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Inflation Expectations of Experts and ECB Communication

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Non-technical Summary

The communication policy of central banks attracts a lot of attention from financial markets. For the ECB in particular with its complex two pillar strategy and its definition of price stability, it is crucial that the public understands monetary policy decisions and strategy. The literature so far stresses mostly the influence on interest rates and exchanges rates. However, the impact of communication on inflation expectations is also important to understand.

We contribute to the literature by investigating the influence of the informational content of the ECB Presidents' statements on inflation expectations. Because both measures, communication and expectations, are not directly observable, we have to approximate the respective variables. Communication is measured by an indicator that captures the informational content of the monthly introductory statements of the ECB president explaining interest rate decisions by aggregating the frequency of phrases used in this highly standardised communication devise. For inflation expectations, the qualitative answers of financial market experts regarding the question of an expected change of inflation in the next six months posed in the ZEW Financial Market Test are transformed in a quantitative measure of inflation expectations. The analysed time period is February 1999 to June 2007.

An influence of communication on inflation expectations is possible in two ways. First, the gap between realised and expected inflation can be influenced by the rhetoric of the central bank. Second, the communication could directly influence the expectations formation process. As the results show, there is a significant influence of the wording indicator on inflation expectations whereas the impact on the gap between inflation expectations and realised inflation does not seem to be robust. A possible interpretation is that the rhetoric of the ECB communicates risks to price stability in a credible way and that financial market experts react to the announcements by adjusting their inflation expectations in the short run. The influence arises because the indicator seems to summarise information that would otherwise be provided by different macroeconomic variables that are publicly available.

Inflation Expectations of Experts and ECB Communication

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Abstract

The communication policy of the European Central Bank attracts a lot 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 February 1999 to June 2007. Estimations are conducted for the influence of ECB communication on expectations formation besides other macroeconomic variables. As the results indicate, 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 formation, 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 influence the effectiveness of monetary policy by providing information for the public. The assumption is that a heightened transparency increases monetary policy effectiveness. If, for instance, interest rates are close to zero, the leeway for actual policy decisions is limited and communication would play an important role in influencing expectations. Also, under normal circumstances, transparency helps to improve the transmission of monetary policy impulses. Transparency enables financial markets to interpret the monetary signals of the central bank in a correct manner, as it provides markets with the necessary information and the possibility to learn the central bank's strategy, the central bank's interpretation of a changing economic environment, and the respective policy reactions. In this manner, the central bank influences expectations formation of 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 European Central Bank (ECB) communication on inflation expectations of experts. Communication as well as inflation expectations are not directly observable but have to be approximated. To measure the informational content of communication, we concentrate on the ECB press conferences following the Governing Council meetings where decisions about the interest rate are taken. These statements are complemented by analysing the editorial of the ECB *Monthly Bulletins* for those months in which no statements are given. To measure the informational content of ECB statements, a variant of the wording indicator of Heinemann and Ullrich (2007) is used. We assume that the statements and the *Monthly Bulletins* are sources of information that are intended for the informed public – central bank watchers in the broader sense. Since financial market experts watch the central bank very closely, we would expect that an

influence on their expectations formation is more likely than an influence on expectations of consumers, for example.

To measure expert inflation expectations, we use data from the ZEW Financial Markets Test. The qualitative answers of experts with regard to the development of inflation in the following six months in the euro area are transformed into quantitative inflation expectations using the standard Carlson-Parkin method (Carlson and Parkin 1975) with asymmetric but constant thresholds which are also results from the survey. To investigate the influence of the wording indicator we rely on two approaches. The estimation equations are based on a theoretical setup that relies on a model by Svensson (2003) explaining why communication should have an impact on inflation expectations. First, we estimate the influence of the indicator on the difference between inflation and inflation expectations. In a second approach, we explicitly model expectations formation as partly forward-looking and partly backward-looking. For the forward-looking part, we use a set of explanatory variables including the wording indicator to capture the influence of different macroeconomic variables on 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. If the rhetoric communicating concern about inflation risks is rather hawkish, financial market experts are induced to adjust inflation expectations with a six month horizon upwards. At the same time, the decisions of the ECB do not seem to have an impact on expectations formation. It is most likely that the time horizon of six months is too short to capture the effects of interest rate decisions on inflation and therefore on inflation expectations. The ECB does not only rely on interest rate decisions to reveal information to the public but also provides information via communication and increasing transparency of monetary policy in this way. See e.g. Gosselin et al. (2006) for a theoretical rationale of such central bank behaviour. However, the ECB communication could be seen as a summary measure of other macroeconomic variables that influence expectations formation.

We proceed as follows: First, we give a short motivation arising from gaps in the existing literature regarding communication of the ECB. The two crucial time series, inflation expectations and the wording indicator to measure the informational content of ECB rhetoric are introduced in section three. There is a broad theoretical literature taking into account transparency, but a common model to include communication seems to be missing to our knowledge. For this reason, we use Svensson's model (2003) to motivate a rationale for the effects of communication on inflation expectations in the fourth section. In section five, the relationship between expected and realised inflation is empirically investigated. The sixth section deals with the explicit expectations formation and the respective estimation results. The last section concludes.

2 Motivation

The amount of literature dealing with central bank communication issues is growing fast. One strand of the literature deals with the influence on the exchange rate (e.g. Jansen and de Haan 2005 for an overview, Jansen and de Haan 2007), and, more generally, on financial markets and the predictability of monetary policy decisions (Bernoth and von Hagen 2004, Gaspar et al. 2001, Hartmann 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 directly concerned with the communication policy of the ECB (e.g. Ehrmann and Fratzscher 2007, Gerlach 2004, Heinemann and Ullrich 2007 and Jansen and de Haan 2006).

The transparency and communication of central banks not only influences 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 this, 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 the UK, Canada, and New Zealand. However, the analysis does not rely on direct measures of inflation expectations but rather employs indirect approaches such as the Taylor rule and the time series properties of inflation rates. Czogała et al. (2005) analyse 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. Instead, they 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) take a closer look at the influence of surprises in macroeconomic data releases, monetary policy surprises and central bank communication of the Federal Reserve on inflation expectations. The inflation expectations are gathered from concepts of inflation compensation included in nominal Treasury securities and inflation indexed Treasury securities. Communication measured as an indicator variable for days when communication is priced in the market reduces the uncertainty of future inflation rates measured as the volatility of the series. Kohn and Sack (2003) find that communication matters as much as policy actions for the Federal Reserve in the longer run 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 superior to those of the private sector (Romer and Romer 2000). Van der Cruijsen and Demertzis (2007) investigate the influence of central bank transparency on inflation expectations.

As this short overview shows, there are a number of empirical studies investigating the influence of communication on financial markets and the predictability of interest rate decisions. However, the impact on inflation expectations formation needs further analysis, especially for the ECB. Whereas the empirical investigations 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. Theoretical modelling is dominated by transparency issues (Geraats 2002, Neumann 2002). Transparency is regarded

as a multidimensional concept which includes the presentation and explanation of the objectives, methods, forecasts, models, tactics, and decisions of a central bank (Blinder et al. 2001) and communication can be treated as an integral part of it (Winkler 2002). Since transparency means openness and clarity, the mere presentation of data is not sufficient to achieve a common understanding, the ultimate objective of genuine transparency. In this sense, communication not only provides quantitative information. The more articulated information plays a crucial role (Di Bartolomeo and Marchetti 2004, p. 17). An analysis that comes close to providing a rationale for communication in monetary policy is Svensson (2003). He introduces a judgment factor of the central bank with regard to potentially unobservable components of the economy into a model to analyse reaction functions of monetary policy. We make use of this analysis to develop a basis for the empirical investigation.

3 The Measures of Inflation Expectations and Central Bank Communication

3.1 Inflation Expectations of Experts

Since the analysis of inflation expectations is the focus of this paper, we describe the expectations series in more detail (see also Heinemann and Ullrich 2006). The series is generated on the basis of the ZEW Financial Market Survey that is conducted every month. Financial market experts working mostly in the financial, research, and economic departments or the investment and securities departments of their companies are asked to assess the current economic situation and voice their expectations with regard to various macroeconomic variables. Since February 1999, one question refers to inflation expectations of the euro area. The experts are asked whether 'The annual inflation rate in the general economy in the medium term (6 months) will increase/not change/decrease/don't know'.

To quantify these expectations, 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 answer on a subjective probability distribution for inflation rates given the knowledge contained in her information set. The expected inflation rate is identical to 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 it is 'decrease' and the space in between shows the indifference interval resulting in a 'no change'-answer. The 'don't know category' is simply ignored. The thresholds distinguishing the categories stem from the ZEW survey itself which were polled in January 2006. 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 at -0.24 percentage points for the lower threshold and at 0.22 percentage points for the upper threshold.

For the calculation we assume that the subjective probability distributions are independent of one another and have the same known form across individuals. Thus, the proportion of 'rise' answers is identical to the probability that inflation in six months exceeds the upper threshold and the proportion of the 'decrease' answers corresponds to the probability that the future inflation rate falls below the lower threshold conditional to the information set at the time expectations are formed. The quantification depends on the chosen form of the aggregate distribution function. For the calculation we use a standard normal distribution following a number of examples in the literature on transforming qualitative survey data (see Mitchell 2002 or Berk 1999). From the survey results we obtain the expected change of inflation for the following six months,

$$\Delta^e \pi_{t+6|t} = \frac{-a r_{t+6|t} + b f_{t+6|t}}{f_{t+6|t} - r_{t+6|t}} \tag{1}$$

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. In addition to the ZEW thresholds, we use the thresholds

from Henzel and Wollmershäuser (2005, 338) that are based on a time-varying calculation of the indifference limen based on the Weber Fechner-Law as a robustness check:

$$\text{lower threshold: } a_t = -0.14 - 0.15\pi_t \tag{2}$$

$$\text{upper threshold: } b_t = 0.32 + 0.13\pi_t. \tag{3}$$

Since the above calculation (1) gives the absolute expected change, we assume that inflation expectations can be gathered from the following equation:

$$\pi_{t+6|t} = \tilde{\pi}_t + \Delta^e \pi_{t+6|t} \tag{4}$$

where $\tilde{\pi}$ denotes perceived inflation. To approximate perceived inflation, we use the inflation rate published in the latest ECB Monthly Bulletin as the last publicly known inflation rate. This induces a publication lag of two months until October 2001 and of one month afterwards. The resulting expectations series with constant thresholds is very similar to actual inflation (see Figure 1). Experts do not expect inflation six months ahead to deviate a great deal from actual inflation. This is reasonable given that the Euro area inflation rate moves around two percent, the definition of price level stability of the ECB. In addition to this, the standard deviation of the expectations based on constant thresholds is lower than the standard deviation of the expectations series that is based on variable thresholds. The variance of the latter is almost as high as that of the actual inflation series.

3.2 Measurement of ECB Communication

To empirically investigate the influence of communication on expectations formation, the informational content of the ECB communication has to be measured. We restrict the analysis to the introductory statement of the ECB president given at the monthly ECB press conferences. There are different ways of capturing the meaning of the ECB rhetoric. We rely on a variant of the wording indicator of Heinemann and Ullrich (2007).[1] The construction period of the indicator, *wd*, covers the period of January 1999 to December 2001 ensuring that the first interest rate cycle for the euro area is included.

[1]For a similar approach to counting words, see Cecchetti (2003).

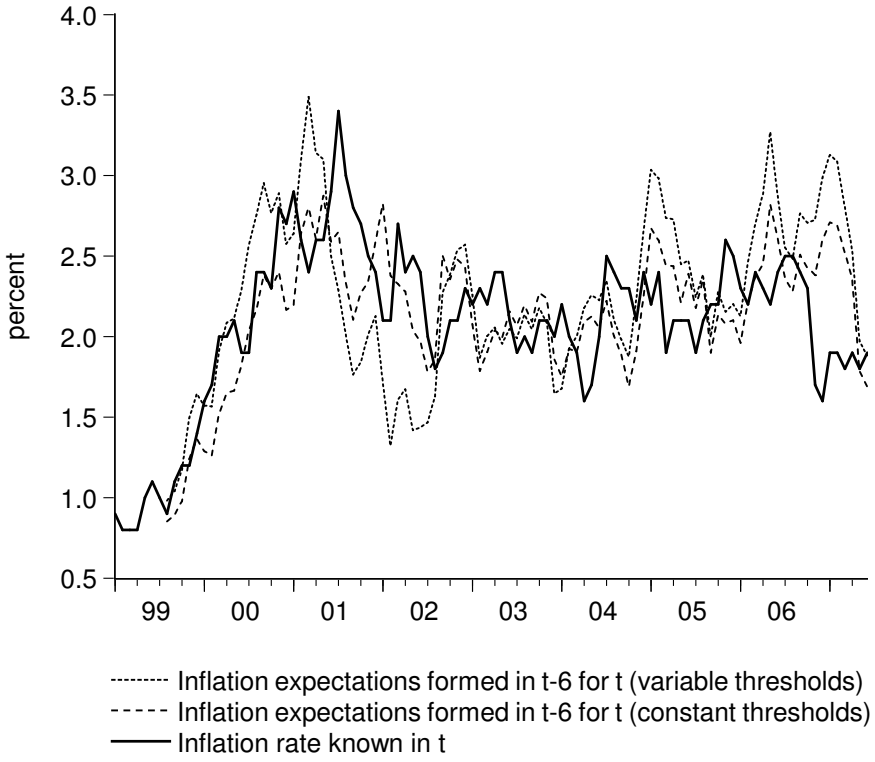

Figure 1: The series of the inflation rate and the two inflation expectations series.

First, we use a list of phrases that potentially signal the information which the central bank intends to disseminate to the public (see Tables 4 for the phrases). To this list, the length of the statements is added. The frequency of occurrence of these phrases are counted in the introductory statements of the ECB president, explaining interest rate decisions in the press conference given after the Council meetings. For months in which no meeting takes place, the editorial of the ECB *Monthly Bulletin* is used, which is very similar in terms of structure and content to the introductory statements. The recourse to the *Bulletin* takes place in August of the years 1999 to 2005 and in January 2001. In some months two press conferences are held, that are taken into account separately for the calculation (March 2000, October 2000, and June 2001). The statement of 30 August 2001 is used as the September 2001 statement. Then, the statements are grouped according to the direction of the interest rate change in the next month assuming that the statements prepare these decisions and communicate the bank's economic assessment

and expectations to the public. In order to determine whether the use of the phrases has the potential to convey information to the public, we test whether the average frequency of the phrases is different in the month before rising, decreasing or unchanged interest rates. If the test indicates differences in frequencies at least at the 10 percent level, the phrase is a candidate to be included in the indicator formation (see Table 4 for the test results).

In a second step, pair-wise F-tests are conducted to determine the actual inclusion and the sign of the phrase when calculating the indicator (see Table 5 for the test results). 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. If the word is most often used in months before unchanged interest rates, it is not included in the calculation. Thus, the resulting indicator is, by construction, positively associated with an increasing 'hawkishness' of ECB rhetoric. Next, the informational content of a phrase is determined by using the η^2 statistic that gives the share of the total variance attributable to differences in frequency means between the three different categories.

Summing up, the wording indicator wd is constructed using the standardised frequency of phrases as follows:

$$wd_t = \sum_{i=1}^{k} \frac{\text{nobs}(phrase_{i,t}) - \text{meanobs}(phrase_i)}{stdv(x_i)} \text{sign}(phrase_i)\eta^2(phrase_i). \tag{5}$$

Figure 2 shows the indicator together with the interest rate. The indicator is assumed not only to measure the informational content with regard to the explanation and preparation of interest rate decisions, but also with regard to the ECB assessment of inflation risks. Given that the mandate of the ECB is to first and foremost guarantee price stability in the euro area, the central bank will react to inflationary pressure with rising interest rates. Deflation would also be a violation of the ECB definition of price stability with an inflation rate of below, but close to two percent based on the Harmonised Consumer Price Index. A higher hawkishness in the rhetoric of the ECB would hint at inflationary pressure identified by the central bank. If the expectations rise with higher hawkishness

but do not react to decisions, this would indicate that the economic agents also see a danger of rising inflation such as the central bank but are not confident that the ECB can bring inflation back to target. To make a judgement in this respect, however, the time horizon of expectations formation and the length of the transmission mechanism have to be taken into account. If the central bank communicates inflation risks that have an impact on inflation sooner than the effect of an interest decision would take place, expectations formed with regard to the short time horizon would react to communication but not to interest rate decisions. This is one reason why central banks are responsible for keeping inflation on target in the medium and long run and do not react to short-term developments that might influence short-run inflation expectations.

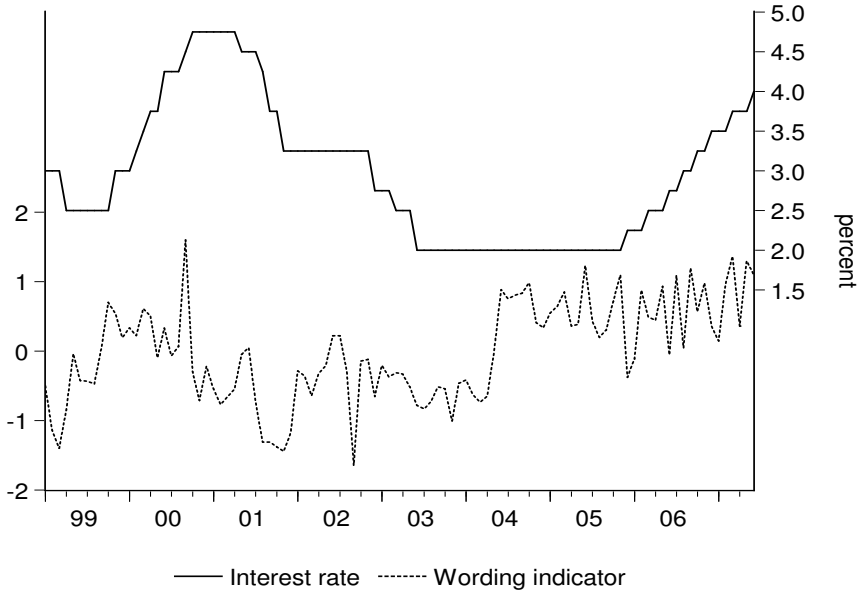

Figure 2: The wording indicators *wd* (left axis) and the policy rate (right axis).

4 Influence of Communication on Inflation Expectations

The influence of central bank communication on inflation expectations of private agents can be explained in two different ways. First, we investigate the difference between inflation expectations and realised inflation that could be influenced by central bank communication. Second, communication can directly effect the level of inflation expectations. To show this, we rely on the model introduced by Svensson (2003). The relation between the inflation expectations of private agents, $\pi_{t+1|t}$, and realised inflation, π, can be derived from the backward-looking model that is described by the following equations:

$$\pi_{t+1} = \pi_t + \alpha_x x_t + \alpha_z z_{t+1} + \epsilon_{t+1} \tag{6}$$

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

$$x_t = \beta_x x_{t-1} + \beta_z z_t - \beta_r(i_{t-1} - \pi_{t|t-1} - \overline{r}) + \eta_t \tag{7}$$

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

$$i_{t-1} = \overline{r} + \pi^* + \left[1 + \frac{1-c}{\alpha_x \beta_r}\right](\pi_{t,t-1} - \pi^*) + \frac{\beta_x}{\beta_r} x_{t-1} + \frac{\beta_z}{\beta_r} z_{t,t-1} + \frac{1-c}{\alpha_x \beta_r} \tilde{z}_{t+1,t-1} \tag{8}$$

where π^* denotes the inflation target, and $z_{t+1,t-1}$ and $\tilde{z}_{t+1,t-1} = \sum_{s=0}^{\infty} (\delta c)^s z_{t+1+s,t-1}$ are valuations of the central bank about the exogenous variables influencing inflation and the 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 judgement of the central bank therefore matters with respect to inflation and inflation expectations two periods ahead. The inflation rate one period ahead is predetermined and the gap between $\pi_{t+1|t}$ and π_{t+1} is only influenced by expectations errors, $z_{t+1|t} - z_{t+1}$, and the shocks, ϵ and η.

Since 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 an equation for both variables that allow for a translation into an estimation equation. We determine private sector inflation expectations in $t-1$ for $t+1$, $\pi_{t+1|t-1}$, where monetary policy decisions about the interest rate in $t-1$ have a first impact on the inflation rate, and, therefore, inflation expectations influence the inflation rate. Correspondingly, the inflation rate π_{t+1} is determined. The difference between inflation expectations of private agents and the inflation rate is thus given as

$$\begin{aligned}\pi_{t+1|t-1} - \pi_{t+1} \quad = \quad & \underbrace{\pi_{t|t-1} - \pi_t}_{\text{autoregressive part}} \quad + \quad \underbrace{[(1-c) + \alpha_x\beta_r]\left(\pi_{t,t-1} - \pi_{t,t-1|t-1}\right)}_{\text{gap between central bank and private inflation expectations}} \\ & + \underbrace{(1-c)\left(\tilde{z}_{t+1,t-1} - \tilde{z}_{t+1,t-1|t-1}\right) + \alpha_x\beta_x(z_{t,t-1} - z_{t,t-1|t-1})}_{\text{expectations gap with regard to exogenous variables}} \\ & + \underbrace{\alpha_z(z_{t+1|t-1} - z_{t-1}) + \alpha_x\beta_z(z_{t|t-1} - z_t) - \alpha_x\eta_t - \epsilon_{t+1}}_{\text{private sector expectation errors and shocks}} \end{aligned} \tag{9}$$

where $y_{t+s,t|t}$ gives the expectations of private agents about the judgement of the central bank on the variable y. When 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 inflation and the exogenous variables has an impact on the gap between inflation and expectations. If the central bank and the private agents possess the same information set and form expectations in the same way based on the underlying model, the difference would be reduced to

$$\pi_{t+1|t-1} - \pi_{t+1} = \pi_{t|t-1} - \pi_t + \alpha_z(z_{t+1|t-1} - z_{t+1}) + \alpha_x\beta_z(z_{t|t-1} - z_t) - \alpha_x\eta_t - \epsilon_{t+1} \tag{10}$$

consisting only of expectations errors and shocks.

The difference between expected and realised inflation is influenced by different expectations of the variable z. This variable plays a crucial role for the following analysis. In z, exogenous variables are collected that influence supply and demand but are not 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'. Judgement is necessary because 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. However, the judgement of private agents might be different from that of the central bank, e.g., because of using another model of the economy. If the central bank could communicate its judgement on the model of the economy as well as its inflation expectations and be economically transparent in the classification of Geraats (2002), inflation and inflation expectations of private agents would be more in line.

In the case of the forward-looking model and forward-looking expectations, the inflation rate and inflation expectations are given by (Svensson 2003, 434, 435)

$$\pi_{t+1} = \pi + \delta(\pi_{t+2|t} - \pi) + \alpha x_{t+1|t} + \alpha z_{t+1} + \eta_{t+1} \tag{11}$$

$$\pi_{t+1|t} = \pi + \delta(\pi_{t+2|t} - \pi) + \alpha x_{t+1|t} + \alpha z_{t+1|t} \tag{12}$$

where π denotes average inflation. The output gap as well as private expectations about the output gap depend on the private sector forecast of the interest rate. In the case of the expectations for the following period, the central bank would credibly announce its interest rate setting. But even if the expectations for the two periods ahead are formed, the general mechanism would not change. Only private sector expectations matter. Even if private sector expectations with regard to the interest rate would be incorrect, this would lead to a difference between the expected and the realised output gap but would not influence the gap between expected and realised inflation because expected and realised inflation depend on private sector expectations in the same way. Therefore, the difference between private agents' expectations and central bank expectations does matter for the level of the inflation rate and the level of inflation expectations, but not for the gap between the two variables.

As the theoretical model shows, the influence of central bank communication on inflation expectations can come from two different sources. For adaptive expectations, the communication influences the gap between the inflation rate and inflation expectations. For forward-looking expectations, the communication influences the level of inflation expectations. These two approaches are employed in the remainder of the paper. First, the difference between inflation and inflation expectations is analysed. Second, expectations formation is directly estimated.

Before presenting the estimation results, we address a problem that arises for modern central banks following an inflation targeting strategy or a similar monetary strategy that attempts to anchor inflation expectations. The inflation target replaces inflation expectations in the long-run if expectations are firmly anchored at the aimed level of inflation and the prices of the economy normally aggregating private information about market conditions cannot fulfill their role of information aggregation anymore (Morris and Shin 2005).[2] However, the ECB emphasises that it does not follow direct inflation targeting but rather 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. The value of below but near two percent is set mainly to anchor inflation expectations. Given the anchoring of inflation expectations, they should not respond to changes in the economic condition in the middle to long run because a credible monetary policy would bring inflation back to target (Levin, Natalucci, and Piger 2004).

In this case, a hypothesis of inflation expectations formation seems to be useless, since inflation expectations equal the numerical target of monetary policy. However, this should only be applicable over a mid- to long-term horizon because the central bank will not react to every (expected) change in inflation. Temporary violation of the inflation target would not be counteracted by interest rate decisions. In this case, short-term inflation expectations could deviate from target inflation even if medium- and long-term expectations are well 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.

[2]In contrast to these concerns, 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.

4.1 The Relation between the Inflation Rate and Inflation Expectations

As the preceding analysis shows, inflation and inflation expectations differ because of expectations errors and when the expectations of the central bank are not fully in line with those of private agents. To translate equation (9) into an estimation equation, we first have to be aware that the available expectations data have a time horizon of six months. Even if the time horizon implied by the theoretical model is longer than six months, it gives a reasonable structure to the estimation approach.

The theoretical model states that the difference between inflation expectations and realised inflation is determined by an autoregressive part and a part that can be described as the gap between central bank inflation expectations and the assessment of private agents with regard to these central bank forecasts. The terms that follow sum up the difference between central bank and private sector expectations with regard to the exogenous variables and the last part of the equation consists of a number of expectations errors and shocks.

For the autoregressive part, we assume that we can approximate expectations for inflation five months ahead by using inflation expectations formed one period before, $\pi_{t+5|t} \approx \pi_{t+5|t-1}$ (see Döpke et al. 2005). In addition to this, we estimate the unrestricted model where the coefficient of the lagged endogenous variable is not bound to be one. Expectations errors that account for the difference between the realisation of the respective variable and the expectations of the private sector are assumed to be purely random and are included into the error term of the estimation equation, ε.

The gap between central bank expectations concerning the exogenous component, z, and private sector expectations with regard to these forecasts is assumed to be influenced by communication efforts of the central bank. Given that we do not possess a communication measure for different time horizons and contents, we approximate all differences by the wording indicator known at the time of expectations formation. We use the indicator of the same month in which expectations are formed because the ECB statements are

usually given at the beginning of the month. Besides direct communication via statements, the interest rate decisions of the ECB reveal information as well (Gosselin, Lotz, and Wyplosz 2006). To ensure that the wording indicator reflects communication policy and does not capture the effects of interest rate decisions, we also include the policy rate into the estimation.

Since the ECB does not publish its inflation forecasts on a monthly basis, the gap between the expectations of private agents and that of the central bank has to be approximated by a number of variables, v_i, that help to forecast inflation. In addition to this, these variables could help to explain the shocks present in the theoretical model. The estimation equation adjusted for the six months expectations horizon thus results in

$$\pi_t - \pi_{t|t-6} = a_1(\pi_{t-1} - \pi_{t-1|t-7}) + a_2 wd_{t-6} + a_3 i_{t-6} + \sum_i a_{3+i} v_{i,t-6} + \varepsilon_t. \quad (13)$$

The estimation equation (13) assumes that realised and expected inflation move together. To test this assumption, we use a second specification. Given that the unit root could not be rejected for inflation as well as expectations, we use this characteristic to estimate a vector error correction model (VECM) of the two series treating all further explanatory variables as exogenous. In this case, the estimation equations become:

$$\begin{aligned} \Delta\pi_t &= b_1\left[\pi_{t-1} + c\pi_{t-1|t-7}\right] + \sum_{i=1}^{7} b_{1+i}\Delta\pi_{t-i} + \sum_{i=1}^{7} b_{8+i}\Delta\pi_{t-i|t-6-i} \\ &\quad + b_{16} wd_{t-6} + b_{17} i_{t-6} + \sum_i b_{17+i} v_{i,t-6} + \epsilon_t \quad (14) \\ \Delta\pi_{t|t-6} &= d_1\left[\pi_{t-1} + c\pi_{t-1|t-7}\right] + \sum_{i=1}^{7} d_{1+i}\Delta\pi_{t-i} + \sum_{i=1}^{7} b_{8+i}\Delta\pi_{t-i|t-6-i} \\ &\quad + d_{16} wd_{t-6} + d_{17} i_{t-6} + \sum_i d_{17+i} v_{i,t-6} + \varepsilon_t \quad (15) \end{aligned}$$

The optimal lag length according to the Akaike as well as the Schwarz criterion is given by seven lags for the inflation expectations determined with constant thresholds where lag four does not pass the lag exclusion test and is therefore precluded from the final specification. For the model based on inflation expectations with variable thresholds, the two information criteria give diverging information for seven lags or just one lag. Using the more extensive specification, the lag exclusion test indicates that lags two to four are not needed, thus providing a more parsimonious specification of the equation.

To determine the explanatory variables v_i, we base our considerations on models explaining the behaviour of the inflation rate. In this case, two approaches are considered. The first is the mark-up approach that attributes price changes to demand and cost factors (Bronfenbrenner and Holzman 1963). Since 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 the determination of a measure of capacity utilisation to capture the demand situation, and the import price index and unit labour costs to depict cost components serving as explanatory variables for inflation. The second approach, the P-Star model, relies on the quantity theory of money. It contains a simple monetary model as well as an expectations-augmented Phillips curve for special cases (Lee 1999). The generalised form of the model contains the price gap that can be reduced to its component parts: the liquidity and the output gap (Svensson 2000). This approach ultimately results in money growth and some measure of potential output serving as explanatory variables.

Since we are not interested in discriminating between different models to explain inflation but rather 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:[3] We test three different measures of capacity utilisation, namely the unemployment rate measured as a percentage of the labour force, u, the economic sentiment indicator published by the European Commission, esi, in the form $100[indicator - mean(indicator)]/mean(indicator)$, and the annual growth rate of industrial production, Δip. To discriminate between the three possible measures, we rely on information criteria. For all tested specifications, the equations including the economic sentiment indicator are chosen by the information criteria. Therefore, we always use the sentiment indicator in the final estimation equation. For the cost push, we use the annual percentage price change of raw materials excluding energy, $\pi^{rawexcl}$, and the oil price, oil. Additionally, the annual growth rate of the real effective exchange rate, Δe^{real}, hints at the competitiveness of the European economy. Furthermore, we consider annual

[3]For an alternative approach determining influences on inflation expectations formation see Gerberding (2001).

money growth M3, $\Delta m3$, in the form of the centred three month moving average. These data seem to be a reasonable collection of time series that are also used in the literature to explain inflation expectations (see e.g. Pesaran 1987, Gramlich 1983, Johnson 1997 or Ball and Croushore 2003).

One problem in the use of time series in estimations where the behaviour of economic agents and their information set matter is the revision of the series. Given that expectations are based on the knowledge at the time when expectations are formed, the use of revised data to uncover the relationship between the macroeconomic variables and expectations formation seems to be problematic. Therefore, we use data collected from the *Monthly Bulletins* of the ECB to obtain time series that reflect as closely as possible the knowledge of the financial market experts at the time of expectations formation.[4] The time series span the period from January 1999 to June 2007. For further description of the data, see appendix.

With regard to the time series characteristics, we test for a unit root. The choice of the maximum lag length is made as the integer part of $12(T/100)^{1/4}$ (see Hayashi 2000, p. 594). With about 98 observation, this gives a maximum of 12 lags for all analysed time series. Due to 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 concerns the inclusion of deterministic terms in the test equation. In deciding whether to incorporate a constant and a trend, we rely on a graphical inspection of the GLS detrended series compared to the actual series used. We do not expect a trend in either of the series. However, since the matter is not unambiguously clear, we test the series with and without a trend (see Table 6 in the appendix).

We can reject the unit root unambiguously for the wording indicator and the monthly change of the unemployment rate. The exchange rate variable, the interest rate and the annual change of industrial production show ambiguous results. However, for these time series, the assumption of a time trend is not reasonable. In this case, we reject the

[4]Since the estimation equation includes lags of the explanatory variables, vintage data would be needed.

hypotheses of a unit root for the annual percentage change of the real effective exchange rate, the interest rate and industrial production. For all other time series, the unit root could not be rejected. Whenever the theoretical model gives the estimation equation in level form, we take first differences of the time series where the unit root could not be rejected. The same procedure applies for the inclusion of the exogenous variables in the VECM approach.

The estimation results as well as the test statistics are displayed in Table 1. Both estimation approaches for both expectations series perform reasonably well. First, the relationship between the expected and the realised inflation rate is close to one for expectations calculated with constant thresholds as the VECM approach shows. For the variable threshold expectations, the relationship is not as close but still considerably high. A Trace test as well as a Eigenvalue test indicate a cointegration relationship between expected and realised inflation for both expectations series if the exogenous variables are included. Next, the lagged difference between inflation and expectations in the level specification is significant as well. But in contrast to the theoretical model, the coefficient is below unity.

The additional explanatory variables show a convincing pattern. Whereas the level specification leaves us with an influence of the annual percentage change of raw materials excluding energy and the economic sentiment indicator, the interest rate and the economic sentiment have an impact on inflation when using the VECM approach. First, the annual change of the raw material prices without energy significantly reduces the gap between expected and realised inflation. This influence disappears in the VECM approach and is therefore not attributable to a reaction of the inflation rate or inflation expectations. The economic sentiment indicator also leads to a reduction of the gap between realised and expected inflation. As the VECM estimation shows, this reaction is attributable to a reaction of expected inflation; a higher economic sentiment indicator leads to higher expected inflation whereas the inflation rate does not react to this variable in a significant way.

After controlling for influences of the other macroeconomic variables known at the time of expectations formation, the wording indicator exerts a significant influence on the gap between expected and realised inflation where the effect is more pronounced for expectations with variable thresholds. A higher hawkishness in the rhetoric would lead to a lower gap between the two series. Surprisingly, the higher indicator does not seem to be attributable to a reaction of expectations but rather to a adjustment of the inflation rate as the VECM approach shows. Increasing risks to price stability communicated by the central bank would then lead to lower inflation in six months. One interpretation is that the communication of the risk leads to precautionary reactions of economic agents and the risks do not materialise. To investigate this matter further, we take a closer look at expectations formation in the following section.

Even after controlling for the contemporaneous effect of macroeconomic variables besides the wording indicator, it could be that the communication of the central bank only summarizes past developments of these variables. To estimate the informational content of the wording indicator beyond the past macroeconomic development, we add two additional lags of the wording indicator and the other explanatory variables (see Table 2 where the significant lags are displayed). On re-estimating the level equation as well as the VECM with the additional lags, we again find an influence of the economic sentiment indicator, the interest rate and the annual price change of raw materials and, in addition to that, of the oil price change. However, the impact of ECB communication on inflation expectations changes. Whereas the gap between actual and expected inflation for constant thresholds does not seem to react to the wording indicator anymore, the VECM approach still displays a significant influence of communication. In contrast to the previous results, the indicator now influences inflation expectations in a positive way. As it is more plausible that communication drives expectations and not realised inflation, this result confirms the need for further analysis to shed light on the expectations formation process.

Table 1: Estimation results for the gap between expected and realised inflation.

	Level equation		VECM			
Adj. sample:	1999:12 - 2007:06		2000:04-2007:06			
Dependent var.	$\pi_t - \pi_{t\|t-6}$		$\Delta\pi_t$	$\Delta\pi_{t\|t-6}$	$\Delta\pi_t$	$\Delta\pi_{t\|t-6}$
Threshold	constant	variable	constant		variable	
$\pi_{t-1} - \pi_{t-1\|t-7}$	**0.65** (9.06)	**0.66** (10.71)				
Adjustment coeff.			**-0.31** (-2.94)	**0.10** (3.20)	**-0.16** (-2.95)	**0.15** (3.35)
Cointegration coeff.			**-0.97** (-10.54)		**-0.89** (-7.12)	
wd_{t-6}	**-0.09** (-1.66)	**-0.18** (-2.62)	**-0.08** (-2.08)	0.02 (1.36)	**-0.08** (-2.02)	0.04 (1.37)
i_{t-6}	0.002 (0.25)	-0.004 (-0.33)	0.01 (0.98)	-0.003 (-1.15)	0.01 (0.91)	**-0.01** (-1.95)
Δoil_{t-6}	0.002 (0.21)	-0.01 (-0.96)	-0.001 (-0.11)	0.001 (0.24)	-0.001 (-0.16)	0.003 (0.45)
$\Delta\pi_{t-6}^{rawexcl}$	**-0.01** (-1.90)	**-0.01** (-2.26)	-0.01 (-1.09)	-0.002 (-0.97)	-0.01 (-1.58)	-0.01 (-1.43)
Δe_{t-6}^{real}	-0.004 (-1.00)	-0.005 (-1.06)	-0.01 (-1.32)	0.0004 (0.41)	-0.001 (-0.46)	0.001 (0.46)
Δesi_{t-6}	-0.03 (-1.32)	**-0.06** (-3.41)	0.01 (0.80)	**0.01** (2.57)	-0.01 (-0.55)	**0.04** (2.88)
$\Delta m3_{t-6}$	-0.01 (-0.12)	-0.002 (-0.02)	-0.05 (-0.60)	0.0004 (0.02)	-0.04 (-0.43)	0.03 (0.46)
$\overline{R}^2$	0.51	0.75	0.30	0.93	0.24	0.59
LM test (2 lags)	**7.30** (0.03)	2.37 (0.31)	3.48 (0.48)		6.80 (0.15)	
LM test (6 lags)	**19.20** (0.00)	**21.95** (0.00)	2.91 (0.57)		4.94 (0.29)	
Heteroscedasticity test (White)	35.56 (0.48)	40.09 (0.29)	37.12 (0.60)	**64.66** (0.01)	22.71 (0.89)	**60.65** (0.00)
Normality test (Jarque Bera)	3.24 (0.20)	0.51 (0.77)	**9.65** (0.01)	2.10 (0.35)	**30.20** (0.00)	3.12 (0.21)
	Newey-West HAC standard errors and covariance		Short-run dynamics: $\Delta\pi_{t-i}, \Delta\pi_{t-i\|t-6-i}$, $i = 1-3, 5-7$		Short-run dynamics: $\Delta\pi_{t-i}, \Delta\pi_{t-i\|t-6-i}$, $i = 1, 5-7$	

Note: t statistic for coefficients in parenthesis, bold numbers indicate significance at least at the ten percent level.

Table 2: Estimation results for the gap between expected and realised inflation.

	Level equation		VECM			
Adj. sample:	2000:02 - 2007:06		2000:04-2007:06			
Dependent var.	$\pi_t - \pi_{t\|t-6}$		$\Delta\pi_t$	$\Delta\pi_{t\|t-6}$	$\Delta\pi_t$	$\Delta\pi_{t\|t-6}$
Threshold	constant	variable	constant		variable	
$\pi_{t-1} - \pi_{t-1\|t-7}$	**0.66** (6.67)	**0.61** (7.87)				
Adjustment coeff.			**-0.32** (-2.59)	**0.09** (2.67)	**-0.19** (-2.63)	**0.12** (2.14)
Cointegration coeff.			**-0.99** (-8.26)		**-0.96** (-5.24)	
wd_{t-6}		**-0.12** (-1.80)	-0.03 (-0.66)	**0.03** (2.29)	-0.01 (-0.17)	**0.09** (2.36)
wd_{t-8}			-0.02 (-0.40)	**-0.03** (-1.75)		
i_{t-6}	**0.50** (2.13)	**0.39** (1.69)				
i_{t-8}			0.001 (0.00)	**0.13** (2.35)	0.04 (0.22)	**0.27** (1.73)
Δoil_{t-6}						
Δoil_{t-7}	**-0.03** (-2.55)	**-0.03** (-2.71)				
$\Delta\pi_{t-7}^{rawexcl}$			**0.02** (2.07)	0.0003 (0.18)	**0.01** (1.93)	0.001 (0.27)
$\Delta\pi_{t-8}^{rawexcl}$			**0.01** (1.78)	0.0004 (0.26)	**0.01** (1.72)	0.005 (1.01)
Δesi_{t-6}	**-0.06** (-2.32)	**-0.08** (-3.41)	-0.01 (-0.67)	**0.01** (2.40)	**-0.03** (-1.67)	**0.03** (2.19)
Δesi_{t-7}					**-0.04** (-2.25)	-0.01 (-0.91)
Δesi_{t-8}			0.02 (1.11)	**0.02** (3.61)	0.02 (1.13)	**0.04** (2.35)
$\Delta m3_{t-8}$	**-0.22** (-2.07)	**-0.26** (-2.33)			-0.10 (-0.96)	**0.14** (1.72)
$\overline{R}^2$	0.53	0.76	0.34	0.95	0.35	0.65
LM test (2 lags)	**8.51** (0.01)	**7.91** (0.02)	5.67 (0.23)		7.26 (0.12)	
LM test (6 lags)	**14.22** (0.03)	**17.10** (0.01)	3.86 (0.42)		2.70 (0.61)	
Heteroscedasticity test (White)	39.91 (0.65)	**57.46** (0.08)	60.88 (0.72)	**73.67** (0.30)	52.32 (0.75)	**77.18** (0.07)
Normality test (Jarque Bera)	0.84 (0.66)	0.21 (0.90)	**14.35** (0.00)	**8.53** (0.01)	**10.20** (0.00)	**3.48** (0.18)
	Newey-West HAC standard errors and covariance		Short-run dynamics: $\Delta\pi_{t-i}, \Delta\pi_{t-i\|t-6-i}$, $i = 1-3, 5-7$		Short-run dynamics: $\Delta\pi_{t-i}, \Delta\pi_{t-i\|t-6-i}$, $i = 1, 5-7$	

Note: t statistic for coefficients in parenthesis, bold numbers indicate significance at least at the ten percent level.

5 Explicit Modelling of Inflation Expectations

The theoretical model as well as the estimation results for the gap between expected and realised inflation suggest taking a closer look at the expectations formation process. Two kinds of expectations formation processes can basically be distinguished; rational or forward-looking expectations and adaptive or backward-looking expectations formation. More formally, inflation expectations formed in period t for time $t+s$ can be described as the expected value of the inflation rate conditional on the information set, Ω, available at time t. This information set includes private as well as public information. If we assume that part of the individuals form expectations rationally and others employ adaptive expectations formation, the series of inflation expectations could be displayed as the weighted average of both parts

$$\pi_{t+s|t} = \rho E[\pi_{t+s}|\Omega_t] + (1-\rho)E[\pi_{t+s}|S_t] \tag{16}$$

where ρ gives the relative weight of these two formation processes. The information set S_t for forming adaptive expectations is only part of the public information set, $S_t \subseteq \Omega_t$, that is used in case of rational expectations (Pesaran and Weale 2006, p. 720-721).

Since we are interested in the explicit representation of expectations formation, we have to find a suitable form to express forward-looking expectations whereas for the adaptive part, we rely on the usual expressions determined by past values of the inflation rate and inflation expectations. For the part of rational expectations, we assume that the information set contains a number of time series, v, that give signals with respect to the future inflation rate. In this case, and under the additional assumption of normally distributed random variables, we obtain the regression equation

$$E[\pi_{t+s}|v] = E[\pi_t] - \sum_{i=1}^{p} \alpha_i E[v_{i,t}] + \sum_{i=1}^{p} \alpha_i v_{i,t} + e \tag{17}$$

limiting the number of explanatory variables to p (Graybill 1961, p. 62-67).

To include additional explanatory variables in the traditional models explaining expectations formation, we need to test whether there is indeed a part of forward-looking expectations formation. If there are no forward-looking expectations present, we could

rely solely on the lagged inflation rate and lagged inflation expectations to determine expectations formation. In a first step we therefore estimate the traditional model of expectations formation (Model I):

$$\begin{aligned}\pi_{t+6|t} &= c_1\left[\pi_{t|t-6} + c_2\Delta^e\pi_{t+5|t-1} + c_3(\pi_t - \pi_{t-6}) + c_4(\pi_t - \pi_{t|t-6})\right] \\ &\quad +(1-c_1)\pi_{t+6} + \epsilon_t \end{aligned} \tag{18}$$

where part of the expectations with regard to inflation are allowed to be formed six months ahead. In the estimation approach, the expected value of the inflation rate is replaced by the realisation of the inflation rate and estimation is carried out using instrument variables. As the calculation of the expectations series heavily depends on the choice of perceived inflation, we estimate equation (18) with the expected change of the inflation rate as the direct outcome of transforming qualitative survey answers into quantitative expectations as a robustness check. In this case, Model I becomes

$$\begin{aligned}\Delta^e\pi_{t+6|t} &= c_1\left[c_2\Delta^e\pi_{t+5|t-1} + c_3(\pi_t - \pi_{t-6}) + (c_4-1)(\pi_t - \pi_{t|t-6})\right] \\ &\quad +(1-c_1)\left(\pi_{t+6} - \pi_t\right) + \epsilon_t. \end{aligned} \tag{19}$$

For the backward-looking part of expectations formation, it is possible to allow for three different approaches (Pesaran 1984). First, expectations can be formed regressively. This would include the lagged change of expectations, that we adapt to be the lagged expected change of expectations, $\Delta^e\pi_{t+5|t-1}$. The second approach assumes that expectations formation can be oriented towards the change of actual inflation over the last six months, $(\pi_t - \pi_{t-6})$. The third approach would be an adaptive part that allows for the correction of the last known expectations error, $(\pi_t - \pi_{t|t-6})$. We include all three possibilities in the equation.

If the forward-looking part is significant and cannot be neglected, we can proceed by explicitly modelling expectations formation. To identify the set of explanatory variables for the forward-looking part of expectations formation, we rely on the same thoughts as those determining the variables that influence the difference between inflation and inflation

expectations. In this case, the original estimation equation transforms into Model II given by

$$\begin{aligned}\pi_{t+6|t} &= c_1\left[\pi_{t|t-6} + c_2\Delta^e\pi_{t+5|t-1} + c_3(\pi_t - \pi_{t-6}) + c_4(\pi_t - \pi_{t|t-6})\right] \\ &\quad +(1-c_1)\left[c_5 + c_6 wd_t + \sum_i c_{6+i}v_{i,t}\right] + \epsilon_t \end{aligned} \tag{20}$$

Once again, we have the expected change of inflation as dependent variable to check the robustness of the estimation. The equivalent change of the estimation equation results in the following terms:

$$\begin{aligned}\Delta^e\pi_{t+6|t} &= c_1\left[c_2\Delta\pi_{t+5|t-1} + c_3(\pi_t - \pi_{t-6}) + (c_4-1)(\pi_t - \pi_{t|t-6})\right] \\ &\quad +(1-c_1)\left[c_5 + c_6 wd_t + \sum_i c_{6+i}v_{i,t} - \pi_t\right] + \epsilon_t. \end{aligned} \tag{21}$$

With regard to the estimation strategy of Model I, Two Stage Least Squares estimation is used because the value of the inflation rate in $t+6$ is not known in t. Since we follow the errors-in-variables approach to replace expected inflation with realised inflation six months ahead, we need a list of reasonable instruments (Blake 1991). This list includes only contemporaneous and lagged inflation but does not contain lagged inflation expectations because the survey data may measure inflation expectations with error. The test for over-identifying restrictions shows that the instruments seem to be valid and the specification of the equation is reasonable (see Table 3). Moreover, the estimation has to deal with the fact that the time horizon for expectations is six months. Therefore, the time period of expectations formations differs from the monthly frequency of the survey. This would generate serial correlation that has to be taken into account by using robust standard errors when estimating the model.

The estimation results show that an important part of expectations formation can be regarded as backward-looking. Depending on the specification, this part reaches up to 89 percent but is still significantly different from unity for the constant threshold expectations. The adaptive part splits into the correction of the last known expectations error and the adjustment to the development of realised inflation. In addition to this, expectations formation seems to be sluggish as the significance of the inclusion of the

expected change of the inflation rate of the preceding month shows. Rearranging terms and exploiting the fact that c_2 and c_4 are not significantly different from unity results in the following expectations formation for the adaptive part, exemplary for the constant threshold variant:

$$\pi_{t+6|t} = \pi_{t+5|t-1} + (\pi_t - \pi_{t-1}) - 0.25\Delta^e\pi_{t|t-6} \tag{22}$$

In this case, economic agents take the previous month's expected inflation rate as a basis and add the change of the inflation rate. This is corrected by the expected change of the inflation rate anticipated six months before. When modeling the forward-looking part of expectations formation explicitly in Model II, almost the same structure arises. However, the adaptive part is now dominated by the previous month's expected change of inflation and the previous month's one to one correction of the expectations error. This results in a static expectations formation process, where the previous month's expected change is now added to the last known inflation rate,

$$\pi_{t+6|t} = \pi_{t+5|t-1} + \Delta^e\pi_{t+5|t}. \tag{23}$$

However, the explicit inclusion of macroeconomic variables receives a significant weight. With regard to the influence of the various macroeconomic variables, monetary policy seems to have no influence. The time horizon of expectations formation appears to be too short to detect an observable effect of money growth as well as interest rate decisions. Surprisingly, no other variable besides the oil price change with regard to constant threshold expectations exerts a significant influence when the wording indicator is incorporated into the estimation. Without the wording indicator, inflation expectations would be higher when the economic sentiment increases and when the oil price displays a positive change compared to the preceding month. In addition to this, a higher annual change of raw material prices without energy have a negative impact on variable threshold inflation expectations.

The wording indicator displays a significantly positive influence on inflation expectations. A higher indicator leads to higher inflation expectations. This shows that financial market experts believe in the risks to price stability that are communicated by the central bank.

Even if there is no reaction to an interest rate decision, this result does not necessarily interfere with the credibility of the central bank. The expectations formation horizon of expert is too short to allow for effects from interest rate decisions at the time expectations are formed. However, because it cannot be excluded that the indicator could be seen as a summary measure for other variables that influence expectations. To explore this idea, we use two additional lags of the wording indicator and the other explanatory variables once again in the Model II estimations (see Table 3 for estimation results indicating only significant variables). The estimations change the previously obtained results in the following way. In this case, not only the change of the oil price, but also the economic sentiment indicator affects expectations in a significant way and with the expected sign. Furthermore, the wording indicator does not have a significant influence on variable threshold expectations anymore.

On interpreting the empirical evidence, there are hints that the wording indicator seems to work as a summary of information contained in the macroeconomic variables, especially the economic sentiment indicator, that could influence inflation. This assumption is supported when taking a look at the estimation including additional lags of the explanatory variables such that the economic sentiment and the oil price are now significant compared to the estimations where only contemporaneous variables are used. In addition to this, communication measured with the wording indicator seems to influence expectations formation more directly. The results are not sufficiently robust to draw unambiguous conclusions about the influence of the indicator on the gap between realised and expected inflation.

The overall results with regard to expectations formation are in line with answers of financial market experts to a number of special questions asked within the framework of the Financial Market Test in March 2006 (ZEW Finanzmarktreport, Volume 14, March 2006). A large proportion of experts (62.3 percent) evaluates the communication of the ECB as clear or very clear. The statements of the ECB also play a role in forecasting macroeconomic variables. If the statements are considered, they mainly influence inflation expectations, followed by the exchange rate and long-run interest rates. Around 40 percent

of the experts take statements of the ECB into account when forecasting inflation under the condition that the rhetoric is regarded when forecasting macroeconomic variables.

Table 3: Estimation results for explicit expectations formation.

	Model I				Model II			
Adj. sample	1999:09-2007:06		1999:08-2007:06		1999:08-2007:06			
Threshold	constant	variable	constant	variable	constant	variable	constant	variable
Dependent var.	$\pi_{t+6\|t}$	$\pi_{t+6\|t}$	$\Delta^e\pi_{t+6\|t}$	$\Delta^e\pi_{t+6\|t}$	$\pi_{t+6\|t}$	$\pi_{t+6\|t}$	$\pi_{t+6\|t}$	$\pi_{t+6\|t}$
c_1	**0.86** (14.28)	**0.68** (3.55)	**0.89** (15.18)	**0.72** (3.64)	**0.89** (40.56)	**0.77** (13.89)	**0.90** (34.71)	**0.79** (10.82)
c_2	**1.11** (13.03)	**1.37** (4.89)	**1.13** (20.63)	**1.36** (5.46)	**0.86** (16.04)	**1.03** (13.13)	**0.85** (12.99)	**1.03** (9.26)
c_3	**-0.25** (-1.93)	**-0.33** (-2.07)	**-0.25** (-2.69)	**-0.34** (-2.27)	-0.06 (-1.33)	-0.10 (-1.20)	**-0.07** (-2.27)	**-0.17** (-2.92)
c_4	**1.23** (6.97)	**1.20** (4.75)	**1.21** (10.04)	**1.24** (5.48)	**1.06** (25.23)	**1.06** (19.50)	**1.07** (27.62)	**1.03** (24.26)
constant					**2.52** (9.17)	**2.77** (7.19)	**2.58** (8.58)	**2.89** (6.64)
wd_t					**0.27** (2.73)	**0.28** (2.07)	**0.30** (1.68)	
i_t					-0.09 (-1.04)	-0.15 (-1.27)		
Δoil_t					**0.04** (1.84)	0.05 (1.60)	**0.06** (2.37)	**0.07** (1.81)
$\Delta\pi_t^{rawexcl}$					-0.01 (-0.89)	-0.03 (-1.43)		
Δe_t^{real}					-0.02 (-1.41)	-0.02 (-1.10)		
Δesi_t					0.07 (1.63)	0.08 (1.41)	**0.09** (2.49)	**0.12** (2.00)
Δesi_{t-2}							**0.14** (2.54)	**0.14** (1.95)
$\Delta m3_t$					-0.16 (0.81)	-0.13 (-0.49)		
$\overline{R}^2$	0.94	0.84	0.92	0.90	0.97	0.89	0.97	0.90
LM test(2 lags)	**21.82** (0.00)	**19.27** (0.00)	**17.82** (0.00)	**17.11** (0.00)	**5.16** (0.08)	**8.22** (0.02)	1.26 (0.53)	2.13 (0.35)
LM test(6 lags)	**24.56** (0.00)	**22.39** (0.00)	**20.35** (0.00)	**20.88** (0.00)	**10.84** (0.09)	**12.77** (0.05)	8.60 (0.20)	4.92 (0.55)
Jarque Bera	**5.65** (0.06)	**8.40** (0.02)	**7.30** (0.03)	**15.89** (0.00)	**12.76** (0.00)	**102.32** (0.00)	**23.02** (0.00)	**70.40** (0.00)
White test	12.31 (0.26)	**26.88** (0.00)	9.67 (0.47)	**29.24** (0.00)	89.59 (0.15)	92.37 (0.11)	59.92 (0.16)	**65.39** (0.07)
Test $c_1 = 1$	**4.75** (0.03)	2.69 (0.10)	**3.21** (0.07)	1.93 (0.16)	**25.06** (0.00)	**17.85** (0.00)	**15.67** (0.00)	**7.97** (0.00)
Test of overid. restrictions	0.02 (0.88)	0.86 (0.35)	0.89 (0.64)	1.65 (0.44)				
Instruments	constant, π_t π_{t-1}, π_{t-7}, π_{t-8}		constant, π_t π_{t-1}, π_{t-2}, π_{t-6}, π_{t-7}					

Note: Newey-West HAC standard errors (lag truncation=3); t-statistic for coefficients in parenthesis, bold numbers indicate significance at least at the ten percent level

6 Conclusion

The conduct of monetary policy has seen a change towards increased transparency in the past years and in the course of this development, the communication strategy of central banks is attracting increasing attention. For the ECB in particular with its complex two pillar strategy and its definition of price stability, it is crucial that the public understands monetary policy decisions and strategy. The literature focuses to a large extent on the short-run effects of communication and comes to the conclusion that the interest rate decisions of the ECB are predictable to a large extent. Whereas the monetary policy of the ECB is well understood in this respect, the influence of communication on inflation expectations is not equally well investigated. We contribute to the literature by investigating the influence of the informational content of the ECB Presidents' statements on inflation expectations. To measure expectations, we use inflation expectations of financial market experts provided by the ZEW Financial Markets Test. Even if the qualitative answers of the survey have to be transformed into a quantitative time series of expectations, they provide a more direct measure of expectations than the extraction from interest rates. The informational content of ECB communication is not directly observable either. It is captured by a wording indicator and the question whether there is a significant influence on inflation expectations formation and whether there is a difference between the inflation rate and inflation expectations is analysed.

As the estimations reveal, there is a significant influence of the wording indicator on inflation expectations whereas the impact on the gap between inflation expectations and realised inflation does not seem to lead to unambiguous conclusions. A possible interpretation is that the rhetoric of the ECB communicates risks to price stability in a credible way and that financial market experts react to the announcements by adjusting their inflation expectations. The influence arises because the indicator seems to summarise information that would otherwise be provided by different macroeconomic variables that are publicly available. The question whether the communication measure has an independent impact that goes beyond publicly available information contained in macroeconomic time series calls for further investigation.

Appendix

Construction of the Indicator

Table 4: Phrases counted in the ECB president's statements.

	Further information and explanation	F-Test (all categories)	η^2	sign
appropriate(ly)		2.62 (0.09)	0.13	-1.00
inappropriate	or "not appropriate"; used in connection with actions as well as assessment of developments	0.76 (0.47)		0
in line	used as assessment; not counted when used in connection with the Stability and Growth pact	0.94 (0.40)		0
not in line		2.46 (0.10)	0.12	1.00
for the time being	or "at present", "at the moment"	0.96 (0.39)		0
to monitor closely	or "to monitor carefully"	5.46 (0.01)	0.23	-1.00
vigilant	or "vigilance", "alert"	5.87 (0.01)	0.25	1.00
risks to price stability	or "inflationary risk", "inflationary pressure"	3.23 (0.05)	0.15	1.00
no risk for price stability	or "no inflationary risk", "no inflationary pressure"; definite negation	1.63 (0.21)		0
risks	in connection with all other assessments	0.99 (0.38)		0
no risk	in connection with all other assessments	1.37 (0.27)		0
upside	or "upward"	3.05 (0.06)	0.15	1.00
no upside	or "no upward"; definite negation	0.21 (0.81)		0
downward	or "downside"	1.45 (0.25)		0
no downward	or "downside"; definite negation	0.21 (0.81)		0
balanced	or "no upward or downward pressure"	0.95 (0.40)		0
slowdown		5.90 (0.01)	0.25	-1.00
second-round effects		0.04 (0.96)		0
mixed		0.67 (0.52)		0
favourable	in the assessment of the outlook for price stability	1.36 (0.27)		0
favourable	in connection with all other assessments besides price stability	3.45 (0.04)	0.16	1.00
unfavourable	or "not favourable"	2.29 (0.12)		0
compatible	or "consistent"	0.26 (0.77)		0
not compatible	or "not consistent"; definite negation	0.76 (0.47)		0
consistently		0.76 (0.47)		0
Number of words		0.53 (0.59)		0

Table 5: Phrases and test results for the frequencies.

	F-test (increasing to unchanged interest rate)	F-test (decreasing to unchanged interest rate)	F-test (decreasing to increasing interest rate)	Mean (increasing interest rate)	Mean (unchanged interest rate)	Mean (decreasing interest rate)
appropriate(ly)	3.96	0.50	7.50	0.14	0.74	1.00
	(0.06)	(0.49)	(0.02)			
inappropriate						
in line						
not in line	4.24	- (-)	0.69	0.29	0.00	0.00
	(0.05)		(0.42)			
for the time being						
to monitor closely	0.00	11.63	4.46	0.57	0.56	1.60
	(0.95)	(0.00)	(0.06)			
vigilant	7.91	1.64	7.50	0.86	0.26	0.00
	(0.01)	(0.21)	(0.02)			
risks to price stability	4.83	0.56	5.84	5.43	3.52	2.80
	(0.04)	(0.46)	(0.04)			
no risk for price stability						
risks						
no risk						
upside	4.07	1.03	5.08	4.86	2.89	1.80
	(0.05)	(0.32)	(0.05)			
no upside						
downward						
no downward						
balanced						
slowdown	4.07	4.45	62.22	0.00	0.70	1.60
	(0.05)	(0.04)	(0.00)			
second-round effects						
mixed						
favourable						
favourable	6.25	0.09	3.13	2.29	1.15	1.00
	(0.02)	(0.76)	(0.11)			
unfavourable						
compatible						
not compatible						
consistently						
Number of words						

Data Description

The unemployment rate measured as a percentage of the labour force is seasonally adjusted. The data are released with a lag of 2 months as a rule, so that in January for example, the value of November of the previous year is known. However, sometimes only the value of the previous month was published in the Monthly Bulletin and in the following month two new values were published to keep on track with the two month publication lag. This occurred ten times in the above-mentioned period. We construct a series that captures the knowledge of an observer displaying the latest available unemployment rate at that time.

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 due to an adjustment to price changes. There are some special features in this series. For January 1999, the value is calculated from the respective exchange rate indices published in the February 1999 Monthly Bulletin. For the period before April 2000, the effective exchange rate change is published for the countries that are 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'.

For money growth M3, the value for the centred three month moving average was first published in August 2001 (May 2001 value). For the period of January 1999 to April 2001, the values are calculated from the seasonally adjusted index of M3, first published in August 1999 (May 1999 value). For the period of 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.

Table 6: ADF-GLS test the time series potentially included in the regressions.

	Sample	Test statistics	
		without trend	with trend
Money M3 (annual growth rate) $\Delta m3$	1999:05-2007:06	-0.65^{A}	-2.53^{B}
Exchange rate (annual growth rate) Δe^{real}	1999:05-2007:06	$-2.14^{A,**}$	-2.23^{C}
Economic sentiment *esi*	1999:02-2007:06	-1.34^{A}	-1.30^{C}
Unemployment rate u	1999:01-2007:06	1.65^{A}	-0.92^{C}
Change of the unemployment rate Δu	1999:02-2007:06	$-6.57^{A,***}$	$-6.46^{C,***}$
Oil price *oil*	1999:02-2007:06	0.17^{A}	-1.87^{C}
Prices of raw materials excl. energy (annual growth rate) $\pi^{rawexcl}$	1999:01-2007:06	-0.85^{A}	-1.71^{C}
Prices of raw materials (annual growth rate) π^{raw}	1999:01-2007:06	-1.28^{A}	-1.60^{C}
Industrial production (annual growth rate) Δip	1999:01-2007:06	$-2.12^{A,**}$	-2.23^{C}
Inflation rate π	1999:01-2007:06	-1.17^{A}	-1.85^{C}
Expected inflation rate $\pi_{t\|t-6}$ (constant thresholds)	1999:02-2007:06	-1.10^{A}	-2.72^{C}
Expected inflation rate $\pi_{t\|t-6}$ (variable thresholds)	1999:01-2007:06	-0.85^{A}	-2.19^{C}
Interest rate i	1999:01-2007:06	$-2.25^{A,**}$	-2.32^{C}
Wording indicator *wd*	1999:01-2007:06	$-2.02^{A,**}$	$-5.17^{C,***}$

Critical values

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

B: 10% level: -2.75; 5% level: -3.04; 1% level: -3.60

C: 10% level: -2.74; 5% level: -3.03; 1% level: -3.58

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

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