Inflation Expectations of Experts and ECB Communication*

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Abstract

The communication policy of the European Central Bank (ECB) receives lots of attention from financial markets. This paper analyses the informational content of the monthly introductory statements of the ECB president explaining interest rate decisions with regard to inflation expectations of financial market experts for the euro area from January 1999 to July 2006. We test for the influence of ECB communication on expectations formation besides other macroeconomic variables. As it is shown, the indicator measuring the informational content of ECB rhetoric contributes to the explanation of inflation expectations formation.

JEL Classification: E52, E58, D83, D84

Key Words: inflation expectations, central bank communication, Carlson-Parkin method, survey expectations

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1 Introduction

The transparency of monetary policy and the communication policy of central banks are gaining weight in discussions about good monetary policy because both measures affect the effectiveness of monetary policy by providing information to the public. The assumption is that more transparency increases monetary policy effectiveness. If interest rates are close to zero, for example, the leeway for actual policy decisions will be limited and communication would play an important role to influence expectations. Also, in normal times, transparency helps to improve the transmission of monetary policy impulses. More transparency enables financial markets to interpret the monetary signals of the central bank properly, because it provides markets with the necessary information and the possibility to learn the strategy of the central bank, the interpretation of a changing economic environment by the bank, and the respective policy reactions. In this way, the central bank influences expectations formation by private agents. Moreover, the ability to influence expectations provides the link between the short-term interest rate, which the central bank can influence more or less directly, and the long-term interest rates, asset prices, and exchange rates. Furthermore, inflation expectations play a crucial role in determining wage and price setting.

We investigate the influence of the ECB rhetoric at its press conferences following interest rate decisions and the information provided in the *Monthly Bulletin* on the formation of inflation expectations of financial market experts received from the ZEW Financial Markets Test. We assume that the statements and the *Monthly Bulletins* are sources of information that are meant for the informed public – central bank watchers in the broader sense. Therefore, we can test whether this rhetoric has an influence on inflation expectations formation of experts. If this is the case, we could reason that the ECB is at least understood by the informed public and ECB wording differs from noise.

The inflation expectations are calculated from the ZEW Financial Markets Test using a standard Carlson-Parkin method. To measure the information content of ECB statements, the wording indicator of Heinemann und Ullrich (2005) is used. For estimation, we follow a VECM approach and control for the influence of other macroeconomic variables on inflation and inflation expectations. The estimation results allow for the conclusion that the ECB statements given at the press conferences following the interest rate decisions influence inflation expectations of experts. However, the effects do not seem to be very pronounced. If the rhetoric is rather hawkish, communicating concern about infla-

tion risks, this induces financial market experts to adjust inflation expectations upwards. At the same time, the decision of the central bank to increase the interest rate would counteract the increasing inflation expectations. This would allow the conclusion that the words and deeds of the ECB are seen as credible from the point of view of financial market experts.

We proceed as follows: First, we give a short motivation arising from gaps in the existing literature regarding communication of the ECB. There is a broad theoretical literature taking into account transparency, but a common model to include communication seems to be missing, at least to our knowledge. Therefore, we use the model of Svensson (2003) to develop a rationale for the effects of communication on inflation expectations in the third section. The theoretical results built the basis for the estimation approach in form of an error correction model. We describe the data used in the estimation in section four. The empirical results and the interpretations of the findings follow. and the last section concludes.

2 Motivation

The literature concerned with economic transparency does not provide a unambiguous answer to the question of advantages of economic transparency. Depending on the target of transparency and modelling framework, especially the assumed transmission mechanism, proposals for more or less transparency have emerged from the literature (Geraats 2002a).

There is a fast growing amount of empirical literature investigating the influence of ECB communication on the exchange rate (e.g. Jansen and de Haan 2003 and the papers cited therein, Jansen and de Haan 2005), and, more generally, on financial markets and the predictability of monetary policy decisions (Bernoth and von Hagen 2004, Hartmann et al. 2001, Gaspar et al. 2001). Ross (2002) concludes that the Fed and the Bank of England are more predictable than the ECB whereas Connolly and Kohler (2004) come to the conclusion that the predictability of monetary policy of the Fed, the Bank of England, and the ECB is similar. Furthermore, there are some investigations concerned directly with the communication policy of the ECB (e.g. Jansen and de Haan 2004, Ehrmann and Fratzscher 2005, Gerlach 2004, and Heinemann and Ullrich 2005).

Transparency and communication of central banks will not only influence the expectations of agents in financial markets regarding the next interest rate decision. Sellon (2004)

describes the impact of central bank behaviour and communication on the term structure of interest rates, on the link between short-term and long-term rates and the different reactions of the rates on policy rate changes depending on the maturity of the rates. In addition to that, inflation expectations are also influenced.

The monetary strategy of inflation targeting is also connected with the provision of extensive information and with transparency. Kuttner and Posen (1999) investigate the link between inflation expectations and inflation targeting coupled with more communication in UK, Canada, and New Zealand. However, the analysis does not rely on direct measures of inflation expectations but rather employ indirect approaches as the Taylor rule and the time series properties of inflation rates. Czogała et al. (2005) investigate the influence of the communication policy of the Polish central bank on corporate inflation expectations without explicitly incorporating a measure for communication into the estimations but relate the econometric findings with regard to the rationality of expectations formation to the communication policy of the National Bank of Poland. Kliesen and Schmid (2004) investigate the influence of macroeconomic data releases of the Federal Reserve on inflation expectations. The inflation expectations are produced from concepts of inflation compensation included in nominal Treasury securities. Kohn and Sack (2003) find that, at the longer horizon, communication matters as much as policy actions for the Federal Reserve. The longer horizon works by altering the perceptions of the central bank's economic outlook. Although private agents may have the same information available with regard to the future development of economic variables, central bank forecasts seem to be better than these of the private sector (Romer and Romer 2000). Cruijsen and Demertzis (2005) investigate the influence of central bank transparency on inflation expectations. The investigation whether communication influences inflation expectations will be more focused than transparency as a whole.

As this short literature overview shows, there are a number of empirical studies investigating the influence communication has on the formation of expectations. However, the link is not well investigated with regard to the ECB. For the euro area, analysis with regard to financial markets and predictability dominates. Whereas the empirical investigation seem to have a clear understanding about the concept of communication, the theoretical meaning is not equally clear and cannot easily be distinguished from transparency. E.g., Winkler (2000) treats communication as an integral part of transparency and analysis of transparency dominate the theoretical literature (Geraats 2002, Neumann 2002). Transparency is a multidimensional concept which includes the presentation and expla-

nation of the objectives, methods, forecasts, models, tactics, and decisions of a central bank (Blinder et al. 2001). Because transparency means openness and clarity, the mere presentation of data is not enough to reach a common understanding as ultimate objective of genuine transparency. Put more formally, transparency is defined as the degree of common knowledge or common understanding across agents (Winkler 2000, p. 13). Communication does not only provide quantitative information. The more articulated information plays the crucial role (Di Bartolomeo and Marchetti 2004, p. 17). An analysis that comes close to provide a rational for communication in monetary policy is Svensson (2003). He introduces a judgment factor of the central bank with regard to possibly unobservable components of the economy into a model to analyse reaction functions of monetary policy. We take this analysis to develop a basis for the empirical investigation.

3 Influence of Communication on Inflation Expectations

3.1 Theoretical Approach

We investigate the possible link between central bank communication and inflation expectations based on one version of the Svensson model (Svensson 2003). Thereby, we have to take into account that a theoretical model has a time structure that is not necessarily compatible with real time. The empirical investigation will be based on monthly time series. Because it is unrealistic to assume that monetary policy affects the inflation rate two months ahead as proposed by the model structure[1], we assume that a monetary policy decision has a first impact on the output gap five months ahead and the output gap influences the inflation rate the following month. This choice is affected by the available data for the inflation expectations with a six month time horizon.

Taking these assumptions into account and using the notation of Svensson, the supply function is given by

$$\pi_{t+5} = \pi_{t+4} + \alpha_x x_{t+4} + \alpha_z z_{t+5} + \epsilon_{t+5}$$

[1]Svensson gives the length of a period with three quarters.

where π denotes the inflation rate, and x the output gap. In z, all other exogenous influences that affect the inflation rate are collected. Demand is described by

$$x_{t+5} = \beta_x x_{t+4} + \beta_z z_{t+5} - \beta_r(i_t - \pi_{t+5|t} - \overline{r}) + \eta_{t+5}$$

where i denotes the policy rate, $\overline{r}$ the average real interest rate, and $\pi_{t+1|t}$ are private sector inflation expectations formed in t with regard to inflation in $t+1$. In the backward-looking model of the transmission mechanism, the central bank employs a reaction function based on a linear-quadratic loss function (Svensson 2003, p. 437) as follows

$$i_t = \overline{r} + \pi^* + \left(1 + \frac{1-c}{\alpha_x \beta_r}\right)(\pi_{t+5,t} - \pi^*) + \frac{\beta_x}{\beta_r} x_{t+4,t} + \frac{\beta_z}{\beta_r} z_{t+5,t} + \frac{1-c}{\alpha_x \beta_r} \tilde{z}_{t+6,t}$$

where π^* denotes the inflation target, and $z_{t+1,t}$ and $\tilde{z}_{t+6,t} = \sum_{s=0}^{\infty} (\delta c)^s z_{t+\tau+s,t}$ are valuations of the central bank about the exogenous variables influencing inflation and output gap. The parameter c is the appropriate solution of the characteristic equation for the determination of the interest rate rule (for a detailed description see Svensson 2003).

The variable z plays a crucial role for the following results. In z, exogenous variables are collected that influence supply and demand but are nor necessarily observable. The central bank assesses the future development of these variables for monetary policy decisions and, therefore, the information set of the central bank is expanded by these 'judgement factors'. E.g., judgement would be necessary if the true model of the economy is not known. As Lomax (2005) describes the role of the Bank of England forecasts, formal economic models are always accompanied by judgement even if the framework of the judgement is based on models. Svensson assumes that the central bank and the private agents possess the same information set and, therefore, private sector and central bank judgement are the same. We change this assumption by allowing a difference between the judgement of private agents and central bank with regard to the deviations, z.

Because we are not interested in the solution of the model but in the estimation of the relationship between inflation rate and inflation expectations, we concentrate on the derivation of equations for both variables that allow a translation into a system of estimable equations. We determine private sector inflation expectations in t for $t+6$, $\pi_{t+6|t}$, where monetary policy decisions about the interest rate in t have a first impact on the inflation rate. Correspondingly, the inflation rate π_{t+6} is analysed. The inflation rate in $t+6$ is then given by

$$\begin{aligned}\pi_{t+6} &= \pi_{t+5} + \alpha_x\beta_r\pi_{t+5|t} - (\alpha_x\beta_r + (1-c))\pi_{t+5,t} + (1-c)\pi^* + \alpha_z z_{t+6} - (1-c)\alpha_z\tilde{z}_{t+6,t} \\ &\quad + \alpha_x\beta_z(z_{t+5} - z_{t+5,t}) + \alpha_x\beta_x(x_{t+4} - x_{t+4,t}) + \alpha_x\eta_{t+5} + \eta_{t+6}\end{aligned}$$

and inflation expectations in t for $t+6$ are determined as follows

$$\begin{aligned}\pi_{t+6|t} &= \pi_{t+5|t} + \alpha_x\beta_r\pi_{t+5|t} - (\alpha_x\beta_r + (1-c))\pi_{t+5,t|t} + (1-c)\pi^* + \alpha_z z_{t+6|t} - (1-c)\alpha_z\tilde{z}_{t+6,t|t} \\ &\quad +\alpha_x\beta_z(z_{t+5|t} - z_{t+5,t|t}) + \alpha_x\beta_x(x_{t+4|t} - x_{t+4,t|t})\end{aligned}$$

The difference between inflation expectations of private agents and the inflation rate is calculated as

$$\begin{aligned}\pi_{t+6|t} - \pi_{t+6} &= \pi_{t+5|t} - \pi_{t+5} - (\alpha_x\beta_r + (1-c))\left(\pi_{t+5,t|t} - \pi_{t+5,t}\right) \\ &\quad -\alpha_z(1-c)\left(\tilde{z}_{t+6,t|t} - \tilde{z}_{t+6,t}\right) - \alpha_z(z_{t+6} - z_{t+6|t}) \\ &\quad -\alpha_x\beta_x(z_{t+5} - z_{t+5,t} - z_{t+5|t} + z_{t+5,t|t}) \\ &\quad -\alpha_x\beta_x(x_{t+4} - x_{t+4,t} - x_{t+4|t} + x_{t+4,t|t}) - \alpha_x\eta_{t+5} - \epsilon_{t+6} \qquad (1)\end{aligned}$$

where $z_{t+s,t|t}$ gives the expectations of private agents about the judgement of the central bank on the exogenous influences on inflation and output. If the central bank and the private agents would possess the same information set and form expectations in the same way based on the underlying model, the difference would reduce to

$$\begin{aligned}\pi_{t+6|t} - \pi_{t+6} &= \pi_{t+5|t} - \pi_{t+5} - \alpha_z(z_{t+6} - z_{t+6|t}) - \alpha_x\beta_x(z_{t+5} - z_{t+5|t}) \\ &\quad -\alpha_x\beta_x(x_{t+4} - x_{t+4|t}) - \alpha_x\eta_{t+5} - \epsilon_{t+6}\end{aligned}$$

In the case where the inflation rate is predetermined, actual monetary policy does not influence expectations. Only the actual inflation rate, output gap, and other factors influencing demand and supply can affect inflation expectations. In the case where the inflation rate is not predetermined, monetary policy and the assessment of the central bank play a crucial role in the process of forming inflation expectations by private agents. If the information set of private agents differs from that of the central bank, the evaluation of central bank expectations by private agents with regard to the deviations has an impact.

If the central bank could communicate its judgement about the model of the economy and be economically transparent in the classification of Geraats (2002), inflation and inflation expectations of private agents would be mor in line. Economic transparency would be enhanced, e.g., if the central bank communicates its models and forecasts. Presuming that the information sets of the central bank and private agents coincide, inflation and inflation expectations, that are not predetermined, would only differ because of the purely random shocks to output and inflation. However, one part of the private sector expectations error with regard to the judgement factor, $z_{t+s} - z_{t+s|t}$, could not be influenced by the central

bank. What could be influenced by communication of the central bank is the gap between the private and the central bank assessment of the exogenous factors influencing inflation and output, $z_{t+s,t|t} - z_{t+s|t}$.

The gap between the assessment of the deviation factor by the bank and by private agents is not necessarily closed with the provision of more data or central bank forecasts without explanation of the assumptions and risks associated with the forecast. In the outline above, the central bank is assumed to know private expectations perfectly well. On the other hand, private agents do not know the judgement of the central bank but have to form expectations of the knowledge and assessment of the central bank.[2]

3.2 Empirical Approach

As the preceding analysis shows, inflation and inflation expectations should only differ in the short-run. In the long-run, both time series follow the same pattern. In this case, the estimation should use the presumed cointegration property of the time series and a VECM approach can be employed.

To receive a system of equation that can be estimated, we rearrange terms and allow for non-unity coefficients of right-hand-side inflation and inflation expectations. In addition to that, the term $x_{t+4} - x_{t+4|t}$ is replaced by an explicit term depending on a sequence of expectations errors of the exogenous variables, $z_{t+s} - z_{t+s|t}$, and error terms, η_{t+s}.

$$
\begin{aligned}
\pi_{t+6|t} &= \alpha_1 \pi_{t+5|t} + \alpha_2 \pi_{t+6} + \alpha_3 \pi_{t+5} \\
&\quad + \alpha_4 \left(\pi_{t+5,t|t} - \pi_{t+5,t}\right) + \alpha_5 \left(\tilde{z}_{t+6,t|t} - \tilde{z}_{t+6,t}\right) + \alpha_6 (z_{t+5,t|t} - z_{t+5,t}) + \alpha_7 (x_{t+4,t|t} - x_{t+4,t}) \\
&\quad + \sum_{i=1}^{6} \alpha_{7+i} (z_{t+i} - z_{t+i|t}) + \sum_{j=1}^{5} \alpha_{13+j} \eta_{t+j} + \alpha_{19} \epsilon_{t+6} \\
\pi_{t+6} &= \beta_1 \pi_{t+5} + \beta_2 \pi_{t+6|t} + \beta_3 \pi_{t+5|t} \\
&\quad + \beta_4 \left(\pi_{t+5,t|t} - \pi_{t+5,t}\right) + \beta_5 \left(\tilde{z}_{t+6,t|t} - \tilde{z}_{t+6,t}\right) + \beta_6 (z_{t+5,t|t} - z_{t+5,t}) + \beta_7 (x_{t+4,t|t} - x_{t+4,t}) \\
&\quad + \sum_{i=1}^{6} \beta_{7+i} (z_{t+i} - z_{t+i|t}) + \sum_{j=1}^{5} \beta_{13+j} \eta_{t+j} + \beta_{19} \epsilon_{t+6}
\end{aligned}
$$

To translate this system of two equations into a vector error correction model, we lag all variables by six months. Moreover, we assume that we can approximate expectations for inflation five months ahead by inflation expectations formed one period before, $\pi_{t+5|t} \approx \pi_{t+5|t-1}$.

[2] In contrast to this assumption, Eijffinger et al. (2004) have analysed the effects of central bank communication about the model that is employed by the central bank to assess private sector expectations.

The difference between the expectations of the central bank and the expectations of the private sector about the expectations of the central bank with regard to the exogenous and presumably unobservable component, z, is assumed to be influenced by communication efforts of the central bank. Because we do not posses a communication measure for different time horizons and contents, we approximate all of the differences by a wording indicator known at the time of expectations formation, wd_{t-6} and wd_{t-7}. We can use wd_{t-6} because the decision about the interest rate is done at the beginning of the month most of the time. The difference between the realisation of the component and the expectations of the private sector is assumed to be purely random and included into the error term of the estimation equation, e and ε.

The observable error terms of the theoretical model are approximated by a collection of other variables besides lagged output gap and inflation, v_i, that could influence inflation and inflation expectations. Expressing in error correction form and assuming a cointegration relationship between the inflation rate and inflation expectations, the two equations can be written as follows

$$\begin{aligned}
\Delta\pi_{t|t-6} &= a_{11}(\pi_{t-1} + b\pi_{t-1|t-7}) + \sum_{i=1}^{p} c_{1,i}\Delta\pi_{t-i} + \sum_{i=1}^{q} d_{1,i}\Delta\pi_{t-i|t-6-i} \\
&\quad + f_{1,1}wd_{t-6} + f_{1,2}wd_{t-7} + \sum_{i}\sum_{s=0}^{5} g_{1,i}v_{i,t-s} + e_t \\
\Delta\pi_{t} &= a_{21}(\pi_{t-1} + b\pi_{t-1|t-7}) + \sum_{i=1}^{p} c_{2,i}\Delta\pi_{t-i} + \sum_{i=1}^{q} d_{2,i}\Delta\pi_{t-i|t-6-i} \\
&\quad + f_{2,1}wd_{t-6} + f_{2,2}wd_{t-7} + \sum_{i}\sum_{s=0}^{5} g_{2,i}v_{i,t-s} + \varepsilon_t
\end{aligned}$$

To better capture the short-term dynamics, additional lags of the two endogenous variables are added.

The finite vector of further explanatory variables, that are treated as exogenous in the estimation, has to be determined. Here, we follow the literature that uses explicit quantities to model inflation expectations. E.g., Pesaran (1987) uses cost and output factor and general economic conditions for explain adaptive inflation expectations formation in British Manufacturing. The additional explanatory variables are the rate of change of raw materials and fuel prices, wages, and the effective exchange rate, as well as the change of manufacturing output and overall rate of unemployment, and the change of money supply. Besides this, policy variables like the exchange rate regime and different periods of price policy are considered. Gramlich (1983) also extends a model of adaptive expectations for-

mation and includes money growth, unemployment or capacity utilisation, budget deficit, and supply shocks. For rational expectations, he considers expected money growth and lagged output gap where the derivation is based on the quantity equation of money. In the end the list of explanatory variables contains the inflation rate, rate of change of wages, a fiscal impact variable, and shock dummies, as well as money growth. Johnson (1997) uses lagged inflation, the recent forecast difference, an average of the bank rates over the last twelve months, 12-month percentage change of the exchange rate, the average difference between home and foreign interest rate over the last twelve months, the average slope of the term structure, the unemployment rate and an announcement dummy of monetary policy. In an monetary policy context, Ball and Croushore (2003) estimate the effect of changes in the federal funds rate as policy variable on inflation expectations.

For a more systematic approach to determine the explanatory variables, we rest our considerations on models explaining the behaviour of the inflation rate. In this case, two approaches can be considered. The first is the mark-up approach that attributes price changes to demand and cost factors (Bronfenbrenner and Holzman 1963). Because the traditional separation between cost push and demand pull is controversial, we take both aspects into account (Laidler and Parkin 1975). This approach results in determining a measure of capacity utilisation to capture the demand situation, and the import price index and unit labour costs to depict cost components as explanatory variables for inflation.

The second approach of the P-Star model relies on the quantity theory of money and contains a simple monetary model as well as an expectations-augmented Phillips curve as special cases (Lee 1999). The generalised form of the model contains the price gap that can be reduced to its component parts that are the liquidity and the output gap (Svensson 2000). This approach ultimately results in money growth and some measure of potential output as explanatory variables.

Because we are not interested in discriminating between different models to explain inflation but in the determination of potential influences on the short-term difference between inflation and inflation expectations, we extract the following variables as candidates for influencing the inflation formation process: Both approaches contain a measure of capacity utilisation. We use two different measures, that are the unemployment rate measured as percent of labour force and the economic sentiment indicator published by the European Commission (for a more extensive description of the data see next section). For the cost push, we use the annual percentage price change of raw materials. Additionally, the annual growth rate of the real effective exchange rate give a hint for the competitiveness

of the European economy. Furthermore, we contain money growth. For an alternative approach determining influences on inflation expectations formation see Gerberding (2001).

4 Description of the Data

4.1 Inflation Expectations of Experts

We generate the inflation expectations series on the basis of the ZEW Financial Market Survey. This survey among German financial market experts has been carried out on a monthly basis since December 1991. The covered experts (regularly 300-350 participants) come from banks, insurance, investment, and industrial companies. Within their companies, the respondents mostly hold positions in the financial, research, and economic departments or the investment and securities departments. The experts are asked for a qualitative assessment of their inflation expectations. The forecast horizon is six months. With regard to inflation expectations respondents have the choice between 'The annual inflation rate in the general economy in the medium term (6 months) will increase/not change/decrease/don't know'. This assessment is given for the euro area since January 1999.

For quantifying these qualitative assessments we follow a standard variant of the probability approach pioneered by Carlson and Parkin (1975). The starting point of the approach is the assumption that every individual bases her answers on a subjective probability distribution for inflation rates given her information set. The expected inflation rate is then identical with the conditional expected value of the distribution. If the expected inflation rate exceeds a certain threshold the answer is 'increase' and if the expected inflation falls below a threshold 'decrease' and in between is the indifference interval resulting in a 'no change'-answer. There are different possibilities for the treatment of the 'don't know category' (Marnet 1995). Since the category is minimally occupied in the ZEW survey with maximal seven answers per month, we simply ignore them. The next assumption of Carlson-Parkin is that the thresholds are identical across individuals even if they do not have to be symmetric and constant over time. Hints to the relevant thresholds come from the ZEW panel itself which was polled in January 2006 to quantify these thresholds. The answer categories allow for asymmetric thresholds. For the calculation of the inflation expectations series the mean value of the answers is used and is given by 0.24 for the lower threshold and 0.22 for the upper threshold.

The final assumption of the Carlson-Parkin approach is that the subjective probability distributions are independent of one another and have the same known form across individuals. If the assumptions are satisfied we can conclude that the proportion of 'rise' answers is identical to the probability that inflation in 6 months exceeds the upper threshold and the proportion of the 'decrease' answers is the same as the probability that the future inflation rate will be lower than the lower threshold given the information at the time expectations are formed. The expected inflation rate corresponds to the expected value of the distribution given the information set. The quantification will crucially depend on the chosen form of the aggregate distribution function. For the calculation we use a standard normal distribution following most of the literature on transforming qualitative survey data.[3] From the survey results we get the expected change of inflation regarding the next 6 months,

$$\Delta^e \pi_{t+6|t} = \frac{a r_{t+6|t} + b f_{t+6|t}}{f_{t+6|t} - r_{t+6|t}}$$

where a denotes the lower threshold and b the upper threshold (Smith and McAleer 1995). The variables $r_{t+6|t} = \phi^{-1}(1 - R_{t+6|t})$ and $f_{t+6|t} = \phi^{-1}(F_{t+6|t})$ are the inverse of the cumulative standard normal distribution of the share of experts expecting a fall ($F_{t+6|t}$) or a rise ($R_{t+6|t}$) in inflation.

Because this gives the absolute expected change, $\Delta^e \pi_{t+6|t} = \pi_{t+6|t} - \pi_t$, we assume that inflation expectations can be gathered from the following equation:

$$\pi_{t+6|t} = \pi_t + \Delta^e \pi_{t+6|t}.$$

4.2 Measurement of ECB Communication

For our analysis we use the wording indicator of Heinemann and Ullrich (2005). The construction periods of the indicator cover the period January 1999 to December 2000 ($wi9900$) and the whole Duisenberg period (wd) from January 1999 to November 2003.

[3]The normal distribution of inflation expectations is criticized by different authors, e.g. Batchelor and Orr (1988). But Balcombe (1996) does not find a hint for skewness or curtosis in QSBO survey data and Mitchell (2002) analyses the class of stable distributions and finds no advantaged with regard to the normal distribution using data of the Industrial Trends Survey in the UK manufacturing industry. Using the Dutch consumer survey Berk (1999)(Berk 1999) compares the transformation of qualitative data into inflation expectations using the normal, central and non-central t-distribution. He finds that the accuracy of the inflation expectations is not improved although the effect of the non-normal asymmetry is substantial.

If ECB rhetoric may influence inflation expectations, the economic agents should know how to interpret the statements of the ECB. Therefore, we admit that the public first had to get to know the ECB and its communication policy. On the other hand, we need a reasonable time span to estimate the effect communication has on expectations formation. Therefore, we assume a two year period until the end of 2000 where economic agents can get adjusted to the communication policy of the ECB.

The quantification starts with identifying possible signal words in the introductory statement of the monthly ECB press conferences. The lengths of the statements is also tested. In order to determine the words' informational content, we count their use in the introductory statements in each monthly ECB press conferences. In those months where no press conference took place we take the editorials of the monthly ECB reports as substitute which are very similar in contents, length, and terminology to the press conferences' initial statements. Then, observations are grouped into periods of neutrality, tightening, and easing bias. The grouping criterion is the observed interest rate policy of the two months following the press conference. On the basis of a 10 percent significance level, potential signal words that do not show significant differences in mean frequencies are excluded from the calculation of the indicator.

Then, pair-wise tests are used to decide the sign of the specific code word in the indicator. A positive sign is attributed to those words for which tests show significantly larger frequencies in tightening compared to easing periods, tightening compared to neutral periods, or in neutral compared to easing periods. A negative sign is assigned to words where the significant relative frequencies are opposite. Thus, the resulting indicator is, by construction, positively associated with an increasing 'hawkishness' of ECB rhetoric. The informational content of a word is measured by the η^2 statistic. The statistic measures the share of the total variance attributable to differences in means between the three different kinds of periods.

Summing up, the wording indicator WI is constructed using frequency of code words x_i as follows:

$$wi_t = \sum_{i=1}^{k} \frac{nobs(x_{i,t}) - meanobs(x_i)}{stdv(x_i)} sign(x_i)\eta^2(x_i)$$

The index adds for each period the (standardised) number of observations. These numbers are weighted by the η^2 statistic in order to account for the differences in the informational content of code words. The sign of each individual code word is determined on the basis

of significant pair-wise tests as described. Figure 1 in the appendix shows the indicators for the two construction periods.

Although the indicator is constructed with regard to the next interest rate decision of the ECB, it is also applicable for the analysis of inflation expectations. Because the mandate of the ECB is to guarantee price stability in the euro area, the central bank will react to inflationary pressure with rising interest rates. A deflation would also be a violation of the inflation target of lower but near the two percent ceiling for the inflation rate of the Harmonised Consumer Price Index. A higher hawkishness in the rhetoric of the ECB would hint to inflationary pressure identified by the central bank and would also lead to reactions of the ECB. If the expectations rise with higher hawkishness, this would indicate that the economic agents too see danger for inflation as the central bank but are not confident that the ECB would bring inflation back to target.

4.3 Further Macroeconomic Variables

One problem for the use of time series in estimation where the behaviour of economic agents and their information set matter is the revision of the series. Because expectations are based on the knowledge at the time when expectations are formed, the used of revised data to uncover the relationship between the macro variables and expectations formation seems to be problematic. Therefore, we follow a twofold estimation strategy and use revised data[4] and data collected from the Monthly Bulletins of the ECB to get time series that reflect as closely as possible the knowledge of the financial market experts at the time of expectations formation.[5]

The unemployment rate measured as percent of labour force is seasonally adjusted. The data are released with a lag of 2 months as a rule, so that e.g. in January the value of November of the previous year is known. However, for the time series form January 1999 to January 2006, it happens 10 times that only the value of the previous month was published in the Monthly Bulletin and that in the following month two new values were published to keep on track with the two month publication lag. We construct the series that captures the knowledge of an observer that displays the latest available unemployment rate at that

[4]All revised data are provided by Ecowin.

[5]Because the estimation equation contains lags of the explanatory variables, vintage data would be needed.

time. As Figure 2 (see appendix) shows, there is a considerable difference between the revised (Source: Eurostat) and the real time series before mid-2002.

The annual percentage change of the real effective exchange rate is used in the narrow definition of trading partners of the euro area. It has a publication lag of one month. There are some special features of this series. For January 1999, the value is calculated from the respective exchange rate indices published in the February 1999 Monthly Bulletin. Before April 2000, the effective exchange rate change is published for the countries also individually displayed in the Monthly Bulletin. Since April 2000 it is a narrow group of 23 trading partners. The values for January 2001 to December 2001 are calculated using the Table 'Past data for selected economic indicators for the euro area plus Greece'. As Figure 3 shows, the revised time series (Source: ECB) does not differ much from the real time data besides the publication lag.

The annual percentage change of prices of raw materials (Source: HWWA) is displayed in Figure 4 together with the annual percentage change of world market prices of raw materials (including energy) collected from the Monthly Bulletins. As for all other price series, the revision does not seem to reach an important magnitude. The publication lag is one month.

For money growth, some considerable differences between the real time series and the revised series (Source: ECB) occur at the beginning of the EMU (see Figure 5). In addition, the value for the centred three month moving average was first published in August 2001 (Mai 2001 value). For January 1999 to April 2001, the values are calculated from the seasonally adjusted index of M3, firstly published in August 1999 (May 1999 value). For the January 1999 to April 1999, the data are calculated using the index values taken from the August 1999 Monthly Bulletin. The publication lag is four months.

For two of the employed time series, the policy rate of the ECB (Source: ECB) and the economic sentiment indicator, the problem of real time data does not exist. For the interest rate, no revision takes place. The only source of change of the economic sentiment indicator is the seasonal adjustment of the series. This is especially attractive in case of the economic sentiment indicator because other measures of capacity utilisation are prone significant changes compared with the first publication values. The economic sentiment indicator is published by the European Commission. We use it in the form $100(esi - \overline{esi})/\overline{esi}$.

To be sure that the wording indicator reflects communication policy and does not capture the effects of interest rate decisions, we include a dummy variable for policy rate changes in the euro area. To compute the dummy, we use the interest rate of the Main Refinancing Operations (Source: ECB) as basis. Because the ECB change the interest rates as multiples of 25 basis points and past changes do not exceed 50 basis points, we construct the dummy as follows

$$\Delta^5 i_t = \begin{cases} -2 & \\ -1 & \\ 0 & \text{if} \\ 1 & \\ 2 & \end{cases} \begin{array}{l} \Delta i_t = -0.5 \\ \Delta i_t = -0.25 \\ \Delta i_t = 0 \\ \Delta i_t = 0.25 \\ \Delta i_t = 0.5 \end{array}$$

To use the time series in the VECM estimations, we test of a unit root to avoid estimating spurious regressions. The choice of the maximal lag length is done as the integer part of (see Hayashi 2000, p. 594)

$$12 \left(\frac{T}{100} \right)^{1/4}$$

This gives 12 lag as maximum for all analysed time series. Because of the improved finite-sample properties compared to the original ADF test, we use the ADF-GLS test of Elliott, Rothenberg and Stock (1996). One question to be addressed is the inclusion of deterministic terms in the test equation. To get an impression whether to incorporate a constant and a trend, we rely on graphical inspection of the GLS detrended series compared to the actual series used. We would not expect a trend in either of the series. However, when the matter is not unambiguously clear, we tested the series with and without a trend.

Only the exchange rate variable shows an ambiguous result. A crosscheck with the simple ADF test gives a highly insignificant trend and no rejection of a unit root. As a result, we get a mixture of stationary and unit root processes (see Table 4 in the appendix). As a consequence, we take first differences of the exogenous time series where the unit root could not be rejected.

5 Estimation Results for the Relation between Inflation Rate and Inflation Expectations

Before presenting the estimation results, we have to address a problem that arises for modern central banks following an inflation targeting strategy. The inflation target replaces inflation expectations in the long-run and the prices of the economy normally aggregating private information about market conditions cannot provide its role of information aggregation anymore (Morris and Shin 2005).[6] However, the ECB stresses that it does not follow direct inflation targeting but a two pillar strategy taking into account a broad range of signals about the economic stance. Nevertheless, the ECB announces a definition of price stability that includes a numerical value for inflation that is considered appropriate. This value of below but near two percent is not least to anchor inflation expectations. With the anchoring of inflation expectations, they should not respond to changes in the economic condition because a credible monetary policy would bring inflation back to target.

In this case, a hypothesis of inflation expectations formation seems to be useless, because inflation expectations equal the numerical target of monetary policy. However, this should only be true over a mid- to long-term horizon because the central bank will not react to every change in inflation. Temporary violation of the inflation target should not be counteracted by interest rate decisions. In this case, short-term inflation expectations could deviate from target inflation even if middle- and long-term expectations are anchored at the level of the inflation target. We would expect that inflation expectations over a six month horizon are affected by the short-term behaviour of the inflation rate. As Figure 6 shows, a relation between the wording indicator and inflation expectations as well as inflation cannot be denied *a priori*.

For estimation, we use two different data sets, one that consists of revised data and one that contains data collected from monthly bulletins to depict real-time data. To specify the lags of the endogenous variables in the vector error correction model (VECM), the use of information criteria is a common approach. We follow this approach too and get eight lags for the revised data estimation and seven lags for the real-time data estimation using a basic VECM without exogenous variables. However, because we do not have extended

[6] In contrast to these concerns, Orphanides and Williams (2003)(Orphanides and Williams 2003) find that the announcement of an inflation target helps to focus inflation expectations and reduces costs of imperfect knowledge that could otherwise lead to detoriations in stabilisation policies.

time series, we try to reduce the number of parameters to estimate. To do this, we first use a lag exclusion test. The model with the reduced endogenous lag structure is the basis for the reduction of lags of the exogenous variables. We only keep variables that are significant in at least one of the two equations.

In a second approach, we constrain the number of endogenous variables from the beginning. As an inspection of the behaviour of the information criteria of the basic VECM shows, there is a jump in the numbers at lag seven (revised data) resp. six (real-time data). This is most probably the case because the construction of inflation expectations relies heavily on the past inflation rate. Because inflation expectations are lagged six month, it is not surprising that the adjustment increases dramatically with the inclusion of the respective lags of the inflation rate. In addition to this observation, an autoregressive model of the inflation rate and of inflation expectations only needs one lag for a satisfying adjustment. Therefore, we include lag one and two and seven and eight resp. six and seven and perform the lag exclusion test for this more parsimonious model. Then the lags of the exogenous variables are adjusted as in the first approach. For the estimation with real time data for the whole period, this results in the same equation independent of the chosen strategy to reduce the the number of coefficients.

In addition to the different lag structures of the endogenous variables, we estimate the VECM with and without a constant in the long-run relationship. Even if the theoretical model does not call for a constant, it seems to be possible that there could be a long-run difference between inflation rate and inflation expectations. Moreover, we test the influence of ECB communication on inflation expectations for two different time periods. The first period covers the whole ECB era and uses the indicator that relies on the Duisenberg era for its construction. The second time period starts in January 2001. The indicator for the latter estimation is built using ECB statements from January 1999 to December 2000. Therefore, this procedure can be seen as a kind of out of sample estimation.

To control for the possibility that the wording indicator does not provide additional information besides interest rate decisions of the ECB, we add the dummy variable for the interest rate decisions with the same lag as the wording indicator.

The estimation results are collected in Table 1 (revised data, time period 1999:01 - 2006:06), Table 3 (real-time data, time period 1999:01 - 2006:06), and Table 2 (revised and real-time data, time period 2001:01 - 2006:06). The tables contain the estimation

coefficients of the cointegration relationship, the adjustment coefficient, and the wording indicator as well as the interest rate dummy. To keep the tables clear, we did not include the coefficients of the lagged endogenous and the other exogenous variables. As the tests show, all equations do not suffer much from autocorrelation and do not provide concerns with regard to heteroscedasticity. However, the residuals are not normally distributed because of violation of the kurtosis requirements. All in all, the performance of the equations seems to be satisfactory.

The results using revised data give the following picture. First, there seems to be no reliable adjustment of inflation expectations to the long-run relationship. All adjustment is done by the inflation rate. However, because the inflation rate is the basis for inflation expectations by construction, this would also influence the behaviour of expectations. Without a constant, the estimation shows a one to one-relationship between inflation and inflation expectations in the long run. If the cointegration relationship allows for a constant, this connections collapses. In this case, the long-run relationship seem to exist between the inflation rate and a constant of 1.6 or 2.1. A cautiously interpretations would be that the inflation rate converges to the inflation target of the ECB.

Even if inflation expectations do not show a long-run relationship with the inflation rate, there is an influence of the wording indicator on inflation expectations but not on the inflation rate. This influence is positive. A higher hawkishness of the rhetoric would lead to increasing inflation expectations. The explanation of risks to inflation by the central bank seems to be translated into higher expected inflation in the short-run even if the influence is not very pronounced. At the same time, interest rate changes display the opposite sign as the wording indicator. This would lead to the conclusion that a higher interest rate would reduce inflation expectations. Both effects have the expected sign and are significant. In this case, the announcement of risks to inflation as well as measures to counteract these risks are both credible because influencing inflation expectations. The described influence of wording on expectations depends on the specification of the model. With a lag-structure of 1, 2, and 7 for the endogenous variables, the proposed relationship does not exist. If we discriminate between the two specification with the help of information criteria, the Akaike as well as the Schwarz Criterium favours the specification where the wording indicator influences inflation expectations.

The most pronounced difference between revised and real-time data is that the latter take the publication lag into account. The use of real-time data changes the results as follows. Inflation expectations now show an adjustment to the long-run relationship with the

inflation rate. Without a constant, this cointegration relationship gives again an one to one connection between inflation and inflation expectations. With the inclusion of a constant, the adjustment of inflation expectations is still significant. However, the inclusion of the constant changes the long-run relationship between inflation and inflation expectations drastically. The one to one-relation between inflation and inflation expectations is no longer valid. Whereas with revised data, where an adjustment of the inflation rate to the inflation target seems to be possible, this interpretation fails for real-time data. On the other hand, if the inflation rate and inflation expectations converge to the inflation target of two percent, no adjustment is needed anymore:

$$\begin{aligned} \Delta\pi_t &= \pi_t - 1.76\pi_{t|t-6} + 1.55 \\ &= 0.03 \text{ for } \pi_t, \pi_{t|t-6} = 2 \end{aligned}$$

For the influence of the wording indicator, the same picture arises as for revised data. Again, there is a significant positive coefficient. A higher hawkishness of the rhetoric increases inflation expectations. This development is counteracted by the influence of the interest rate decisions where a rising policy rate leads to reduced inflation expectations. But now, the wording indicator also influences the inflation rate. Depending on the lag of the indicator, the influence changes sign and no reliable interpretation seems to be possible.

The out of sample analysis confirms the one to one relationship between the inflation rate and inflation expectations without a constant. With constant, the results have the same qualitative results as the estimations for the whole time period. However, the quantitative results cannot be reproduced exactly. This might be due to the even shorter sample. If the wording indicator significantly influences inflation expectations, the sign is still positive and accompanied by a negative influence of interest rate increases. This result is only observable for real-time data. For revised data, the interest rate changes now affect the inflation rate with a positive sign. Higher policy rates would lead to increased inflation. One possible explanation is that the estimation reproduces the price puzzle that exactly describes the observed effect. The inflation reducing effect of higher policy rates would then be observable later than the six month horizon assumed in the estimation equation. Besides, equation (1) shows that inflation and inflation expectations should be expected to be influenced by the wording indicator with opposite signs if the wording indicator is an approximation of the difference between central bank and private judgement about future economic development.

Because the wording indicator is only significant in connection with the interest rate decisions, the narrow relationship between words and deeds of the central bank is stressed. The insignificance as well as the significance of the wording indicator hint to a credible monetary policy and communication strategy of the ECB. First, the positive impact of wording on inflation expectations implies that the agents believe the inflation risks identified and communicated by the central bank, especially for the short run. If the policy is credible, this risks should be counteracted by the central bank and inflation expectations should decrease in reaction to the interest rate decision. This is supported by the negative coefficient of the interest rate dummy. In addition, the interest rate decision is more significant than the communication of risks.

Another possibility is that the expectations do not react to the communication of inflationary risks because private agents believe that the central bank will counteract these risks and inflation expectations do not rise at all. This is especially relevant for the long-run. This interpretation could also be relevant to the estimation results. However, in this case the interest rate dummy also is not significant. Inflation expectations do not react at all to monetary policy. Therefore, the first interpretation of the results seems to be more promising.

6 Conclusion

With the change of monetary policy in direction of more transparency, the communication strategy of central banks comes more and more into focus. Especially for the ECB with a complex two pillar strategy and a definition of price stability, the understanding by the public is crucial. The literature focuses to a large extend to the short-run effects of communication and comes to the conclusion that the interest rate decisions of the ECB are predictable to a large amount. Whereas the ECB is well understood in this respect, the influence on inflation expectations is not equally well investigated.

We contribute to the literature by investigating the influence of the information content of the ECB president statements on inflation expectations. We measure the influence by a wording indicator and analyse whether there is a significant influence on inflation expectations. For expectations we use inflation expectations of financial market experts provided by the ZEW Financial Markets Test.

As the estimations show, there is a measurable influence of the wording indicator that is accompanied by an opposite effect of interest rate decisions. A possible interpretation is that the words as well as deeds of the ECB are credible and well understood by financial market experts. However, the influence is not very pronounced. Therefore, the further development of an indicator more tailored to the ECB statements that are concerned with the inflation outlook would be the next step of research.

Appendix: Tables

Table 1: Estimation results for WD with revised data.

Estimation period	2000:04 - 2006:07							
Endogenous lag	1, 6, 7		1, 6, 7		1, 2, and 7		1, 2, and 7	
dependent variable	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$
adjustment coeff.	-0.30	0.01	-0.44	-0.01	-0.31	0.05	-0.43	-0.07
	(-4.14)	(0.37)	(-4.73)	(-0.40)	(-4.06)	(1.56)	(-4.66)	(-1.73)
$\pi_{t-1\|t-7}$	-1.04		-0.29		-1.05		-0.06	
	(-36.37)		(-1.23)		(-41.50)		(-0.31)	
constant			-1.57				-2.07	
			(-3.08)				(-5.49)	
wd_{t-6}	-0.03	0.02	-0.02	0.02	-0.05	0.02	-0.03	0.02
	(-0.96)	(2.14)	(-0.78)	(2.07)	(-1.83)	(1.25)	(-1.22)	(1.35)
wd_{t-7}	-0.01	0.02	0.00	0.02	-0.04	0.003	-0.01	0.001
	(-0.46)	(1.79)	(0.09)	(1.76)	(-1.26)	(0.26)	(-0.16)	(0.11)
$d5i_{t-6}$	0.02	-0.03	0.03	-0.02	0.09	-0.01	0.06	-0.01
	(0.62)	(-2.19)	(0.80)	(-2.22)	(2.58)	(-0.41)	(1.72)	(-0.72)
$d5i_{t-7}$	0.03	-0.02	0.04	-0.02	0.07	0.001	0.05	0.002
	(0.86)	(-1.61)	(1.18)	(-1.58)	(2.05)	(0.06)	(1.47)	(0.16)
$\overline{R}^2$	0.57	0.96	0.61	0.96	0.56	0.93	0.60	0.93
White heteroscedasticity	162.30		151.46		174.46		167.00	
Lutkepohl normality								
- skewness	0.29		1.22		0.52		1.54	
- kurtosis	23.49***		18.44***		15.64***		12.87***	
- Jaques-Bera	23.78***		19.66***		16.16***		14.41***	
Autocorrelation LM								
- lag 2	5.98		2.06		4.45		3.65	
- lag 6	1.31		2.06		9.97**		5.86	
- lag 12	8.16*		11.00*		4.95		6.09	
Portmanteau autocorr.								
- lag 24 (Q-statistic)	99.49***		98.55***		79.65		81.61	
Control variables	A				B			

Control variables

A: monthly change of yearly percentage change of raw material (-1, -2, -3, -5), monthly change of the unemployment rate (-1, -3, -4, -5), monthly change of the economic sentiment indicator (-1, -3, -5), monthly change of yearly percentage change of the effective real exchange rate (-1, -3, -5), monthly change of the yearly percentage change of money growth M3 (-1, -3).

B: monthly change of yearly percentage change of raw material (-1 to -3), monthly change of the unemployment rate (-1, -3, -4, -5), monthly change of the economic sentiment indicator (-1, -3, -4, -5), monthly change of yearly percentage change of the effective real exchange rate (-1 to -4).

Table 2: Estimation results for WD with real time data.

Estimation period	2000:04 - 2006:06				2000:04 - 2006:07			
Endogenous lag	1, 6, 7		1, 6, 7		1, 6, 7		1, 6, 7	
dependent variable	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$
adjustment coeff.	-0.17	0.10	-0.09	0.08	-0.17	0.10	-0.09	0.08
	(-2.49)	(3.22)	(-1.77)	(3.88)	(-2.49)	(3.22)	(-1.77)	(3.88)
$\pi_{t-1\|t-7}$	-1.04		-1.76		-1.04		-1.76	
	(-36.67)		(-4.30)		(-36.67)		(-4.30)	
constant			1.55				1.55	
			(1.73)				(1.73)	
wd_{t-6}	-0.04	0.02	-0.05	0.02	-0.04	0.02	-0.05	0.02
	(-1.91)	(1.55)	(-1.95)	(1.73)	(-1.91)	(1.55)	(-1.95)	(1.73)
wd_{t-7}	0.07	0.00	0.07	0.00	0.07	0.00	0.07	0.00
	(2.60)	(0.00)	(2.53)	(0.41)	(2.60)	(0.00)	(2.53)	(0.41)
$d5i_{t-6}$	0.00	-0.03	0.00	-0.03	0.00	-0.03	0.00	-0.03
	(0.01)	(-1.77)	(0.03)	(-1.94)	(0.01)	(-1.77)	(0.03)	(-1.94)
$d5i_{t-7}$	0.01	-0.01	0.01	-0.01	0.01	-0.01	0.01	-0.01
	(0.33)	(-0.68)	(0.41)	(-0.98)	(0.33)	(-0.68)	(0.41)	(-0.98)
$\overline{R}^2$	0.66	0.93	0.65	0.93	0.66	0.93	0.65	0.93
White heteroscedasticity	138.22		139.93		138.22		139.93	
Lutkepohl normality								
- skewness	0.04		0.38		0.04		0.38	
- kurtosis	8.50**		9.02**		8.50**		9.02**	
- Jaques-Bera	8.53*		9.40**		8.53*		9.40**	
Autocorrelation LM								
- lag 2	4.20		4.29		4.20		4.29	
- lag 6	2.71		1.65		2.71		1.65	
- lag 12	2.25		3.29		2.25		3.29	
Portmanteau autocorr.								
- lag 24 (Q-statistic)	66.84		63.83		66.84		63.83	
Control variables	A				A			

Control variables

A: monthly change of yearly percentage change of raw material (0, -1, -2),monthly change of the unemployment rate (-5), monthly change of the economic sentiment indicator (-1, -2, -4, -5), monthly change of yearly percentage change of the effective real exchange rate (-2), monthly change of the yearly percentage change of money growth M3 (-5).

Table 3: Estimation results for WI9900 with revised data and real time data.

Estimation period	2001:07 - 2006:06				2001:07 - 2006:07			
Data	revised				real time			
Endogenous lag	1, 2, 7, 8		1, 2, 7, 8		1, 6, 7		1, 6, 7	
dependent variable	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$	$\Delta\pi$	$\Delta\pi^e$
adjustment coeff.	-0.30	0.12	-0.43	0.11	-0.17	0.08	-0.28	0.08
	(-3.58)	(2.17)	(-4.29)	(1.38)	(-2.07)	(3.14)	(-3.25)	(3.56)
$\pi_{t-1\|t-7}$	-0.98		-0.42		-1.00		-1.31	
	(-36.80)		(-1.55)		(-31.67)		(-4.12)	
constant			-1.21				0.73	
			(-2.07)				(1.03)	
wd_{t-6}	-0.02	0.01	-0.02	0.01	-0.01	0.01	-0.03	0.01
	(-1.09)	(1.47)	(-1.21)	(1.13)	(-0.63)	(2.89)	(-1.57)	(2.75)
wd_{t-7}	-0.04	-0.00	-0.03	-0.01	0.01	-0.00	-0.03	0.001
	(-2.14)	(-0.38)	(-1.95)	(-1.08)	(0.78)	(-0.43)	(-1.19)	(0.28)
$d5i_{t-6}$	0.16	0.00	0.14	0.01	0.00	-0.02	0.05	-0.02
	(4.42)	(0.17)	(4.07)	(0.32)	(0.11)	(-1.35)	(1.06)	(-1.76)
$d5i_{t-7}$	0.18	-0.02	0.16	-0.01	0.00	-0.02	0.06	-0.03
	(4.81)	(-0.68)	(4.73)	(-0.34)	(0.05)	(-1.83)	(1.26)	(-2.59)
$\overline{R}^2$	0.78	0.94	0.81	0.93	0.59	0.96	0.50	0.96
White heteroscedasticity	-		-		111.12		133.99	
Lutkepohl normality								
- skewness	0.12		0.13		0.19		1.25	
- kurtosis	27.84***		27.63***		16.65***		13.83***	
- Jaques-Bera	27.95***		27.76***		16.83***		15.08***	
Autocorrelation LM								
- lag 2	3.12		2.57		2.34		2.10	
- lag 6	2.97		1.56		3.11		5.10	
- lag 12	2.64		2.17		8.24*		5.31	
Portmanteau autocorrelation								
- lag 24 (Q-statistic)	65.81		64.07		72.88		69.02	
Control variables	A				B			

Control variables

A: monthly change of yearly percentage change of raw material (0 to -5), monthly change of the unemployment rate (0, -1, -3, -4), monthly change of the economic sentiment indicator (-1, -5), monthly change of yearly percentage change of the effective real exchange rate (0, -1, -5), monthly change of the yearly percentage change of money growth M3 (0, -2, -4).

B: monthly change of yearly percentage change of raw material (-2, -4), monthly change of the economic sentiment indicator (-1, -2, -4, -5), monthly change of yearly percentage change of the effective real exchange rate (-1, -2), monthly change of the yearly percentage change of money growth M3 (-5).

Appendix: Figures

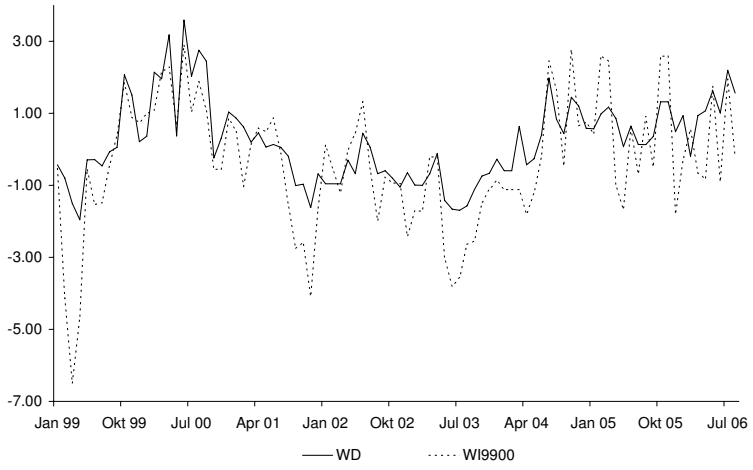

Figure 1: Wording indicators wd (longer support period) and wi9900 (shorter support period).

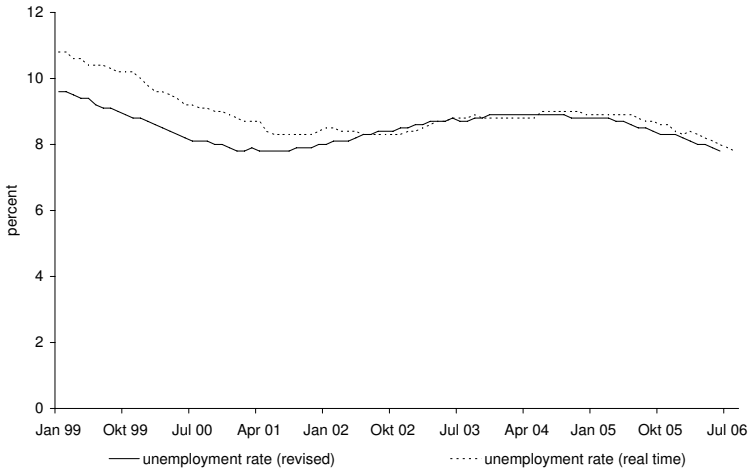

Figure 2: Unemployment rate: revised series and series displaying the knowledge at a certain point in time.

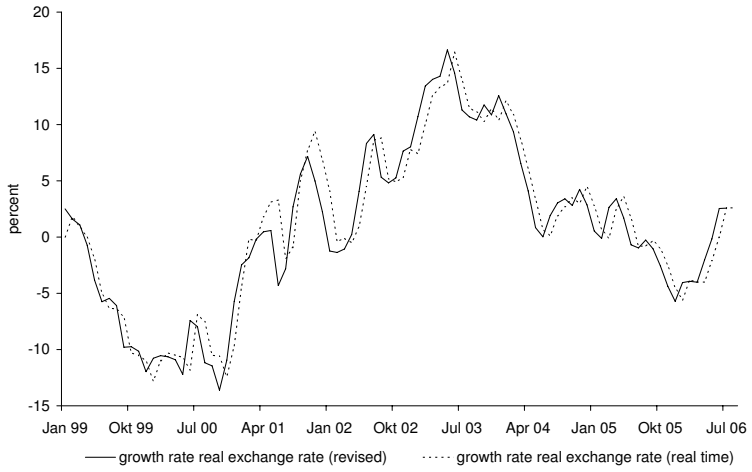

Figure 3: Annual percentage change of the real effective exchange rate: revised and real time data.

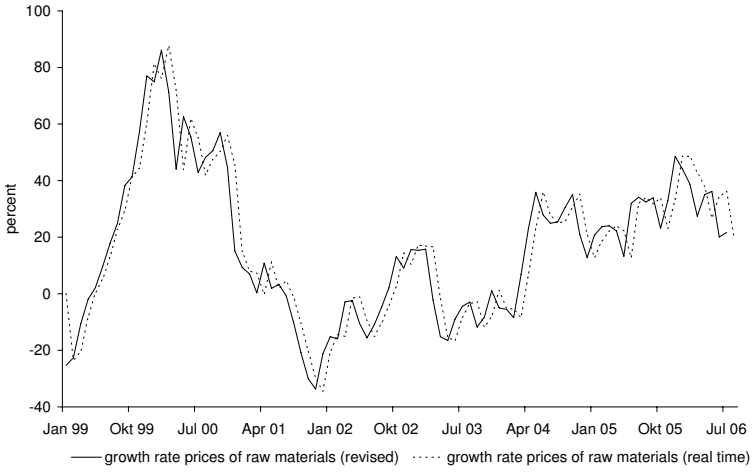

Figure 4: Annual percentage change of prices of raw materials excluding energy: real time and revised data.

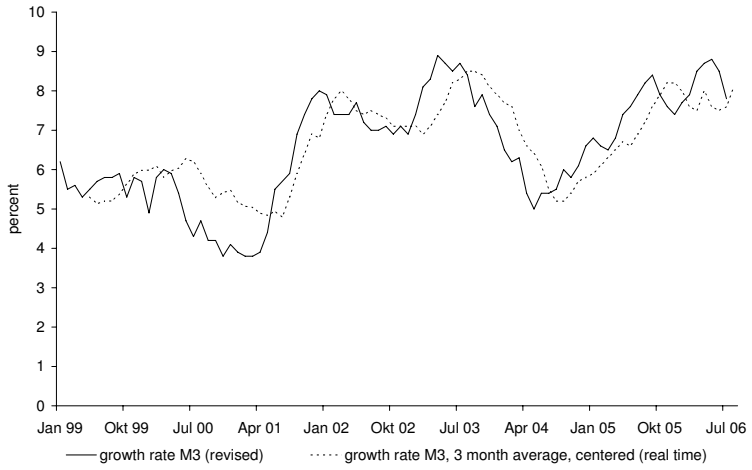

Figure 5: Money growth: revised and real time data (centred three month moving average).

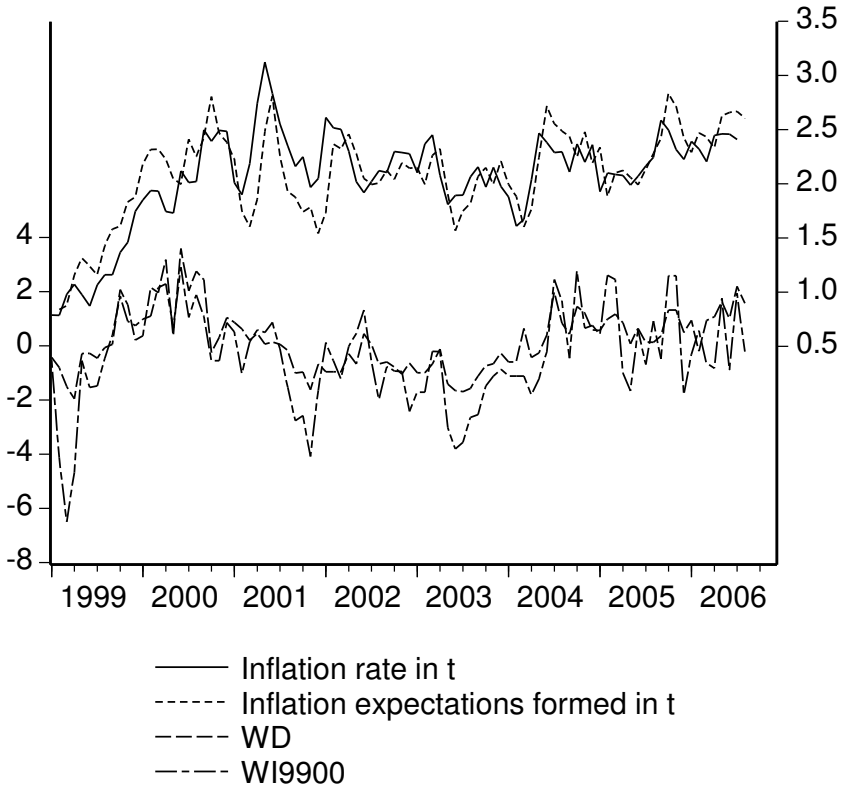

Figure 6: The wording indicators wd and wi9900, inflation expectations and the inflation rate.

Table 4: ADF-GLS test for revised/real time series potentially included in the regressions.

	Test statistics	
	without trend	with trend
Money M3 (annual growth rate)	$-1.80^A / -1.19^A$	$-2.60^B / -2.51^C$
Exchange rate (annual growth rate)	$-2.03^A / -2.06^A$	$-2.14^C / -2.17^C$
Economic sentiment	-1.35^A	-1.34^C
Unemployment rate	$0.40^A / 0.95^A$	$-1.59^D / -0.96^C$
Prices of raw materials (annual growth rate)	$-1.20^A / -1.25^A$	
Prices of raw materials excl. energy (annual growth rate)	$-1.04^A / -0.93^A$	
Industrial production (annual growth rate)	$-2.56^A / -2.61^A$	
Inflation rate	$-0.92^A / -0.91^A$	
Expected inflation rate	-0.81^A	
Wording indicator wd	-4.12^A	
Wording indicator wi9900	-4.64^A	

Critical values

A: 1% level: -2.59; 5% level: -1.94; 10% level: -1.61

B: 1% level: -3.64; 5% level: -3.08; 10% level: -2.79

C: 1% level: -3.62; 5% level: -3.07; 10% level: -2.77

D: 1% level: -3.63; 5% level: -3.07; 10% level: -2.78

Critical values for the test including a trend are provided by EViews interpolating the critical values of ERS. For the constant and no deterministic term, McKinnon (1996) critical values are applied.

References

Balcombe, K. (1996): "The Carlson-Parkin Method Applied to NZ Price Expectations Using QSBO Survey Data," *Economics Letters*, 51(1), 51–57.

Ball, L., and D. Croushore (2003): "Expectations and the Effects of Monetary Policy," *Journal of Money, Credit, and Banking*, 35(4), 473–484.

Batchelor, R., and A. Orr (1988): "Inflation Expectations Revisited," *Economica*, 55, 317–331.

Berk, J. M. (1999): "Measuring Inflation Expectations: A Survey Data Approach," *Applied Economics*, 31(11), 1467–1480.

Bernoth, K. u. J. v. H. (2004): "The Euribor Futures Market: Efficiency and the Impact of ECB Policy Announcements," *International Finance*, 7(1), 1–24.

Blinder, A., C. Goodhart, P. Hildebrand, D. Lipton, and C. Wyplosz (2001): *How Do Central Banks Talk?* CEPR.

Bronfenbrenner, M., and F. D. Holzman (1963): "Survey of Inflation Theory," *American Economic Review*, 53(4), 593–661.

Connolly, E., and M. Kohler (2004): "News and Interest Rate Expectations: A Study of Six Central Banks," *Reserve Bank of Australia Research Discussion Paper*, No. 10.

Cruijsen, C. v. d., and M. Demertzis (2005): "The Impact of Central Bank Transparency on Inflation Expectations," *DNB Working Papers*, No. 031.

Czogała, A., A. Kot, and A. Sawicka (2005): "Inflation Expectations of Polish Entrepreneurs. Does the Central Bank Communication Matter?," *Working Paper*.

Di Bartolomeo, G., and E. Marchetti (2004): "Central banks and information provided to the private sector," *Economics Working Paper Archive at WUSTL*, No. 0504025.

Ehrmann, M., and M. Fratzscher (2005): "Communication and Decision-Making by Central Bank Committees. Different Strategies, Same Effectiveness?," *ECB Working Paper*, No. 488.

Eijffinger, S. C., M. M. Hoeberichts, and M. F. Tesfaselassie (2004): "Central Bank Communication and Output Stabilization," *CEPR Discussion Paper*, No. 4408.

Elliott, G., T. J. Rothenberg, and J. H. Stock (1996): "Efficient Tests for an Autoregressive Unit Root," *Econometrica*, 64(4), 813–836.

Gaspar, V., G. P. Quiros, and J. Sicilia (2001): "The ECB Monetary Policy Strategy and the Money Market," *ECB Working Paper*, No. 69.

Geraats, P. M. (2002a): "Central Bank Transparency," *Economic Journal*, 112(483), F532–F565.

Gerberding, C. (2001): "The information content of survey data on expected price developments for monetary policy," *Economic Research Centre of the Deutsche Bundesbank Discussion Paper*, No. 09.

Gerlach, S. (2004): "Interest Rate Setting by the ECB: Words and Deeds," *CEPR Discussion Paper*, No. 4775.

Gramlich, E. M. (1983): "Models of Inflation Expectations Formation," *Journal of Money, Credit & Banking*, 15(2), 155–173.

Hartmann, P., M. Manna, and A. Manzanares (2001): "The Microstructure of the Euro Money Market," *CEPR Discussion Paper*, No. 3081.

Hayashi, F. (2000): *Econometrics*. Princeton University Press, Princeton.

Heinemann, F., and K. Ullrich (2005): "Does it Pay to Watch Central Bankers' Lips? The Information Content of ECB Wording," *ZEW Discussion Paper*, No. 05-70.

Jansen, D.-J., and J. de Haan (2003): "Statements of ECB Officials and Their Effect on the Level and Volatility of the Euro-Dollar Exchange Rate," *CESifo Working Paper*, No. 927.

——— (2004): "Look Who's Talking: ECB Communications During the First Years of EMU," *CESifo Working Paper*, No. 1263.

——— (2005): "Were Verbal Efforts to Support the Euro Effective? A High-Frequency Analysis of the ECB Statements," *DNB Working Paper*, No. 33-2005.

Johnson, D. R. (1997): "Expected Inflation in Canada 1988-1995: An Evaluation of Bank of Canada Credibility and the Effect of Inflation Targets," *Canadian Public Policy - Analyse de Politiques*, 23(3), 233–258.

Kliesen, K. L., and F. A. Schmid (2004): "Monetary Policy Actions, Macroeconomic Data Releases, and Inflation Expectations," *Federal Reserve Bank of St Louis Review*, 86(3), 9–21.

Kohn, D. L., and B. P. Sack (2003): "Central Bank Talk: Does It Matter and Why," *Federal Reserve Board Finance and Economics Discussion Series*, No. 55.

Kuttner, K. N., and A. S. Posen (1999): "Does Talk Matter After All? Inflation Targeting and Central Bank Behavior," *CFS Working Paper*, No. 04.

Laidler, D. E. W., and J. M. Parkin (1975): "Inflation: A Survey," *Economic Journal*, 85(340), 741–809.

Lee, J. (1999): "Alternative P* Models of Inflation Forecasts," *Economic Inquiry*, 37(2), 312–25.

Lomax, R. (2005): "Inflation Targeting in Practice: Models, Forecasts and Hunches," *Bank of England Quarterly Bulletin*, Summer, 237–246.

Marnet, V. (1995): *Eigenschaften und Bestimmungsfaktoren Von Finanzmarkttesterwartungen. Eine Theoretische und Empirische Analyse unter Verwendung der ZEW-Finanzmarkttestdaten*. Nomos, Baden-Baden.

Mitchell, J. (2002): "The Use of Non-Normal Distributions in Quantifying Qualitative Survey Data on Expectations," *Economics Letters*, 76(1), 101–107.

Morris, S., and H. S. Shin (2005): "Central Bank Transparency and The Signal Value of Prices," *Brookings Papers on Economic Activity*, 2, 1–43.

Neumann, M. J. (2002): "Transparency in Monetary Policy," *Atlantic Economic Journal*, 30(4), 353–365.

Orphanides, A., and J. C. Williams (2003): "Imperfect Knowledge, Inflation Expectations, and Monetary Policy," *NBER Working Paper Series*, No. 9884.

Pesaran, M. H. (1987): *The Limits to Rational Expectations*. Basil Blackwell, Oxford.

Romer, C. D., and D. H. Romer (2000): "Federal Reserve Information and the Behavior of Interest Rates," *American Economic Review*, 90(3), 429–457.

Ross, K. (2002): "Market Predictability of ECB Monetary Policy Decisions: A Comparative Examination," *IMF Working Paper*, No. 233.

Sellon Jr., G. H. (2004): "Expectations and the Monetary Policy Transmission Mechanism," *Federal Reserve Bank of Kansas City Economic Review*, 89(4), 5–41.

Smith, J., and M. McAleer (1995): "Alternative Procedures for Converting Qualitative Response Data to Quantitative Expectations: An Application to Australian Manufacturing," *Journal of Applied Econometrics*, 10, 165–185.

Svensson, L. E. (2003): "What Is Wrong with Taylor Rules? Using Judgment in Monetary Policy Through Targeting Rules," *Journal of Economic Literature*, 41(2), 426–477.

Svensson, L. E. O. (2000): "Does the P* Model Provide Any Rationale for Monetary Targeting?," *German Economic Review*, 1(1), 69–81.

Winkler, B. (2000): "Which Kind of Transparency? On the Need for Clarity in Monetary Policy-Making," *ECB Working Paper*, No. 26.