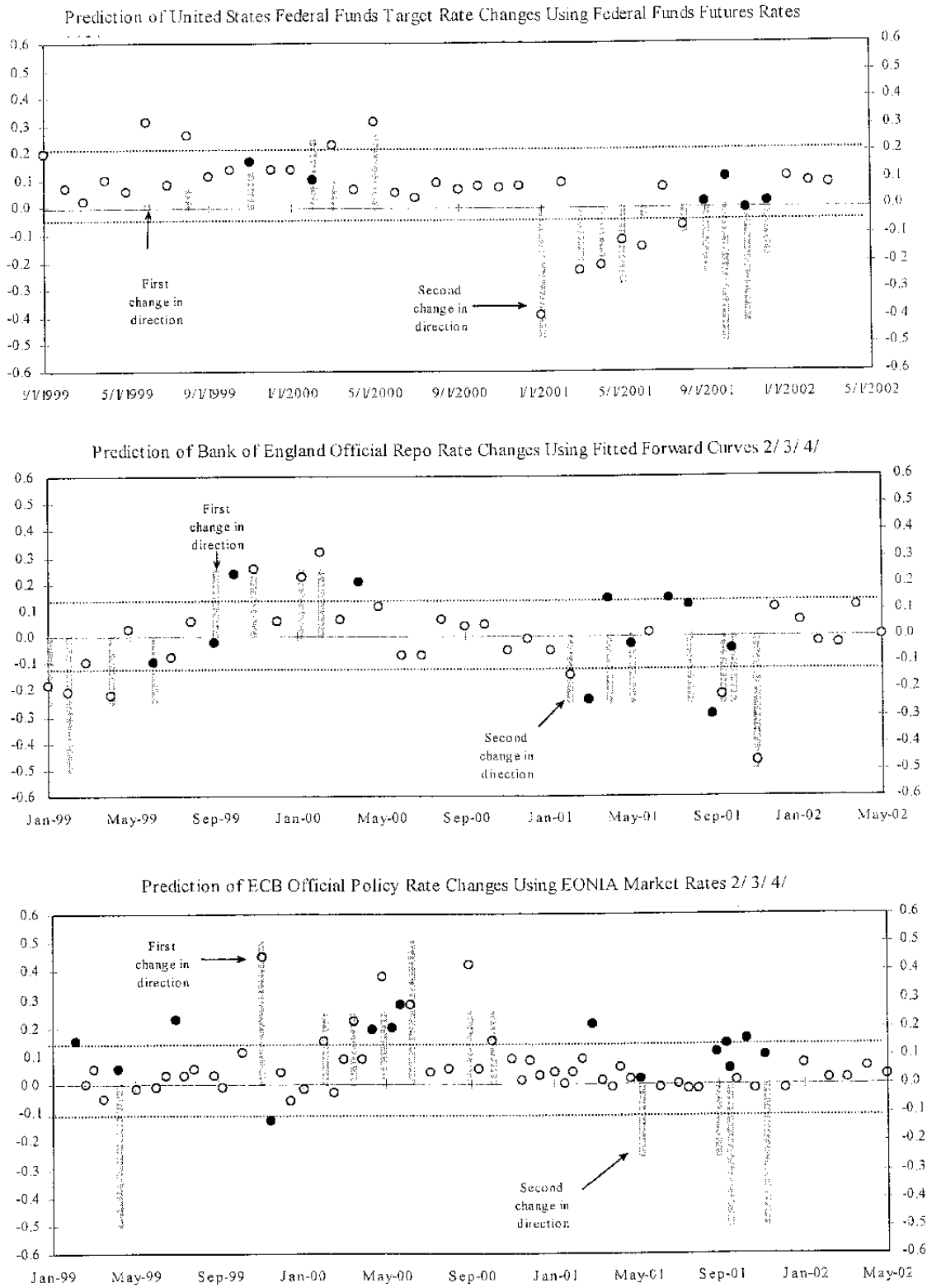
A second caveat is the use of the range of the prediction interval. We made the model operational by using the min/max bounds of  $(\overline{ff}_{t+i} - \overline{fftar}_{t+i})$  over the whole sample period. These bounds were influenced by rather large end-of-year values; adjusting for these values resulted in a min/max range of -9.8 to +5.9 basis points. Re-tabulating the contingency table under the adjusted bands resulted in very similar numbers. The model predicts 11 out of the 16 policy rate changes and 20 out of the 25 no-change months. The overall hit ratio falls to 31 out of 41, or 76 percent, while the reliability of a change prediction falls to 69 percent or 11 out of 16. In sum, given that the accuracy of a no-change forecast was around 40 percent, it is clear that the markets, as embodied in the futures markets data, do a fair job of predicting policy decisions of the U.S. Federal Reserve's FOMC.

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<sup>14</sup> In order to allow rate hikes to be shown as positive changes, the negative of the spreads are used. Similarly, for the min/max ranges.

<sup>15</sup> Two rate moves were undertaken in January 2001, which are considered as one monthly move in the analysis. Thus the 17 policy moves tabulated in Table 1 must be considered as 16 policy moves.

Figure 3. Financial Market Predictions of Central Bank Policy Decisions



Source: MF staff estimates.

1/ Bars represent change in average federal funds rate (one month ahead) over current target. Circles represent the bias adjusted futures spread. Dotted lines represent range of the historical difference between average effective federal funds rate and average federal funds target.

2/ Dark (clear) circles represent incorrect (correct) market predictions.

3/ Bars represent changes in the official rate.

4/ Dotted lines are drawn at +/- 0.125 basis points, reflecting the 50 percent probability of at least a 25 basis point change.



Table 2. United States: Contingency Table Using Federal Funds Futures Rates

	Actual Change	Actual No Change	Predicted Total
Predicted Change	10 62.5%	0 0.0%	10 24.4%
Predicted No Change	6 37.5%	25 100.0%	31 75.6%
Actual Total	16	25	41
Reliability on changes 1/ Overall "hit rate" 2/	100.0%		85.4%

Source: IMF staff estimates.

1/ Percentage of time model signals rate change and one actually happens.

2/ Percentage of correct signals.

### B. The BoE's Monetary Policy Committee

Money market instruments available to extract expectations of future changes in the Bank of England's (BoE) official two-week repo rate include: (i) generalized collateral (GC) repurchase agreements, (ii) interbank loans fixed at LIBOR rates, (iii) short-sterling futures contracts, (iv) forward rate agreements (FRAs), (v) the sterling swap market, and (vi) the sterling overnight interest average (SONIA) deposit rate. However, in each instrument the existence of term premia, and differences in credit quality, maturity, liquidity and other biases complicate the extraction of a "pure measure" of market expectations.<sup>16</sup>

Recognizing the inability of any one money market instrument to provide the best indication of Bank repo rate expectations, the BoE estimates two alternative forward curves from two alternative sets of instruments, each with common credit risk characteristics. One curve is fitted using mostly GC repos and gilt yields (known generically as the VRP<sup>17</sup> curve), while the second (known as the bank liability curve) is fitted using synthetic bond prices from interbank offer rates, short-sterling futures, FRAs, and swaps. After adjusting for biases, these curves can be seen as the best measure of the market's expectation of two-week forward rates. In what follows, we focus on market predictability taken from the short-end of the VRP curve since it resulted in slightly better results.<sup>18</sup>

<sup>16</sup> See Brooke, Cooper, and Scholtes (1999), "Inferring Market Interest Rate Expectations from Money Market Rates," Bank of England, Quarterly Bulletin.

<sup>17</sup> The BoE uses a variable roughness penalty (VRP) technique to fit various types of forward curves.

<sup>18</sup> Near-term three-month short sterling futures contracts were used. This method relied on more judgmental calculations of the time-varying term premia between the three-month interbank deposit rate and the official repo rate, and resulted in somewhat less satisfactory outcomes. These results are available from the author upon request.

In order to determine the degree of predictability of BoE policy decisions, the interest rate from the fitted VRP curve is defined as a linear combination of two events:

$$i_t = \beta i_{25} + (1 - \beta) i_0 \quad (7)$$

where  $\beta$  is the probability of at least a 25 basis point change and  $(1 - \beta)$  is the probability of a no change decision. The interest rates are the present BoE official two-week repo rate with a 25 basis point change  $i_{25}$  added on and the current official rate  $i_0$ . The assumption is that a  $\beta$  of 50 percent or greater implies the market expected the BoE to change interest rates during the upcoming MPC meeting. The observations are taken the day before the two-day meeting of the Bank's MPC<sup>19</sup>. In the analysis, 42 meetings are used, 1 more than in Table 1 given the two meetings in September 2001.

Figure 3 (middle panel) reveals in graphical form the number of times financial markets correctly anticipated BoE decisions:

- The graph shows that the two 50 basis point cuts in interest rates (February 1999 and November 2001) were anticipated by the market but the first change in direction (September 1999) caught the market off guard;
- In contrast to the U.S. Federal Reserve results, about a third of the incorrect signals can be found in and around the fall of 2001;
- The figure also demonstrates that the lull before the second change in direction—and the move toward loosening policy rates in early 2001—was also correctly viewed by markets as a “wait and see” period.

The contingency table results (Table 3) reveals that the simple rule correctly predicted 9 out of the 15 (60 percent) changes in the BoE policy rate and 83 percent of the no-change months. While the overall hit rate was about 71 percent—with 30 of the 42 decisions correctly predicted—the reliability of the model's prediction of a policy change was slightly lower at 60 percent or 9 out of 15.

### C. The ECB Governing Council

This section, follows the heuristic methodology of Gaspar, Pérez, and Sicilia (GPS), who examined the ability of euro area overnight interbank to anticipate changes in ECB policy rates. Pérez and Rodríguez (2001) showed that without market frictions and with risk neutral participants, euro area interbank funds within a reserve maintenance period (and with a reserve averaging provision) could be considered perfect substitutes. In this framework, any expected differences between current and future cost of funds would be arbitrated away. Thus, EONIA rates at the start of any reserve maintenance period theoretically should

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<sup>19</sup> The BoE supplied the data for both curves.

Table 3. United Kingdom: Contingency Table Using VRP Fitted Forward Curve

	Actual Change	Actual No Change	Predicted Total
Predicted Change	9 60.0%	6 22.2%	15 35.7%
Predicted No Change	6 40.0%	21 77.8%	27 64.3%
Actual Total	15	27	42
Reliability on changes 1/ Overall "hit rate" 2/	<b>60.0%</b>		<b>71.4%</b>

Source: IMF staff estimates.

1/ Percentage of time model signals rate change and one actually happens.

2/ Percentage of correct signals.

already incorporate expectations of changes in overnight rates until the end of the reserve maintenance period. At the same time, new information could influence rates between the start of the reserve maintenance period and the day of the Governing Council meeting. Thus, the analysis could also be run using EONIA rates the day before the Governing Council meets.<sup>20</sup>

With this in mind, the EONIA overnight rate before ECB decisions on monetary policy can be viewed a linear combination of two events as in equation (7). However, here the interest rates involved are the present main refinancing operation (MRO) rate with a 25 basis point change  $i_{25}$  and the current MRO rate  $i_0$ . Again, assuming that a  $\beta$  of 50 percent or greater implies the market expected the ECB to change interest rates, we can evaluate the number of times financial markets anticipated ECB decisions.<sup>21</sup>

Figure 3 (bottom panel) presents the results in graphical form using thresholds of +/-0.125 basis points to represent EONIA outcomes with at least a 50 percent probability of a change in the official MRO rate. Bars are used to show the size and direction of the change in interest rates. With 12 of the 77 meetings close to the end of the reserve maintenance period, we have 65 usable observations. The figure clearly highlights a number of conclusions:

<sup>20</sup> As in GPS, we eliminate meetings that fall within four days of the end of the reserve maintenance period to avoid liquidity effects.

<sup>21</sup> The average spread between EONIA and MRO rates will vary based upon a (time-varying) risk premia associated with the cyclical expectations of interest rates. Thus, as in GPS, we undertook the analysis with a "structural" spread of 3, 5, and 7 basis points. The outcomes were broadly similar, and here we report results using the 3 basis points spread.

- Although the October decision to reverse the April 1999 50 basis point cut was anticipated by markets, the second change in direction in May 2001 caught the markets by surprise;
- Financial markets were unable to anticipate any of the 5 ECB rate cuts over the last 3½ years;<sup>22</sup>
- Two of the five large rate changes were expected, although in one case (June 2000), it would appear that financial market participants were looking for a smaller 25 basis point change;
- About one-third of the market prediction errors in anticipating ECB policy actions appear in and around the fall of 2001.

The contingency table results (Table 4) reveals that the market correctly predicted 7 out of the 12 (58 percent) changes in the ECB policy rate and 83 percent of the no-change months. While the overall hit rate was about 79 percent—with 51 of the 65 decisions correctly predicted—the reliability of the model's prediction of a policy change was only 44 percent or 7 out of 16.

Table 4. Euro Area: Contingency Table Using EONIA Rates (Day-before-ECB Meetings)

	Actual Change	Actual No Change	Predicted Total
Predicted Change	7 58.3%	9 17.0%	16 24.6%
Predicted No Change	5 41.7%	44 83.0%	49 75.4%
Actual Total	12	53	65
Reliability on changes 1/ Overall "hit rate" 2/	43.8%		78.5%

Source: IMF staff estimates.

1/ Percentage of time model signals rate change and one actually happens.

2/ Percentage of correct signals.

Finally, Table 5 provides a summary of the results across all three central banks. The overall result is that the number of correct signals regarding policy decisions were roughly equal across all three central banks. The majority—about four fifths—of the policy decisions of these three central banks have been correctly anticipated by financial markets. However, on the basis of the models used here, the ECB is less predictable as regards large changes in or decreases in rates.

<sup>22</sup> This result also holds when the analysis used EONIA rates at the beginning of the reserve maintenance period.

Table 5. Summary Results of Central Bank Predictability

	Percent no changes 1/	Predictability Statistics								
		Large rate changes 2/ 3/		Changes in direction 2/ 4/		Percentage of cuts correctly anticipated 2/ 5/		Reliability of changes 6/	Incorrect signals in and around Fall 2001	Overall "hit" rate 7/
ECB	84%	(5)	40%	(2)	50%	(5)	0%	44%	1/3	79%
BoE	64%	(2)	100%	(2)	50%	(11)	73%	60%	1/3	71%
U.S. Fed	43%	(9)	56%	(2)	100%	(10)	60%	100%	2/3	85%

Source: IMF staff estimates.

1/ Percentage of monetary policy meetings in which the decision not to change rates was undertaken.

2/ Numbers in parentheses represent changes.

3/ Percentage of large rate changes correctly anticipated by financial markets. Large rate changes are defined as 50 basis points or greater.

4/ Percentage of changes in the direction of the interest rate policy cycle.

5/ Numbers in parentheses represent total number of policy rate cuts.

6/ Percentage of time model signals rate change and one actually happens.

7/ Percentage of correct signals over all policy decision days.

## VI. A VIEW FROM SHIFTS IN THE TERM STRUCTURE OF INTEREST RATES

Evidence on the predictability of central bank policy decisions can also be discerned from movements in the term structure of interest rates. From an expectations perspective, each point on the yield curve represents private sector agents' best guesses on the current and future path of official interest rates. In forming these expectations, two sources of policy reaction uncertainty can arise. The first is related to private information on the macroeconomic indicators used by monetary authorities reaction function or in the monetary transmission process itself. Surprises here would reveal themselves at the short end of the yield curve, particularly since lags on superior statistical data or monetary transmission mechanism itself is short lived. The second source of uncertainty is current and future (expected) policy targets, which may stem from imperfect policy credibility. This uncertainty on policy credibility could be due to reputation building or to an ongoing discovery process of market participants uncovering the central bank's true policy targets.

To extract a measure of interest rate surprises along the yield curve, the following equation was estimated for each area across various maturities:

$$\Delta i_t^m = \alpha + \beta(L)\Delta i_t^m + \theta\Delta i_t^p + \gamma d_t \Delta i_t^p + \varepsilon_t \quad (8)$$

where  $\Delta i_t^m$  is the change in interest rates of maturity length  $m$ ;  $\Delta i_t^p$  is the change in the central bank policy rate;  $d_t$  is a multiplicative regime shift dummy variable; and  $\varepsilon_t$  is a random error term.

Each regression uses daily data<sup>23</sup> and is based on a set maturity length. Regressions were first run for the pre-1999 period to set baseline reaction levels, and then run over the January 1999 to May 2002 period to see if the reaction of yields changed over the last 3½ years. Yields on changes in German securities and in Bundesbank policy rates are used for the euro area given the lack of a true euro-area benchmark security and the de facto Bundesbank setting of area-wide policy in the pre-ECB period. In the post-1998 period, changes in the ECB two-week repo rate are used to represent changes in the monetary authorities policy stance.

Table 6 presents coefficient estimates on the main variable of interest ( $\theta$ ) and Newey-West adjusted p-values for each of the three countries at each maturity. A comparison of the results between the two periods suggests that surprises at the short end of the yield curve have diminished in the United States and the United Kingdom since 1998. However, the comparison of euro-area and German interest rate data indicates that the surprises at the short end of the spectrum have increased—between 10 to 20 basis points—since the start of

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<sup>23</sup> All data were taken from Bloomberg. Libor rates were used at short maturities. U.K. gilt, U.S. treasury bond, and German bund rates were used at longer maturities.

Table 6. Estimates of Interest Rate Surprise Effects in the United States, United Kingdom, and Euro Area 1/

	United States		United Kingdom		Germany \ ECB	
	1991-1998	1999-2002	1991-1998	1999-2002	1991-1998	1999-2002
1-month	0.218 (0.004)	0.074 (0.034)	0.574 (0.000)	0.308 (0.001)	0.142 (0.039)	0.346 (0.000)
3-months	0.263 (0.000)	0.051 (0.197)	0.402 (0.001)	0.236 (0.003)	0.131 (0.037)	0.253 (0.008)
6-months	0.257 (0.002)	0.039 (0.386)	0.275 (0.008)	0.194 (0.014)	0.130 (0.011)	0.223 (0.003)
9-months	0.171 (0.006)	0.106 (0.064)	0.246 (0.009)	0.192 (0.023)	0.128 (0.030)	0.215 (0.002)
1-year	n.a. n.a.	0.062 (0.198)	0.206 (0.046)	0.156 (0.072)	0.117 (0.019)	0.212 (0.003)
2-years	0.232 (0.000)	0.076 (0.122)	0.191 (0.157)	0.030 (0.305)	0.064 (0.063)	0.066 (0.283)
5-years	0.154 (0.016)	0.002 (0.972)	0.088 (0.306)	0.045 (0.161)	0.066 (0.002)	0.039 (0.504)
10-years	0.081 (0.153)	-0.039 (0.502)	0.035 (0.617)	0.047 (0.080)	0.015 (0.623)	-0.019 (0.622)
20-years	0.034 (0.469)	-0.052 (0.221)	0.009 (0.845)	0.042 (0.038)	-0.010 (0.835)	-0.046 (0.255)
Nobs. 2/	2348	973	1637	975	2085	968
Noprcs. 3/	32	17	22	15	18	12

Source: IMF staff estimates.

1/ Numbers in parentheses are p-values, calculated using Newey-West adjusted standard errors.

2/ Number of observations.

3/ Number of policy rate changes.

Stage III of EMU. In all cases, there would appear to be very little change at the long end of the yield curve. Financial markets continue to view all three of these central banks as credible institutions, with well known policy targets.

## VII. CONCLUDING OBSERVATIONS

Together with the general public, media and academic community, financial markets are an important constituency group of any central bank. In particular, although central banks can control short-term interest rates through monetary policy, their control on longer-term yields and asset prices (and therefore the transmission of monetary policy) is somewhat more tenuous, being enacted mainly through the formulation of expectations. In this regard, the stability of expectations—and therefore the effectiveness of monetary policy—can be greatly enhanced if markets are able to anticipate correctly central bank policy decisions.

To some market participants, the early record of the ECB has created the impression that financial markets are less able to predict ECB policy decisions, particularly when compared to other central banks. To evaluate the validity of these impressions, this paper has examined the predictability of ECB, BoE, and U.S. Fed policy decisions over the last 3½ years.

Any comparison on the predictability of these three particular central banks should acknowledge the rather unique circumstances of the ECB. The ECB is a relatively young institution with a track record of only a few years, which has needed to be mindful of establishing its independence from political influences. In addition, unlike the Fed or the BoE, it must communicate its strategy and decisions to a very diverse constituency covering a variety of countries with distinctive political backgrounds and views on the role of monetary policy. For example, some of the ECB's communication appears to be directed toward price and wage setters, in line with a European tradition that focuses on ensuring wage moderation. An added complexity arises from communicating central bank views on fiscal policy actions, particularly given the rather distinct nature of the Stability Pact framework. These factors, plus the two pillar monetary framework, suggest that the ECB may be, a priori, somewhat less predictable than the other two older institutions.

The empirical results provide support for a number of conclusions:

- All three central banks are relatively predictable institutions with a high degree of credibility. Through prudent policy management, each institution has helped to achieve low inflation environments, and markets appear to generally understand the policy objectives and frameworks of each central bank with few marked surprises in policy decisions.
- The U.S. Federal Reserve—the most active central bank among the three with over 55 percent of meetings resulting in a decision to change rates—appears to be the most predictable central bank. Broadly speaking, the results on the predictability of the BoE fall in-between those of the U.S. Fed and the ECB. This outcome may be linked to the small size of the U.K. economy, which is subject to a sizable number of shocks. In such circumstances, the potential for disparate interpretations between the central



bank and financial markets on the implications of these shocks may be frequent, the result of which would be reflected in “unanticipated” policy decisions.

- In the case of the ECB, the market has had difficulty anticipating—at least in our calculations—large changes and cuts in policy interest rates. To some extent, this may be due to the large number of Governing Council meetings with no policy changes and the debate about the ECB’s monetary framework. A second factor may have been that rate cuts (4 out of the 5) have taken place during periods when the monthly bulletin was indicating a neutral bias in policy rates for the medium term. The market’s mediocre record in predicting cuts in ECB policy rates, however, may be related to a specific characteristic of the euro-area inter bank market. For example, inter bank yields may not be able to respond quickly to rate cut signals given the well-known tendency of banks to be short of reserves preceding the end of the reserve maintenance period. Thus, additional work on the predictability of ECB policy decisions will need to examine other markets.
- Finally, the finding of a high degree of overall policy predictability among these three central banks during a relatively turbulent period demonstrates that a variety of monetary policy frameworks, be it inflation targeting, a uniquely continental European two-pillar system, or a more discretionary U.S. model can be successfully understood by financial markets.

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