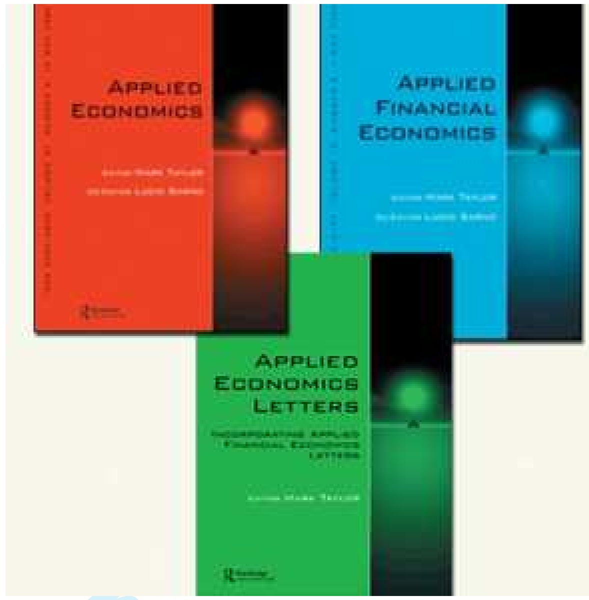
Has ECB communication been helpful in predicting interest rate decisions? An evaluation of the early years of the Economic and Monetary Union

Jansen, David-Jan; Haan, Jakob de



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Has ECB communication been helpful in predicting interest rate decisions? An evaluation of the early years of the Economic and Monetary Union.

David-Jan Jansen[1] Jakob De Haan[2]

De Nederlandsche Bank *University of Groningen*

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Abstract

We examine the usefulness of communication by the European Central Bank for predicting its policy decisions during the early years of the European Economic and Monetary Union. Using ordered probit models based on the Taylor rule, we find that statements on the main refinancing rate and future inflation are significantly related to interest rate decisions. At the same time, an out-of-sample evaluation shows that communication-based models do not outperform models based on macroeconomic data in predicting decisions. Both types of models have difficulty in predicting *changes* in the main refinancing rate.

JEL classifications: E43, E52, E58

Keywords: European Central Bank, communication, interest rate decisions, Taylor rule, ordered probit models

[1] Corresponding author. De Nederlandsche Bank, Economics and Research Division, P.O. Box 98, 1000 AB Amsterdam, The Netherlands, tel.: +31-20-5243170, fax: +31-20-5242514, e-mail: d.jansen@dnb.nl.

[2] Faculty of Economics and Business, University of Groningen, P.O. Box 800, 9700 AV Groningen, The Netherlands, tel.: +31-50-3633706, fax: +31-50-3633850, e-mail: jakob.de.haan@rug.nl.

1. Introduction

Nowadays, monetary authorities actively use communication as an instrument of monetary policymaking. By commenting on future economic or policy developments, the central bank may influence financial markets' expectations of upcoming interest rate decisions. Central banks may use various channels for their communications: regular publications (like Inflation Reports), testimonies in parliament, speeches, interviews, press conferences, and press releases.

This paper studies how useful one particular form of communication by the European Central Bank (ECB) - namely statements by high-level policymakers - has been for predicting its policy decisions. During the early years of the Economic and Monetary Union (EMU), the ECB often has been criticized for its communication strategy. Since late-2005, ECB communication has at times relied on keywords, such as 'vigilance', that seem a good predictor of subsequent interest rate decisions.[3] During the early years of the EMU, these keywords were absent in communication. Financial market participants had to forecast ECB policy decisions on the basis of their interpretation of macroeconomic data or the ECB's communicated assessment of macroeconomic developments. The question now arises how informative ECB communication has been during the early years of the EMU. We focus on the period 1999 to 2002, a sample which covers nearly all of the ECB policy changes during the early period. We study whether this type of communication has been informative, and we consider how models based on central bank talk compare to models based on macroeconomic variables. In all cases, we use ordered probit models based on the Taylor rule. Our communication variables are constructed using statements by euro area central bankers in the form of interviews, speeches, and press conferences as reported by Bloomberg. One benefit of our study is the richness of our data on communication. It includes statements by all high-level euro area central bankers, also those comments given in between Governing Council meetings.[4]

Our results are as follows. Statements by euro area central bankers on the main refinancing rate and future inflation are significantly related to ECB policy decisions. Also, communication variables are jointly significant in a regression that also includes various macroeconomic series. This

[3] Jansen and De Haan (2006) show that communication by the ECB during the early years of the EMU has often been contradictory. Jansen and De Haan (2007) analyse the ECB´s use of the keyword `vigilance´.

[4] In the remainder of this paper, we often use the term `ECB communication´ for sake of brevity.

evidence would suggest that comments by central bankers have been helpful for understanding interest rate decisions. However, an out-of-sample forecast evaluation shows that communication-based models do not outperform models based on macroeconomic data in predicting interest rate decisions.

The remainder of this paper is structured as follows. Section 2 gives an introduction to the relevant literature. This section also outlines the ordered probit model. Section 3 presents the data. Section 4 compares various models and section 5 considers the robustness of our findings. The final section offers our conclusions.

2. Using the Taylor rule to model ECB interest rate decisions

Since monetary policy is increasingly becoming the art of managing expectations, communication has developed into a key instrument in the central bankers' toolbox in recent years. First, communication may be used to guide private sector expectations. Second, communication may be used to reduce noise in financial markets. The extent to which central bank communication has been successful is very much an empirical issue. Therefore, it is no surprise that the empirical literature on central bank communication has seen major developments in recent years (see Blinder, Ehrmann, Fratzscher, De Haan and Jansen, 2008 for a survey).

Many studies focus on the communication policy of the ECB. There is substantive evidence that ECB communications move financial markets in the intended direction (see, for instance, Ehrmann and Fratzscher, 2007).[5] However, it is less clear whether communication adds information compared to the information contained by variables typically included in a Taylor-rule like model. For instance, whereas Heinemann and Ullrich (2007) and Rosa and Verga (2007) conclude that communication adds information not provided by Taylor-rule variables, we argue that models including communication indicators do not outperform straightforward Taylor rule models.[6]

Taylor (1993) suggested that a simple monetary policy rule relating the nominal short-term interest rate to inflation and the output gap accurately describes US monetary policy over the period

[5] Also, Sager and Taylor (2004) find that announcement by the ECB Governing Council contain significant news content.

[6] Recent studies that estimate Taylor rule models for ECB monetary policy are Sauer and Sturm (2007), Belke and Polleit (2007), Garcia-Iglesias (2007), Moons and Van Poeck (2008), and Gorter, Jacobs and De Haan (2008).

1987-1992. The Taylor rule seems a reasonable description of central bank behaviour in other countries as well. The Taylor rule models the policy interest rate i^* as a linear function of inflation (π), the equilibrium real interest rate (r^*), the difference between actual inflation and target inflation (π-π^*) and the output gap (y). Following Sauer and Sturm (2007) and Gorter *et al*. (2008), when applying the Taylor rule to the ECB, we include money supply (M3) growth in the specification. First, according to the ECB, deviations between actual money growth and the so-called 'reference value' play a role in its monetary policy strategy. During the period under consideration, monetary developments were taken into account under the so-called 'first pillar' of this strategy (see De Haan, Eijffinger, and Waller, 2005 for further details). Second, although the empirical evidence is mixed, various authors report that monetary developments play a role in ECB policy decisions (see, for instance, Gerlach, 2007). The expanded Taylor rule can thus be written as:

$$i^*(t) = \pi(t) + r^* + \alpha_1 (\pi(t) - \pi^*) + \alpha_2\, y(t) + \alpha_3 (m(t) - m^*) \qquad (1)$$

where (m(t) – m*) denotes the difference between actual money (M3) growth and the 'reference value' for money growth.

There are several issues that need to be addressed when taking the Taylor rule to the data. First, as stressed by Orphanides (2001), data should be used that were available at the time of the interest rate decisions. Therefore, we take our macroeconomic data from the ECB's Monthly Bulletin (as in Coenen, Levin and Wieland (2005)) and publications by Consensus Forecast. Second, there is the issue of using backward-looking versus forward-looking information. Backward-looking information may be important input in the decision-making process as it presents the most recent information on the state of the economy. On the other hand, since the ECB aims at ensuring price stability in the medium run, it acts forward-looking.[7] Because of these reasons, we use both backward-

[7] Svensson (2003) has shown that, even if the ultimate objective of monetary policy is to stabilize inflation and output, a simple Taylor rule will not be optimal in a reasonable macroeconomic model. Interest rate changes affect inflation and output with a sizable lag. Therefore, monetary policy has to be forward-looking, i.e., it should be based on expected inflation and output. Realized outcomes for inflation and output enter the optimal decision rule if they help to predict future inflation and output.

looking data (HICP figures, output gap estimates) and forward-looking data (inflation expectations, confidence indicators). Third, the variables used should be stationary. For the macroeconomic variables included in our analysis, we cannot conclusively establish that all of them are I(0). Based on the Johansen test, we also find that these variables are not cointegrated.[8] Therefore, we use the differenced version of equation (1):

$$\Delta i^*(t) = (1 + \alpha_1)\, \Delta\pi(t) + \alpha_2\, \Delta y(t) + \alpha_3\, \Delta m(t) \tag{2}$$

Most importantly, we take into account that ECB interest rate setting is a discrete rather than a continuous process by using an ordered probit model. A similar approach to modelling interest rate policy is used in Lapp, Pearce and Laksanasut (2003) and Gerlach (2007). Building on (2), we postulate the following index function:

$$\Delta i^*(t) = (1 + \alpha_1)\, \Delta\pi(t) + \alpha_2\, \Delta y(t) + \alpha_3\, \Delta m(t) + \varepsilon_t \tag{3}$$

where $\Delta\, i^*(t)$ now represents a latent continuous random variable representing the preferred change in the ECB main refinancing rate. The actual interest rate decision $\Delta\, i(t)$ is represented as a ternary variable which has the value 0 if interest rates are kept constant, +1 if interest rate policy is tightened, and -1 if interest rate policy is eased. Interest rate policy is characterized by threshold behaviour: the main refinancing rate is only changed if the value of the index function is either lower than a lower threshold τ_1 or higher than an upper threshold τ_2. Both τ_1 and τ_2 are unobserved. Assuming that ε_t follows a standard normal distribution, we can write the probabilities of the different outcomes as:

$$\Pr[\Delta i(t) = -1 \mid z(t)] = \Phi(\tau_1 - z(t)'\beta)$$

$$\Pr[\Delta i(t) = 0 \mid z(t)] = \Phi(\tau_2 - z(t)'\beta) - \Phi(\tau_1 - z(t)'\beta)$$

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[8] Results are reported in the appendix. To assess stationarity, we use both augmented Dickey-Fuller tests and the Kwiatkowski, Phillips, Schmidt and Shin (1992) test. The latter test is useful as it has a higher power in small samples. See also Hu and Phillips (2004) for a discussion on stationarity in the context of Federal Reserve policy.

$$\Pr[\Delta i(t) = 1 \mid z(t)] = 1 - \Phi(\tau_2 - z(t)'\beta)$$

where Φ denotes the cumulative standard normal distribution and z(t) is a vector with explanatory variables. The ordered probit model is estimated using maximum likelihood procedures as described in Maddala (1983). The thresholds variables τ_1 and τ_2 are estimated together with the β-vector.

We first estimate the ordered probit model using various proxies for the macroeconomic variables (i.e., $\Delta\pi(t)$, $\Delta y(t)$ and $\Delta m(t)$). Next, we estimate the model using the interpretation of developments in these variables signalled by euro area central bankers. Instead of using the information provided by macro-economic realizations and forecasts, a financial analyst who wants to forecast the ECB policy rate might use ECB communication. Using various communication devices, ECB officials frequently provide their views on (future) inflation, output, and money growth. As an alternative, we therefore estimate an ordered probit model in which the macroeconomic variables are substituted by variables reflecting the signals sent by the ECB concerning inflation, output growth, and money growth. For each of the macroeconomic series, we substitute a signal variable S in the index function, which then reads as follows:

$$\Delta i^*(t) = b_1 S^{\pi}(t) + b_2 S^{y}(t) + b_3 S^{m}(t) + \varepsilon_t \qquad (4)$$

where $S^{\pi}(t)$ denotes the ECB signal on inflation, $S^{y}(t)$ denotes the signal on economic growth[9], and $S^{m}(t)$ denotes the signal on M3, and ε_t ~N(0,1).

We consider one final extension to the Taylor rule. Sometimes, central bankers will directly communicate on the likely path of the interest rate. For example, they could state that `interest rates are appropriate´. Such a statement on the interest rate could be important information for market participants. To assess the information value of this type of statement, we also estimate a model which

[9] We use the term `economic growth´ rather than `output gap´ here. The reason is that, in our dataset, central bankers communicated in terms of economic growth (i.e., growth of gross domestic product) rather than the output gap (i.e., the difference between actual and potential output).

includes a signal variable $S^i(t)$ that is based on comments on the main refinancing rate. The index function in this case reads as:

$$\Delta i^*(t) = b_1 S^{\pi}(t) + b_2 S^{y}(t) + b_3 S^{m}(t) + b_4 S^{i}(t) + \varepsilon_t \quad (5)$$

3. Data

For our backward-looking macroeconomic variables, we use real-time monthly data on euro area inflation, industrial production (excluding construction), and money growth as published in the ECB Monthly Bulletin. As there were two interest rate decisions per month until November 2001, the monthly values are, in most cases, used to explain two subsequent decisions. For inflation, we use the most recent value of the year-on-year change in HICP inflation as available at the time of the decision. For money growth, we use the most recently reported value of the three-month moving average of annualised growth in M3. We use the published series of industrial production (excluding construction) to proxy the output gap *y(t)*. There are only a limited number of monthly figures reported in each Monthly Bulletin. Therefore, we add historical Eurostat data for the months that are not reported, starting in 1985:1. We calculate the output gap as the difference between the natural logarithm of the index of industrial production (1995=100) and the trend of this series, where we use a HP filter with a smoothing parameter of 14,400 for de-trending.

To proxy inflation expectations, we use data from Consensus Economics (see also Sauer and Sturm, 2007 and Gorter *et al*., 2008). Consensus surveys a number of financial institutions on a monthly basis asking for the expected change in consumer prices in the current and the next year. We use data for the eleven individual euro area countries that are surveyed. We include Greece beginning in 2002. Luxemburg is not included in the survey. For month *x* of a given year *t*, we compute expected inflation for each country as [(13-*x*)/12] times the inflation forecast for the current year plus (1-[(13-*x*)/12]) times the inflation forecast for the next year. The national series are aggregated with annually-updated real GDP weights into an expected inflation series for the euro area. Usually, the survey is taken around the 10th of each month and published with a short lag. Therefore, if the interest decision was scheduled on or after the 15th of each month, we take the change in expectations between the current month and the previous. Otherwise, we take the lagged change.

Following, Gerlach (2007) and Sauer and Sturm (2007) we employ the economic sentiment indicator (ESI) published by the European Commission as the forward-looking output gap measure. The ESI is based on confidence indicators for consumers, the retail sector, the construction sector, and the manufacturing sector. The data come from the European Commission web-site. We use the difference between the value of the ESI in a particular month and a long-term average. The long-term average is calculated using a rolling window consisting of the 144 preceding months.

To measure communication, we obtained data on ECB communication by searching the Bloomberg news wire, scanning the news headlines for keywords such as names of euro area central bankers (e.g., Duisenberg, Trichet, and Issing) or issues related to monetary policy (i.e., inflation, economic growth, M3, and interest rates). We coded the statements of the central bankers on a ternary scale (-1, 0, +1) reflecting the direction in which the central banker suggested the variable to develop. One way to interpret this scale is to think of it as measuring \`dovish´, \`neutral´ and \`hawkish´ statements on the future direction of monetary policy. Our approach in coding central bank statements is common in the literature on central bank communication (see Blinder *et al*., 2008). For example, Ehrmann and Fratzscher (2007) and Rosa and Verga (2007) follow a similar methodology. Table 1 gives a number of examples of statements on the interest rate and our classification of them. Likewise, comments on lower (higher) levels of euro area inflation receive a -1 (+1), whereas statements with a positive (negative) outlook for economic growth or comments hinting at higher (lower) M3 growth are coded with the value +1 (-1).

Table 1 here

During our sample period (4 January 1999 to 2 May 2002), the ECB took 75 interest rate decisions, the first one on 7 January 1999, the last one on 2 May 2002. There were 5 downward and 7 upward changes in the main refinancing rate. In this period, financial markets were still getting accustomed to the new central bank so that communication was of paramount importance. Searching Bloomberg, we found 925 reports containing comments by three groups of central bankers, i.e., members of the ECB Executive Board (EB), national central bank (NCB) presidents, and high-level policymakers of the Bundesbank. The possibility that the words of high-level Bundesbank officials may be informative is aptly illustrated by the following quote from a financial analyst: “Bundesbank council members are probably as close as one can get to being a fly on the ECB's wall” (Bloomberg, 1 August 2001). The data-set contains 277 statements on interest rates, 394 on inflation, 356 on economic growth and 98 on M3. EB members made 93 statements on interest rates, 149 on inflation, 157 on economic growth and 32 on M3. For NCB presidents, these figures are 135, 210, 174 and 49; for Bundesbank officials, the figures are 49, 35, 25 and 17, respectively.

How can we relate communication on monetary policy in the time span between the interest rate meeting at time *t-1* and the decision at time *t* to the decision taken at time *t* ? To do this, we have to transform the coded communications of all euro area central bankers into one summary variable. We focus on comments with a value different from zero as these give information on upcoming *changes* in the main refinancing rate. We construct the measure *S* of ECB communication per particular topic as follows:

$$S^x(t) = \Sigma^t_{d=1}\ (n^+_d - n^-_d)\ \ *\ \ (NT^{avg}/N_t*T_t) \qquad (6)$$

where *x* may be inflation, economic growth, money growth or interest rates, n^+_d denotes the number of statements with the value +1 on day *d*, n^-_d denotes the number of statements with the value -1, day d = 1 refers to the remaining part of the day after the interest rate meeting at time *t-1*, T_t denotes the number of days in the event window, and N_t denotes the total number of comments per topic for the event window related to the decision at time *t*. As there may be differences in the length of the event window as well as the number of comments made during the event window, we multiply by the ratio of the average value of NT in our sample (NT^{avg}) and N*T. In summary, the indicator *S* captures the balance between signals implying `tightening´ and `easing´ whilst taking into account the relative number of comments and the number of days in the event window. Table 2 illustrates how incorporating indicators for the various topics may be useful as they contain different information. The highest correlation coefficient – found for signals on inflation and economic growth, and for inflation and M3 – is only 0.47.

Table 2 here

4. Results for the ordered probit models

Table 3 shows the estimation results for six ordered probit models of interest rate decisions. Columns 1 and 2 present the outcomes using backward-looking variables (inflation, industrial production, and M3 growth). Column 3 shows estimates employing forward-looking variables (inflation expectations and the ESI), while columns 4 and 5 contain results using ECB communication variables. The two models based on communication variables have the best fit. If we include signals on inflation, economic growth, and M3, we find a pseudo-R^2 of 0.15 (column 4). If we include the direct signal on the interest rate, the pseudo-R^2 rises to 0.20. In contrast, the two models using backward-looking variables have a very poor fit. Including data on HICP, industrial production, and M3 results in a fit of 0.07 (column 1). None of these variables are significant at the 10% level. When we drop the M3 variable, the pseudo- R^2 drops to 0.04, but the inflation variable becomes significant at the 10% level with a point estimate of 1.29. The fit of the Taylor rule estimated with forward-looking variables lies between the other four models. The coefficients of expected inflation and the economic sentiment indicator are significantly different from zero.

Table 3 here

One way to assess whether communication adds information is to estimate a model encompassing both macroeconomic data and communication. Therefore, we have estimated a model using all macroeconomic series and all communication variables we have used in the above. Column 6 of Table 2 shows the estimation results. It turns out that the ESI indicator and statements on the interest rate are significant in this equation. Furthermore, we can reject the null hypothesis that the communication variables are jointly zero (conditional on the macroeconomic variables) at the 5% level, indicating that communication adds information. At the same time, we should note that more often than not, the coefficients for the individual signal variables are not significant.

Table 4 reports marginal effects for four specifications: two using macroeconomic data and two using communication variables.[10] We find particularly strong results for the forward-looking macroeconomic variables. A 1%-point increase in our measure of expected inflation leads to an increase in the probability of higher interest rates of 0.56. For the economic sentiment indicator a 1%-point increase leads to a 0.39 rise in the probability of higher interest rates and reduces the probability of a rate reduction by 0.23. Also, we find that a 1%-point increase of realized HICP inflation increases the probability of a higher interest rate by 0.20. The effects of the communication variables are smaller in absolute terms: a 1-point higher signal on euro area inflation decreases the probability of a policy easing by 0.01, while a 1-point higher signal on the main refinancing rate increases the likelihood of tighter policy by 0.02. The fact that the marginal effects for the communication variables are smaller may be due to different scales of measurement.

Table 4 here

Which of these models is better suited to predict the next interest rate decision? To answer this question, we use rolling-window out-of-sample forecasts. We start by estimating each model using the first 25 observations and then generate the probability that each model attaches to a decision of higher, constant, or lower interest rates at $t = 26$. Next, we re-estimate the models using the first 26 observations and predict the decision at $t = 27$, and so on. In general, the models give accurate predictions in cases when rates were left unchanged. That is to say, the probability of constant interest rates is equal to or larger than 50% in most of these cases. Only in 5% of the cases do we find a predicted change when actually no change took place. However, this is not surprising, given that the unconditional probability of no change in the interest rates was 84%. Also, we find that the models have great difficulty in predicting interest rate changes as they fail to generate a probability of change

[10] In the remainder of the paper, we no longer report results for the model including changes in money growth. Results including M3 are similar to those reported.

of at least 50% in all cases when rates were actually changed. The closest prediction is for 27 April 2000 when both models based exclusively on communication generate a probability of higher rates of 34%. There is no clear ranking for the models in terms of ability to predict changes in the main refinancing rate. Overall the differences are small. For decisions to tighten policy the model with backward-looking macroeconomic data is most accurate in three of the six cases. However, for decisions to ease policy it is least accurate in two out of four cases. For both types of decisions, the model with forward-looking variables gives the best prediction in four out of ten cases. However, it gives the worst prediction in two cases and also incorrectly predicts changes in the policy rate on two occasions. In five out of ten cases, one of the communication-based models gives the best prediction. However, in the other cases, these models generate the worst prediction. Additionally, both communication models incorrectly predict three changes in the policy rate.[11]

5. Robustness

We explored the robustness of the results in several ways.[12] First, we re-estimated the ordered probit models using also lags of the explanatory variables. Central bankers may signal rate changes earlier than in the inter-meeting period which we use as the event window. Also, in setting the interest rate, they may take lagged values of the macroeconomic variables into account. However, including more lags does not change our main results. Most importantly, we are unable to substantially improve the forecasting ability of the models.

Second, we considered whether allowing for interest rate smoothing may influence the results. We implemented this by including lagged values of the interest rate decision Δ i(t) into the model. However, this adjustment also did not improve the ability of the models to predict interest rate changes, although in some cases the lagged decisions were significant.

Thirdly, in order to check whether it is appropriate to include comments by high-level officials of the Bundesbank, we created separate signal variables for this group of central bankers. It turned out

[11] The decision to lower rates by 50 basis points on 17 September 2001 was unscheduled. It came in the aftermath of the 9/11 terrorist attacks in the United States. In this individual case, the results may be biased in favour of the communication-based models. After such an event, communication will adjust more quickly and be more readily available than forward-looking variables.

[12] We only describe the results of these extensions in broad terms here. Detailed results are available on request from the corresponding author.

that the communication variables are significant in the ordered probit model which suggests that including Bundesbank statements is justified.

6. Conclusions

This paper has studied the predictability of ECB interest rate decisions based on ECB communication and macroeconomic data. We find that decisions are most closely linked to changes in inflation expectations and economic sentiment. However, comments by euro area central bankers on the main refinancing rate and future inflation are also helpful in modelling interest rate decisions. At the same time, we find no great difference in the predictive power of models based on communication and macroeconomic data. In general, the models have great difficulty in explaining changes in the main refinancing rate. However, decisions to leave rates unchanged are usually correctly predicted. Our results differ from those of Rosa and Verga (2007) who find that statements by the ECB president at the press conference following an interest rate decision have predictive power, even if Taylor-rule like variables are included. This suggests that different channels of central bank communication may not be equally informative.

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Table 1: Examples of classification of ECB statements on interest rates

Date and time stamp	**Who?**	**Comments**	**News report headline**	**Our coding**
19/5/99 at 12:43	Trichet	It would be inappropriate	ECB's Trichet sees no further scope for further ECB cuts	0
09/09/99 at 08:48	Quaden	The next move will probably be a move upwards	ECB's Quaden sees faster growth pushing rates higher	+1
28/03/00 at 08:42	Rojo	Europe's growing economy is likely to lead to more interest rate increases	Bank of Spain's Rojo sees rate rise; Says stocks overvalued	+1
12/12/00 at 13:31	Welteke	Under the given circumstances I regard current central bank rates as appropriate	ECB's Welteke on inflation, interest rates, the euro: Comment	0
28/01/02 at 11:25	Noyer	this could be a case for a slight reduction in benchmark rates	Noyer says ECB may cut rates if growth, inflation slows, BZ says	-1

Notes: Source of all quotes is Bloomberg. Dates are listed as DD/MM/YY. The final column shows our coding of the comments.

Table 2: correlations between communication indicators

Signal on:	Inflation	Economic growth	M3
Economic growth	0.47	-	-
M3	0.47	0.40	-
Interest rates	0.42	0.17	0.26

Table 3: Full sample results for ordered probit models

	(1)	(2)	(3)	(4)	(5)	(6)
	Macro data (backward)	Macro data (backward)	Macro data (Forward)	ECB comments	ECB comments	Macro data + comments
$\Delta\pi$ (HICP)	0.86 (0.57)	1.29* (0.66)				0.43 (1.03)
Δy (IP)	-0.02 (0.19)	0.04 (0.17)				-0.28 (0.25)
Δm (M3)	-1.02 (0.67)					-0.51 (0.88)
$\Delta\pi^e$ (Consensus)			4.36** (2.10)			1.92 (3.42)
Δy (ESI)			3.01** (0.98)			1.98* (1.12)
<u>*Signal on:*</u>						
Inflation				0.13** (0.06)	0.08 (0.06)	0.02 (0.08)
Economic growth				0.05 (0.07)	0.06 (0.06)	0.06 (0.07)
M3				0.27* (0.17)	0.27 (0.18)	0.27 (0.20)
Interest rates					0.22 (0.12)	0.23* (0.12)
τ_1	-1.65***	-1.51***	-1.78***	-1.55***	-1.47***	-1.65***
τ_2	1.36***	1.42***	1.53***	1.79***	2.05***	2.21***
Pseudo-R^2	0.07	0.04	0.14	0.15	0.20	0.26

*Note: Sample period is 4 January 1999 to 2 May 2002. Standard errors in parentheses. */**/*** denotes significance at the 10/5/1 % level. Hubert-White robust estimates of variance is used in all cases.*

Table 4: Marginal effects for four selected specifications

	Effects on:											
	Pr[Δi(t) = -1]				Pr[Δi(t) = 0]				Pr[Δi(t) = 1]			
	Macro data		Comments		Macro data		Comments		Macro data		Comments	
$\Delta\pi$ (HICP)	-0.15				-0.05				0.20**			
Δy (IP)	0.00				0.00				0.01			
$\Delta\pi^e$(Consensus)		-0.34				-0.22				0.56**		
Δy (ESI)		-0.23**				-0.16				0.39**		
Signal on:												
Inflation			-0.01*	-0.01			0.00	0.00			0.02	0.01
Economic growth			0.00	0.00			0.00	0.00			0.01	0.01
M3			-0.02	-0.02			-0.01	-0.01			0.03	0.03
Interest rates				-0.02				-0.01				0.02*

*Note: Marginal effects are evaluated at sample means. */**/*** denotes significance at the 10/5/1 % level*

Appendix: Stationarity and cointegration tests for macroeconomic variables used in the Taylor rule.

Table A.1: Results for ADF-test and KPSS-test

	ADF-test		**KPSS-test**
	t-statistic	# lags	LM-statistic
π (HICP)	-1.52	0	1.01***
π^e (Consensus)	-1.98	2	0.62**
y (IP)	-1.42	0	0.26
y (ESI)	-1.47	0	0.40*
m (M3)	-2.07	2	0.28
i	-0.89	0	0.69**

Note: 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 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.

Table A.2. Results for Johansen test

Cointegration between:	**Hypothesised # cointegrating equations**	**Eigenvalue**	**Trace statistic**	**5% critical value**
HICP, IP and M3	None	0.16	18.96	29.80
	At most one	0.06	6.46	15.49
	At most two	0.03	2.20	3.84
Consensus and ESI	None	0.20	13.47	15.49
	At most one	0.13	4.27	3.84

Note: A constant was allowed for in the cointegrating equations.