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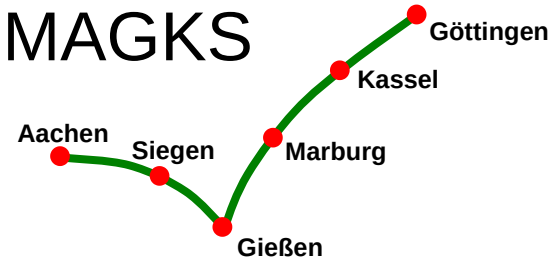

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Abstract

We explain changes in the federal funds target rate using macroeconomic variables and Federal Open Market Committee (FOMC) communication indicators. Econometrically, we employ an ordered probit model of a Taylor rule to predict 75 target rate decisions between 1998 and 2006. We find, first, that FOMC communication is forward-looking, with a horizon that goes beyond the next meeting. Second, our communication indicators significantly explain target rate changes and improve explanatory power in and out of sample. Third, speeches by members of the Board of Governors and regional presidents have a statistically significant and equal-sized effect, whereas the less-frequent monetary policy reports and testimonies are insignificant. Fourth, our findings are robust to variations in the specification, including changes in the communication strategy as well as a measure of unambiguous communication. Finally, our communication indicator based on FOMC speeches performs better in explaining rate changes than do newswire reports of Fed communications.

JEL: E43, E52, E58

Keywords: Central Bank Communication, Federal Reserve Bank, Interest Rate Decision, Monetary Policy, Federal Funds Target Rate, Taylor Rule

1. Introduction

Today, central bank communication is widely accepted as an important aspect of monetary policy. Woodford (2005, 55) concludes that "*the increased willingness of the FOMC under the Chairmanship of Alan Greenspan to speak openly about both current policy decisions and the Committee's view of likely future policy has greatly increased the ability of markets to anticipate Fed policy.*"

The U.S. Federal Reserve Bank (Fed) engages in several methods of communication: post-meeting statements accompanying target rate decisions, the semi-annual monetary policy report, congressional hearings, and speeches by members of the Board of Governors (BoG) and regional presidents. Usually, all these are based on a 12–18-month economic outlook for the United States. In recent years, it has become common practice to indicate the future course of U.S. monetary policy. The more formalized channels, such as statements and monetary policy reports, are used infrequently (8 and 2 events per year, respectively) and thus it is chiefly speeches that are used to impart the new information upon which financial market expectations are based. Several studies show that U.S. financial market returns and volatility are affected by these less formal types of communication (e.g., Ehrmann and Fratzscher, 2007; Hayo et al., 2008).

In this paper, we focus on the question of whether the Fed's informal communication actually contains useful information about future monetary policy that agents could not have acquired otherwise. Put differently, does Fed communication provide information additional to that already incorporated in a real-time forward-looking Taylor rule? Extant findings are ambiguous: Blinder (2008) shows that communication can enhance the predictability of monetary policy decisions, whereas Petersen and Pozdnyakov (2008) conclude that financial markets concentrate too much on communication and too little on past policy behavior.

Under our approach to answering this question, we examine all forms of FOMC communication and investigate whether it helps explain and predict the Fed's monetary policy actions. Our sample starts with the first target rate decision in 1998 (February 4) and ends with the last one in 2006 (December 12), a period that shows an increasing trend in the number of communication events.[1] The remainder of the paper is organized as follows. In the next section, we summarize previous work in this area and outline our contributions to the field. Section 3 describes the construction of our communication indicators and the other variables, as well as the econometric methodology. Section 4 analyzes the relationship between communication and actual target rate changes. Section 5 studies whether

[1] In 1998, 114 speeches were delivered by FOMC members, while in 2006 the central bankers spoke 190 times.

communication helps explain and predict target rate changes. Section 6 presents further specifications and robustness checks. Section 7 concludes.

2. Related Literature and Our Contribution

The literature discussing communication as an instrument for explaining target rate changes generally employs a Taylor-rule framework. There are only a few studies on the Fed, which we review first.

Pakko (2005) examines the predictive content of post-meeting statements in a Taylor-rule setting. He finds that statements convey useful information for forecasting changes in the federal funds rate target, even after controlling for policy responses to inflation and the output gap. Lapp and Pearce (2000) investigate the information content of asymmetric directives in post-meeting statements for the likelihood of inter-meeting changes in policy during the Greenspan chairmanship. They show that a bias in FOMC policy decisions significantly affects the probability that the target will be changed in the period between two meetings.

Lapp et al. (2003) discover a statistically significant relationship between FOMC decisions and measures of inflation and real activity, but the relationship does not accurately predict the direction of FOMC decisions. Short-term interest rate changes prior to FOMC meetings have predictive power; however, other financial variables appear unrelated to FOMC policy changes. Overall, FOMC decisions are not highly predictable using publicly available data, and adding the private information contained in the FOMC's *Greenbook* (available after a five-year delay) does not significantly increase predictive accuracy.

Other papers assess the predictive power of European Central Bank (ECB) communication. Jansen and de Haan (2008) examine whether ECB communications are useful in predicting its policy decisions. Using ordered probit models based on the Taylor rule, they find that statements about the main refinancing rate and future inflation are significantly related to interest rate decisions. An out-of-sample evaluation shows that communication-based models do not outperform models based on macroeconomic data in predicting decisions.

Heinemann and Ullrich (2007) integrate an indicator measuring the "hawkishness" of the ECB's monthly press conferences into a standard Taylor-type ordered probit model designed to explain the interest rate. They show that the wording indicator can improve the model's fit when added to the standard explanatory variables. However, a model based solely on this indicator performs worse than the baseline Taylor rule. Gerlach (2007) estimates empirical reaction functions for the ECB with ordered probit techniques, using the ECB's

Monthly Bulletin as a guide in choosing variables. The results show that policy reacts to the state of the real economy, M3 growth, and exchange rate changes, but not to inflation.

Another strand of the literature focuses on the use of financial market data and macroeconomic news as predictive instruments. One major drawback of using financial market data is potential endogeneity, as interest rates, which are used to predict target rate changes, are strongly affected by expectations as to future monetary policy (the variable they should be helping to forecast). Kauppi (2007) finds that the current values of the six-month Treasury bill spread relative to the federal funds rate, the unemployment rate, and the real GDP growth rate are superior predictors of the direction of target change a week to several months ahead. Lagged target change decisions do not contain additional predictive power.

Piazzesi (2005) discovers that bond yields respond to Federal Reserve policy decisions and vice versa. The policy rule crucially depends on two-year yields and describes Fed policy better than do Taylor rules. Krueger and Kuttner (1996) identify the federal funds futures rate as a good predictor of Federal Reserve behavior. Gurkaynak et al. (2007) conclude that federal funds futures dominate all other securities in forecasting monetary policy at horizons out to six months.

Markov transition processes can also be used to forecast target rate decisions. Petersen and Pozdnyakov (2008) show that a simple Markov transition process outperforms the federal funds futures market in forecasting future FOMC policy. A model that takes into account only past monetary policy is better at predicting the federal funds rate than the forward-looking federal funds futures market or a model incorporating FOMC communication or other current and forward-looking information.

In this paper, we explain changes in the federal funds target rate using macroeconomic variables and FOMC communication indicators. Fed communications are analyzed on the basis of their written contents. Econometrically, we use an ordered probit model to take into account the discrete nature of U.S. target rate changes. Our sample starts on February 4, 1998 and ends on December 12, 2006, a period that shows an increasing trend in the number of communication events. To our knowledge, which is backed up by the Blinder et al. (2008) literature review, there are no other studies explaining U.S. target rate changes using all types of FOMC communication.

3. Data and Econometric Methodology

Our analysis takes advantage of a new data set introduced by Hayo et al. (2008), which includes indicator variables for 1,423 speeches and 148 congressional hearings, covering all members of the Federal Open Market Committee, as well as 67 post-meeting statements and 20 monetary policy reports. The communications are sorted into two categories depending on whether they indicate likely increases or decreases in the federal funds rate. Communications that directly reference monetary policy are easily interpreted; others are not so straightforward. For example, speeches presenting a bright economic outlook can be interpreted as an indication of future rate hikes because in good economic times, the Fed needs to take steps to prevent the economy from overheating. Hayo et al. (2008) point out that the Fed typically does not talk extensively about rate cuts and therefore a speech about a negative economic outlook can be a particularly useful indicator of this possibility.[2]

Consequently, we employ a ternary variable for every communication event that takes the value +1 when the central bank leans toward a rate hike, 0 when the monetary policy will likely remain unchanged, and –1 when loose monetary policy is a strong possibility.[3] Our sample contains 75 target rate decisions. Often, more than one communication event takes place in the period between Fed meetings so we have to construct an indicator that captures the monetary policy stance over the entire inter-meeting period. For this purpose, we net out the instances of tighter and looser monetary policy inclinations and code the communication indicator accordingly.[4] If the amount of downward and upward news is equal or if no communication events occur during an inter-meeting period, the variable is coded as 0.

Table A1 sets out descriptive statistics of our communication indicator. An extensive description of the data is given in Section 4. Compared with the actual target rate changes, there is a bias toward target rate hikes in the communication data. This bias is related to the Fed representative's often (too) positive economic outlook. Jansen and de Haan (2008) find a similar phenomenon for the ECB.

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[2] In a very few cases, a positive economic outlook coincides with a trend toward loose monetary policy or a pessimistic outlook is communicated together with tighter monetary policy. As the monetary policy stance is a more direct indicator of future target rate decisions, we code these rare cases based on monetary policy stance.

[3] We could also use a scale up to +2 (down to –2) when both monetary policy and economic outlook point in the same direction. As pointed out earlier, the Fed increased the frequency and the content of its communication gradually during our sample. So, a scaling up to +2 could distort the results as earlier speeches often lack a monetary policy part. Furthermore, it is questionable whether an indication via both variables makes a rate change more likely. Finally, some preliminary estimations show that the +1/0/–1 coding approach is more appropriate.

[4] For example, in our view, eight indications of higher monetary policy do not result in an eight-times-higher probability of a rate hike. Consequently, we use the +1/0/–1 scale and ensure the validity of our results with extensive robustness tests.

Our econometric methodology employs a variation of the interest rate setting rule proposed by Taylor (1993). Molodtsova et al. (2008) estimate Taylor rules for the United States and detect the best fit using real-time output data and inflation forecasts. Based on these findings, we use real-time data (Orphanides, 2001) that are available at the time the interest rate decisions are made, instead of ex post revised data.

We employ forward-looking indicators measuring the output gap and inflation (expectations) instead of backward-looking ones based on past economic conditions. Central banks have to be forward-looking when planning interest rate changes, as the maximum monetary policy effect reaches the real economy with a lag of about 12–18 months. We utilize the ISM Manufacturing Purchasing Manager Index as a proxy for the forward-looking output gap (Hu and Philipps, 2004). Inflation expectations gathered by the University of Michigan in its Consumer Survey approximate the inflation expectations over the next 12 months (Kauppi, 2007). To ensure stationarity of expected inflation, we compute first differences. The output gap is derived based on the trend of the ISM index for 1948–2008.[5] Both the augmented Dickey-Fuller (1979) test and the KPSS test (Kwiatkowski et al., 1992) show that the output gap series and the first difference of the inflation series are stationary.[6]

Econometrically, we use an ordered probit model to account for the discrete nature of U.S. target rate changes (Lapp et al., 2003; Jansen and de Haan, 2008). Our specification is as follows:

$$(1)\ \Delta i_t^* = \alpha \Delta i_{t-1} + \beta_1 \Delta \pi_t^e + \beta_2 y_t + \gamma_1 Last\ Statement_t + \gamma_2 Comm.Indicator_t + \varepsilon_t$$

where Δi_t^* is the latent continuous variable representing the preferred change in the federal funds target rate. Again, we use a ternary variable (+1 represents a rate hike; 0 an unchanged rate; –1 a rate cut) to describe the change in monetary policy.[7] Target rate changes occur only when the value of the index function is either below a lower unobserved threshold τ_1 or higher than an upper unobserved threshold τ_2.

[5] The trend is computed by applying a Hodrick-Prescott filter (1997) with $\lambda = 14{,}400$.

[6] ISM Gap: ADF –2.75*, KPSS 0.074; Δ(Inflation Expectations): ADF –10.06***, KPSS 0.229. The ADF test assumes a unit root under the null hypothesis. The KPSS test assumes that the series is stationary under the null hypothesis. The number of lags (0 in both cases) for the ADF test is selected on the basis of the Schwartz criterion. All test equations contain a constant. */**/*** denotes significance at the 10/5/1% level.

[7] During our sample period, the Fed raised or lowered the target rate 10 times by 50 bps, and 29 times by 25 bps. Instead of the ternary variable, we could use a quintuple (+2/+1/0/–1/–2) variable to describe the Fed behavior. As it turns out, the modeling describes very well whether rate hikes/cuts occur or not, but it largely fails to differentiate between small and large interest rate steps.

Our Taylor rule incorporates three groups of explanatory variables. First, lagged target rate changes are included to capture interest rate smoothing behavior.[8] Second, output gap and expected inflation capture forward-looking macroeconomic information. Third, communication enters the equation via two variables: lagged post-meeting statements (Lapp and Pearce, 2000; Pakko, 2005) and our communication indicator. The former is included to extract the impact of inter-meeting communication from the information available after every target rate decision. The residuals ε_t are assumed to follow a standard normal distribution, which implies that the probabilities of the different outcomes can be written as:

$$\Pr[\Delta i_t = -1|z_t] = \Phi(\tau_1 - z_t'\beta)$$
$$\Pr[\Delta i_t = 0|z_t] = \Phi(\tau_2 - z_t'\beta) - \Phi(\tau_1 - z_t'\beta)$$
$$\Pr[\Delta i_t = 1|z_t] = \Phi(\tau_2 - z_t'\beta)$$

where Φ denotes the cumulative standard normal distribution and z_t is our vector of explanatory variables. The ordered probit models are estimated by maximum likelihood (Maddala, 2006) and the threshold variables are obtained simultaneously with the vector of explanatory variables β.

In Section 5, we present the empirical results of estimating different variations of Equation (1), including: (i) one employing a pure Taylor rule using only lagged target rate changes and macroeconomic variables; (ii) target rate changes modeled as depending on lagged changes and both communication variables; and (iii) an assessment of the joint model that includes both macroeconomic and communication variables.

4. Consistency of FOMC Communication

In this section, we evaluate how consistent FOMC communication is with actual policy decisions. We examine every single communication event and relate it to target rate decisions in four different ways. We investigate whether the communication is adaptive, i.e., reflective only of past interest rate decisions, or forward-oriented and in line with upcoming decisions. We check whether the communication content is consistent with (1) the decision in the last FOMC meeting and/or (2) with the upcoming FOMC decision. We call these "backward-looking" and "forward-looking" target consistency (Ehrmann and Fratzscher, 2007), respectively. As communication could refer to a horizon farther away than the previous or the next meeting, we also evaluate "path consistency," investigating whether (3) FOMC

[8] We employ a lagged dependent variable rather than an autoregressive error specification (Rudebusch, 2002) based on results presented by Castelnuovo (2003). However, the interpretation of interest rate smoothing behavior is still a subject of debate (Rudebusch, 2006).

communication is in line with its last target rate *change* and/or (4) with its next target rate *change*. The top part of Table 1 shows the consistency of different communication forms; the bottom part shows consistency over time.

Comparing the figures for target consistency (Columns 1 and 2 of Table 1) and path consistency (Columns 3 and 4), we find that the latter dominates the former for forward-looking as well as for backward-looking indicators. We conclude that communication has a longer horizon than one FOMC meeting, whether the previous meeting or the next one. Turning to the question of whether the Fed communicates forward- or backward-looking, Table 1 shows that forward-looking path consistency dominates backward-looking path consistency in both BoG and presidents' speeches as well as in testimonies. Over the whole sample, 71 percent of the speeches are consistent with the next target rate change.[9] Ehrmann and Fratzscher (2007) derive two consistency measures over the period 1999–2004 that yield, on average, a comparable degree of forward-looking target and path consistency.

Table 1: Consistency of FOMC Communication

	Last Decision	**Next Decision**	**Last Change**	**Next Change**
MPR	10 / 50%	9 / 45%	15 / 75%	14 / 70%
Testimonies	9 / 45%	10 / 50%	11 / 55%	15 / 75%
BoG Speeches	49 / 41%	56 / 47%	66 / 56%	82 / 69%
Presidents' Speeches	118 / 44%	128 / 47%	167 / 62%	196 / 72%
1998	5 / 18%	7 / 25%	23 / 82%	9 / 32%
1999	12 / 27%	14 / 32%	16 / 36%	43 / 98%
2000	23 / 50%	26 / 57%	42 / 91%	30 / 65%
2001	28 / 64%	28 / 64%	28 / 64%	28 / 64%
2002	6 / 13%	4 / 8%	15 / 31%	15 / 31%
2003	1 / 2%	3 / 7%	12 / 26%	32 / 70%
2004	22 / 34%	33 / 52%	23 / 36%	62 / 97%
2005	59 / 89%	59 / 89%	59 / 89%	59 / 89%
2006	29 / 66%	28 / 64%	40 / 91%	28 / 64%

Notes: The first figure shows the absolute number of consistent speeches, whereas the second figure indicates the relative share of consistent speeches.

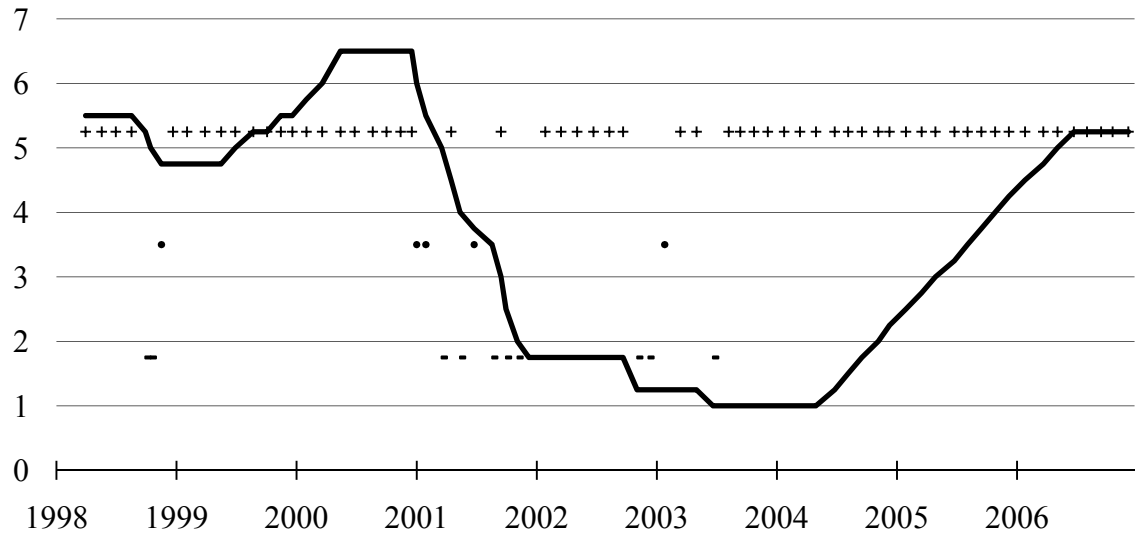
Looking at the different years in our sample shows that, generally, the forward-looking measure is a better predictor most of the time. However, unexpected financial crises can have a drastic effect on the model's accuracy. For example, in 2006, the Fed ended its last tightening cycle but the speeches thereafter were mostly of the bright economic outlook variety, with no hint whatsoever of the looming economic and financial crisis that would

[9] If 1998 is excluded, this figure rises to 74 percent.

trigger large rate cuts as part of central bank crisis management.[10] Another example is the East Asian financial crisis in 1998, which caused the Fed to cut the target rate three times during a tightening cycle (see Figure 1). The model's bad fit for 2002 can be explained by the Fed's surprisingly loose monetary policy that year, which threw a wrench into the models of other researchers as well. The Taylor rule put forward by Belke and Polleit (2007) predicts a larger than observed interest rate in 2002–2003. Furthermore, Petersen and Pozdnyakov (2008) report problems with predicting Fed interest rate setting at the end of 2002 using both a Markov transition process and information derived from federal funds futures.

A visual illustration of our communication indicator is shown in Figure 1, where the federal funds target rate is the black line and our communication indicators are symbolized by + (indicator suggests rate increase), 0 (rate expected to be constant), and - (rate predicted to decrease).

Figure 1: Federal Funds Target Rate and Communication Indicator



As mentioned in Section 3, there is an upward bias in the data that is chiefly due to those communications expressing a too-positive economic outlook, as in times of unchanged monetary policy our indicator is often positive. This does not necessarily violate path consistency, but it does violate target consistency. Furthermore, based on our communication indicator, we find that the Fed is very cautious about mentioning rate cuts in too much detail. Only when a rate cut is truly imminent do the majority of speeches signal such a decision. Except for two outliers in 2001, our communication indicator turns negative, or at least becomes neutral, when the Fed lowers its target rate at the next meeting. This bias should not

[10] Restricting the end point of the sample to the rate hike in June 2006 shows that 97 percent of FOMC speeches in 2006 are forward-looking path consistent.

affect the predictability in a negative way, as in an ordered probit model we only expect the upper threshold to be absolutely higher than the lower threshold.

5. Predicting Federal Funds Target Rate Changes with FOMC Communication

In this section, we present the results of our empirical estimations employing different specifications based on Equation (1). Column (1) of Table 2 shows the model based on macroeconomic news only, Column (2) incorporates communication variables only, and Column (3) uses both types of information. Measured by the pseudo R^2, the joint model (Column (3)) has a slightly better fit than the communication model in Column (2), whereas the macro model (Column (1)) is clearly the worst. Reflecting the mentioned economic outlook bias, the upper thresholds are larger in absolute terms than the lower ones in Models (2) and (3). Interest rate smoothing is evident in all three specifications, as lagged target rate decisions help predicting current ones. The coefficients of inflation expectation and output gap are significant in the Taylor-rule model and they remain significant in the joint model. The same is true of both communication variables (last post-meeting statement and communication indicator), which are also significant in the communication and the joint model.

Table 2: Predicting Federal Funds Target Rate Changes with FOMC Communication

Model	(1)	(2)	(3)
Last Rate Decision	1.94 ***	1.8 ***	2.24 ***
ISM Gap	0.066 **	---	0.073 *
Δ(Inflation Expectations)	0.639 *	---	0.804 *
Last Statement	---	2.84 ***	3.31 ***
Communication Indicator	---	1.91 ***	1.99 **
Lower Threshold	-1.58 ***	-2.21 ***	-3.13 ***
Upper Threshold	1.28 ***	5.38 ***	6.34 ***
LR Statistic	47.74 ***	24.75 ***	29.06 ***
Pseudo Log-Likelihood	-39.88	-21.11	-23.5
Pseudo R^2	0.49	0.7	0.73

Notes: */**/*** denote significance at the 10/5/1% level. Huber (1967)/White (1980) robust standard errors are used.

The estimated coefficients are difficult to interpret as they measure the influence of the explanatory variables on the latent variable Δi_t^*. Furthermore, we cannot say anything about the impact of the middle category of our ternary variables on the probability of an interest rates change. Therefore, Table 3 shows the average marginal effects. These are insignificant in all three specifications when computing the probability of an unchanged target rate. In the

Taylor rule specification (1), a one-point higher value for the last target rate decision, i.e., no change instead of a rate cut, or a rate hike instead of no change, decreases (increases) the probability of a cut (hike) today by 29.4 (25.9) percentage points. If the output gap goes up by 1 percentage point, a rate hike (cut) is more (less) likely by 1 percentage point. Finally, a 1 percentage point higher inflation expectation lowers (raises) the chance of a rate cut (hike) by 10.8 (7.8) percentage points.

Table 3: Average Marginal Effects for Models (1)–(3)

	Prob[Rate Cut]	**Prob[No Change]**	**Prob[Rate Hike]**
Model (1) Taylor Rule			
Last Rate Decision	-0.294 ***	0.035	0.259 ***
ISM Gap	-0.011 **	0.003	0.008 **
Δ(Inflation Expectations)	-0.108 *	0.03	0.078 *
Correct Predictions	12/16	29/36	17/23
Model (2) Communication			
Last Rate Decision	-0.115 **	0.049	0.066 ***
Last Statement	-0.191 ***	0.095	0.096 **
Communication Indicator	-0.122 **	0.052	0.069 ***
Correct Predictions	14/16	32/36	19/23
Model (3) Taylor Rule and Communication			
Last Rate Decision	-0.129 *	0.063	0.066 ***
ISM Gap	-0.003	0.001	0.002
Δ(Inflation Expectations)	-0.036	0.014	0.022
Last Statement	-0.208 ***	0.11	0.097 ***
Communication Indicator	-0.112 **	0.053	0.059 ***
Correct Predictions	14/16	32/36	19/23

Notes: The figures show the average of marginal effects over all observations. */**/*** denotes significance at the 10/5/1 % level.

When using only communication variables to predict FOMC decisions, the importance of interest rate smoothing decreases (–11.5 percentage points for rate cuts; 6.6 for rate hikes). Some information in the lagged rate changes is captured by the combined influence of statements and the communication indicator.[11] A one-point change in the last statement causes a rate cut (hike) to be less (more) likely by 19.1 (9.6) percentage points. The same change in the communication indicator also changes the probability of target rate changes (–12.2 percentage points for rate cuts; 6.9 for rate hikes).

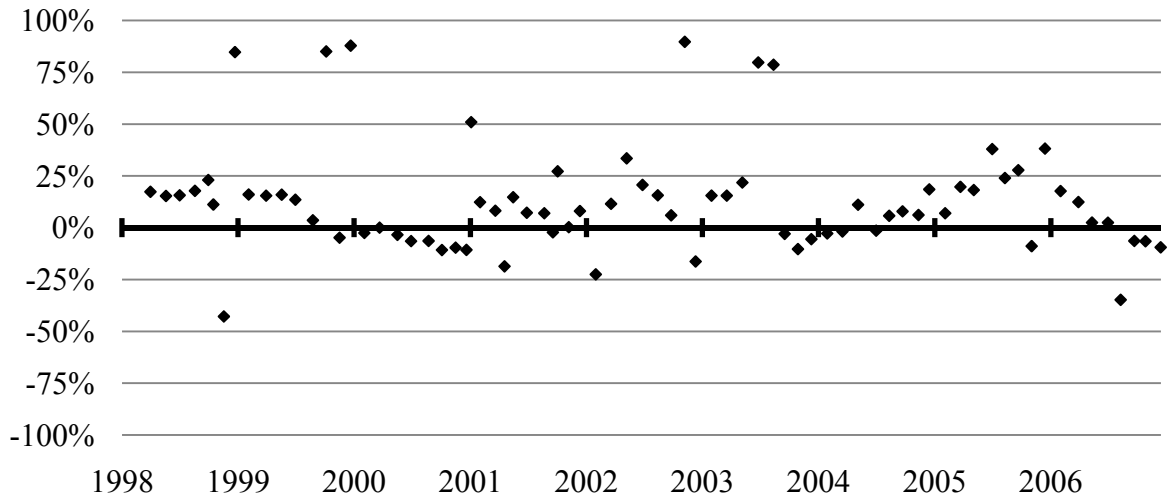
[11] The lessening of the impact of the lagged interest rate cannot be clearly assigned to either last statements or the communication indicator.

In the joint model, the average marginal effects of both macro variables become insignificant, suggesting collinearity with the communication variables. The latter's average marginal effects remain significant, with values similar to those in Model (2). Consequently, the information in FOMC communication partly crowds out publicly available information about the output gap and inflation expectations. This may reflect the Fed's use of Taylor rules in making monetary policy decisions.

Table 3 also shows that the communication indicator improves the model's ability to correctly explain target rate decisions. Model (2) predicts two hikes, two cuts, and three no change events over and above those predicted by the pure Taylor rule of Model (1). The joint model (Model (3)), however, is not an improvement over Model (2). A more detailed examination reveals 11 differing predictions when using Model (1) compared to Models (2) and (3). Nine of these cases are correctly explained by Models (2) and (3), whereas only two are captured by Model (1). Finally, when comparing Models (2) and (3), there are two different predictions of target rate decisions and each model is correct once.

To this point, we have shown the importance of the communication variables for explaining target rate decisions by the FOMC. In a next step, we compare the probability of predicting the correct decision at each FOMC meeting using the pure communication Model (2) and the pure Taylor rule of Model (1). The differences are plotted in Figure 2.

Figure 2: Gain in Predictability of Target Rate Changes by Watching FOMC Communication



The Y-axis of Figure 2 indicates the gain (in percentage points) of Model (2) over Model (1). There are six decisions where Model (2) gains 75 percentage points or more over Model (1); in six other cases, the increase is at least 25 percentage points. In contrast, there are only two cases where Model (2) performs more poorly (–43 and –35 percentage points). The average gain of the pure communication model over the pure Taylor-rule model is 13

percentage points. Thus, communication indicators substantially improve the probability of making the correct prediction.

Given the absence of necessary data, we cannot study the out-of-sample performance of the models. However, to approximate an out-of-sample assessment, we re-estimate Models (1)–(3) initially for the subsample 1998–2002 and predict target rate changes for the remaining period using a rolling-window of out-of-sample forecasts that requires re-estimating the model after every period.[12]

Table 4 shows that the predictive ability of the communication-based Model (2) is excellent, as 30 out of 32 interest rate decisions are correctly anticipated. The two wrong predictions occur at the start and the end of the 2004–2006 tightening cycle (June 30, 2004 and August 8, 2006). The joint Model (3) performs well, too (26 correct predictions), whereas the pure Taylor rule (Model (1)) does rather poorly, with a success rate of only 50 percent.

Table 4: Approximating Out-of-Sample Predictions Using Rolling-Window Estimations

	(1)	**(2)**	**(3)**
Target Rate Cuts	0/1	1/1	1/1
No Change in Target Rate	11/14	13/14	10/14
Target Rate Hikes	5/17	16/17	15/16
All Rate Changes	16/32	30/32	26/32

Notes: The initialization period is 1998–2002 (43 rate changes) and parameters are updated every period throughout the remaining sample period 2003–2006 (32 rate changes).

Instead of using rolling-window estimations that update parameters in every period, we can test temporal stability by estimating parameters over the period 1998–2002 and using the resulting models to derive predictions by plugging in values of the relevant variables in each period. Table 5 shows that the communication model (Model (2)) holds up extremely well with regard to stability, whereas Models (1) and, particularly, (3) suffer from a deterioration of predictive ability.

Testing parameter instability using Chow-type tests at a 5 percent confidence level (see Figure A1 in the Appendix), we can reject constancy in the case of the Taylor rule (Model (1)) but not for the communication model (Model (2)). These results suggest that the communication model is a robust and reliable device for predicting federal funds rate changes even out-of-sample.

[12] We start by estimating each model using the first 43 observations and then evaluate whether the model correctly predicts the interest rate decision at t = 44. Next, we re-estimate the models using the first 44 observations and predict the outcome at t = 45, and so on.

Table 5: Approximating Out-of-Sample Predictions Using a Fixed Estimation Period

	(1)	**(2)**	**(3)**
Target Rate Cuts	1/1	1/1	1/1
No Change in Target Rate	11/14	13/14	9/14
Target Rate Hikes	2/17	16/17	4/16
All Rate Changes	14/32	30/32	14/32

Notes: The initialization period is 1998–2002 (43 rate changes) and the out-of-sample period is 2003–2006 (32 rate changes).

6. Further Results and Robustness Tests

The outcome of alternative specifications and robustness tests are given in Table 6. Poole (2005) discusses the steps the Fed undertook in an effort to enhance its transparency in post-meeting statements. For example, in August 2003, the Fed replaced the policy bias/balance of risks terminology with more forward-looking language. Model (4) of Table 6 explores whether this forward-looking indicator exerts a different impact on the predictability of target rate decisions. As the nearly equal coefficients suggest, we cannot statistically distinguish between either indicator ($Chi^2(1) = 0.001$), which implies that the change in language did not improve the predictive power of Fed communications.

Another effort to increase transparency was implemented in January 2002: henceforward the names of dissenting members were included in the post-meeting statement. Previously, this information had not been available until the minutes were released following the subsequent FOMC meeting. To control for dissenting votes, we include a variable measuring the lagged dissenter's impact. The variable is constructed as a ternary variable, which takes the value +1 if there is a "hawkish" dissent, 0 if there is no dissent, and –1 if there is a "dovish" dissent. The prior is that any dissent in the last meeting in either direction should increase the probability of a rate decision in line with the dissenter's vote. Unfortunately, we have collinearity problems, as the model only converges if all communication variables are excluded. However, even in this set-up involving fewer explanatory variables, the dissenter's impact is statistically insignificant.[13]

Four unscheduled interest rate changes occurred between meetings during our sample period. Model (5) of Table 6 explores the robustness of our finding with respect to these inter-meeting changes. These are modeled as ternary variables, assigning the value +1 to an unscheduled hike, 0 to a regular decision, and –1 to an inter-meeting cut. Between two meetings, new information about the state of economy or inflation expectations emerges that is not reflected in the last statement or by the macroeconomic variables. Consequently, when

[13] The outcome of this regression is not shown as, unlike Models (4)–(7), this setup is not an extension of Model (3). Results are available on request.

controlling for inter-meeting changes, the coefficient of the former becomes smaller and the latter are now (marginally) insignificant. The coefficient of our communication indicator increases slightly, as the Fed can disseminate new information through speeches.

Table 6: Further Results in Predicting Target Rate Changes

	(4)		**(5)**		**(6)**		**(7)**	
Last Rate Decision	2.24	***	2.10	***	2.26	***	2.17	***
ISM Gap	0.07	**	0.07		0.06		-0.03	
Δ(Inflation Expectations)	0.81	*	0.64		1.03	**	0.91	*
Last Statement	---		2.88	***	3.37	***	2.67	***
Last Statement Bias/Balance	3.32	***	---		---		---	
Last Statement Forward-Looking	3.30	***	---		---		---	
Communication Indicator	1.99	**	2.09	**	1.85	**	---	
MPR	---		---		---		-0.13	
Testimonies	---		---		---		0.23	
BoG Speeches	---		---		---		1.10	**
Presidents' Speeches	---		---		---		1.21	**
Inter-Meeting Moves	---		8.50	***	---		---	
Unambiguous Communication	---		---		0.64		---	
Lower Threshold	-3.14	***	-3.15	***	-3.01	***	-1.99	**
Upper Threshold	6.33	***	5.93	***	6.64	***	5.07	***
LR Statistic	27.3	***	328.6	***	35.3	***	24.1	***
Pseudo Log-Likelihood	-21.11		-20.25		-20.44		-21.14	
Pseudo R^2	0.73		0.74		0.74		0.73	

Notes: */**/*** denote significance at the 10/5/1% level. Huber/White robust standard errors are used.

Model (6) of Table 6 accounts for possible dispersions in communication. An additional variable is added to the equation that measures the impact of unambiguous communication. We would expect unequivocal communication to have a positive impact on the predictability of target rate changes. Again, we use a ternary variable that is 1 when there is unambiguous communication of tighter monetary policy, 0 if there is dispersion, and –1 if loose monetary policy is communicated unequivocally. The coefficient is positive, as expected, but statistically insignificant.

Model (7) of Table 6 examines the impact of different types of Fed communication. On the one hand, monetary policy reports and congressional hearings have no significant impact, either individually or jointly ($Chi^2(2) = 0.36$). These types of communication occur too infrequently to contain up-to-date information.[14] On the other hand, speeches are made much more regularly and often contain updates on the business cycle and expected inflation.

[14] We observe only 17 nonzero events for MPRs and 19 for testimonies.

Consequently, we find that speeches by both groups, BoG members and regional presidents, significantly help to explain interest rate decisions. Statistical testing shows that the coefficients of both groups ($Chi^2(1) = 0.03$) are indistinguishable.

Hayo et al. (2008, 27) examine how financial markets react to central bank communication and conclude that *"financial market news is not necessarily created at the time when the information becomes available, but comes into existence only after it goes through a filtering process by the media."* To check whether this media filtering is also present when predicting target rate changes, we compare our communication indicator with a variable based on news agency reports collected by Ehrmann and Fratzscher (2007). For this purpose, we need to shorten the sample period to May 1999–May 2004 (43 observations). In line with the procedure sketched above, we derive a communication indicator for the news agency data. Since the newswire information does not include post-meeting statements, we omit these from our set of communication variables to ensure comparability. Table 7 reports the results using the communication indicator created on the basis of our data (Model (8)), the newswire reports (Model (9)), and using both indicators in one equation (Model (10)).

Table 7: Predicting Interest Rate Changes Using Newswire Reports

	(8)		**(9)**		**(10)**	
Last Rate Decision	0.693		1.08	*	0.952	
ISM Gap	0.147	***	0.14	**	0.143	***
Δ(Inflation Expectations)	0.292		0.941		0.46	
Communication Indicator	0.913	**	---		0.974	**
Communication Indicator News Agency Reports	---		0.772		0.811	
Lower Threshold	-1.18	**	-2.05	***	-1.89	***
Upper Threshold	2.73	***	2.26	***	3.19	***
LR Statistic	23.57	***	26.8	***	24.81	***
Pseudo Log-Likelihood	-18.82		-21.35		-18.62	
Pseudo R^2	0.55		0.48		0.55	

Notes: */**/*** denote significance at the 10/5/1% level. Huber/White robust standard errors are used.

The newswire communication indicator is not significant in either Model (9) or in Model (10), whereas our communication variable significantly explains target rate changes in both Models (8) and (10). We conclude that newswire reports of central bank communications are not a substitute for the full range of central bank communication when trying to predict changes in the federal funds rate.

Finally, we test for endogeneity in our regressions by instrumenting the ISM gap and the change in inflation expectations by their respective lagged values.[15] A Hausman test does not reject the null of exogeneity ($Chi^2(2) = 1.85$).

7. Conclusions

In this paper, we explain changes in the federal funds target rate by macroeconomic variables and various forms of FOMC communication. We focus on the question of whether FOMC communication contains information additional to that already incorporated in a real-time forward-looking Taylor rule. The communication indicator is derived on the basis of post-meeting statements, the semi-annual monetary policy report, congressional hearings, and speeches by Board of Governor members and Fed regional presidents. Econometrically, we use an ordered probit model to take into account the discrete nature of target rate changes. The sample period starts on February 4, 1998 and ends on December 12, 2006, covering 75 target rate decisions and a period that shows an increasing trend in frequency of communication. Our communication indicator summarizes the communication that takes place between FOMC meetings and is based on a data set constructed by Hayo et al. (2008). Inflation expectations are provided by the University of Michigan; the ISM Index is used as a proxy for the forward-looking output gap.

In a first step, we check whether communication content matches actual monetary policy and find that FOMC communication has a longer horizon than one meeting when examining both forward-looking and backward-looking consistency. Communication is clearly forward-looking and, over the whole sample, 71 percent of the speeches are consistent with the next target rate change (74 percent when excluding 1998).

In a second step, we insert the communication variables (lagged statements and our communication indicator) into different models describing the Fed's interest rate setting behavior. These variables provide a significant and robust explanation of the Fed's target rate changes. Including the communication indicator helps predict seven additional target rate changes compared to a Taylor rule (two hikes, two cuts, and three no-change events) and increases the probability of making correct forecasts by an average of 13 percentage points over all target rate decision. Regarding different types of communication, speeches by BoG members and regional presidents have a statistically significant and equal-sized effect. The

[15] Auxiliary regressions show that the first lag of the ISM gap and the first three lags of inflation expectations should be used as instruments. Tests for over-identification and weak instruments (Staiger and Stock, 1997) support this choice of instruments.

infrequency of monetary policy reports and testimonies tends to make their impact insignificant.

In a third step, we approximate out-of-sample predictions by using rolling-window estimations and parameter constancy tests. The communication variables help to generate quite accurate one-step-ahead forecasts: the outcome of 30 out of 32 FOMC meetings over the period 2003–2006 is correctly predicted. In addition, the coefficients associated with the communication indicators are stable over time, whereas variables in the forward-looking Taylor-rule model are plagued by instability.

Our findings are robust to a variety of alternative specification. Changes in Fed transparency do not significantly affect our results. A change in Fed terminology in post-meeting statements from one emphasizing policy bias and balance of risks to a more forward-looking terminology does not result in greater predictability. The same applies to an earlier disclosure of dissenting members after FOMC decisions. When controlling for inter-meeting target rate changes, our coefficients remain significant. Univocal communication has a positive but insignificant impact. Our communication indicator explains rate changes much better than does an indicator derived from news agency reports collected by Ehrmann and Fratzscher (2007). Potential endogeneity problems of our macroeconomic variables are ruled out by a Hausman test.

The results of our study suggest that the Fed's communication, particularly in its more informal guise, such as speeches by FOMC members, contains useful information about future monetary policy that agents cannot acquire by relying on a Taylor rule even if this is forward-looking. In other words, the Fed prepares the public for its monetary policy decisions through informal methods of communication and, at least with regard to the actual timing of decisions, does not rely very much on a Taylor rule.

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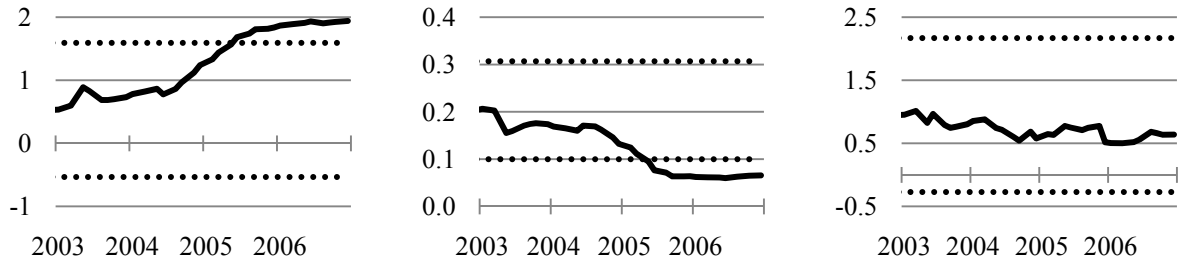
Appendix

Table A1: Descriptive Statistics

	Mean	Median	Max.	Min.	Std. Dev.	+1	0	–1
Rate Decisions	0.09	---	---	---	0.72	23	36	16
ISM Gap	-1.44	-0.86	11.97	-19.23	7.10	---	---	---
Δ(Inflation Exp.)	0.01	0	1.5	-1.8	0.46	---	---	---
Statements	0.29	---	---	---	0.82	39	19	17
Comm. Indicator	0.64	---	---	---	0.73	59	5	11
MPR	0.15	---	---	---	0.46	14	58	3
Testimonies	0.15	---	---	---	0.49	15	56	4
BoG Speeches	0.36	---	---	---	0.75	39	24	12
Presidents' Speeches	0.63	---	---	---	0.73	58	6	11

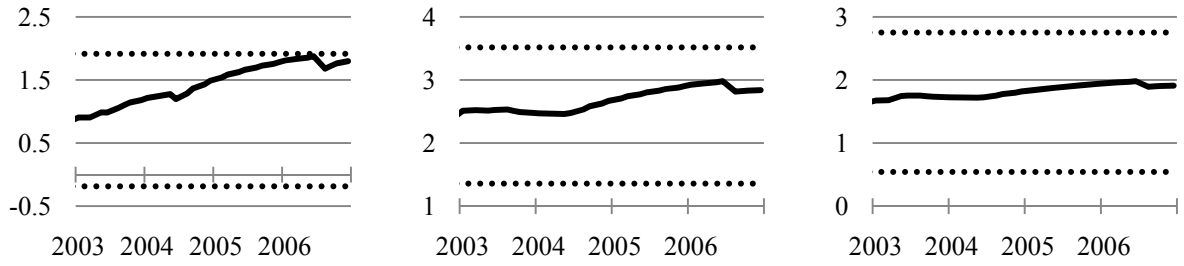
Figure A1: Parameter Stability of Models (1) and (2)

(1) Taylor Rule Model



Last Rate Decision | ISM Gap | Δ(Inflation Expectations)

(2) Communication Model



Last Rate Decision | Last Statement | Communication Indicator

Notes: Parameter estimates based on one-step updating over the period 2003–2006 and 95 percent confidence bands based on coefficient estimates from the subsample 1998–2002.