Social value of public information – testing the limits to transparency

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July 2007

Abstract

Transparency has become an almost universal virtue among central banks. The paper tests empirically, for the case of the Federal Reserve, two hypotheses about central bank transparency derived from the debate of Morris and Shin (2002) and Svensson (2006). First, the paper finds that the precision of communication is a key determinant of the predictability of both FOMC decisions as well as the future policy path. Second, the effectiveness of communication is found to depend on the market environment. Specifically, a given statement may enhance predictability in an environment of high market uncertainty, but may reduce it when uncertainty is low. The findings underline the limits to transparency and stress the need for communication to be flexible and adjust to market conditions in order for central banks to achieve their ultimate objectives.

JEL classification: E52, E58, D82.
Keywords: communication; transparency; monetary policy; predictability; effectiveness; Federal Reserve.

* We would like to thank Terhi Jokipii for excellent research assistance, and Tao Zha, as well as Reuters and Standard and Poor's for sharing some of the data series. We are grateful for comments to Alex Cukierman, Athanasios Orphanides, and the participants at the 2005 NBER Summer Institute's Workshop on Monetary Economics, the 2006 Annual Meetings of the American Economic Association, the Benomics workshop on optimal monetary policy and central bank communication and a seminar at Tilburg University. We have benefited substantially from and would like to thank, without implicating them, a number of central banking colleagues at the Federal Reserve, the Bank of England and the ECB and the Eurosystem for numerous discussions, insights and suggestions. This paper presents the authors' personal opinions and does not necessarily reflect the views of the European Central Bank.

1. Introduction

Central banks around the world have strived towards transparency and accountability over the past decade. Transparency is crucial for central banks to influence asset prices and interest rates, and ultimately to manage market expectations effectively and achieve policy objectives. However, despite this universal agreement about the importance of transparency, there is no consensus about *how* central banks should communicate, i.e. what elements precisely constitute an optimal and effective communication strategy. In fact, not only do central banks differ in their given mandates, but they also pursue fundamentally different communication strategies, even when mandates are similar (Blinder and Wyplosz 2004, Ehrmann and Fratzscher 2007a). This disagreement about communication strategies stems from the fact that not all communication may always be effective in enhancing transparency, e.g. as it may reduce clarity and common understanding among market participants or because there are limits to how much information individuals can digest (e.g. Kahneman 2003).

The debate on transparency has in recent years been shaped to a considerable extent by the important work of Morris and Shin (2002) and Amato, Morris and Shin (2002) and the subsequent discussion by Svensson (2006), Woodford (2005) and Morris, Shin and Tong (2006). The main argument of Amato, Morris and Shin is that central bank communication carries a dual role; first, as an information provider about private information of central banks (Romer and Romer 2000), thereby helping guide expectations. And second, central bank communication serves as a focal point, and thus as a coordination device for the beliefs of financial market participants.

Due to this role as focal point, communication may be welfare-reducing because of the risk that market participants may pay too much attention to central bank communication and too little to their own private information. In particular the disclosure of central bank information that is imprecise and noisy may lead markets away from equilibrium and thus reduce welfare. By contrast, Svensson (2006) shows that the validity of this argument depends on rather strong assumptions regarding the signal-to-noise ratio of central bank communication. He argues that in reality these assumptions may never be fulfilled, and thus that providing information through central bank communication may always be beneficial. Moreover, Woodford (2005) argues that the Morris-Shin result is even less likely to hold if one considers that the coordination of private agents' actions may be a welfare objective as well.

The present paper identifies two hypotheses that allow empirical testing of the Morris-Shin argument and ensuing debate, both under the assumption that one of the key contributions of communication to welfare lies in making central bank actions predictable. First, it analyses whether the effect of communication on predictability of monetary policy at short and medium horizons depends on the precision of this communication, and on the attention paid by financial markets. Second, it tests another key insight derived from the Morris-Shin model, namely, that the effectiveness of communication is dependent on the environment in which it occurs. On the one hand, a particular statement may be welfare-enhancing when private signals are noisy, i.e. when there is a relatively high degree of uncertainty among market participants about the economy and the future path of monetary policy. Yet, on the other hand, the same communication may be detrimental if it occurs when such private signals are relatively precise, thus raising the overall level of noise in financial markets. The paper tests whether, and under what conditions such a non-linear effect of communication exists.

The paper tests these hypotheses for the case of the Federal Reserve since February 1994, when it started announcing interest rate decisions immediately following its Federal Open Market Committee (FOMC) meetings. We exploit a database of real-time newswire reporting (Ehrmann and Fratzscher 2007a) that contains statements by the committee as well as by the individual FOMC members, such as speeches and interviews in the inter-meeting period.

Overall, the empirical results of the paper provide strong support for the main hypotheses formulated by the Morris-Shin and Svensson debate. The findings show that communication is indeed a major determinant of the predictability of FOMC decisions and the future policy path.

First, a higher *precision of the Federal Reserve's communication*, as proxied by its frequency, is found to improve predictability. However, there is a sizeable asymmetry in this effect as more information appears to help financial markets primarily in times of large uncertainty, i.e. when there is a high degree of noise in the information held by market participants. Communication that is characterized by a high degree of *dispersion* among committee members, and therefore most likely relatively imprecise, is detrimental for predictability, in particular when market uncertainty is otherwise low. Moreover, this dispersion is economically meaningful as, on average, it accounts for about one third of the market's forecast errors of FOMC decisions since 1994. However, while being consistently harmful for predictability at short horizons, dispersed communication can be beneficial when it comers to the predictability at the longer term. These results shed light on the ongoing debate on whether central banks 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, is still highly controversial.[1]

Second, the *attention paid by financial markets* matters. We identify the purdah period[2] as a case where financial markets are particularly, and possibly overly, attentive to central bank communication. The empirical results underline that communication during the purdah period reduces predictability of decisions.

Third, the effects of these different elements of central bank communication *depend on the environment* in which they are made. The same single element of communication may be beneficial in an environment of high market uncertainty; yet it may be detrimental under low market uncertainty. The findings of the paper thus underline the importance of flexibility in communication policies and the need to adapt to market conditions in order to achieve their ultimate objectives. In fact, a number of central banks are currently (and sometimes fundamentally so) changing their communication strategies, with some implicitly acknowledging the limits to transparency and thus restricting the amount and type of information they are willing to share.[3]

The paper is organized in the following way. Section 2 briefly discusses related literature on central bank strategies and communication. To motivate our empirical analysis, section 3 outlines a simple conceptual framework, along the lines of Morris and Shin (2002), stressing

[1] Some policy-makers have argued that it is important to communicate this diversity among individual committee members because it helps markets understand the risks and anticipate monetary policy decisions (e.g. Bernanke 2004). By contrast, others have argued that such a communication strategy may not necessarily provide greater clarity and common understanding and thus that it may be important for central banks to communicate "with one voice" (e.g. Issing 1999, 2005).

[2] The purdah period, used by most central bank committees in mature economies, implies a voluntary, self-imposed rule that no member should communicate about monetary policy in the days immediately preceding and/or following policy-setting meetings.

[3] An interesting example is the decision by the Swedish Riksbank, announced on 11 May 2007, to increase the frequency of press conferences and to reveal the voting of individual committee members. Yet, the Swedish Riksbank also announced that it wants its committee members to abstain from communicating about monetary policy intentions in the inter-meeting period through speeches and interviews: "The Executive Board has come to the conclusion that there is not normally any reason to indicate how the repo rate will be set in speeches and press releases issued prior to the monetary policy meetings. Our assessment is that it is enough to signal our intentions clearly in connection with the seven monetary policy meetings held every year." (Riksbank 2007)

the importance of the interaction between communication and private information. 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 effectiveness of communication, as well as several robustness tests. Section 6 summarizes the findings and draws some policy implications.

2. Literature on communication and committees

The present paper is linked to two strands of the literature; one focusing on the effect of central bank communication on financial markets; and a second on the design and effectiveness of central bank committees. This section briefly reviews some key studies in these areas in order to help place the present paper and outline its intended contribution.

A number of recent studies build on the model by Morris and Shin (2002) and analyze the welfare implications of central bank transparency. Much of this work has concentrated on the quasi time consistency problem a central bank may face when providing new information. Due to the role as a focal point of a central bank, market participants are likely to discount the noisiness of central bank information and the conditionality of forward-looking information. While Faust and Leeper (2005) and Rudebusch and Williams (2006) focus on the existence of information asymmetry, Gosselin, Lotz and Wyplosz (2006) stress the role of information heterogeneity between central banks and the public, which may lead to the welfare-reducing effect of transparency. Cornand and Heinemann (2006) show in a theoretical setting that a limited dissemination of information by central banks may reduce the scope of coordinated action and thereby lower the likelihood of welfare-reducing communication effects. Limits to central bank transparency are furthermore discussed in Mishkin (2004) and Cukierman (2007). More general approaches underlining the value of transparency are Eijffinger and Geraats (2006), Geraats (2002) and Dincer and Eichengreen (2007).

As to the effect of communication on asset prices, Kohn and Sack (2004) investigate the effect of statements by former Federal Reserve Chairman Greenspan on the volatility of various asset prices and find that overall they have had a sizeable effect. Reinhart and Sack (2006) analyze different types of communication by the FOMC and find that it is primarily the committee-wide communication that affects markets. Ehrmann and Fratzscher (2007a) take a broader perspective by analyzing and comparing the effects of communication on monetary policy inclinations 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 exerts substantial effects on financial markets for all three central banks, but that markets react significantly to statements about the economic outlook only by the FOMC. Andersson et al. (2006) find for the case of the Swedish Riksbank that both speeches and the inflation report affect the short end of the term structure, whereas only speeches exert an effect on the longer end.

Gürkaynak, Sack and Swanson (2005) and Ehrmann and Fratzscher (2007b) 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 (2007b) find that the balance-of-risks assessment has crowded out other sources of information. 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.

On the literature on central bank committees, an important choice of a central bank is about the design and purpose of the policy-setting committee, and specifically also how much of the diversity of views in the committee to communicate 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. As mentioned above, some policy-makers have emphasized the advantages of having an individualistic approach to communication in which the diversity of views across committee members are communicated (e.g. Bernanke 2004), while others have stressed the risks and potential costs (e.g. Issing 1999, 2005).

The important work by Blinder and Wyplosz (2004) provides a broader framework for analyzing 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. Their study encompasses a wider strand of the literature that has analyzed 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 2006). 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. In particular, understanding how communication affects the predictability of policy decisions and of the path of future interest rates as well as the degree of market uncertainty about policy decisions remains highly controversial, but is crucial for assessing the overall effectiveness and success of central bank communication strategies. This is the objective of the present paper and its intended contribution to the literature.

3. Morris-Shin framework of communication and noisy public signals

The purpose of this section is to present a simple modeling framework, illustrating the effect of central bank communication, in order to motivate our subsequent empirical analysis. The model follows closely Morris and Shin (2002) and Amato, Morris and Shin (2002), the discussion thereof by Svensson (2006) and the reply by Morris, Shin and Tong (2006). The main feature of the model is the analysis of the conditions under which central bank communication may be welfare-reducing and how communication interacts with other, private signals of financial market participants.

The main feature of the model is that communication has a dual role. On the one hand, communication provides information about relevant fundamentals to financial markets. This information is relevant for markets because a central bank may have superior information, not just about its own objectives, but also about the economy more generally as it puts substantial resources into understanding and forecasting economic developments (Romer and Romer 2000). Even if it does not have superior information, the central bank's assessment of the relevant fundamentals will be of importance to market participants, as it will affect future policy actions. On the other hand, central bank communication may serve as a focal point, and as such as a coordination device for the beliefs of financial market participants. Agents receive not only private signals about relevant fundamentals, but they also care about other agents' beliefs, akin to the example of Keynes' beauty contest. This feature is particularly relevant for understanding the incentive structure of financial market participants, who are partly assessed and rewarded not based on their absolute performance, but on their performance *relative* to that of other market participants. Hence decisions by investors are based both on their private information and their beliefs about other agents' beliefs.

The potentially welfare-reducing effect of central bank communication stems from the fact that the coordination role of communication induces agents to place too much weight on this public signal as compared to their private information than is socially optimal. This is of course only a problem to the extent that the public signal is noisy, i.e. inaccurate about the underlying fundamentals. A key point of the analysis is that public information, as e.g. provided through central bank communication, and private information might in essence become substitutes.

The starting point, based on Morris and Shin (2002) and Svensson (2006) is Lucas' (1972) "island economy" model with a continuum of private agents of unit mass indexed over the unit interval [0,1]. Agent $i \in [0,1]$ takes a decision p_i – such as for instance the pricing of a security – and has a utility function of the following form:

$$U_i(p,\theta) \equiv -\left[(1-r)(p_i-\theta)^2 + r\left(L_i - \overline{L}\right)\right] \quad (1)$$

with θ as the state variable, or fundamentals, $r \in [0,1]$ as a constant, and

$$L_i \equiv \int_0^1 (p_j - p_i)^2\, dj \quad , \quad \overline{L} \equiv \int_0^1 L_j\, dj$$

The first term of (1) is a standard component indicating that the agent wants her decision p_i to closely reflect and be consistent with the fundamentals θ, while the second element corresponds to the loss arising from the disagreement or "beauty contest" with (the average of) other agents. The constant *r* is the relative weight attached to each of the two components.

Given this utility function, the optimal decision rule of agent *i* is given by

$$p_i = (1-r)\, E_i(\theta) + r\, E_i(\overline{p}) \quad (2)$$

with E(.) as the expectations operator and $\overline{p}$ the average decision across all other agents. From a welfare perspective, the social planner (or central bank) only cares about the first component of (1), i.e. the welfare objective is to induce decisions by agents that are as close as possible to the underlying fundamentals θ. This fundamental may be interpreted as the expected monetary policy rate. Thus the realized social welfare function can be written as

$$W(p,\theta) = -\int_0^1 (p_i - \theta)^2\, di \quad (3)$$

which averages over the utilities of all agents, normalized by (1–r). The difficulty stems from the fact that the state variable θ is not observable and is surrounded by uncertainty. Each agent receives two types of signals about θ; the first is a private signal, $x_i = \theta + \varepsilon_i$, where ε_i is i.i.d. with zero mean and variance σ_ε^2. The second signal agents receive is the public signal, $y = \theta + \eta$, where η is also normally distributed with zero mean and variance σ_η^2. Defining the relative precisions of the private signal as $\beta \equiv 1/\sigma_\varepsilon^2$ and of the public signal as $\alpha \equiv 1/\sigma_\eta^2$ implies that the expected value of the fundamental θ is

$$E_i(\theta) = (\alpha y + \beta x_i)/(\alpha + \beta) \tag{4}$$

The substitution of this expected value into (2) yields a unique equilibrium for the optimal decision rule of agent *i* as a function of the signals received:

$$p_i = \frac{\alpha\, y + (1-r)\beta\, x_i}{\alpha + (1-r)\beta} = \theta\, \frac{\alpha\, \eta + (1-r)\beta\, \varepsilon_i}{\alpha + (1-r)\beta} \tag{5}$$

The key insight is that agents give relatively more weight to the public signal than the private signal – indicated by (1–r) in (5) – given that the former is common knowledge and given the objective of minimizing the disagreement with other agents, than the relative precisions of each of the signals would otherwise warrant. Substituting (4) and (5) into (3) yields the expected social welfare function

$$E\left[W\left(p,\theta\right)\right] = -\frac{\alpha + \beta\,(1-r)^2}{\left[\alpha + \beta(1-r)\right]^2} \equiv V(\alpha) \tag{6}$$

Linking this welfare function to communication, the parameter α can be interpreted as the degree of transparency of a central bank. The question is under what conditions an increase in transparency may be detrimental to welfare. Through maximization of (6) with regard to α, it results that this is the case if

$$\alpha/\beta < \left(2r-1\right)\left(1-r\right) \tag{7}$$

Figure 1 illustrates this trade-off between the precision of private and public signals. There are two key insights that result. First, an increase of transparency may be detrimental to welfare, and second, the condition under which it is detrimental depends crucially on the precision of the private signal. The first point is illustrated in the figure by the fact that, in the area to the left of the dashed line, an *increase* in α actually lowers welfare for any given β. The second point is that whether increasing α from a given level is detrimental or not is dependent on the precision of the private signal (the size of β).

Figure 1

The important point of Svensson (2006) is that this condition can hold only for specific values of *r*, i.e. only for $r \in (0.5,1)$. For a value of $r=0.75$, the right-hand-side of (7) is maximized, so that condition (7) holds if and only if $\alpha/\beta < 1/8$. In other words, for a value of r = 0.75 – i.e. agents attaching three quarters of their importance to the actions of other agents, and only one quarter to θ – providing a public signal can reduce welfare only if the public signal is more than eight times as noisy as the private signal. Svensson argues that it is rather unrealistic that any public signal could be so noisy as to fulfill this condition.

In their reply to Svensson, Morris, Shin and Tong (2006) suggest a slightly different twist to their model, by applying it to a central bank that ponders whether or not to release a public signal, rather than to a central bank that has established a certain level of transparency and needs to decide whether or not to increase the degree of transparency. The latter case can, for instance, be thought of as a central bank that has already communicated a monetary policy objective (and thus positioned itself in Figure 1 with a certain α), and deliberates publishing its monetary policy rule, or its macroeconomic model (to increase the level of α). The former possibility can be portrayed by a central bank that has just released a monetary policy decision, and needs to decide how much forward-looking communication it provides to the markets in order to guide their expectations about upcoming decisions. In this case, withholding the signal would imply setting $\alpha = 0$, and the resulting welfare would need to be compared to the welfare with the signal. The hurdle rate, i.e. the level of precision of the public signal $\overline{\alpha}$ required for its release to be welfare enhancing is then the value of α that solves $V(\alpha) = V(0)$, and is given by

$$\overline{\alpha} = \beta(2r - 1) \tag{8}$$

Morris, Shin and Tong argue that the hurdle rate can actually be quite high, in particular as r approaches unity. This is shown in Figure 1, where the resulting hurdle rate for a given level of β lies substantially to the right of the dashed line. They state: “The debate thus moves on to the question of whether the public signal is *sufficiently* precise to justify disclosure. The issues are then empirical, and the answer depends on the context.” (p. 453; emphasis in original).

The empirical test of this hypothesis is the key objective of the present paper. Although we are obviously not able to formulate a structural model based on this conceptual framework, we use the insights of the Morris-Shin model to motivate the formulation and specification of our empirical model.

4. Hypotheses and data

This section outlines the empirical specification of our model for testing the effectiveness of central bank communication. The section starts by stating the main hypotheses of the empirical analysis (section 4.1), and then discusses the choice of proxies for the model variables (section 4.2)

4.1 Hypotheses

The Morris-Shin model postulates that social welfare (W) depends on the quality of public signals provided by the central bank (α), and the quality of the available private signals (β). To put this hypothesis to an empirical test, we have to find proxies for each of these. Denoting the proxies as z_W, z_α and z_β, respectively, a simple empirical model can be written as:

$$z_{W,t} = k + \lambda\, z_{\alpha,t} + \mu\, z_{\beta,t} + \nu_t \tag{9}$$

The parameter of interest is λ, the effect of the release of a public signal on welfare. Depending on its quality, λ can take different signs: for sufficiently precise signals, λ should be positive, whereas the essential question is whether it is possible to identify signals that do lead to a deterioration in welfare, i.e. for which $\lambda < 0$.

However, the Morris-Shin model also implies that the desirability of the disclosure of a public signal depends on the market environment. It does so in two dimensions. Even though this is not discussed in the Morris-Shin and Svensson debate, it is evident from equation (8) that the hurdle rate depends also on the weight r given to the beauty contest by market participants. Relaxing the assumption that r is a constant, a given signal is more likely to be too noisy the higher is r, such that the probability of finding a negative λ should be accordingly larger. We will therefore attempt to identify types of communication or time periods where we can reasonably assume that r is relatively high.

Furthermore, the model postulates an effect of the quality of the private information of market participants. This is formalized in equation (8) and implies that the issuance of a public signal with a level of precision α is more likely to be beneficial when the quality of private information is low (i.e. for low β). To test this possibility, we transform model (9) to yield:

$$z_{W,t} = \kappa_0 + \mu\, z_{\beta,t} + \gamma_1\ (z_{\alpha,t}\, D_t^{\beta}) + \gamma_2\ (z_{\alpha,t}\,(1 - D_t^{\beta})) + \nu_t \qquad (10)$$

with $D^{\beta} = 1$ if the noisiness of private information is above its mean over the whole sample period and $D^{\beta} = 0$ if it is below or equal to its mean. This formulation obviously has the drawback of not fully exploiting the continuity of the variable $z_{\beta,t}$ in the interaction, but it has the advantage of yielding more easily interpretable coefficients.

Thus the second hypothesis of primary interest for our analysis is whether the effect of public information, as provided through communication, is more beneficial for welfare when the precision of private signals is lower, or formally:

$$H_0: \quad \gamma_1 > \gamma_2$$

The hypothesis that public information is beneficial under noisy private information, and detrimental otherwise amounts to

$$H_0: \quad \gamma_1 > 0;\ \ \gamma_2 < 0$$

Models (9) and (10), and the hypotheses derived from them, constitute the core of our empirical analysis. However, we first turn to the issue of how to measure welfare, public signals and the quality of private signals.

4.2 Data: measuring welfare and the quality of public and private information

The empirical analysis is conducted for the Federal Reserve since February 1994, when it started announcing interest rate decisions immediately following its Federal Open Market Committee (FOMC) meetings. Our sample ends in May 2004. This sub-section outlines the definitions of the dependent and independent variables for the empirical analysis.

4.2.1 Dependent variables: Measuring predictability at short and medium horizons

To find a proxy for social welfare *W*, it is necessary to identify the objective of central bank communication. Our main premise is that a successful communication strategy should make a central bank well understood by the public, which should in turn imply that the public can infer the future actions of the central bank by observing the current or expected macroeconomic conditions. Hence the actions p_i of agents in the social welfare function (3) may be interpreted as the pricing of agents' expectations about the upcoming decision, e.g. on the Feds Funds futures market. Accordingly, the fundamental θ in (3) may be interpreted as the policy rate after the decision. Equation (3) thus can be understood as communication being conducted by central banks with the objective of maximizing the predictability of its future policy path.

We use two alternative dependent variables to proxy for welfare, $z_{W,t}$, which may be influenced by central bank communication and transparency: the predictability of the next FOMC decision, and of the future path of interest rates. For the first of these variables, measures of predictability at the short horizon are easily obtained. We measure the surprise component of interest rate decisions 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 2005).[4] To obtain a measure of *predictability*, we multiply the surprise measure with -1 so that a smaller (more negative) value implies less predictability. Our first proxy is therefore $z_{W,t} = -\left| \frac{\sum_{i=1,N} E_{i,t*}(r_t)}{N} - r_t \right|$, where r_t denotes the policy rate resulting at the FOMC meeting on date t, and $E_{i,t*}(r_t)$ the corresponding expectation of an individual respondent expressed in the Reuters survey at $t*$, a few days prior to the meeting.

As to the second proxy, it is much more difficult to measure monetary policy predictability at longer horizons. Calculating mean forecast errors over a longer horizon of e.g. one or two years is not meaningful as it is understood that future decisions are conditional on incoming macroeconomic data. As such, a large forecast error at a given point in time can reflect either the arrival of new information or that central bank communication was not able to convey well the central bank's views or reaction function to the public. We are not able to disentangle these two alternatives, such that we need to find an alternative measure of predictability.

In the vein of Faust and Svensson (2001), transparency and successful central bank communication at longer horizons should imply that market participants can fully understand the intentions and goals of a central bank and how it may react to specific shocks in the future. Given a specific set of expectations about future macroeconomic variables, such transparency about the goals and the reaction function should thus entail that there is a homogeneous understanding of the likely future path of monetary policy across financial market participants. We therefore use the heterogeneity or dispersion of policy monetary policy forecasts across financial market participants as our proxy for the medium-run predictability of FOMC policy.[5]

This measure is derived from the Reuters surveys mentioned above, which includes expectations about monetary policy rates at the end of the current or the subsequent year. We construct a measure of uncertainty within each survey, which is the standard deviation of the responses across individual forecasters. To obtain a measure of predictability, we multiply this uncertainty measure with -1. Our second proxy is therefore $z_{W,t} = -stdev\left[E_{i,t*}(r_{t+k})\right]$, where k denotes the forecast horizon in a given Reuters survey.

It is important to note that the forecast horizon for this type of survey differs over time; on average, it amounts to 2 quarters. In our empirical analysis, we will therefore control for the length of the forecast horizon in each survey. It is furthermore important to stress that this definition of predictability of policy at a medium-term horizon is also conditional on expectations about future macroeconomic conditions and shocks. Controlling for the degree of macroeconomic uncertainty prevailing at the time of the survey allows us to understand the extent to which central bank communication can affect uncertainty among financial market participants about later decisions.[6]

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[4] Note that the empirical findings are very similar when using market-based measures of expectations, based on fed funds futures as in Gürkaynak et al. (2005). The main rationale for using survey data is to be consistent between the two measures for the dependent variable.

[5] Swanson (2006) studies cross-sectional heterogeneity in the forecasts of monetary policy, and finds this to be reduced with increasing FOMC transparency over the last decades.

[6] In line with this reasoning, Bauer et al. (2006) find that the immediate release of FOMC decisions since 1994 has led to more synchronized private sector forecasts of future economic conditions, while they find only little evidence that this change has reduced the magnitude of common forecast errors.

The availability of these survey data defines our sample frequency: surveys are conducted prior to each FOMC meeting. Accordingly, we have 8 observations each year, bringing us to a total of 80 observations for our sample period February 1994 – May 2004 for the short-term predictability. Data for medium-term predictions are available to us starting May 1999, amounting to 44 observations in total.

4.2.2 Independent variables: communication – public signals

As described in Section 3, Morris, Shin and Tong (2006) argue that an empirical test of the model should study the welfare effects of the issuance of a public signal, rather than those of an incremental increase in the degree of transparency. We therefore have to identify measures for the release of public signals by the FOMC, for testing purposes ideally with some variation in their precision. One possible application is the extent to which the FOMC is willing to guide financial market expectations about upcoming interest rate decisions through forward-looking statements beyond that provided in the statements accompanying the announcement of a policy decision. Hence, we will treat all inter-meeting communication that occurs between the day following an FOMC meeting and prior to the next FOMC meeting as one communication event, and try attempt to measure the degree of its precision.

To do so, we employ the data developed and described in detail in Ehrmann and Fratzscher (2007a). This dataset collects all pieces of communication that contain some reference to monetary policy inclinations by the committee as well as by its individual members in the intermeeting period, using the newswire service *Reuters News* to extract all statements at a daily frequency. Each individual statement has subsequently been classified as to whether it indicates an inclination towards monetary policy tightening, towards an easing, or is neutral. Appendix A gives a detailed account of the underlying methodology of the construction of the dataset, and Table 1 provides an overview of the communication data in this database.

Table 1

Based on this dataset, we construct a few measures that provide a characterization of the entire inter-meeting communication according to two dimensions.

1. *The precision of the FOMC's inter-meeting communication*
   Here, we try to identify whether communication in a given inter-meeting period shows a high or low α, differentiating two aspects. First, in their inter-meeting communication, FOMC members might want to give their individual views about monetary policy inclinations. Doing so will reveal information to financial markets, namely about the diversity of views on the committee. However, we argue that dispersed communication is relatively noisy, and should therefore be associated with a rather *low* α. Appendix A2 explains how we construct a measure for dispersion of communication (*"dispersion among committee members"*). The basic idea is to create a measure that lies between 0 and 1, with zero implying that all committee members' statements in an inter-meeting period show the same policy inclination (i.e. towards tightening, easing or neutral). By contrast, a dispersion of 1 means that there is a maximum degree of disagreement among committee members. A related measure of communication dispersion (*"dispersion with committee releases"*) is used for the consistency of statements of individual FOMC members with that of the entire committee, such as the release of the Minutes or the Humphrey-Hawkins testimonies.

   Controlling for the degree of dispersion, more frequent communication should provide more information and better understanding among market participants about future policy decisions. Accordingly, we conjecture that this characteristic of inter-meeting communication bears *a high degree of precision* α. The measure *"frequency* *of communication"* is constructed by simply counting the number of statements by FOMC members in a given inter-meeting period.

2. *The relevance of the beauty contest*.
These characteristics attempts to identify whether communication takes place under a high or low *r*. Having controlled for the content and the frequency of communication as described above, we proxy the market's attention to FOMC communication by its market impact on interest rates in the inter-meeting period ("size of communication effects").[7] Here, our prior is less clear cut. On the one hand, a sizable market reaction suggests that r is relatively large. On the other hand, for this to be a true measure of r, it is important to control for the content of communication, as otherwise a large market reaction could also arise in response to informative communication. However, as the two scenarios imply different signs for the effect of communication on welfare (communication under high *r* is more likely to be detrimental for welfare, informative communication more likely to bear a high α and thus to raise welfare), it is an empirical issue to see which dominates.

Finally, our last characteristic of communication in the intermeeting period is based on the fact that the FOMC, like most central banks in mature economies has a self-imposed purdah period during which committee members agree not to communicate with the public. For the FOMC, the purdah appears to apply 7 days before and 3 days after FOMC meetings (Federal Reserve 1995). The underlying reasoning is that statements just prior to policy-setting meetings are undesirable as they risk unsettling markets and possibly limiting the options of the committee (Bank of England 2000, Federal Reserve 1995). The existence of such purdah periods suggests that situations where more communication lowers welfare are a real possibility. In the framework of the Morris-Shin model, this implies a time-varying weight given the public signal; if it is excessively high, central banks prefer not to communicate. We use the fact that there are occasional instances of communication during the purdah period – either intentionally to communicate important new information, by mistake, or because the media may hold back reporting on statements until the purdah period – to test whether such communication is indeed detrimental to welfare.[8] We therefore include a dummy variable capturing whether or not communication during a purdah period took place ("communication in purdah period"), and assume that such communication carries a high r.

4.2.3 Independent variables: the precision of private signals

What are "private signals" that market participants receive and which influence their decisions? Recall from section 3 the definition of private signals as $x_i = \theta + \varepsilon_i$, with θ as the fundamentals and ε_i as the private signals and their relative precision $\beta \equiv 1/\sigma_\varepsilon^2$. The quality of private signals is difficult to measure, as information that differs across agents, by its very nature, is hard to observe. We define three proxies $z_{\beta,t}$ – which, however, are naturally defined as noisiness rather than precision of private signals. The first two are the *heterogeneity across market participants in their forecasts for CPI inflation and for GDP growth* over the coming year. The source of this data is the Blue Chip Economic Indicators data, which conducts monthly surveys of about 30 market participants. These forecasts are certainly strongly influenced by economic conditions which are common knowledge, but the *difference* across

[7] We measure the reaction of three-month treasury bills on the day of each statement (controlling for the effects of macroeconomic announcements), and cumulate the absolute reactions over the days of the inter-meeting period where a statement is recorded.
[8] For instance, former Chairman Greenspan testified to Congress a few days prior to FOMC meetings in January 1994, September 1994, March 1997, and May 2003.

agents should largely reflect private information, either about underlying economic factors or about how these affect inflation and growth over the medium term. We use the cross-sectional standard deviation of the last survey before an FOMC meeting of the two forecasts as two proxies for the noisiness of private signals.[9]

As a third proxy for the underlying uncertainty, we use the *volatility of short-term (3-month) interest rates* in the inter-meeting period. A larger degree of interest rate volatility is likely to partly reflect a larger heterogeneity in private information. In order to avoid a potential endogeneity that communication may cause more interest rate volatility, we measure interest rate volatility as the standard deviation of daily interest rate changes during the pre-event window, i.e. before communication takes place in each inter-meeting period (see Figure 2).

Figures 2 and 3

Figure 3 plots these three proxies for the noisiness of private signals over the FOMC inter-meeting periods since February 1994. While there is some variability in all three of the series from one inter-meeting period to the next, also some longer term patterns are present in the data. In particular, forecast dispersion was higher in 1998 and again in 2001-2002. Similarly, interest rate volatility was larger in earlier periods and has declined somewhat in recent years. Note that the large volatility outlier prior to the FOMC meeting in October 2001 is related to the September 11 attacks but does not drive the empirical results presented below.

4.2.4 Other controls

As discussed in detail above, it is important to control for relevant economic factors that are common knowledge and may influence policy predictability, apart from communication and the noisiness of private signals. In particular, information that is fundamentally distinct from communication *and* is likely to be relevant to predict policy decisions is information about important macroeconomic variables released in an inter-meeting period. Policy decisions may be harder 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 use ten of the most relevant macroeconomic news releases for to the United States and construct a *macro news dispersion* measure similar to those for communication dispersion.[10] Moreover, again similar in methodology to the proxies for communication, we use the frequency and the cumulated impact of macroeconomic news on short-term interest rates in each inter-meeting period as two further proxies for the *information content* inherent in macroeconomic announcements.

Finally, we also include dummy variables indicating whether the FOMC had changed interest rates or issued an asymmetric bias at the previous FOMC meeting, as these may help markets better anticipate future decisions.

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[9] Cukierman and Wachtel (1979, 1982) show that the cross-sectional variance of survey expectations data provides a proxy for macroeconomic uncertainty. We are grateful to Tao Zha for kindly sharing these data series with us. Note that the survey asks its participants to provide expectations through the end of the subsequent year. We use standard deviation measures of expectations that are seasonally adjusted, using a regression of the series on monthly dummies, in order to control for different time lengths of forecast horizons.

[10] The set of macro news comprises advance GDP, consumer confidence, CPI, industrial production, ISM survey, nonfarm payrolls, PPI, retail sales, trade balance and unemployment. 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. The macro dispersion measure follows that for communication, detailed in Appendix A2., using the direction of the surprise of macro announcements to classify them as containing positive or negative news about the economy. Higher than expected inflation releases are counted as "positive" surprises, as they would point towards higher interest rates in the same fashion as "positive" real developments.

5. The effectiveness of communication

Turning to the empirical results, we start by analyzing the overall effectiveness of communication for our two welfare proxies of the short-term and medium-term predictability of FOMC decisions (section 5.1), before we present a number of extensions and robustness tests (section 5.2). Finally, the section discusses the evidence concerning the dependence of the effectiveness of communication on the noisiness of private signals (section 5.3).

5.1 Effectiveness of communication

We first analyze the overall effect of the various communication elements on the two welfare proxies – the short-term predictability of FOMC decisions, and the heterogeneity of medium-horizon forecasts of market participants – based on the empirical model of equation (9). We employ a censored regression or tobit model in order to take into account that a few of our dependent variables are censored to lie at or above zero. The main hypothesis of interest is whether $\lambda > 0$ or $\lambda < 0$, i.e. whether we can identify characteristics of communication or instances that exert different effects on predictability.

Table 2 shows the estimates for the *short-term predictability* of subsequent FOMC decisions, starting from a full model, i.e. including both proxies for public and private signals respectively, in the first column, and then showing separately the estimates for only the public signals and only the private signals in the second and third columns. The findings indicate that a higher frequency of statements by the FOMC and its members helps improve short-term predictability. This stresses that frequent information of markets through central bank communication is indeed beneficial.

Table 2

By contrast, communication dispersion among FOMC members lowers the predictability of policy decisions significantly. Importantly, the effect of communication dispersion is sizable. 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 about 5 basis points.[11] Given that the average absolute surprise component contained in FOMC decisions, as calculated from our Reuters poll dataset, is around 3.4 basis points, this implies that dispersion among committee members about policy inclinations has a substantial overall effect on the predictability of monetary policy. As the average degree of communication dispersion on policy inclination is 0.252, as indicated in Table 1, this suggests that overall this communication dispersion has accounted for about one third of the market's prediction errors of FOMC monetary policy decisions since 1994. This suggests that highly dispersed communication is on average not sufficiently precise to pass the hurdle rate, such that its provision reduces welfare.

Also our measures for the relevance of the beauty contest show that the release of a public signal can reduce predictability. The coefficient for the size of communication effects, though

[11] Note 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, and thus one cannot easily evaluate the effect of *any* change on the dependent variable. 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 2 a change of US communication dispersion on policy inclinations from zero to one raises the prediction error by 5.4 basis points as compared to a marginal effect of 5.1 (or 0.051) in the table.

statistically significant only in (2), suggests that predictability could be lower in situations where markets pay a lot of attention to central bank communication. This is corroborated by the findings on the effects of communication during the purdah period, which are detrimental and reduce the short-term predictability of FOMC decisions. In fact, communicating during the purdah period raises the forecast error by 2.6 b.p. in the full model. This confirms what policy-makers in virtually all central banks of mature economies have argued, namely that making statements just prior to policy meetings introduces uncertainty which lowers the market's ability to anticipate decisions.

As to the noisiness of private signals, more forecast heterogeneity about GDP growth indeed appears to lower the predictability of FOMC decisions, though neither CPI forecast heterogeneity nor interest rate volatility are significant in the benchmark specification (1). It should be stressed that it is not clear whether a lower precision of private signals should necessarily affect the predictability of monetary policy decisions. If this uncertainty is fully shared by and reflects that of the members of the policy-setting committee, then a higher dispersion in information among private agents may not affect the predictability of policy decisions. Recall that the key argument of the model presented above is that the noisiness of private signals merely alters the effect that communication has on financial markets. We turn to this hypothesis in detail below in section 5.3.

Moreover, there seems to be little role for macroeconomic news and uncertainty in influencing the predictability of FOMC decisions, with the exception of the size of the effect of macroeconomic news on financial markets. This implies that when a lot of new and unexpected macroeconomic information comes to the market, it may induce market participants to become more uncertain about how the FOMC may react to it in the subsequent meeting, thus making it more difficult for markets to anticipate decisions.

As to our second welfare proxy, we turn to the effects of private and public signals on the *predictability of FOMC decisions at a medium term*. This is an interesting extension to Table 2, because communication frequently has a much longer time horizon by conveying views of policy-makers and the FOMC about the path of future monetary policy. Table 3 shows that the results are to some extent similar to those for the short-term predictability in that a higher frequency of statements increases, but communication dispersion lowers predictability of the future path of US interest rates.

Table 3

However, there are also some interesting and intuitive differences between the impact of communication on the short- and the medium-term predictability of US monetary policy. Communication in the purdah period negatively affects predictability only at the short horizon for the next meeting, but has no effect on the uncertainty surrounding the future policy path. This result seems intuitive and sensible given the specific characteristics of this type of communication. Finally, interest rate changes at the previous FOMC meeting appear to influence only the predictability of decisions at the next meeting, but not beyond.

In summary, we find that communication exerts a statistically and economically significant effect on the predictability of US monetary policy, both at the short and the medium-term. More frequent and regular communication appears to be beneficial in helping markets settle and better anticipate future decisions. By contrast, communication dispersion and the timing of statements close to meetings during the purdah period seem to be detrimental. Moreover, the section has outlined a few differences in the effect of central bank communication on predictability at different horizons. This first test therefore suggests that the welfare effects of communication depend critically on the precision of the public signal, and on the weight given to these signals by market participants. Less precise signals, or signals that are disclosed in the presence of a large r are more likely to be welfare-reducing.

5.2 Extensions and robustness

We now turn to several sensitivity tests to check for the robustness of our results. Two crucial issues are the possibility of an omitted variable bias affecting our results and the potential endogeneity of communication. The reasoning goes as follows: the fact that we find a significant effect of communication on predictability in Tables 2-3 may simply reflect the possibility that some elements of communication are influenced and determined by other factors that are not included in the model. In particular the communication dispersion and statements in the purdah period may partly reflect changes in the economic environment or new and conflicting information. 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, implying an 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, inducing an endogeneity bias. Similarly, the fact that FOMC members communicate in the purdah period could be explained by new information that they wish to share with the market, but which need to be controlled for when analyzing the impact of such communication on markets.

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 (1) in Tables 2-3 as here we can control for several other factors. However, as a comparison of the various specifications ranging from a more minimalist specification (2) to a more extensive one in (1) shows, the results with regard to communication are mostly 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 alternative measures of dispersion. The results are robust to these tests, but for brevity reasons not shown here.

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, ii) 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 iii) a variable capturing the voting dispersion in the preceding meeting.

As a second approach, we instrument communication dispersion and statements in the purdah period through various factors that may influence these but at the same time are truly exogenous to communication as well as to monetary policy decisions. For instance, macro news dispersion can be considered as 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 and then to employ the instrumented communication variables in model (9) to see whether the findings are sensitive to those shown in Tables 2-3. We therefore estimate a tobit model for communication dispersion, and similarly a simple probit model for the dummy variable of whether or not there was communication during the purdah period.

Table 4 shows the results for communication dispersion on policy inclinations, using both the tobit estimator and an OLS estimator. 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 2), it also raises communication dispersion, while communication dispersion itself worsens predictability. Moreover, more market uncertainty, proxied by the pre-event interest volatility, also raises communication dispersion. This suggests that to some extent dispersed views among committee members reflect a more uncertain economic environment. We conduct a similar analysis for explaining communication in the purdah period, which is not shown here for brevity reasons.

Table 4

As a final step, we re-estimate the empirical model but use the instrumented communication variables in the model instead of their actual values. Table 5 shows that our previous findings are robust and confirmed by this approach using instrumented variables.[12] First, communication dispersion among committee members is again highly statistically significant, showing that more dispersion leads to lower predictability. Moreover, also statements in the purdah period lower predictability. By contrast, a higher frequency of communication enhances the predictability of decisions.

Table 5

For a final robustness test, we want to understand whether the results depend on the judgmental, and thus subjective, classification of the content of communication, as described in Appendix A1. As an alternative classification of communication, we categorized statements based on the reaction of short-term interest rates on the day of the statements. For instance, a statement is classified as a tightening statement if interest rates rise on the same day. 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 results that confirm the importance of communication for the predictability of monetary policy decisions. The results are not shown here for brevity reasons but broadly confirm the results outlined above.

5.3 State-dependence of communication effects

The second key hypothesis in the vein of the Morris-Shin and Svensson debate is that the effectiveness of central bank communication may depend on the specific environment in which it occurs. Specifically, disclosure of a public signal is more likely to be beneficial and welfare enhancing if it takes place when private signals are relatively noisy. The model to be tested is that of equation (10), and our hypothesis of interest is $\gamma_1 > \gamma_2$, or in a more stringent form $\gamma_1 > 0$ and $\gamma_2 < 0$.

As discussed in section 4, we proxy the noise of private signals through the three variables of forecast heterogeneity about CPI inflation and GDP growth as well as the pre-event interest rate volatility in each inter-meeting period. Table 6 shows the results for the effect of communication on the short-term predictability of FOMC decisions. In the table, each element of communication has two coefficients, the upper one ("high noise of private signals") corresponding to γ_1 and the lower one ("low noise of private signals") to γ_2. Table 7 provides the same set of results for the heterogeneity of medium-horizon forecasts of the future path of monetary policy. The columns labeled "sig." provide p-values for a t-test of the hypothesis H_o: $\gamma_1=\gamma_2$.

Tables 6-7

[12] Note that we estimate both steps separately, i.e. we first obtain the instrumented variables, and then in the second step use these instrumented variables 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).

Table 6 shows evidence that the effect of communication on policy predictability indeed depends on the noise of the private information present. In all 15 cases but two it holds that $\gamma_1 > \gamma_2$, i.e. communication is more beneficial (or less detrimental in case γ_1 and γ_2 are smaller than zero) to short-term predictability when private information is relatively noisy. However, given the limited number of observations of 80, this difference is significant statistically mostly only when proxying private signals through GDP forecast heterogeneity and interest rate volatility, as indicated by the columns labeled "sig." showing the p-values for the test of equality of the two coefficients. A higher frequency of communication always improves predictability, but more so when market uncertainty is high. By contrast, communication dispersion across FOMC members and statements in the purdah period are always detrimental for predictability, but in particular when the noisiness of private signals is low.

Table 7 provides evidence that this state-dependence of the effects of communication also applies to the predictability of the policy path, though the asymmetries are statistically significant only for CPI forecast heterogeneity as well as interest rate volatility as proxies for the noisiness of private signals. Again, for most cases (12 out of 15) communication is more beneficial when there is a high noise of private signals. When taking interest rate volatility as a proxy for market uncertainty, this different effect of communication is statistically significant for all five elements of communication analyzed.

Overall, the empirical findings therefore suggest that the effectiveness of communication is indeed dependent on the market environment in which it takes place. An interesting difference arises when comparing the results of short-term and medium-term predictability, namely the sharp difference in the effect of communication dispersion, in particular the dispersion across FOMC members. Communication dispersion always *worsens* short-term predictability, but it is actually *beneficial* at the medium term when interest rate volatility is high. Although it should be stressed that this finding is not robust across the different proxies of market uncertainty, it again underlines the difference in the effect of communication on short-term predictability versus the longer-term policy path. It is also suggestive that e.g. communicating the dispersed views across FOMC members hurts short-term predictability but may actually be beneficial in improving market participants' understanding of future FOMC policy.

6. Conclusions

How central banks should communicate remains controversial and intensely debated both in the academic literature as well as among policy-makers. While an increase in transparency over the past decade has helped improve the effectiveness of monetary policy, it is unclear what precisely constitutes an optimal communication strategy. The seminal work by Morris and Shin (2002), Amato, Morris and Shin (2002), the comment by Svensson (2006) and the reply by Morris, Shin and Tong (2006) illustrates that there is an important controversy about whether central bank communication is necessarily enhancing welfare and under what conditions it may actually be detrimental. There are two central hypotheses in this debate. The first is that communication per se may not always be beneficial as a central bank statement may be noisy and thus lead to sub-optimal market reactions. The second is that the effectiveness of communication may depend on the market environment in which it occurs, i.e. it is more likely to be beneficial under conditions of high market uncertainty and noisiness of private signals.

The objective of this paper has been to test these two hypotheses empirically for the Federal Reserve since 1994. The paper has employed two benchmarks for this purpose: the effect of communication on the short-term predictability of subsequent FOMC decisions and on the extent of uncertainty about the medium-term path of monetary policy. A limitation of this approach is clearly that it does not capture all goals of central bank communication, as also the improvement of the market's understanding of the policy strategy and the reaction of a central bank to shocks are important objectives of communication (Woodford 2005), which is, however, beyond the scope of the paper.

Concerning the first of the hypotheses, the empirical results of the paper indicate that communication exerts a statistically and economically significant effect on the short-term predictability as well as the uncertainty about the future policy path. The effect of communication does depend on the precision of the signal that is issued, however. More precise signals, namely more frequent communications, are beneficial in helping markets better anticipate future decisions. By contrast, communication that is dispersed and conveys not a single committee view but a variety of views on monetary policy inclinations reduces the predictability of decisions and worsens the ability of market participants to understand the future path of monetary policy. Moreover, the effect of communication depends also on the weight that financial markets attach to it; if this weight is exceptionally large, communication can easily be detrimental for welfare. In particular, statements that occur during the purdah period before FOMC meetings appear, on average, to have such a detrimental effect.

As to the second hypothesis, the empirical findings suggest that the effectiveness of communication is highly state-dependent. In general, communication is more effective in an environment of large market uncertainty and more likely to be detrimental if the noisiness of private signals is low. Moreover, there are remarkable differences when comparing the results with regard to short-term predictability and the uncertainty about the policy path. One of these differences is that communication amid high market uncertainty often lowers the heterogeneity about the future FOMC policy path, but rarely improves short-term predictability. This is suggestive that statements that may enhance the understanding of the policy path over the medium term may not necessarily improve the short-term predictability of subsequent decisions, highlighting a further important trade-off for communication policy.

There are several caveats and limitations to the approach of the paper, partly related to the difficulty of measuring transparency and communication, and identifying their effect on policy objectives. Nevertheless, understanding how communication can guide and shape expectations is crucial for central banks to achieve their ultimate policy objectives. An important insight stemming from the current debate on transparency and from the empirical findings of the paper is that the effectiveness of communication depends on the market environment in which it operates. In fact, a number of central banks are currently in the process of reviewing their communication strategies, with some implicitly acknowledging the limits to transparency and thus restricting the amount and type of information they are willing to share. The findings of the paper may contribute to this debate by underlining the limits to transparency and stressing the importance of flexibility in communication policies to adjust to market needs and conditions in order to achieve their ultimate objectives.

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Appendix A:

Measuring communication and its dispersion

This appendix explains in detail the measurement of communication by the FOMC and its members and the identification of communication dispersion or disagreement among the committee members.

A.1 Communication

For the measurement of communication, our analysis is based on the data developed and described in more detail in Ehrmann and Fratzscher (2007a). The objective is to obtain all pieces of communication that contain statements about the monetary policy inclination, by the FOMC as well as by its individual members. We use the Federal Reserve website to identify statements by the FOMC, and the newswire service *Reuters News* to extract all statements by FOMC members, focusing on forward-looking statements and avoiding duplication of statements in the database. The extraction is done in a mechanical manner using a set of search words, consisting of the name of the policy maker together with the words "interest rates", "monetary policy" or "inflation". This classification follows the examples by the work of Guthrie and Wright (2000) and Kohn and Sack (2004).

As a final step, we classify the statements into those that indicate an inclination towards monetary policy tightening, those that suggest an easing, and those that are neutral:

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

The upper panel of Table 1 provides an overview of the communication data in our database. 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 minimize the number of false classifications. In our case, the statements have been double-checked by the authors and independently by a 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.[13]

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

[13] 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 inclinations 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 by the FOMC or testimonies of the Chairman). 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. The results reported in this paper refer to the first classification scheme.

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 recognize 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.

A.2 Communication dispersion

An important element of communication for our analysis is the degree of its dispersion. Our proxy is based on a dispersion measure used in Jansen and de Haan (2006) and Ehrmann and Fratzscher (2007a), which is defined as follows:

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

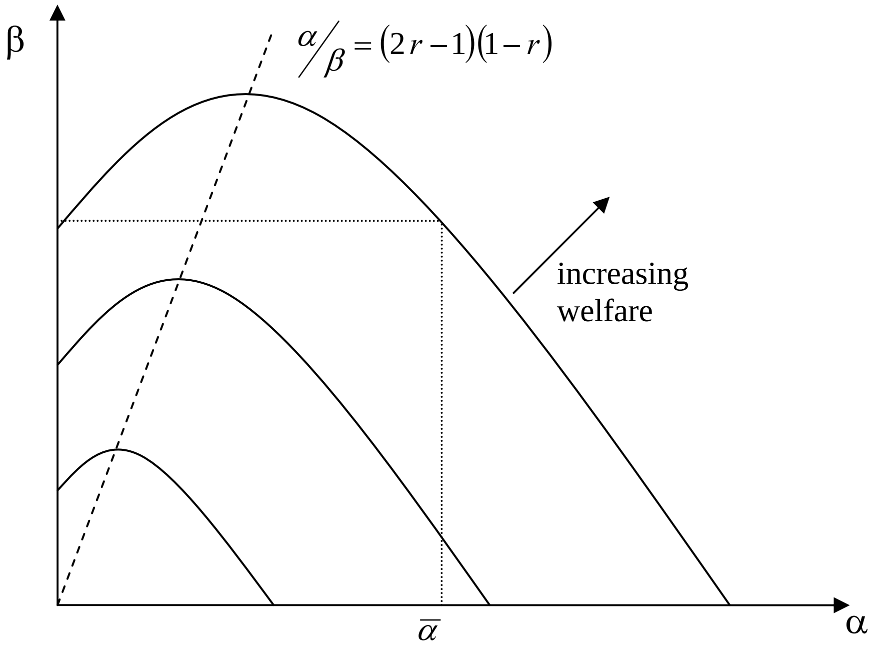
with N as the number of statements in the inter-meeting period t, C^{MP} the statements on monetary policy inclinations classified as {-1,0,+1}, as outlined above, and a dummy D with D=0 if N is an even number and D=1 if it is odd. This normalization allows us to obtain a dispersion measure that lies 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. This measure proxies the dispersion of each member's statements *i* with that of the committee as a whole *j*, based on the semi-annual Humphrey-Hawkins testimonies and the release of the FOMC Minutes:

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

D=0 if (N+M) is an even number and D=1 if it is odd.

Figure 1: Social welfare contours



Note: The figure illustrates the interaction between the precision of public signals (communication), α, and the precision of the private signals, β, and the resulting welfare. The dashed line shows the combinations of α and β at which a marginal increase in α has no effect on welfare. To the left of the dashed line, a marginal increase in α reduces welfare, to the right it raises it. See Section 2 for the derivation of the slope of the dashed line. The dotted lines locate the hurdle rate $\overline{\alpha}$ for the precision of a public signal, such that its issuance does not lower welfare.

Figure 2: Sequence of events

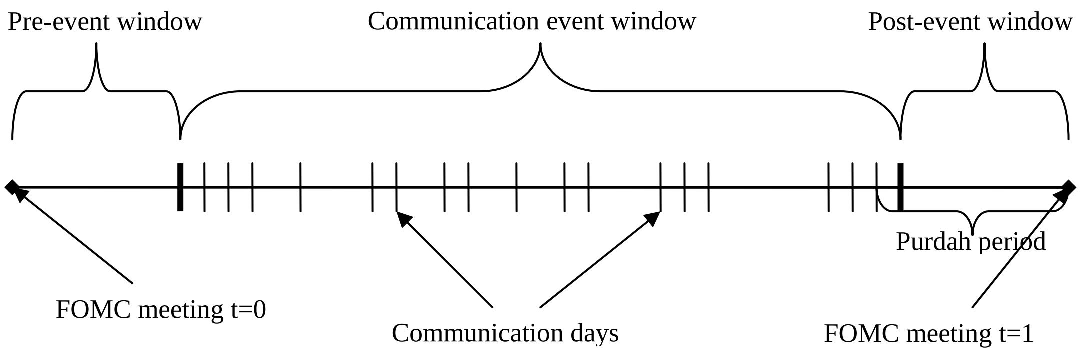
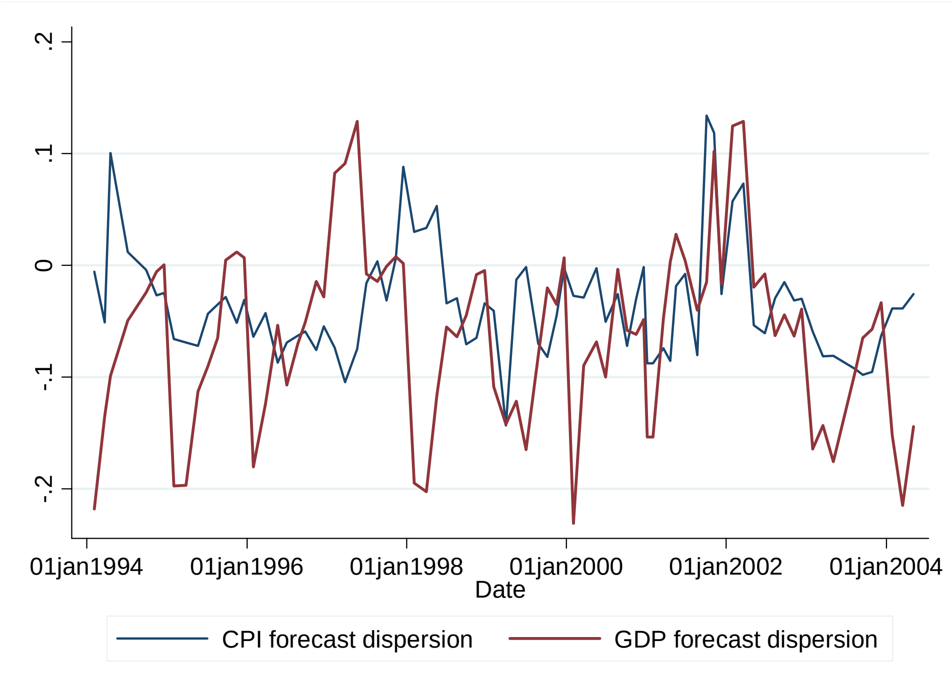
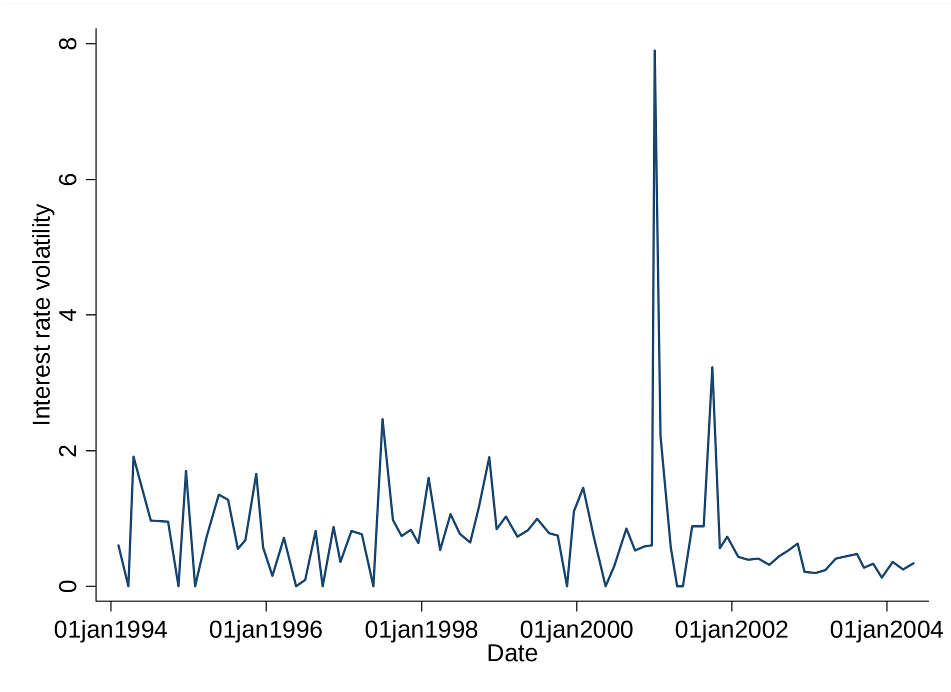


Figure 3: Precision of private signals – forecast heterogeneity and interest rate volatility

A. Forecast heterogeneity



B. Interest rate volatility



Note: Figure 3.A shows the seasonally-adjusted standard deviation of CPI forecasts and GDP forecasts across survey participants in the *Blue Chip Economic Indicators* data. Figure 3.B shows the unconditional volatility in the pre-event window (see Figure 2) of US 3-month treasury bill rates for each inter-meeting period.

Table 1: Summary statistics for communication, private signals and macroeconomic environment

	mean	std. dev.	min.	max.
Number of statements by committee members				
Total	172			
Tightening	56			
Neutral	56			
Easing	60			
A. PUBLIC SIGNALS - CENTRAL BANK COMMUNICATION				
Precision:				
Frequency of communication	2.200	1.919	0	9
Dispersion among committee members	0.252	0.342	0	1
Dispersion with committee releases	0.175	0.708	0	1
Relevance of beauty contest:				
Size of communication effects	0.072	0.100	0	0.480
Communication in purdah period	0.181	0.351	0	1
B. PRIVATE SIGNALS				
CPI forecast dispersion	0.214	0.094	0.059	0.450
GDP forecast dispersion	0.256	0.146	0.062	0.711
Pre-event interest rate volatility	0.797	0.990	0	7.90
C. CONTROLS				
Macroeconomic news:				
Macro news dispersion	0.920	0.102	0.556	1
Frequency of macro news	9.125	2.399	2	15
Size of macro news effects	0.097	0.098	0	0.470
Prior FOMC decisions:				
Interest rate change last meeting	0.325	0.471	0	1
Asymmetric bias last meeting	0.375	0.487	0	1

Note: The table reports summary statistics of the variables analyzed in this paper. Frequency of communication: number of statements by FOMC members in each inter-meeting period. Size of communication effects: cumulated change in 3-month treasury bill rates no days where a statement by FOMC members is recorded, expressed in % p.a.. Dispersion among committee members and with committee releases: see Appendix A. Communication in purdah period: dummy variable, set to one if communication during a purdah period took place.

Table 2: Communication, private signals and the short-term predictability of FOMC decisions

Tobit estimator	(1)		(2)		(3)	
	coef.	*std. err.*	coef.	*std. err.*	coef.	*std. err.*
A. PUBLIC SIGNALS - CENTRAL BANK COMMUNICATION						
Precision:						
Frequency of communication *(high α)*	0.009 *	*0.005*	0.009 **	*0.004*		
Dispersion among committee members *(low α)*	-0.057 ***	*0.018*	-0.054 ***	*0.019*		
Dispersion with committee releases *(low α)*	0.003	*0.007*	0.005	*0.007*		
Relevance of beauty contest:						
Size of communication effects *(high r)*	-0.086	*0.060*	-0.119 **	*0.052*		
Communication in purdah period *(high r)*	-0.034 **	*0.015*	-0.030 *	*0.015*		
B. PRIVATE SIGNALS						
CPI forecast dispersion	0.014	*0.103*			0.130	*0.116*
GDP forecast dispersion	-0.125 **	*0.065*			-0.149 **	*0.076*
Pre-event interest rate volatility	0.002	*0.006*			-0.010 *	*0.005*
C. CONTROLS						
Macroeconomic news:						
Macro news dispersion	-0.047	*0.050*			-0.061	*0.061*
Frequency of macro news	0.002	*0.002*			0.003	*0.003*
Size of macro news effects	-0.112 **	*0.048*			-0.108 **	*0.054*
Prior FOMC decisions:						
Interest rate change last meeting	0.025 **	*0.010*			0.014	*0.012*
Asymmetric bias last meeting	-0.014	*0.012*			-0.008	*0.012*
# of observations	80		80		80	
Likelihood ratio Chi^2	35.45		22.67		17.16	

Note: Using a tobit estimator for equation (9), the table shows the marginal effects of a change in the independent variables $z_{\alpha,t}$ and $z_{\beta,t}$ with regard to the predictability of the upcoming interest rate decision, $z_{w,t}$. All variables are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 3: Communication, private signals and the heterogeneity in medium-horizon forecasts of FOMC decisions

Tobit estimator	(1)			(2)			(3)		
	coef.		*std. err.*	coef.		*std. err.*	coef.		*std. err.*
A. PUBLIC SIGNALS - CENTRAL BANK COMMUNICATION									
Precision:									
Frequency of communication *(high α)*	0.029	***	*0.008*	0.029	***	*0.007*			
Dispersion among committee members *(low α)*	-0.091	*	*0.051*	-0.120	**	*0.052*			
Dispersion with committee releases *(low α)*	0.063	**	*0.030*	0.035		*0.025*			
Relevance of beauty contest:									
Size of communication effects *(high r)*	-0.151		*0.168*	0.043		*0.129*			
Communication in purdah period *(high r)*	-0.031		*0.036*	-0.015		*0.032*			
B. PRIVATE SIGNALS									
CPI forecast dispersion	-0.587	*	*0.340*				-0.113		*0.298*
GDP forecast dispersion	-0.538	**	*0.215*				-0.406	*	*0.219*
Pre-event interest rate volatility	-0.020		*0.017*				-0.023	*	*0.013*
C. CONTROLS									
Macroeconomic news:									
Macro news dispersion	0.105		*0.111*				0.108		*0.114*
Frequency of macro news	-0.022	***	*0.006*				-0.006		*0.006*
Size of macro news effects	-0.055		*0.140*				-0.152		*0.147*
Prior FOMC decisions:									
Interest rate change last meeting	0.014		*0.032*				0.011		*0.033*
Asymmetric bias last meeting	0.013		*0.033*				0.020		*0.034*
# of observations	44			44			44		
Likelihood ratio Chi^2	79.22			53.10			45.14		

Note: Using a tobit estimator for equation (9), the table shows the marginal effects of a change in the independent variables $z_{\alpha,t}$ and $z_{\beta,t}$ with regard to predictability of monetary policy decisions at a medium-term horizon. All variables are defined as explained in the text.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 4: Explaining dispersion in communication about monetary policy inclinations

Estimator:	**Tobit**			**OLS**		
	coef.		*std. err.*	coef.		*std. err.*
Macro news dispersion	0.076		*0.173*	0.217		*0.297*
Pre-event interest rate volatility	0.031	**	*0.016*	0.074	**	*0.031*
Frequency of communication	0.057	***	*0.010*	0.103	***	*0.016*
Monetary policy surprise last meeting	-0.023		*0.208*	-0.138		*0.366*
Interest rate change next meeting	0.044		*0.037*	0.096		*0.068*
# of observations	80			80		
Pseudo R-squared	0.372			0.411		

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

Table 5: Robustness – IV estimation

	Short-term predictability			Medium-term predictability		
IV for dispersion & purdah communication	coef.		*std. err.*	coef.		*std. err.*
A. PUBLIC SIGNALS - CENTRAL BANK COMMUNICATION						
Precision:						
Frequency of communication *(high α)*	0.024	**	*0.011*	0.033	***	*0.008*
Dispersion among committee members *(low α)*	-0.199	*	*0.100*	-0.281	***	*0.068*
Dispersion with committee releases *(low α)*	0.020		*0.022*	-0.020		*0.016*
Relevance of beauty contest:						
Size of communication effects *(high r)*	-0.095		*0.056*	0.054		*0.050*
Communication in purdah period *(high r)*	-0.074	**	*0.043*	-0.024	*	*0.015*
# of observations	80			44		

Note: Instrumenting communication dispersion and timing and using a tobit estimator for equation (9), the table shows the marginal effects of a change in the independent variables $z_{\alpha,t}$ and $z_{\beta,t}$ with regard to predictability of monetary policy decisions at a short and medium-term horizon in the left and right panels respectively.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 6: Short-term predictability of monetary policy decisions – *Interaction of private and public signals*

Tobit estimator	(1) x_t: CPI forecast heterog.				(2) x_t: GDP forecast heterog.				(3) x_t: interest rate volat.			
	coef.		*std. err.*	sig.	coef.		*std. err.*	sig.	coef.		*std. err.*	sig.
A. PUBLIC SIGNALS - CENTRAL BANK COMMUNICATION												
Precision:												
Frequency of communication *(high α)*												
when high noise of private signals x_t (γ_1)	0.012	*	*0.006*	0.609	0.015	**	*0.006*	**0.075**	0.017	***	*0.006*	**0.066**
when low noise of private signals x_t (γ_2)	0.009	*	*0.005*		0.005		*0.004*		0.009	**	*0.004*	
Dispersion among committee members *(low α)*												
when high noise of private signals x_t (γ_1)	-0.039	*	*0.020*	**0.016**	-0.049	**	*0.021*	0.834	-0.031		*0.021*	**0.062**
when low noise of private signals x_t (γ_2)	-0.072	***	*0.025*		-0.055	**	*0.026*		-0.075	***	*0.023*	
Dispersion with committee releases *(low α)*												
when high noise of private signals x_t (γ_1)	0.014		*0.012*	0.230	-0.010		*0.018*	0.482	0.183	***	*0.017*	**0.000**
when low noise of private signals x_t (γ_2)	-0.002		*0.008*		0.003		*0.007*		-0.003		*0.005*	
Relevance of beauty contest:												
Size of communication effects *(high r)*												
when high noise of private signals x_t (γ_1)	-0.068		*0.096*	0.754	0.015		*0.067*	**0.030**	0.009		*0.099*	0.221
when low noise of private signals x_t (γ_2)	-0.099		*0.068*		-0.179	***	*0.069*		-0.129	*	*0.067*	
Communication in purdah period *(high r)*												
when high noise of private signals x_t (γ_1)	-0.009		*0.016*	**0.019**	-0.030		*0.022*	0.936	-0.028		*0.030*	0.932
when low noise of private signals x_t (γ_2)	-0.056	**	*0.026*		-0.028		*0.030*		-0.030		*0.021*	
# of observations	80				80				80			

Note: Using a tobit estimator for equation (10), the table shows the coefficients γ_1 and γ_2 for the marginal effects of the interaction of communication and the noisiness of private signals with regard to short-term predictability. "sig." shows the p-value of a t-test for the equality of both coefficients.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.

Table 7: Heterogeneity in medium-horizon forecasts of policy rates – *Interaction of private and public signals*

Tobit estimator	(1) x_t: CPI forecast heterog. coef.		*std. err.*	sig.	(2) x_t: GDP forecast heterog. coef.		*std. err.*	sig.	(3) x_t: interest rate volat. coef.		*std. err.*	sig.
A. PUBLIC SIGNALS - CENTRAL BANK COMMUNICATION												
Precision:												
Frequency of communication *(high α)*												
when high noise of private signals x_t (γ_1)	0.039	***	*0.008*	**0.065**	0.027	***	*0.010*	0.408	0.085	***	*0.018*	**0.003**
when low noise of private signals x_t (γ_2)	0.018		*0.011*		0.039	***	*0.013*		0.033	***	*0.008*	
Dispersion among committee members *(low α)*												
when high noise of private signals x_t (γ_1)	0.106	*	*0.063*	**0.000**	-0.084		*0.078*	0.779	0.194	*	*0.103*	**0.005**
when low noise of private signals x_t (γ_2)	-0.187	***	*0.052*		-0.059		*0.070*		-0.138	**	*0.055*	
Dispersion with committee releases *(low α)*												
when high noise of private signals x_t (γ_1)	0.122	**	*0.049*	**0.024**	0.063		*0.059*	0.559	0.182	**	*0.089*	**0.074**
when low noise of private signals x_t (γ_2)	-0.042		*0.042*		0.027		*0.029*		0.013		*0.023*	
Relevance of beauty contest:												
Size of communication effects *(high r)*												
when high noise of private signals x_t (γ_1)	0.192		*0.443*	0.834	0.098		*0.249*	0.950	1.649	***	*0.533*	**0.004**
when low noise of private signals x_t (γ_2)	0.104		*0.194*		0.125		*0.341*		-0.164		*0.211*	
Communication in purdah period *(high r)*												
when high noise of private signals x_t (γ_1)	-0.012		*0.060*	**0.021**	-0.027		*0.051*	0.766	-0.104	**	*0.038*	**0.004**
when low noise of private signals x_t (γ_2)	-0.180	**	*0.052*		-0.005		*0.065*		-0.106	*	*0.053*	
# of observations	44				44				44			

Note: Using a tobit estimator for equation (10), the table shows the coefficients γ_1 and γ_2 for the marginal effects of the interaction of communication and the noisiness of private signals with regard to medium-term predictability. "sig." shows the p-value of a t-test for the equality of both coefficients.
***, **, * indicate significance at the 99%, 95% and 90% levels, respectively.