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Abstract

The paper shows that central bank communication is a key determinant of the market's ability to anticipate monetary policy decisions and the future path of interest rates. Comparing communication policies by the Federal Reserve, the Bank of England and the ECB since 1999, we find that communicating the diversity of views among committee members about monetary policy lowers the market's ability to anticipate policy decisions as well as the future path of interest rates. This effect is sizeable, accounting for instance for one third to half of the prediction errors of FOMC policy decisions. By contrast, individualistic communication regarding the economic outlook is found to be beneficial for the Federal Reserve, enabling market participants to better anticipate the future path of interest rates. Thus, it is the collegiality of views on monetary policy but the diversity of views on the economic outlook that enhance the effectiveness of central bank communication.

JEL classification: E43, E52, E58, G12

Keywords: communication; monetary policy; committee; effectiveness; economic outlook; Federal Reserve; Bank of England; European Central Bank.

Non-technical summary

Communication plays a central role for monetary policy making. Central banks have direct control only over a single interest rate, usually the overnight rate, while their success in achieving their mandate requires that they are able to influence asset prices and interest rates at all maturities. Effective communication as much as credible policy actions are of fundamental importance for achieving these objectives. As in most central banks decisions are taken by a committee, the question arises whether committee members should communicate in a collegial manner, by conveying the consensus or majority view of the committee, or in an individualistic way, by stressing and conveying the diversity of views among the committee members. Communicating the diversity among individual committee members might help markets understand better the uncertainties surrounding the current assessment of the monetary policy stance. On the other hand, dispersed communication may not necessarily provide greater clarity and common understanding among market participants, making it advisable for central banks to communicate "with one voice".

This paper analyses which elements of communication are effective in raising predictability of upcoming policy decisions and the future path of monetary policy and reducing market uncertainty. For this purpose, we analyse the communication strategies pursued by the Federal Reserve, the Bank of England and the European Central Bank for the time period from January 1999 until May 2004. These three central banks have been shown to have fundamentally different strategies, with the Federal Reserve being more individualistic in its communication as FOMC members mostly express their personal views in the inter-meeting period, while the Bank of England and the ECB have followed more collegial strategies where statements of committee members mostly reflect the views of the committee as a whole and are consistent with one another

The paper finds that a higher degree of dispersion in the communication about the monetary policy inclination by committee members worsens the ability of financial markets to anticipate future monetary policy decisions and raises the degree of market uncertainty, a finding that is apparent for all three central banks. This effect is sizeable, as dispersion in the communication on monetary policy among FOMC members, for instance, accounts for about one third to one half of the market's prediction errors of FOMC monetary policy decisions since 1999. On the other hand, communicating the risks and diversity of views regarding the economic outlook enhances the financial markets' ability to anticipate the future path of interest rates, although this is found to be the case only for the Federal Reserve. Moreover, we find that also the balance-of-risk assessment provided by the FOMC since May 1999 has helped markets anticipate the future path of interest rates. Finally, a higher frequency of communication also tends to help markets predict future monetary policy decisions.

The findings of the paper suggest a number of policy implications. Communication has an important role in helping markets anticipate monetary policy and reducing market uncertainty. However, the contrasting findings with regard to the effects of dispersed communication about the monetary policy inclination and the economic outlook suggest that central banks should distinguish between these two types of communication. It is the collegiality of views on monetary policy but the diversity of views on the economic outlook that appear to enhance the effectiveness of central bank communication and policy making.

1. Introduction

Communication plays a central role for monetary policy making. Central banks have direct control only over a single interest rate, usually the overnight rate, while their success in achieving their mandate – whether the focus is on price stability or on economic activity – requires that they are able to influence asset prices and interest rates at all maturities. Effective communication as much as credible policy actions are of fundamental importance for achieving these objectives.

But how should central banks communicate? In particular, should they communicate in a collegial manner, by conveying the consensus or majority view of the committee, or in an individualistic way, by stressing and conveying the diversity of views among the committee members? On the one hand, some policy-makers have argued that it is important to communicate this diversity among individual committee members as it helps markets understand the risks surrounding policy decisions and anticipate monetary policy decisions (e.g. Bernanke 2004). On the other hand, others have argued that such a communication strategy may not necessarily provide greater clarity and common understanding among market participants and thus that it may be important for central banks to communicate "with one voice" (e.g. Issing 1999, 2005).

We start from the conjecture that central bank communication strategies pursue two central goals: first, to allow financial markets to anticipate the policy decisions as well as the future path of monetary policy; and second, to reduce the uncertainty surrounding these expectations. Of course, this does not imply that it may not be necessary at times to surprise markets with policy decisions, but in principle a high degree of predictability and a low degree of uncertainty are important elements for the credibility and effectiveness of monetary policy.

The paper analyses which elements of communication strategies are effective in achieving these objectives of raising predictability and reducing market uncertainty. For this purpose, we analyse the communication strategies pursued by the Federal Reserve, the Bank of England and the European Central Bank for the time period from January 1999 until May 2004. These three central banks have been shown to have fundamentally different strategies, with the Federal Reserve being more individualistic in its communication as FOMC members mostly express their personal views in the inter-meeting period, while the Bank of England and the ECB have followed more collegial strategies where statements of committee members mostly reflect the views of the committee as a whole and are consistent with one another (Ehrmann and Fratzscher 2005c). There may be various reasons for the adoption of such fundamentally different communication strategies, and to some extent the differences may reflect the political and institutional environments the three central banks operate in.

In our analysis we distinguish between several distinct elements of communication strategies. First, we analyse the effect of communication dispersion, i.e. the degree of disagreement among committee members – as well as the disagreement with committee statements – about the future path of monetary policy and about the economic outlook. In particular we ask: does more or less dispersion lead to better predictability of monetary policy decisions and less uncertainty? Second, we ask whether the frequency and the information content of communication affect the predictability of decisions and the underlying uncertainty. And third, we study and control for the effects of several other factors, such as the degree of uncertainty created by the release of macroeconomic data and other sources of uncertainty.

The empirical results are compelling by showing that a higher degree of communication dispersion among committee members about monetary policy worsens the ability of financial markets to anticipate future monetary policy decisions and raises the degree of market uncertainty. This finding is highly robust and significant across all three central banks. And it

is sizeable in its magnitude as dispersion in the communication on monetary policy among FOMC members, for instance, accounts for about one third to one half of the market's prediction errors of FOMC monetary policy decisions since 1999. The second key result is that communicating the risks and diversity of views on the committee surrounding the economic outlook enhances the financial markets' ability to anticipate the future *path* of interest rates. This finding, however, is present in the data only for the Federal Reserve. This may imply that this characteristic is specific only to the communication strategy of the Federal Reserve, or alternatively may reflect differences in monetary policy strategies in that the Bank of England's and the ECB's primary focus is on price stability. Moreover, we find that also the balance-of-risk assessment provided by the FOMC since May 1999 has helped markets anticipate the future path of interest rates. Finally, a higher frequency of communication also tends to help markets predict future monetary policy decisions. This evidence is suggestive that markets may take some time to fully incorporate information and communication by central banks, and thus that frequent statements, independent of whether or not they are in line with previous statements with the committee or other committee members, may enable markets to better anticipate policy decisions.

The findings of the paper suggest a number of policy implications. Overall, the results imply that communication indeed plays a central role for helping markets anticipate monetary policy as well as for reducing market uncertainty. However, central bank communication on monetary policy that is dispersed and shows the disagreement within the committee worsens the predictability of decisions and raises market volatility. By contrast, communication that provides a variety of views on the economic outlook and surrounding risks may help financial markets to better understand the economic environment and thus the likely future path of monetary policy. Overall, this suggests that it is important for central banks to distinguish between communicating information about monetary policy and the economic outlook. It is the collegiality of views on monetary policy but the diversity of views on the economic outlook that appear to enhance the effectiveness of central bank communication and policy making.

The paper is organised in the following way. Section 2 offers a brief discussion of the communication strategies of the three central banks and a brief review of the related literature on central bank communication. Section 3 outlines the measurement of communication and its dispersion in the three central banks. The hypotheses, the underlying data and the methodology for the empirical analysis are presented in section 4. Section 5 then provides the empirical analysis of the effects and effectiveness of communication, as well as several robustness tests. Section 6 offers conclusions and draws some policy implications.

2. Central bank communication and committees

Central bank communication in principle occurs through two channels: by the policy-making committee and by its individual members. The former may include statements commenting and explaining decisions on meeting days but also publications in the inter-meeting period such as minutes of past meetings or Inflation Reports and Monthly Bulletins. However, the communication by individual committee members – such as through testimonies, speeches and interviews – is highly influential as it may provide more detailed information, in particular about the diversity of views and the discussions in the committee, and is usually far more flexible in its timing and content than the statements by the committee itself.

Two important choices central banks need to make relate to the amount of information they may wish to provide to the public as well as on the extent to which they reveal diversity of views in the committee. Each of these two choices is important and can be highly sensitive. To the former, many central banks provide some information about the likely future path of

monetary policy and the economic outlook. But how explicit should a central bank be in this regard? Many central banks publish their staff projections about key economic variables, and some also reveal explicit inflation projections. Others have even gone so far as to provide an explicit forecast of their likely path of future monetary policy rates. While more, and more explicit information may help guide financial markets, there are several risks behind such communication strategies. In particular, such information may be falsely understood by financial markets as implying explicit commitments on behalf of central banks, rather than conditional commitments that may have to be altered, sometimes even radically if underlying economic conditions change.

The second choice for a communication strategy is how much of the diversity of views in the committee a central bank may wish to provide to the public. Forward-looking information is generally surrounded by a substantial degree of uncertainty, which may change over time and be dependent on a variety of economic factors. A central bank must decide to what extent it wants to provide the public with information about the uncertainty it sees, to provide an assessment of the risks and the degree of uncertainty of the economic environment surrounding monetary policy making and to allow market participants to hedge against these risks. But how much of this information should central banks communicate? And in particular, how much of the diversity of views and the disagreement among committee members should be provided to the public?

Several studies in the literature imply that communication, and communication dispersion in particular, may not necessarily be desirable. Amato, Morris and Shin (2002), based on the conceptual work in Morris and Shin (2002), suggest that central bank communication may at times lead markets away from equilibrium, though Svensson (2005) argues that the validity of this argument is based on rather strong assumptions regarding the signal-to-noise ratio of central bank communication. Others (e.g. Winkler 2000) underline that more information, in particular if it reveals dispersion among committee members, may be undesirable if it reduces the degree of clarity and common understanding among market participants. Moreover, there is a limit to how much information individuals can digest (e.g. Kahneman 2003). Thus communication, and underlying transparency of central banks, may not be an end itself, but merely a means that allows the central bank to fulfil its mandate more effectively (Mishkin 2004).

On the empirical side, a number of recent studies have analysed the effect of communication on asset prices. Kohn and Sack (2004) investigate the effect of statements by Federal Reserve Chairman Greenspan on the volatility of various asset prices and find that overall they have had a sizeable effect. Ehrmann and Fratzscher (2005c) take a broader perspective by analysing and comparing the effects of communication on monetary policy and the economic outlook between the Federal Reserve, the Bank of England and the ECB. The paper finds that communication about the monetary policy inclination of committee members is highly effective, but that markets react significantly to statements about the economic outlook only by the FOMC. Moreover, the paper compares the degree of communication dispersion and relates it to the voting behaviour and the predictability of decisions by the three central banks.

Other papers that have focused on the content and dispersion of communication are Jansen and de Haan (2004) who have found that the degree of dispersion in the ECB's communication about the outlook for monetary policy was higher in the initial period after is start in 1999 and has declined over time. Gerlach (2004) analyses the content of the introductory statements of the ECB's Monthly Bulletins and concludes that it can explain well the overall interest rate setting of the euro area.

Gürkaynak, Sack and Swanson (2005) and Ehrmann and Fratzscher (2005b) concentrate on the communication of the Federal Reserve on FOMC meeting days, in particular the effectiveness of the balance-of-risks assessments the Federal Reserve has been providing

since May 1999. Gürkaynak, Sack and Swanson (2005) find that the bias has indeed been an effective guide of market expectations about the path of monetary policy. Ehrmann and Fratzscher (2005b) also find that the balance-of-risks assessment has enhanced the market's ability to anticipate future decisions, but that this type of information has crowded out other sources of information. The paper shows that financial markets were equally good in anticipating the Federal Reserve's policy decisions prior to 1999 as they are under the new disclosure regime since 1999. In particular, markets drew more information from other types of FOMC communication prior to 1999, so that on average market participants nowadays obtain their information more directly through balance-of-risks assessments but are overall not better in predicting decisions. Moreover, Bernanke, Reinhart and Sack (2004), Eggertsson and Woodford (2003) and Woodford (2005) stress that communication by the Federal Reserve has been particularly important when there was a risk that the US economy might be heading into a deflation and interest rates might hit the zero lower bound.

Blinder and Wyplosz (2004) provide a broader framework for analysing the functioning and set-up of different central bank committees. They distinguish between collegial and individualistic committees and central banks where decisions are taken by individuals, such as e.g. the Reserve Bank of New Zealand. Their study encompasses a wider strand of the literature that has analysed the role of committees in the decision-making process. There is a broad consensus that decision-making in committees has improved the overall quality of the decisions, partly because it allows for learning and pooling of information (Blinder and Morgan 2005; Lombardelli, Proudman and Talbot 2005) and partly because it enhances the flexibility of policy to respond to shocks of different magnitude and nature (Sibert 2003, Mihov and Sibert 2004). At the same time, it has been shown that the voting record of committees, if released to the public, can provide useful information about future monetary policy decisions (Gerlach-Kristen 2004).

Despite these various strands of the literature on central bank communication, to our knowledge no paper has so far attempted to provide a systematic assessment of the effectiveness of communication for monetary policy making. In particular, understanding how communication affects the predictability of policy decisions and the path of future interest rates as well as the degree of market uncertainty surrounding policy decisions is crucial for assessing the overall effectiveness and success of central bank communication strategies. This is the objective of the remainder of the paper and its intended contribution to the literature.

3. Measuring communication and its dispersion

We now turn to the issue of measuring communication by the policy-setting committees and its members. In particular, for the purpose of the analysis we want to identify a measure of communication dispersion or disagreement among the committee members.

3.1 Communication

Central bank communication occurs through two principal channels: statements by the committee as a whole, and statements by the individual committee members. There may be various motivations for central banks to choose their communication strategies and to balance their communication between statements of the committee and those by the individual committee members. Many central bank committees, including those of the Federal Reserve, the Bank of England and the European Central Bank, in general make statements at pre-announced dates, usually using a standard format in terms of language and structure. Since May 1999 the FOMC issues a statement explaining its policy decision on its meeting days, also offering a balance-of-risks assessment about its views of underlying risks to inflation and to the economic outlook. The Governing Council of the ECB provides an introductory

statement followed by a press conference, where the President and Vice-President answer additional questions from the media. The MPC of the Bank of England often does not provide any explanatory statements when it announces decisions that monetary policy rates remain unchanged.

Each of the three committees provides some additional information during the inter-meeting period: The FOMC and the MPC publish the Minutes, the ECB its Monthly Bulletin. Additional important publications by central banks are the quarterly Inflation Report by the Bank of England, the Beige Book by the Federal Reserve and the Annual Report by the ECB.

By contrast, the communication by the individual committee members – such as testimonies, speeches and interviews – occur much more frequently and tend to be more flexible in their timing and content. Although some of these statements, in particular testimonies to the legislatures, tend to be at pre-determined dates and have a fixed content in terms of topics, the great majority of statements by committee members are discretionary in nature and thus give the central banks a substantial degree of flexibility and the ability to communicate virtually at any time and on any topic it chooses.

For the measurement of communication, we want to obtain all pieces of communication of each central bank, by the committee as well as by its individual members, which are relevant for monetary policy. We use the newswire service *Reuters News* to extract all statements by the committee members in real time, i.e. on the day they occur. We are also careful in focusing on forward-looking statements and in avoiding duplication of statements in the database. We make a distinction between statements about the monetary policy inclination and statements about the economic outlook. The extraction is done in a mechanical manner using a set of search words, including the name of the policy maker together with the words interest rates, monetary policy or inflation for statements about monetary policy and together with the words economy and economic outlook for the second type of communication. Although different classifications are possible, we decided to adopt such a relatively simple categorisation, also following the examples by the work of Guthrie and Wright (2000), Kohn and Sack (2004) and Ehrmann and Fratzscher (2005c).

As a final step, we classify the statements by the committee members into those that indicate an inclination towards monetary policy tightening, those that suggest an easing, and those that are neutral. An analogous classification is done for the communication on the economic outlook:

$$C_t^{MP} = \begin{cases} +1 & \textit{tightening inclination} \\ 0 & \textit{no inclination} \\ -1 & \textit{easing inclination} \end{cases}$$

$$C_t^{EC} = \begin{cases} +1 & \textit{stronger econ. outlook} \\ 0 & \textit{unchanged econ. outlook} \\ -1 & \textit{weaker econ. outlook} \end{cases}$$

The classification of the statements is important and thus needs a more detailed discussion. The technique of extracting meaning from language is often referred to as content analysis (e.g. Holsti 1969). The idea of content analysis is to devise a number of rules to provide a clean classification and to minimise the number of false classifications. In our case, the statements have been double-checked by the authors and independently by the research analyst. In case there was a disagreement on the classification, other reports were used to classify the statement. A statement was discarded if no agreement could be reached. Overall,

most statements were judged to be unanimous and only a relatively small number of statements was excluded from the analysis.

Nevertheless, a number of additional caveats should be stressed at this point. First, the list of statements included in our database may not capture all statements by all committee members as *Reuters News* may be selective in its reporting. Second, statements by policy-makers may be misreported or be misinterpreted by the markets, and may thus trigger a reaction that is undesired by the policy maker and his or her central bank committee. Although we recognise the potential relevance of these caveats, for the purpose of this study we are primarily interested in the information that market participants receive, and thus we are less concerned for instance by the fact that newswire services may decide not to report all statements.

Table 1 provides an overview of the communication data in our database for the three central banks. The number of statements by committee members of the three central banks is larger for the Federal Reserve and the ECB and lower for the Bank of England, partly reflecting the larger number of committee members for the two former – 19 and 18 members for the FOMC and the Governing Council respectively – compared to 9 members in the MPC of the Bank of England. Moreover, a notable difference between the three central banks lies in the significantly larger number of neutral statements by MPC and Governing Council members as compared to FOMC members. As argued in Ehrmann and Fratzscher (2005c) these differences reflect mainly different communication strategies by the three central banks. We will return to this issue below when discussing communication dispersion.

As an alternative classification of communication, we use the reaction of three-month interest rates on the day of the statement, or more precisely the difference of the closing quote with that of the previous day, as a proxy for the content of each statement. For instance, a statement on monetary policy on a day when interest rates rise is classified as a tightening statement. This same classification is used for the releases of statements by the committee as a whole (Minutes but the FOMC and the MPC, Inflation Report of the bank of England, Monthly Bulletin and Annual Report by the ECB). Clearly, such a classification procedure may be imprecise as several other pieces of relevant news may occur on the day when a statement is made. However, we use this classification mainly as a robustness check in our analysis. In fact, given the importance of central bank communication for interest rates it turns out that both classification procedures provide very similar classifications of the statements and the empirical results below are robust to using either one.

3.2 Communication dispersion

As a second step, we are interested in measuring the degree of disagreement or dispersion of communication across committee members as well as between statements by individual committee members with those by the committee. An important starting point is the question of which time span to choose for measuring communication dispersion. The inter-meeting period between two monetary policy meetings seems a natural choice of data frequency because it is surrounded by two policy decisions by the committee. Each meeting provides a decision on monetary policy rates, and subsequently market participants have to start anew to form their expectations about the subsequent policy decision. Market participants use the communication provided by the committee and by individual members, as well as other types of information such as macroeconomic news, to shape their expectations about the future policy decisions.[1]

[1] Note that this implies a relatively small sample size of 43 observations for the Federal Reserve, 63 for the Bank of England and 97 for the ECB.

Figure 1 illustrates in a stylised fashion the sequence in each inter-meeting period. After a few days following each policy meeting, statements are provided by the committee or by members. The flow of communication continues until before the subsequent policy meeting, though often committee members may have agreed on a purdah or blackout period, i.e. a certain number of days before each meeting (or other important events such as testimonies) during which no external communication to the public is taking place. We term the period during which communication takes place as our "communication event window" and the periods before and after as pre-event and post-event windows.

As our main objective of the paper is to understand the impact of communication on the predictability of decisions, we are primarily interested in the effectiveness of communication events as such, and not merely in the individual statements that constitute each event. Hence our unit of observation is each inter-meeting period and its corresponding communication event.

An important element of communication for our analysis is the degree of dispersion or disagreement among committee members. To measure the degree of dispersion in each inter-meeting period, we use the dispersion measure used in Jansen and de Haan (2004) and Ehrmann and Fratzscher (2005c), which is defined as follows:

$$\Omega_t^{MP} = \frac{\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left|C_i^{MP} - C_j^{MP}\right|}{\frac{1}{2}\cdot\left(N^2 - D\right)} \qquad (1)$$

with N as the number of statements in the inter-meeting period t, C^{MP} the statements on monetary policy classified as {-1,0,+1}, as outlined above, and a dummy D with D=0 if N is an even number and D=1 if it is odd. This normalisation allows us to obtain a dispersion measure that lies strictly between zero and one, with $\Omega_t = 0$ if no dispersion is present and all committee members provide statements with the same inclination about monetary policy. $\Omega_t = 1$ if there is a maximum of degree of dispersion across statements within an inter-meeting period t. An analogous definition of dispersion is used for statements between committee members and that of the committee as a whole in the inter-meeting period, as well as for statements about the economic outlook C^{EC} as discussed above.

Table 2 shows some summary statistics of these different communication dispersion measures for the three central banks. A number of interesting stylised facts stand out. In particular, the degree of dispersion is highest for communication of FOMC members. For instance, monetary policy communication dispersion is with 0.278 among FOMC members about twice as large as that of Governing Council members and even larger than that of the MPC. This underlines that the Federal Reserve is pursuing a highly individualistic communication strategy, though one in which the Fed Chairman may take a prominent role, and in which individual members express their personal views about monetary policy and the economic outlook. By contrast, communication at the Bank of England and the ECB is more collegial.

It is important to emphasise that these differences may not imply that FOMC members are more or more often in disagreement about monetary policy decisions than their peers at the MPC or the Governing Council. As explained by some policy-makers (e.g. Bernanke 2004), the FOMC may intentionally choose to share the diversity of views of its members with the public, whereas the approach of the Bank of England and the ECB is more collegial and thus

exhibits a substantially lower degree of dispersion. Somewhat surprising may be the finding of a relatively low degree of dispersion for the Bank of England as the MPC is generally perceived to be a relatively individualistic committee (Blinder and Wyplosz 2004). Only part of this low dispersion is due to the lower overall number of statements by the relatively fewer MPC committee members. Another reason for the low dispersion may be explained by internal agreements among MPC members to either not communicate or to communicate the committee view, rather than their personal views, before some important statements by the MPC, such as the release of the Minutes or the Inflation Report. A detailed discussion of these issues is provided by Blinder and Wyplosz (2004) and Ehrmann and Fratzscher (2005c).

4. Hypothesis, data and methodology

Two central goals of central bank communication strategies are, first, to enable financial markets to anticipate well the future path of monetary policy; and second, to reduce the uncertainty surrounding these expectations. Of course, this does not imply that it may not be necessary at times to surprise markets with policy decisions, but in principle a high degree of predictability and a low degree of uncertainty are important elements for the credibility and effectiveness of monetary policy. This section discusses the key hypothesis and the data definitions and sources used (section 4.1), and then outlines the empirical methodology (section 4.2).

4.1 Hypothesis and data

A successful communication strategy should imply that monetary policy decisions are anticipated well by financial markets. We employ two alternative proxies as measures of predictability: first, the surprise component of interest rate decisions, measured as the absolute value of the difference between the actual decision and the mean of the survey expectations conducted by Reuters. Reuters conducts these surveys among a fairly wide set of market participants and observers a few days before each decision. This survey-based measure has been shown to be an efficient and unbiased proxy for the surprise component of monetary policy decisions (Ehrmann and Fratzscher 2005a). As an alternative measure, we use the absolute change of the one-month interest rate on the day of the monetary policy meeting. For the United States, we also tested the change of the Fed funds future rates on FOMC meeting days. The results proved robust to using this proxy, but due to lack of comparable data for the UK and the euro area, our preferred measure is the one based on the survey data.

As the second objective, markets should exhibit a low degree of uncertainty surrounding monetary policy decisions if the path of monetary policy is well understood. We therefore also analyse the behaviour of interest rate volatility prior to monetary policy meetings. We do so through the standard deviation of the daily changes in three-month money market or t-bill rates immediately prior to each meeting, but restricted to the post-event period (see Figure 1), i.e. to a period when no communication occurs, in order to avoid a possible endogeneity problem with central bank communication.

Table 2 shows some summary statistics for predictability and interest rate volatility around decisions for the Federal Reserve, the Bank of England and the ECB for the time period covering January 1999 until May 2004. The table indicates that policy decisions by the Federal Reserve and the ECB are most predictable as the surprise components of policy decisions have been on average 3.4 basis points for the FOMC and 3.0 basis points for the

Governing Council. MPC decisions are somewhat less predictable as the average surprise has been 4.8 basis points since 1999.[2]

What explains the predictability of monetary policy decisions? There are several factors that may influence that predictability of policy decisions. The main variables of interest to us here are the ones of central bank communication. The communication variables include the dispersion measures across committee members and vis-à-vis the committee as a whole, as discussed in section 3, but also the frequency of communication and the size of communication effects. The frequency is measured as the number of central bank statements by the committee and its members, while the size variable is the cumulated change in three-month interest rates on communication days in the inter-meeting period. The reasoning for including these variables is that it may not only be the dispersion of communication, but also the relevance and importance of the statements that influence the predictability of decisions.

Of course communication is only one factor determining the predictability of monetary policy decisions. Policy decisions may be hardest to predict when there is a high degree of underlying economic uncertainty. In such an environment, it is more likely that economic news are contradictory and do not provide a unanimous message about the path of the economy. We proxy such market uncertainty in two separate ways. A first measure is to analyse the uncertainty and conflicting messages emanating from the release of macroeconomic news in the inter-meeting period. We use ten of the most relevant macroeconomic news releases for each of the three countries and areas to construct a *macro news dispersion* measure similar to those for communication dispersion defined in (1).[3]

As for communication, the classification of macro news surprises is done in two ways: a first one by classifying them according to the expected impact on interest rates, e.g. a positive US GDP surprise should lead to higher interest rates, while a rise e.g. in US unemployment should induce lower rates. The second proxy is similar to the alternative one for communication dispersion as we use the actual reaction of interest rates on the day of the release as a proxy for whether the news was perceived by the markets as a positive or as a negative signal about the economy. Both proxies produce very similar measures of macro news dispersion. Moreover, similar to that for communication also the frequency and overall market impact of macro news are included as controls.

Second, other factors apart from the measurable macroeconomic news may also influence the degree of market uncertainty and thus the perception of the outlook for monetary policy and the economy. As a second measure for the underlying uncertainty, we use the *volatility of short-term (3-month) interest rates* in the inter-meeting period. In other words, a larger degree of interest rate volatility is likely to reflect a larger extent of uncertainty, which in turn may make it more difficult to anticipate monetary policy decisions. In order to avoid a potential endogeneity that communication or macro news may cause more interest rate volatility, we measure interest rate volatility as the standard deviation of its daily changes during the pre-

[2] Note that the measures shown in Table 2 exclude unscheduled policy meetings, in particular the policy changes by the three central banks on 17/18 September 2001 following the attacks of 11 September 2001. In line with this, also the dispersion measures do not include time periods prior to unscheduled policy meetings. The dispersion measures of the subsequent, scheduled meetings, include only information as from the unscheduled policy meeting.

[3] The set of macro news comprises advance GDP, consumer confidence, CPI, industrial production, ISM survey, nonfarm payrolls, PPI, retail sales, trade balance and unemployment for the United States; GPD, earnings, industrial production, manufacturing production, M4, PPI, RPIX, retail sales, trade balance and unemployment for the UK; euro area business confidence and consumer confidence, German ifo business climate, industrial production, PPI, retail sales, trade balance, unemployment, CPI and GDP for the euro area. We use the surprise component within each macroeconomic announcement, by subtracting a survey-based expectation measure (obtained from MMS International) from the actually released figure.

event window, i.e. before communication takes place in each inter-meeting period. Table 2 above provides some summary statistics for the macro news dispersion measure and for the inter-meeting interest rate volatility measure.

Finally, we control for the potential role of past monetary policy decisions by including a dummy for whether monetary policy rates were changed at the previous meeting. Moreover, we include additional dummies for the FOMC on whether it issued an asymmetric balance-of-risk assessment at the past meeting, and for the MPC whether it published an Inflation Report in the current inter-meeting period. Both of these are important pieces of communication by the committees and may thus influence the ability of market participants to predict the next policy decisions. Other committee communications, in particular the release of the Minutes by the Federal Reserve and the Bank of England and the Monthly Bulletin for the ECB, were tested in the model. The variables did not have any additional effect apart from that captured in the measure communication dispersion with committee releases.

4.2 Methodology

For the formulation of the model, we need to take into account that the dependent variable – the absolute size of the surprise component of monetary policy decisions – is censored to lie at or above zero. In fact, a number of policy decisions by the Federal Reserve, the Bank of England and the ECB are predicted perfectly so that some observations lie on the lower limit of the distribution at zero. This requires estimating a censored regression or tobit model, which is formulated as follows:

$$y_t^* = x_t' \beta + \varepsilon_t \tag{2}$$

where

$$y_t = \begin{cases} y_t^* & if \quad 0 \le y_t^* \\ 0 & if \quad y_t^* < 0 \end{cases}$$

with y^* as the latent, i.e. unobservable variable, y_t the observable variable measuring the surprise component of monetary policy decisions, x_t the vector of independent variables, and t as the time dimension of the inter-meeting periods. The marginal effect of a change in x_t with regard to the observable variable y_t is

$$\frac{\delta E[y_t \mid x_t]}{\delta x_t} = \beta \cdot prob[0 < y_t^*] = \beta \Phi \left(\frac{\beta' x_t}{\sigma} \right) \tag{3}$$

under the condition that the disturbance $\varepsilon_t \sim N(0, \sigma^2)$, and with β as the marginal effect of x_t with regard to the latent variable y^*. All results shown below refer to this marginal effect of x_t with regard to the observable variable y_t. The model is estimated via maximum likelihood estimation of the log-likelihood function for the censored regression at $y_t=0$:

$$\ln L = \sum_{y_t>0} -\frac{1}{2} \left[\log(2\pi) + \ln \sigma^2 + \frac{(y_t - x_t'\beta)^2}{\sigma^2} \right] + \sum_{y_t=0} \ln \left[1 - \Phi \left(\frac{x_t'\beta}{\sigma} \right) \right]$$

which is a mixture of a continuous distribution – for the linear regression of the non-limit observations, and a discrete distribution – for the limit observations at $y_t=0$, again under the condition that ε_t is normally distributed.

5. The effectiveness of communication and its dispersion

We now turn to the empirical analysis. The central objective is to assess the effect of communication and its dispersion on different normative dimensions of monetary policy: on the predictability of the next policy decision (section 5.1), on the degree of uncertainty and interest rate volatility surrounding the next decision (section 5.2), and on the future path of interest rates (section 5.3).

5.1 The predictability of monetary policy decisions

How does central bank communication and its dispersion affect the predictability of monetary policy decisions? Apart from communication dispersion, as discussed in detail in section 4.1, we control for other relevant factors influencing the predictability of decisions. These factors include those that create market uncertainty, as proxied by macro news dispersion and interest rate volatility, as well as the frequency and size of communication and macro news. Moreover, we control for other types of committee communication, such as dummies for the asymmetry of the FOMC balance-of-risks statements and whether an MPC Inflation Report was issued in the respective inter-meeting period, as well as a dummy for whether monetary policy rates were changed at the previous meeting.

Table 3 shows the results for the Federal Reserve, the Bank of England and the ECB, using three specifications starting from a simple model (1) that includes only the communication dispersion and macro dispersion variables, and leading to a more extensive model (3) that includes all sets of variables discussed above. Communication dispersion on monetary policy and on the "economic outlook" refer to the dispersion across committee members, while the second row "with committee releases" is for the dispersion on monetary policy between the committee members and the release of the committee (Minutes, Inflation Report, Monthly Bulletin etc.).

The key result is that communication dispersion on monetary policy in most cases lowers the predictability of policy decisions significantly, i.e. it raises the market surprise of policy decisions. By contrast, communication dispersion neither on the economic outlook nor with the committee matters for predictability. The size of the effect of communication dispersion on monetary policy is quite large. For the Federal Reserve, a high degree of communication dispersion in an inter-meeting period, i.e. when this dispersion variable is one as opposed to zero, raises the surprise of the FOMC decision by between 4 and 5 basis points.[4] Given that the average surprise of FOMC decisions is around 3.4 basis points, as shown in Table 2, this implies that dispersion among committee members about monetary policy has a substantial overall effect on the predictability of monetary policy. As the average degree of communication dispersion on monetary policy is 0.27, as indicated in Table 2, this suggests that overall this communication dispersion has accounted for about one third to one half of the market's prediction errors of FOMC monetary policy decisions since 1999.

[4] Recall from equation (3) that the point estimates shown in the tables for the tobit estimators are marginal effects evaluated at the respective means of the vector independent variables x_t, and thus one cannot easily evaluate the effect of *any* change in x_t on the dependent variable y_t. However, evaluating the model at each dispersion measure of zero and then comparing it to the predicted value with the respective dispersion measure at one, shows that the overall effect of such a change is very similar, in most cases only slightly larger than the marginal effects shown in the tables. For instance, for Table 3 a change of US communication dispersion on monetary policy in model (3) from zero to one raises the prediction error by 4.9 basis points as compared to a marginal effect of 4.1 (or 0.041) shown in the table. For most other comparisons this difference is smaller. Moreover, note that the coefficients shown for dummy variables are for a discrete change of the respective dummy variables from zero to one.

The magnitude of this effect is even somewhat larger for the MPC of the Bank of England. A high degree of communication dispersion on monetary policy lowers predictability of MPC decisions by between six and ten basis points. However, it should be stressed that the average degree of dispersion on monetary policy of the Bank of England is much lower than that of the Federal Reserve (see Table 2), so that overall communication dispersion worsens predictability of decisions by the MPC somewhat less than that by the FOMC. For the ECB, communication dispersion on monetary policy has a statistically significant effect in the extended specification (3); the effect is the smallest of the three central banks, though it is still sizeable at around 3 basis points.

As to the role of market uncertainty, we find that higher interest rate volatility in the inter-meeting period lowers the predictability of decisions by the Federal Reserve and by the ECB. Interest rate volatility has been normalised so as to have a standard deviation of one, so that the coefficients reveal that an increase in volatility by one standard deviation raises the surprise component of the policy decision by 1.6 to 1.8 basis points for the FOMC. Positive but not statistically significant coefficients are found for the respective effect for the Bank of England.

The third variable that shows some systematic impact on policy predictability is the frequency of communication for the FOMC and the MPC. The variable is defined as being one if the number of statements by the committee and its members is larger than its average over all inter-meeting periods and zero otherwise. The empirical finding is interesting as it suggests that communicating more improves the predictability of decisions by around 1 basis point or more.

The only other variables that show any significance are the dummy for an interest rate change in the previous meeting, which for the ECB means that if a change occurred at the last Governing Council meeting the surprise of the subsequent decision is lower. Moreover, big surprises to macroeconomic news in the inter-meeting period lower predictability for the ECB.

Finally, we conduct several sensitivity tests to check for the robustness of our results. Two key issues are the possibility of an omitted variable bias of our results and the potential endogeneity of communication dispersion. The reasoning goes as follows: the fact that we find a significant effect of communication dispersion on predictability in Table 3 may simply reflect the possibility that communication dispersion is influenced and determined by other factors that are not included in the model. For instance, high communication dispersion may merely reflect the large degree of macroeconomic uncertainty caused by conflicting or unclear signals coming from macroeconomic or other news, which in turn lead to lower predictability of policy decisions (omitted variable bias). Alternatively, policy decisions may be more difficult to predict when interest rates are changed, which in turn may raise the degree of disagreement and thus communication dispersion in the inter-meeting period (endogeneity bias).

We deal with these issues in two separate ways. First, we include as broad a set of control variables as possible in our model. Hence our preferred specification is the one shown in columns (3) in Table 3 as here we can control for several other factors. However, as a comparison of the various specifications ranging from a more minimalist specification (1) to a more extensive one in (3) shows, the results with regard to communication are robust, both in terms of significance and in terms of the size of the coefficients. We also tested for other definitions of the various variables, including the alternative measures of dispersion discussed in section 4. The results are robust to these tests, but for brevity reasons are not shown.

Further variables that were added to the regression and tested, but did not alter results, are i) dummy variables indicating whether the balance of views expressed by the committee is in line with the balance of views expressed by the head of the committee, separately for monetary policy and the economic outlook, ii) a dummy variable indicating whether the balance of views on monetary policy expressed by the committee is in line with its balance of views on the economic outlook, iii) a variable that captures different degrees of policy activism by summing the number of times interest rates had been changed at the last 10 meetings prior to the current meeting, and iv) a variable capturing the voting dispersion in the case of the Bank of England through the variation ratio, both for the current and the preceding meeting.

As a second approach, we instrument communication dispersion through various factors that may influence communication dispersion but at the same time are truly exogenous to communication dispersion as well as to monetary policy decisions. For instance, macro news dispersion is strictly exogenous because releases of macroeconomic data – which are for economic developments of previous months – are usually influenced neither by communication nor by the current or the last monetary policy decisions. The aim is to use such instruments for determining communication dispersion and then to employ the instrumented communication dispersion variable in model (2) to see whether the findings are sensitive to those shown in Table 3. We therefore estimate a tobit model for communication dispersion x_t as a function of several exogenous instruments z_t:

$$x_t^* = \rho + \lambda z_t + \mu_t \tag{4}$$

where

$$x_t = \begin{cases} 1 & if \quad x_t^* > 1 \\ x_t^* & if \quad 0 \le x_t^* \le 1 \\ 0 & if \quad x_t^* < 0 \end{cases}$$

with x^* as the latent, i.e. unobservable variable, and x_t the observable communication dispersion variable. This follows the same logic as explained for model (2), and under the condition that $\mu_t \sim N(0, \sigma^2)$. The difference is that communication dispersion, by construction, is censored to lie between zero and one, hence the estimated model is a two-limit tobit.

What induces disagreement in communication among committee members? As discussed above, cross-country differences in dispersion may largely be a matter of policy choice. But what drives changes in dispersion over time within individual countries and areas? First, a larger extent of disagreement among committee members is likely to reflect a higher degree of underlying economic uncertainty. Table 4 shows the results for communication dispersion on monetary policy for the three central banks, using both the tobit estimator of (4) and the OLS estimator.[5] A first variable that comes out as driver for dispersion is the frequency of communication, i.e. a larger participation and number of statements is associated with higher dispersion. This is an interesting result because it indicates that while a higher frequency of communication improves the predictability of decisions (see Table 3), it also raises communication dispersion, while communication dispersion itself worsens predictability. Moreover, an interest rate change in the next meeting is preceded by more communication dispersion on monetary policy for the FOMC and the Governing Council. This indeed may imply an endogeneity of communication dispersion as explained above as communication

[5] The results for communication dispersion on the economic outlook and with the committee are not shown for reasons of brevity.

dispersion is significantly higher for two of the central banks when interest rates are changed in the next meeting. Finally, for the ECB also a large monetary policy surprise in the previous meeting induces larger communication dispersion. These results are robust whether we use all inter-meeting periods, or exclude those where no communication by committee members is recorded (in which case dispersion is obviously zero, yet possibly qualitatively different from times when the measure is zero in the presence of communication), as shown in the lower panel of Table 4.

As a final step, we re-estimate model (2) after replacing the instrumented communication dispersion values for their actual values, for all three communication dispersion variables in the model. Table 5 shows that our previous findings are robust and confirmed by the IV approach.[6] Communication dispersion on monetary policy is again mostly highly statistically significant, showing that more communication dispersion on monetary policy, but not on the economic outlook or with the committee, lead to lower predictability of policy decisions. Moreover, a higher frequency of communication and lower interest rate volatility both enhance the predictability of decisions.

For another robustness test, we are interested in seeing whether the results obtained depend on the judgemental, and thus subjective, classification of the content of communication. Whereas the benchmark results reported in Table 3 are based on the classification explained in Section 3.1, Table 6 shows results based on an alternative classification of communication, whereby statements are categorised based on the reaction of interest rates on the day of the statement. For instance, a statement on monetary policy on a day when interest rates rise is classified as a tightening statement. Such a classification procedure may be imprecise as several other pieces of relevant news may occur on the day when a statement is made, and because it allows only for very few neutral statements. However, it is interesting to note that such an agnostic procedure delivers highly comparable results. Whereas the findings for the Federal Reserve remain basically unchanged, there is an interesting difference with respect to the Bank of England and the ECB: dispersed communication about monetary policy does no longer lower the predictability of interest rate decisions in a significant fashion for the Bank of England. On the other hand, this result now emerges consistently for the ECB, where it had not been found in most specifications before.

Furthermore, it is worth asking to what extent the results could be driven by inter-meeting periods where no communication by committee members is recorded. In such a case, the dispersion measure is obviously not meaningfully defined – as no communication is obviously unanimous, yet might be qualitatively different from periods where communication occurs, and is at the same time not dispersed. We have therefore repeated the benchmark regression, but dropped all inter-meeting periods without communication. The corresponding results are presented in Table 7. Even though the estimates are based on a smaller set of observations, particularly for the Bank of England, results are extremely robust, the only difference being that we can now also identify a predictability-lowering effect of interest rate volatility for the case of the Bank of England.

[6] Note that we estimate both steps separately, i.e. we first obtain an instrumented variable, as described in equation (4), and then in the second step use this instrumented variable in the tobit specification. Thus we do not estimate an explicit tobit-IV due to the demanding assumption this requires to obtain efficient estimators (see Honore and Hu 2003).

Finally, as we had restricted the sample periods to be comparable for all three central banks, it is worthwhile to test whether the results could be sensitive to this choice of sample. Accordingly, table 8 shows results for a repeated analysis, extending the time period under study for the Federal Reserve until May 1994, i.e. until the point in time when the FOMC started to issue its balance-of-risks assessments, and for the Bank of England until May 1997, i.e. when it was granted independence. This extension increases the number of observations substantially, in particular for the case of the Federal Reserve. The obtained results are highly robust, with the only major change an increase in the significance of the effects of dispersion in FOMC members' communication about the monetary policy inclination.

In summary, the results suggest that communication dispersion on monetary policy among committee members is an important determinant of the predictability of monetary policy decisions. The findings indicate that communication dispersion on monetary policy explains on average around one third of the unexpected, surprise component of monetary policy decisions of the FOMC since 1999. Such communication dispersion has also been a relevant though overall somewhat less important driver for the predictability of policy decisions by the Bank of England and the ECB. Moreover, we find that more communication, i.e. a higher frequency of statements by committee members in the inter-meeting period, also induces a significant improvement in the predictability of decisions. These findings are robust to several robustness tests, including an instrumental-variable approach for communication dispersion and a market-based procedure to classify the content of communication.

5.2 Uncertainty and interest rate volatility

A high degree of predictability of policy decisions is only one of the objectives of communication policies of central banks. A related objective may be to reduce the degree of market uncertainty and volatility surrounding monetary policy decisions. In this section, we test whether communication and its dispersion by the three central banks influences the degree of market uncertainty surrounding policy decisions.

We measure market uncertainty as the standard deviation of daily changes in short-term (3-month) interest rates in the post-event period, i.e. after the last communication of an inter-meeting period took place and before the monetary policy meeting (see Figure 1). Although the empirical findings below are robust to using the volatility measure over the whole inter-meeting period, our preferred measure is the one for the post-event period in order to ensure that communication dispersion is exogenous.

Table 9 shows the results for the effects of communication dispersion and the various controls, as defined in section 4 and the previous sub-section. First, communication dispersion on monetary policy – both among committee members and with committee communication – raises interest rate volatility for the Federal Reserve, though not for the Bank of England and the ECB. As to the effect for the Federal Reserve, communication dispersion raises the volatility of interest rates quite substantially, namely by around 0.4 to 0.5 standard deviations. As to the difference between the Federal Reserve versus the Bank of England and the ECB, it seems sensible that this effect is present only for the Federal Reserve as communication dispersion is generally stronger and more important.

Other relevant factors are again the frequency of communication and the overall importance of communication effects – proxied by the overall movement of short-term interest rates on

all communication days in the inter-meting period. For all three central banks, more frequent communication lowers the degree of market uncertainty prior to policy meetings. This is very much in line with the findings of the previous sub-section that more communication also improves the predictability of policy decisions. Moreover, communication raises market volatility in periods in which it is an important overall driver of interest rates. As communication has particularly large effects on markets when it contains unexpected information by the markets, we interpret this finding to suggest that communication in such circumstances tends to raise the overall degree of uncertainty surrounding policy decisions.

Again, we conduct several robustness tests of these results. For brevity, we report only the results of the alternative classification scheme, whereby individual statements are not classified according to the judgemental approach described in Section 3.1, but instead according to the market reaction on the day of the announcement. Table 10 shows that the findings are largely robust. In particular, communication dispersion on monetary policy and with the committee remains important for the Federal Reserve, and also the conclusions about the frequency and overall effects of communication remain valid.

Overall, the results indicate that communication dispersion may induce higher market uncertainty surrounding monetary policy decisions. However, these results hold only for the Federal Reserve, while there is little evidence that communication dispersion has any detrimental impact on market uncertainty for the Bank of England and the ECB. Moreover, higher frequency of communication tends to lower interest rate volatility, which is line with the findings of the benefits of a higher frequency of communication for the predictability of decisions discussed in section 5.1.

5.3 The future path of interest rates

So far we have taken a short-term perspective of the effectiveness of communication by focusing on the role of communication in improving the predictability of the next policy decision and the surrounding degree of market uncertainty. But communication frequently has a much longer time horizon by not only conveying views of policy-makers and policy committees about the next decision but about the *path* of future monetary policy. Hence an assessment of communication also needs to take into account the effects of communication on the understanding of market participants about interest rates in the medium- to long-run. We address this issue in the present sub-section.

How should one measure the understanding of market participants about the path of monetary policy? One possibility is to extract market expectations from financial market contracts. Gürkaynak (2005) uses Fed funds future contracts of different maturities to extract a proxy for market expectations over the medium-run. However, no comparable contracts are available for the UK or the euro area. A second possibility, and our chosen measure, is to analyse the reaction of long-term interest rates on monetary policy meeting days. Just as we have used above the reaction of short-term interest rates on meeting days as one of the proxies for the predictability of decisions, we use here the reaction of long-term interest rates as a proxy for changes in the anticipated future path of monetary policy. The argument is that central bank communication that is effective in conveying to the markets the future path of interest rates and the future path of the economy should imply that long-term interest rates do not move on policy meting days.

Tables 11 and 12 show the results for model (2), where the dependent variables are the absolute change in the 10-year and 20-year yields on the meeting days for the respective central banks. First, we find that communication dispersion on monetary policy worsens the predictability of the future path of interest rates as a higher dispersion raises the reaction of

long-term rates. For the Federal Reserve, the reaction is the strongest at between 2.5 and 3.8 basis points at the 10-year maturities, and at between 2.6 and 3.3 at the 20-year maturities. For the ECB, the reaction is significantly positive at 1.7–1.8 basis points for the 10-year maturity, while the coefficients are positive but not significant for the Bank of England and the ECB at the 20-year horizon.

A second and highly important finding is that for the Federal Reserve an increase in communication dispersion on the economic outlook *improves* the predictability of the path of future interest rates. This effect is highly robust and quantitatively large as communication dispersion on the economic outlook reduces the reaction of US long-term rates by 2 to 3 basis points. The result is important because it suggests that central bank communication that conveys to the markets the whole diversity of views of the committee and its members about the outlook of the economy is valuable in allowing markets to better anticipate the future path of monetary policy.

How should one interpret the finding that communication dispersion about the economic outlook affects long-term rates in the United States, but not in the UK and the euro area? We see at least two possible interpretations. On the one hand, the result may reflect differences in the policy objectives of the three central banks. As the Federal Reserve attaches more importance to economic activity than the Bank of England and the ECB, where the focus is primarily on price stability, one would expect that relevant information about the economic outlook, such as through communication policies, should also have a larger effect on expectations about the path of future interest rates.

Alternatively, one may argue that it is puzzling that central bank communication on the economic outlook has any effect at all on financial markets as in principle markets should have the same information about the economy – though not necessarily about monetary policy intentions and objectives – as central banks. However, as Romer and Romer (2000) showed, the Federal Reserve may indeed have information about the economic outlook and the degree of uncertainty around various scenarios that is superior to that of financial markets as its forecasts have persistently outperformed those of market institutions. Hence the market reaction to Federal Reserve communication on the economic outlook may reflect the fact that markets understand that it contains relevant and new information about the economy and thus on the future path of monetary policy.

A third finding that is consistent with this interpretation relates to the effect of the Federal Reserves balance-of-risks assessment. Table 11 shows that 10-year rates react by 2.0 basis points less (20-year rates by 1.5 basis points less) on FOMC meeting days when an asymmetric bias, as opposed to a neutral bias, was issued at the previous meeting. This may be interpreted as that an asymmetric bias may help markets anticipate better the future path of interest rates, so that long-term rates move less in the short-term.

Moreover, other factors found in Tables 11 and 12 to influence the reaction of long-term rates on meeting days are the degree of interest rate volatility and macro news dispersion in the inter-meeting period, although none of these factors is significant and with the same sign for all three central banks.

The usual battery of sensitivity tests shows that results are overall robust. For brevity, we report only those where the classification of the content of statements is based on market reactions on the release day (Tables 13-14). Whereas the predictability-enhancing effect of dispersed communication about the economic outlook by FOMC members becomes less significant at the 10-year maturity, it remains much more precisely estimated at the 20-year horizon.

In summary, communication dispersion on monetary policy lowers the predictability not only of monetary policy decisions but also reduces the ability of markets to anticipate the future path of interest rates. By contrast, the finding of key importance of this sub-section is that for the Federal Reserve, communication dispersion on the economic outlook lowers the reaction of long-term rates on FOMC meeting days. We interpret this finding as indicating that communication that conveys relevant information about the outlook of the economy and surrounding risks may help markets better anticipate the performance of the economy and hence the future path of interest rates. The fact that this result only holds for the Federal Reserve but not for the Bank of England and the ECB may at least partly reflect the fact that the latter two give primary weight to price stability in their objective functions.

6. Conclusions

How should central banks communicate? Should they communicate in a collegial manner, by conveying the consensus or majority view of the committee, or in an individualistic way, by stressing and conveying the diversity of views among the committee members and with those of the committee as a whole? The objective of this paper has been to answer this question by analysing the effectiveness of the communication strategies by the Federal Reserve, the Bank of England and the European Central Bank. We have used three benchmarks, or normative dimensions, of monetary policy for assessing the effectiveness of communication and its dispersion, as the paper has attempted to assess the effect of communication dispersion on the predictability of monetary policy decisions; the degree of uncertainty and interest rate volatility surrounding policy decisions; and the market's understanding of the future path of interest rates and monetary policy.

A first key result is that communication that is dispersed and conveys not a single committee view but a variety of views on monetary policy decisions reduces the predictability of decisions and worsens the ability of market participants to understand the future path of monetary policy. This finding is not only robust across the three central banks, communication dispersion is also a key factor explaining the lack of predictability of monetary policy decisions. For the Federal Reserve, for instance, a high degree of communication dispersion lowers the predictability the FOMC decision by as many as four to five basis points. Overall, the result indicates that communication dispersion on monetary policy among FOMC members has accounted for about one third to one half of the market's prediction errors of FOMC monetary policy decisions since 1999. This overall effect is similar for the Bank of England and somewhat lower though still statistically significant for the ECB.

A second key result is that communication dispersion about the economic outlook by the Federal Reserve may improve the market's ability to anticipate the future *path* of interest rates and monetary policy. The reaction of long-term rates on FOMC meeting days falls by 2.5 to 3.8 basis points when communication dispersion on the economic outlook is high. Moreover, this result only holds for the Federal Reserve while communication dispersion about the economic outlook has no statistically significant impact for the Bank of England and the ECB. These cross-country differences may partly reflect differences in the objectives across the three central banks and also partly be due to the Federal Reserve's superior knowledge and information about the economic outlook compared to that of the markets, as shown by Romer and Romer (2000).

Several other interesting findings have emerged from the empirical analysis. One of these relates to the frequency of communication: more communication in an inter-meeting period has helped markets to better anticipate monetary policy decisions. This holds for all three central banks. Moreover, we have conducted a battery of robustness tests to scrutinise our findings. A potential caveat is that important omitted variables induce both a high degree of disagreement and dispersion among committee members' views but also make it generally harder to predict monetary policy decisions. We have included various sets of controls – in particular those that capture other sources of economic and market uncertainty – and used instrumental-variable approaches to avoid such a bias, and overall these show that our results are robust to a broad set of alternative specifications.

The findings of the paper provide a clear and compelling policy message. Overall, it is the collegiality of views on monetary policy but the diversity of views on the economic outlook that appear to enhance the effectiveness of central bank communication. Communicating the diversity of views among committee members about monetary policy does not seem to provide any benefits as it lowers the market's ability to predict the next policy decision as well as its ability to anticipate the path of future interest rates. By contrast, conveying the diversity of views about the economy and underlying risks appears to enable market participants to better anticipate the future path of interest rates. Moreover, a high intensity and frequency of communication may not provide additional information, but it appears to lower the degree of market uncertainty and improves the predictability of future policy decisions.

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Appendix

Figure 1: Communication event of monetary policy meeting

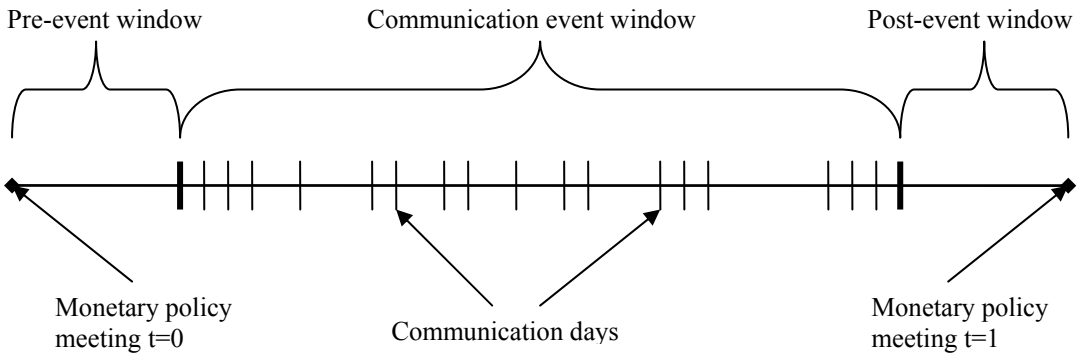

Table 1: Summary statistics communication

	Federal Reserve	Bank of England	European Central Bank
		number of statements	
Monetary policy communication			
total	106	64	185
tightening	34	14	27
neutral	38	34	118
easing	34	16	40
Economic outlook communication			
total	60	31	130
stronger	27	18	72
neutral	6	5	23
weaker	27	8	35

Table 2: Summary statistics predictability and dispersion measures

	Federal Reserve	Bank of England	European Central Bank
Communication dispersion:			
Monetary policy	0.278	0.074	0.145
With committee releases	0.326	0.127	0.103
Economic outlook	0.173	0.060	0.158
Predictability:			
Monetary policy surprise	0.034	0.048	0.030
Inter-meeting interest rate volatility	0.802	0.605	0.519
Macro news dispersion	0.909	0.840	0.663

Note: The table shows the degree of dispersion in communication as defined in equation (1) in the upper part. All data are calculated exclusive of unscheduled policy meetings, in particular the policy changes by the three central banks on 17/18 September 2001 following the attacks of 11 September 2001. Monetary policy surprises are defined through surveys. Inter-meeting interest rate volatility is defined as the standard deviation of the daily changes in 3-month interest rates in the intermeeting period, but prior to the first item of central bank communication. Macro news dispersion relates to the degree of dispersion in macroeconomic news (or surprises?) for a given country, and is defined as in equation (1).

Table 3: Explaining the predictability of monetary policy decisions

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.049 *	*0.025*	0.047 **	*0.022*	0.041 *	*0.022*	0.062 **	*0.025*	0.099 ***	*0.030*	0.106 ***	*0.030*	0.021	*0.015*	0.024	*0.016*	0.029 *	*0.015*
With committee releases	-0.004	*0.008*	0.001	*0.007*	-0.004	*0.008*	-0.005	*0.013*	0.000	*0.014*	0.001	*0.014*	-0.010	*0.010*	-0.008	*0.010*	-0.003	*0.011*
Economic outlook	-0.005	*0.026*	0.011	*0.020*	0.006	*0.019*	-0.004	*0.022*	0.021	*0.025*	0.019	*0.025*	0.002	*0.011*	0.010	*0.013*	0.011	*0.012*
Market uncertainty:																		
Macro news dispersion	0.015	*0.071*	-0.015	*0.053*	0.007	*0.053*	0.015	*0.021*	0.014	*0.023*	0.024	*0.024*	-0.002	*0.009*	-0.001	*0.009*	0.002	*0.009*
Pre-event interest rate volatility			0.018 ***	*0.006*	0.016 *	*0.009*			0.016	*0.019*	0.029	*0.021*			0.013 **	*0.006*	0.008	*0.006*
Frequency and size:																		
Frequency of communication			-0.010 *	*0.005*	-0.010 *	*0.005*			-0.013 **	*0.006*	-0.017 ***	*0.007*			-0.002	*0.003*	-0.003	*0.003*
Frequency of macro news			0.003	*0.003*	0.005	*0.003*			0.000	*0.004*	0.000	*0.004*			-0.001	*0.002*	-0.001	*0.002*
Size of communication effects					0.051	*0.086*					0.213	*0.352*					-0.050	*0.075*
Size of macro news effects					-0.012	*0.074*					-0.093	*0.138*					0.242 **	*0.113*
Committee decisions and communication:																		
Interest rate change last meeting					0.010	*0.015*					-0.013	*0.010*					-0.021 ***	*0.007*
Asymmetric bias last meeting (FOMC)					0.016	*0.014*												
Inflation Report (MPC)											-0.006	*0.010*						
# of observations	43		43		43		63		63		63		97		97		97	
Likelihood ratio Chi^2	3.92		18.80		21.45		6.94		11.80		15.17		2.46		8.52		16.78	

Note: Using the tobit model (equation 2), the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, i.e. the absolute value of the monetary policy surprise. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 4: Explaining communication dispersion of monetary policy

	Federal Reserve - FOMC				Bank of England - MPC				European Central Bank - GC			
	Tobit		OLS		Tobit		OLS		Tobit		OLS	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
All inter-meeting periods												
Macro news dispersion	0.056	*0.196*	0.210	*0.328*	0.090	*0.101*	0.001	*0.092*	-0.015	*0.040*	-0.031	*0.052*
Pre-event interest rate volatility	0.025	*0.023*	0.041	*0.036*	-0.043	*0.065*	-0.060	*0.085*	0.014	*0.024*	0.005	*0.038*
Frequency of communication	0.100 ***	*0.025*	0.172 ***	*0.037*	0.156 ***	*0.026*	0.237 ***	*0.045*	0.089 ***	*0.015*	0.133 ***	*0.024*
Monetary policy surprise last meeting	0.083	*0.054*	0.093	*0.087*	0.012	*0.050*	0.016	*0.052*	0.090 *	*0.049*	0.153 ***	*0.063*
Interest rate change next meeting	0.215 **	*0.100*	0.349 **	*0.145*	-0.008	*0.040*	0.017	*0.056*	0.086 *	*0.050*	0.132 **	*0.064*
# of observations	43		43		63		63		97		97	
Pseudo R-squared	0.392		0.502		0.453		0.373		0.311		0.324	
Excluding inter-meeting periods without communication												
Macro news dispersion	0.105	0.223	0.317	0.368	0.097	0.128	0.002	0.146	-0.031	0.045	-0.051	0.063
Pre-event interest rate volatility	0.015	0.026	0.017	0.040	-0.066	0.084	-0.104	0.140	0.016	0.026	0.007	0.042
Frequency of communication	0.097 ***	0.028	0.151 ***	0.041	0.167 ***	0.043	0.219 ***	0.071	0.089 ***	0.017	0.124 ***	0.027
Monetary policy surprise last meeting	0.091	0.059	0.115	0.094	0.027	0.068	0.044	0.102	0.121 **	0.054	0.193 ***	0.067
Interest rate change next meeting	0.292 ***	0.113	0.503 ***	0.175	-0.002	0.053	0.042	0.096	0.113 *	0.059	0.167 **	0.074
# of observations	38		38		39		39		82		82	
Pseudo R-squared	0.385		0.507		0.357		0.318		0.292		0.315	

Note: Using the tobit model (equation 4), the table shows the marginal effects of a change in the independent variables z_t with regard to the observable variable x_t, which is the communication dispersion on monetary policy among committee members. The independent variables z_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 5: Robustness test – Explaining the predictability of monetary policy decisions: Tobit IV estimation

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator -	(1) IV		(2) IV		(3) IV		(1) IV		(2) IV		(3) IV		(1) IV		(2) IV		(3) IV	
IV for communication dispersion	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.064	*0.042*	0.193 ***	*0.047*	0.228 ***	*0.054*	0.011	*0.048*	0.526 **	*0.217*	0.650 ***	*0.225*	0.083 ***	*0.031*	0.312 ***	*0.058*	0.388 ***	*0.062*
With committee releases	-0.011	*0.033*	0.009	*0.019*	-0.011	*0.019*	0.118	*0.101*	0.120	*0.099*	0.130	*0.099*	0.026	*0.103*	-0.029	*0.090*	-0.050	*0.082*
Economic outlook	-0.301	*0.296*	0.010	*0.186*	0.082	*0.181*	-0.092	*0.376*	-0.022	*0.378*	0.023	*0.372*	-0.052 *	*0.030*	-0.013	*0.028*	-0.010	*0.026*
Market uncertainty:																		
Macro news dispersion	0.025	*0.073*	0.014	*0.048*	0.009	*0.042*	0.017	*0.021*	0.003	*0.024*	0.012	*0.024*	-0.005	*0.008*	0.003	*0.008*	0.005	*0.007*
Pre-event interest rate volatility			0.015 ***	*0.005*	0.008	*0.007*			-0.012	*0.021*	-0.001	*0.022*			0.003	*0.005*	0.002	*0.005*
Frequency and size:																		
Frequency of communication			-0.021 ***	*0.005*	-0.027 ***	*0.006*			-0.051 **	*0.021*	-0.067 ***	*0.022*			-0.019 ***	*0.004*	-0.024 ***	*0.004*
Frequency of macro news			0.003	*0.002*	0.002	*0.002*			0.001	*0.004*	0.001	*0.004*			-0.002	*0.002*	-0.002	*0.002*
Size of communication effects					0.113	*0.076*					0.300	*0.362*					-0.047	*0.061*
Size of macro news effects					-0.050	*0.061*					-0.141	*0.140*					0.029	*0.095*
Committee decisions and communication:																		
Interest rate change last meeting					0.007	*0.011*					-0.020 *	*0.011*					-0.026 ***	*0.005*
Asymmetric bias last meeting (FOMC)					-0.016	*0.017*												
Inflation Report (MPC)											0.003	*0.011*						
# of observations	43		43		43		63		63		63		97		97		97	
Likelihood ratio Chi^2	0.185		1.646		1.905		-0.023		-0.093		-0.144		-0.163		-0.659		-0.983	

Note: Using the tobit model (equation 2) with communication dispersion instrumented as explained in the text, the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, i.e. the absolute value of the monetary policy surprise. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 6: Robustness test – Explaining the predictability of monetary policy decisions: Alternative classification of statements

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.039 *	*0.023*	0.050 ***	*0.019*	0.062 ***	*0.017*	0.001	*0.025*	0.008	*0.028*	0.005	*0.028*	0.024 **	*0.010*	0.031 ***	*0.011*	0.031 ***	*0.011*
With committee releases	0.001	*0.008*	0.006	*0.006*	0.004	*0.006*	0.010	*0.012*	0.011	*0.012*	0.012	*0.013*	0.011	*0.009*	0.011	*0.009*	0.008	*0.009*
Economic outlook	-0.039	*0.033*	-0.029	*0.024*	-0.037 *	*0.019*	-0.005	*0.034*	-0.009	*0.035*	-0.007	*0.035*	-0.017	*0.012*	-0.009	*0.012*	-0.001	*0.012*
Market uncertainty:																		
Macro news dispersion	0.061	*0.072*	0.022	*0.051*	0.028	*0.040*	0.016	*0.022*	0.013	*0.025*	0.023	*0.027*	-0.003	*0.009*	-0.003	*0.009*	0.000	*0.009*
Pre-event interest rate volatility			0.018 ***	*0.005*	0.011 *	*0.007*			0.009	*0.021*	0.019	*0.023*			0.012 **	*0.006*	0.009	*0.006*
Frequency and size:																		
Frequency of communication			-0.011 **	*0.005*	-0.018 ***	*0.006*			-0.004	*0.006*	-0.007	*0.006*			-0.004	*0.003*	-0.005 *	*0.003*
Frequency of macro news			0.004	*0.003*	0.006 **	*0.002*			0.001	*0.004*	0.001	*0.004*			0.000	*0.002*	0.000	*0.002*
Size of communication effects					0.081	*0.071*					0.284	*0.386*					-0.006	*0.070*
Size of macro news effects					-0.008	*0.056*					-0.101	*0.146*					0.215 **	*0.108*
Committee decisions and communication:																		
Interest rate change last meeting					0.023 *	*0.013*					-0.008	*0.012*					-0.021 ***	*0.007*
Asymmetric bias last meeting (FOMC)					0.013	*0.010*												
Inflation Report (MPC)											-0.003	*0.011*						
# of observations	43		43		43		63		63		63		97		97		97	
Likelihood ratio Chi^2	3.74		21.30		28.14		1.37		2.04		3.92		7.56		15.12		22.95	

Note: Using the tobit model (equation 2), the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, i.e. the absolute value of the monetary policy surprise. Statements are classified based on the reaction of three-month interest rates on the day of each statement. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text. ***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 7: Robustness test – Explaining the predictability of monetary policy decisions: Dropping observations without communication

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.055 **	*0.027*	0.048 **	*0.022*	0.038 *	*0.021*	0.089 ***	*0.020*	0.105 ***	*0.023*	0.111 ***	*0.023*	0.022	*0.015*	0.024	*0.016*	0.031 *	*0.016*
With committee releases	-0.004	*0.009*	0.002	*0.007*	0.000	*0.008*	0.004	*0.011*	0.004	*0.010*	0.005	*0.010*	-0.010	*0.010*	-0.008	*0.011*	-0.001	*0.012*
Economic outlook	0.001	*0.027*	0.019	*0.020*	0.017	*0.020*	0.013	*0.016*	0.023	*0.017*	0.023	*0.017*	0.003	*0.011*	0.010	*0.013*	0.011	*0.013*
Market uncertainty:																		
Macro news dispersion	-0.017	*0.077*	-0.050	*0.054*	-0.045	*0.057*	-0.010	*0.017*	-0.015	*0.017*	-0.004	*0.019*	-0.005	*0.010*	-0.003	*0.011*	0.003	*0.011*
Pre-event interest rate volatility			0.018 ***	*0.006*	0.023 **	*0.009*			0.037 **	*0.015*	0.048 ***	*0.018*			0.010 *	*0.006*	0.005	*0.007*
Frequency and size:																		
Frequency of communication			-0.011 *	*0.007*	-0.009	*0.006*			-0.008	*0.006*	-0.012 *	*0.006*			-0.002	*0.003*	-0.003	*0.003*
Frequency of macro news			0.004	*0.003*	0.006 *	*0.003*			0.005	*0.003*	0.006 *	*0.004*			-0.001	*0.002*	-0.002	*0.002*
Size of communication effects					-0.025	*0.089*					0.310	*0.261*					-0.033	*0.076*
Size of macro news effects					-0.083	*0.078*					-0.113	*0.115*					0.241 **	*0.117*
Committee decisions and communication:																		
Interest rate change last meeting					0.021	*0.017*					-0.003	*0.013*					-0.022 ***	*0.008*
Asymmetric bias last meeting (FOMC)					0.010	*0.015*												
Inflation Report (MPC)											-0.008	*0.010*						
# of observations	38		38		38		39		39		39		82		82		82	
Likelihood ratio Chi^2	3.98		19.89		22.76		18.56		25.76		30.04		2.57		6.29		14.05	

Note: Using the tobit model (equation 2), the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, i.e. the absolute value of the monetary policy surprise. Inter-meeting periods with no statements are dropped from the respective samples. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 8: Robustness test – Explaining the predictability of monetary policy decisions: Expanded sample periods for Federal Reserve and Bank of England

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.045 ***	*0.017*	0.053 ***	*0.021*	0.048 **	*0.021*	0.058 **	*0.023*	0.088 ***	*0.028*	0.096 ***	*0.028*	0.021	*0.015*	0.024	*0.016*	0.029 *	*0.015*
With committee releases	-0.004	*0.008*	0.002	*0.007*	-0.002	*0.008*	-0.005	*0.013*	-0.001	*0.014*	0.001	*0.015*	-0.010	*0.010*	-0.008	*0.010*	-0.003	*0.011*
Economic outlook	-0.008	*0.018*	-0.003	*0.016*	-0.003	*0.016*	-0.006	*0.022*	0.013	*0.024*	0.012	*0.023*	0.002	*0.011*	0.010	*0.013*	0.011	*0.012*
Market uncertainty:																		
Macro news dispersion	0.024	*0.062*	0.036	*0.057*	0.057	*0.056*	0.018	*0.017*	0.020	*0.019*	0.027	*0.019*	-0.002	*0.009*	-0.001	*0.009*	0.002	*0.009*
Pre-event interest rate volatility			0.007	*0.006*	-0.001	*0.006*			0.014	*0.016*	0.019	*0.018*			0.013 **	*0.006*	0.008	*0.006*
Frequency and size:																		
Frequency of communication			-0.006	*0.004*	-0.010 *	*0.005*			-0.011 **	*0.006*	-0.016 **	*0.006*			-0.002	*0.003*	-0.003	*0.003*
Frequency of macro news			-0.003	*0.003*	-0.003	*0.003*			-0.001	*0.003*	0.000	*0.003*			-0.001	*0.002*	-0.001	*0.002*
Size of communication effects					0.117 *	*0.069*					0.360	*0.317*					-0.050	*0.075*
Size of macro news effects					0.080	*0.059*					-0.051	*0.123*					0.242 **	*0.113*
Committee decisions and communication:																		
Interest rate change last meeting					-0.010	*0.012*					-0.010	*0.009*					-0.021 ***	*0.007*
Asymmetric bias last meeting (FOMC)					0.014	*0.013*												
Inflation Report (MPC)											-0.005	*0.009*						
# of observations	79		79		79		84		84		84		97		97		97	
Likelihood ratio Chi^2	7.09		16.47		21.22		7.25		11.23		14.87		2.46		8.52		16.78	

Note: Using the tobit model (equation 2), the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, i.e. the absolute value of the monetary policy surprise. Inter-meeting periods with no statements are dropped from the respective samples. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text. Sample periods start in May 1994 for the Federal Reserve, May 1997 for the Bank of England, and January 1999 for the European Central Bank.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 9: Explaining interest rate volatility

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
OLS estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.504 **	*0.222*	0.384 *	*0.223*	0.387 **	*0.168*	-0.034	*0.106*	0.098	*0.114*	0.110	*0.109*	-0.299	*0.299*	-0.205	*0.326*	-0.209	*0.229*
With committee releases	0.295 ***	*0.080*	0.355 ***	*0.071*	0.221 ***	*0.060*	-0.015	*0.062*	-0.032	*0.056*	-0.023	*0.054*	0.056	*0.226*	0.105	*0.234*	0.004	*0.163*
Economic outlook	-0.101	*0.210*	-0.030	*0.183*	-0.097	*0.138*	-0.002	*0.095*	0.097	*0.095*	0.115	*0.092*	0.052	*0.219*	0.209	*0.258*	0.294 *	*0.179*
Market uncertainty:																		
Macro news dispersion	-0.497	*0.575*	-0.413	*0.504*	0.169	*0.421*	-0.194 **	*0.088*	-0.160 *	*0.088*	-0.122	*0.089*	-0.237	*0.173*	-0.145	*0.190*	-0.039	*0.131*
Pre-event interest rate volatility			0.177 ***	*0.060*	-0.018	*0.072*			0.328 ***	*0.071*	0.349 ***	*0.079*			0.172	*0.123*	0.006	*0.092*
Frequency and size:																		
Frequency of communication			-0.037	*0.034*	-0.065 ***	*0.026*			-0.045 *	*0.024*	-0.067 ***	*0.025*			-0.034	*0.059*	-0.081 **	*0.041*
Frequency of macro news			-0.011	*0.030*	-0.029	*0.025*			0.009	*0.014*	0.015	*0.013*			-0.050	*0.044*	-0.006	*0.031*
Size of communication effects					2.881 ***	*0.711*					2.754 **	*1.333*					8.409 ***	*0.906*
Size of macro news effects					0.748	*0.622*					-0.959 **	*0.493*					1.230	*1.659*
Committee decisions and communication:																		
Interest rate change last meeting					0.220 *	*0.114*					0.048	*0.044*					0.134	*0.148*
Asymmetric bias last meeting (FOMC)					0.002	*0.109*												
Inflation Report (MPC)											-0.036	*0.039*						
# of observations	43		43		43		63		63		63		97		97		97	
R-squared	0.448		0.642		0.824		0.082		0.348		0.447		0.032		0.078		0.586	

Note: Using the tobit model (equation 2), the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, i.e. the volatility of daily interest rate changes in the post-event communication period. The independent variables x_t are defined as explained in the text.

***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 10: Robustness test – Explaining interest rate volatility: Alternative classification of statements

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
OLS estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.253	*0.210*	0.081	*0.234*	0.356 **	*0.169*	-0.037	*0.099*	0.006	*0.098*	-0.014	*0.094*	-0.181	*0.208*	-0.215	*0.237*	0.090	*0.167*
With committee releases	0.289 ***	*0.082*	0.309 ***	*0.074*	0.178 ***	*0.058*	0.014	*0.046*	0.019	*0.042*	0.045	*0.042*	-0.105	*0.167*	-0.091	*0.169*	-0.154	*0.116*
Economic outlook	-0.561 *	*0.290*	-0.359	*0.267*	-0.417 **	*0.185*	0.129	*0.135*	0.030	*0.122*	0.053	*0.117*	0.078	*0.247*	0.251	*0.270*	0.198	*0.188*
Market uncertainty:																		
Macro news dispersion	0.184	*0.612*	-0.142	*0.576*	0.585	*0.449*	-0.196 **	*0.089*	-0.169 *	*0.092*	-0.121	*0.093*	-0.215	*0.173*	-0.114	*0.191*	-0.036	*0.131*
Pre-event interest rate volatility			0.224 ***	*0.065*	-0.017	*0.076*			0.305 ***	*0.074*	0.316 ***	*0.081*			0.178	*0.123*	0.002	*0.091*
Frequency and size:																		
Frequency of communication			-0.001	*0.041*	-0.070 **	*0.031*			-0.036 *	*0.021*	-0.056 ***	*0.022*			-0.006	*0.056*	-0.095 ***	*0.040*
Frequency of macro news			0.019	*0.033*	-0.002	*0.026*			0.011	*0.014*	0.016	*0.014*			-0.062	*0.047*	-0.003	*0.033*
Size of communication effects					3.246 ***	*0.759*					2.912 **	*1.359*					8.497 ***	*0.922*
Size of macro news effects					0.936	*0.641*					-0.892 *	*0.489*					1.725	*1.665*
Committee decisions and communication:																		
Interest rate change last meeting					0.288 **	*0.121*					0.056	*0.045*					0.071	*0.147*
Asymmetric bias last meeting (FOMC)					0.012	*0.115*												
Inflation Report (MPC)											-0.046	*0.040*						
# of observations	43		43		43		63		63		63		97		97		97	
R-squared	0.349		0.537		0.805		0.096		0.333		0.439		0.034		0.079		0.586	

Note: Using the tobit model (equation 2), the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, i.e. the volatility of daily interest rate changes in the post-event communication period. Statements are classified based on the reaction of three-month interest rates on the day of each statement. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 11: Explaining the predictability of the *path* of monetary policy decisions: 10-year yields

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.038 ***	*0.013*	0.027 *	*0.014*	0.025 *	*0.014*	0.023	*0.019*	0.031	*0.023*	0.033	*0.023*	0.017 *	*0.009*	0.018 *	*0.010*	0.017 *	*0.010*
With committee releases	-0.008 *	*0.005*	-0.007	*0.005*	-0.003	*0.005*	-0.005	*0.011*	-0.009	*0.011*	-0.008	*0.011*	0.008	*0.008*	0.010	*0.008*	0.009	*0.008*
Economic outlook	-0.029 **	*0.013*	-0.024 *	*0.012*	-0.026 **	*0.012*	-0.003	*0.017*	0.002	*0.019*	0.001	*0.019*	0.000	*0.007*	-0.002	*0.008*	-0.002	*0.008*
Market uncertainty:																		
Macro news dispersion	0.037	*0.033*	0.032	*0.033*	0.024	*0.034*	0.038 **	*0.017*	0.052 ***	*0.018*	0.051 ***	*0.019*	-0.007	*0.005*	-0.007	*0.006*	-0.007	*0.006*
Pre-event interest rate volatility			0.013 ***	*0.004*	0.014 **	*0.006*			0.012	*0.015*	0.026	*0.017*			-0.012 ***	*0.004*	-0.012 ***	*0.004*
Frequency and size:																		
Frequency of communication			0.000	*0.002*	-0.001	*0.002*			-0.001	*0.005*	0.000	*0.005*			0.000	*0.002*	0.000	*0.002*
Frequency of macro news			0.002	*0.002*	0.000	*0.002*			-0.004	*0.003*	-0.005 *	*0.003*			0.001	*0.001*	0.001	*0.001*
Size of communication effects					0.023	*0.057*					-0.469	*0.336*					0.028	*0.039*
Size of macro news effects					-0.044	*0.051*					-0.053	*0.103*					-0.022	*0.072*
Committee decisions and communication:																		
Interest rate change last meeting					-0.012	*0.009*					-0.015 *	*0.008*					0.005	*0.007*
Asymmetric bias last meeting (FOMC)					-0.020 **	*0.009*												
Inflation Report (MPC)											-0.002	*0.008*						
# of observations	43		43		43		63		63		63		97		97		97	
Likelihood ratio Chi^2	14.87		26.08		38.89		6.71		10.02		14.99		7.38		17.19		18.16	

Note: Using the tobit model (equation 2) with communication dispersion, the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, which here is defined as the absolute value of the change in 10-year interest rates on the monetary policy meeting day. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 12: Explaining the predictability of the *path* of monetary policy decisions: 20-year yields

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.033 ***	*0.010*	0.028 **	*0.011*	0.026 **	*0.011*	0.008	*0.016*	0.026	*0.019*	0.029	*0.019*	0.015	*0.012*	0.016	*0.013*	0.017	*0.013*
With committee releases	-0.006	*0.004*	-0.004	*0.004*	-0.002	*0.004*	-0.002	*0.009*	0.001	*0.010*	0.001	*0.010*	0.003	*0.009*	0.005	*0.010*	0.004	*0.010*
Economic outlook	-0.022 **	*0.010*	-0.020 **	*0.010*	-0.023 **	*0.009*	-0.010	*0.014*	0.002	*0.016*	0.000	*0.016*	0.000	*0.009*	-0.001	*0.010*	0.000	*0.010*
Market uncertainty:																		
Macro news dispersion	0.026	*0.026*	0.033	*0.026*	0.035	*0.027*	0.025 *	*0.013*	0.030 **	*0.015*	0.031 **	*0.016*	-0.017 **	*0.007*	-0.016 **	*0.007*	-0.016 **	*0.008*
Pre-event interest rate volatility			0.006 **	*0.003*	0.004	*0.005*			0.001	*0.012*	0.007	*0.014*			-0.012 **	*0.005*	-0.012 **	*0.005*
Frequency and size:																		
Frequency of communication			-0.001	*0.002*	-0.001	*0.002*			-0.006	*0.004*	-0.006	*0.004*			0.000	*0.002*	0.000	*0.002*
Frequency of macro news			-0.001	*0.002*	-0.002	*0.002*			-0.002	*0.002*	-0.002	*0.002*			0.000	*0.002*	0.000	*0.002*
Size of communication effects					0.058	*0.045*					-0.127	*0.234*					0.027	*0.052*
Size of macro news effects					-0.036	*0.039*					0.009	*0.086*					-0.021	*0.095*
Committee decisions and communication:																		
Interest rate change last meeting					-0.006	*0.007*					-0.008	*0.007*					0.001	*0.009*
Asymmetric bias last meeting (FOMC)					-0.015 **	*0.007*												
Inflation Report (MPC)											-0.005	*0.007*						
# of observations	43		43		43		63		63		63		97		97		97	
Likelihood ratio Chi^2	16.01		24.88		36.83		4.40		7.22		9.23		7.69		13.27		13.55	

Note: Using the tobit model (equation 2) with communication dispersion, the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, which here is defined as the absolute value of the change in 10-year interest rates on the monetary policy meeting day. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 13: Robustness test – Explaining the predictability of the *path* of monetary policy decisions: 10-year yields; Alternative classification of statements

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.026 **	*0.012*	0.022 *	*0.014*	0.023 *	*0.013*	0.013	*0.018*	0.013	*0.020*	0.013	*0.020*	0.005	*0.006*	0.004	*0.007*	0.005	*0.007*
With committee releases	-0.006	*0.005*	-0.006	*0.004*	-0.005	*0.005*	-0.001	*0.008*	0.000	*0.009*	-0.004	*0.009*	0.004	*0.005*	0.005	*0.005*	0.005	*0.005*
Economic outlook	-0.026 *	*0.016*	-0.019	*0.016*	-0.020	*0.014*	0.012	*0.024*	0.007	*0.025*	0.006	*0.024*	0.002	*0.008*	-0.002	*0.008*	-0.004	*0.008*
Market uncertainty:																		
Macro news dispersion	0.076 **	*0.034*	0.055 *	*0.034*	0.050	*0.035*	0.035 **	*0.017*	0.044 **	*0.019*	0.042 **	*0.020*	-0.007	*0.005*	-0.007	*0.006*	-0.007	*0.006*
Pre-event interest rate volatility			0.014 ***	*0.004*	0.015 **	*0.006*			0.005	*0.015*	0.019	*0.017*			-0.011 ***	*0.004*	-0.011 ***	*0.004*
Frequency and size:																		
Frequency of communication			-0.001	*0.002*	-0.002	*0.002*			-0.001	*0.004*	0.001	*0.005*			0.001	*0.002*	0.001	*0.002*
Frequency of macro news			0.003	*0.002*	0.002	*0.002*			-0.003	*0.003*	-0.003	*0.003*			0.000	*0.001*	0.001	*0.001*
Size of communication effects					0.037	*0.059*					-0.515	*0.363*					0.037	*0.041*
Size of macro news effects					-0.054	*0.050*					-0.066	*0.102*					-0.050	*0.073*
Committee decisions and communication:																		
Interest rate change last meeting					-0.009	*0.009*					-0.014 *	*0.008*					0.008	*0.007*
Asymmetric bias last meeting (FOMC)					-0.020 **	*0.010*												
Inflation Report (MPC)											0.001	*0.008*						
# of observations	43		43		43		63		63		63		97		97		97	
Likelihood ratio Chi^2	8.96		22.36		35.17		7.32		8.56		13.42		3.00		12.33		14.59	

Note: Using the tobit model (equation 2) with communication dispersion, the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, which here is defined as the absolute value of the change in 10-year interest rates on the monetary policy meeting day. Statements are classified based on the reaction of three-month interest rates on the day of each statement. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 14: Robustness test – Explaining the predictability of the *path* of monetary policy decisions: 20-year yields; Alternative classification of statements

	Federal Reserve - FOMC						Bank of England - MPC						European Central Bank - GC					
Tobit estimator	(1)		(2)		(3)		(1)		(2)		(3)		(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
Communication dispersion:																		
Monetary policy	0.019 **	*0.009*	0.013	*0.011*	0.016	*0.010*	-0.004	*0.015*	0.004	*0.016*	0.002	*0.017*	0.000	*0.008*	-0.003	*0.016*	-0.001	*0.010*
With committee releases	-0.004	*0.004*	-0.003	*0.003*	-0.004	*0.004*	-0.003	*0.007*	0.000	*0.007*	-0.001	*0.007*	-0.002	*0.006*	-0.002	*0.011*	-0.001	*0.007*
Economic outlook	-0.025 **	*0.013*	-0.018	*0.012*	-0.019 *	*0.012*	0.008	*0.020*	0.006	*0.021*	0.007	*0.021*	0.006	*0.010*	0.007	*0.018*	0.003	*0.011*
Market uncertainty:																		
Macro news dispersion	0.060 **	*0.026*	0.053 **	*0.027*	0.060 **	*0.028*	0.025 *	*0.013*	0.027 *	*0.016*	0.028 *	*0.016*	-0.017 **	*0.007*	-0.028 **	*0.013*	-0.016 **	*0.008*
Pre-event interest rate volatility			0.009 ***	*0.003*	0.006	*0.005*			-0.002	*0.013*	0.004	*0.014*			-0.019 **	*0.009*	-0.011 **	*0.005*
Frequency and size:																		
Frequency of communication			0.000	*0.002*	-0.002	*0.002*			-0.004	*0.004*	-0.004	*0.004*			0.002	*0.004*	0.001	*0.002*
Frequency of macro news			0.000	*0.002*	-0.001	*0.002*			-0.001	*0.002*	-0.001	*0.002*			-0.001	*0.003*	0.000	*0.002*
Size of communication effects					0.070	*0.047*					-0.119	*0.239*					0.027	*0.053*
Size of macro news effects					-0.046	*0.040*					0.003	*0.086*					-0.017	*0.096*
Committee decisions and communication:																		
Interest rate change last meeting					-0.004	*0.007*					-0.007	*0.007*					0.003	*0.009*
Asymmetric bias last meeting (FOMC)					-0.014 *	*0.008*												
Inflation Report (MPC)											-0.003	*0.007*						
# of observations	43		43		43		63		63		63		97		97		97	
Likelihood ratio Chi^2	8.76		18.32		30.13		3.95		5.61		6.94		6.18		11.34		11.70	

Note: Using the tobit model (equation 2) with communication dispersion, the table shows the marginal effects (as defined in equation (3)) of a change in the independent variables x_t with regard to the observable variable y_t, which here is defined as the absolute value of the change in 10-year interest rates on the monetary policy meeting day. Statements are classified based on the reaction of three-month interest rates on the day of each statement. Positive parameter estimates do therefore imply lower predictability of monetary policy decisions. The independent variables x_t are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

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