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99 Report by Kerstin Bernoth

Analyzing ECB communications improves forecasting of interest rate decisions

- AI model measures the tone of ECB communications from 2019 to 2025
- Tone provides information on and can improve the forecasting of future interest rate decisions
- High policy uncertainty and planned government investments speak in favor of a cautious monetary policy course by the ECB

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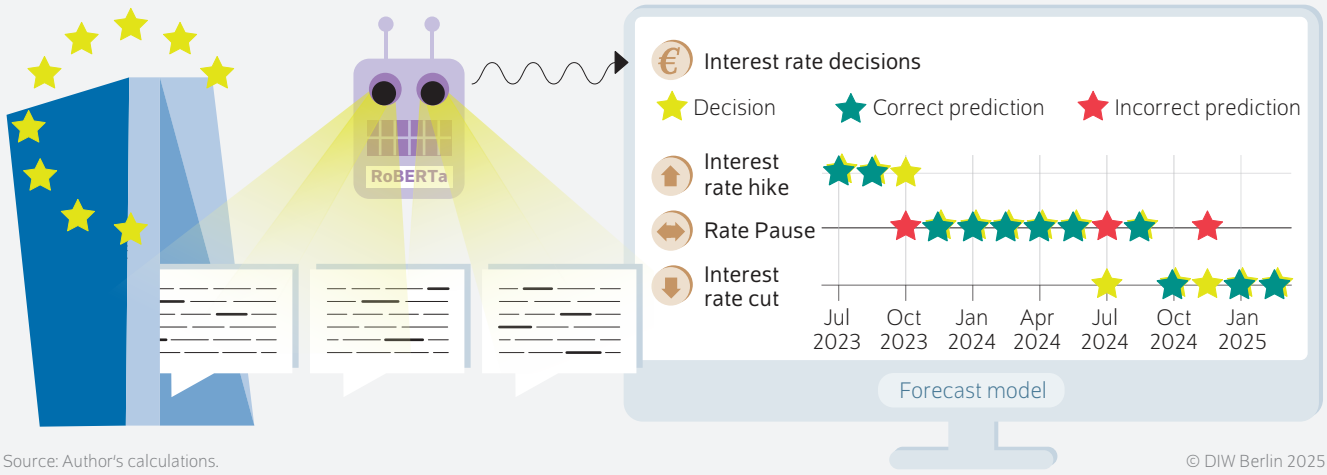
AT A GLANCE

Analyzing ECB communications improves forecasting of interest rate decisions

By Kerstin Bernoth

- Central banks use official communications to explain their decisions, manage expectations, and strengthen trust in their monetary policy strategy
- AI model analyzes ECB statements from 2019 to 2025 to measure the tone as restrictive, expansionary, or neutral
- Tone of ECB communications provides information on and can improve the forecasting of future interest rate decisions
- Interest rate forecast model that includes tone, inflation, and the economic situation predicts with high probability an interest rate cut in April 2025
- Current high level of political uncertainty and planned government investments argue for the ECB to take a cautious monetary policy course

ECB communications contain information that improves the forecasting of future monetary policy decisions
KI model RoBERTa analyzes ECB statements from 2019 to 2025



Source: Author's calculations.

FROM THE AUTHORS

"The tone of monetary policy statements has predictive power for the interest rate decision taken at the next ECB Governing Council meeting, but not the following meeting. ECB statements provide additional information that can be used to determine what will happen to key interest rates the next month."

— Kerstin Bernoth —

MEDIA

Audio Interview with Kerstin Bernoth (in German)
www.diw.de/mediathek

Analyzing ECB communications improves forecasting of interest rate decisions

By Kerstin Bernoth

ABSTRACT

For central banks, official communications serve as essential monetary policy instruments: In press releases, speeches, and interviews, central banks explain their decisions, manage expectations, and promote confidence in their strategy. This Weekly Report analyzes European Central Bank (ECB) communications from January 2019 to March 2025 using a specially trained artificial intelligence (AI) text analysis model. Official ECB statements are evaluated to determine an indicator that categorizes the tone of the communications as restrictive, expansionary, or neutral. The analysis shows that the tone of ECB communications can provide valuable information about future key interest rate decisions. Over the last months, ECB communications have become more neutral in tone, a signal that the ECB is taking a more cautious stance and that the interest rate level currently considered appropriate may soon be reached. An interest rate forecast model that includes inflation, the economic situation, and the tone of ECB communications predicts a further interest rate cut in April 2025 with high probability. However, this is associated with a certain degree of uncertainty, as economic policy events have happened in the past weeks that the model has not yet captured. The current economic uncertainty and planned government investments with a potentially inflationary effect argue for a cautious approach.

Since reaching a peak of around 11 percent at the end of 2022, euro area inflation has been steadily falling and is currently at 2.2 percent. In response, the European Central Bank (ECB) has decreased its key interest rates six times since June 2024. Currently, the ECB's deposit rate, which serves as a reference interest rate for the market interest rates, is 2.5 percent.[1]

However, how will the ECB's monetary policy develop over the coming months?[2] To answer this question, market participants and experts look not only at inflation and the current economic situation, but also at the word choices of leading ECB and euro area national central bank representatives. Central bank communications have grown in importance, in part due to the introduction of forward guidance. Forward guidance, in which a central bank provides information about its future monetary policy intentions, is considered a key instrument of monetary policy: In speeches, interviews, or press releases, central banks explain their decisions, manage expectations, and nurture trust in their monetary policy strategy.

Special attention is paid to the official monetary policy statements that are published every six weeks following the ECB Governing Council meeting.[3] Financial markets and analysts carefully analyze these statements and pay close attention to word choice and sentence formulation, allowing them to draw conclusions about the future monetary policy course.

These official monetary policy statements have a clear, recurring structure: First, current monetary policy decisions, such as changes to key interest rates, are announced. Then, the current economic situation in the euro area and the

1 The deposit rate represents the interest rate that commercial banks receive for their deposits at the ECB.

2 This Weekly Report is based on a study conducted by the author upon request of the European Parliament's Committee on Economic and Monetary Affairs (ECON) in advance of the Monetary Dialogue with the ECB President on March 20, 2025. Kerstin Bernoth, "ECB Communication and Policy Responses: Being Effective in an Era of Disinflation and Economic Policy Uncertainty," Monetary Dialogue Papers (March 2025) (available online; accessed on March 18, 2025. This applies to all other online sources in this report unless stated otherwise).

3 Monetary policy statements (excluding the Q&A) are analyzed (available online).

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Box 1

Data, language models, and RoBERTa

Transformer-based natural language processing sentiment models read complete sentences at once and consider each word in relation to all other words. Thus, they identify meanings and content much better than older methods that process words individually. One such model that has been pre-trained on enormous amounts of text is RoBERTa. It masks random words ("dynamic masking") and thus learns to complete missing terms correctly without relying on word-by-word predictions.[1] Due to these features, RoBERTa has a particularly accurate understanding of speech and is ideal for capturing even subtle differences in tone in ECB communications.

The model was originally trained on the US Federal Reserve and was specifically re-trained using an extensive corpus of ECB communications.[2] Only ECB communications relevant to monetary policy were used to teach the model how monetary policy signals are expressed in the specific language used by the ECB.

To create this ECB training dataset, all speeches relevant to monetary policy by members of the ECB Executive Board and the presidents and board members of the twenty national central banks were used, as well as all official ECB statements on monetary policy decisions in the period from 1999 to 2022. To avoid noise in the training data and to ensure that only text relevant to monetary policy is analyzed, the text corpus was first filtered for content. Speeches were only included in the analysis if one of the following keywords was included in the title: *inflation expectations, key interest rate, deposit rate, refinancing rate, quantitative easing/tightening, prices, economic activity, inflation/deflation, employment, GDP, financial stability, unemployment, growth, exchange rate, productivity, deficit, demand,* or *monetary policy*.[3]

After applying these filter criteria, the training data set includes 1,470 speeches and public statements with a total of around 54,000 sentences. In the next step, only those sentences were retained that could be assigned to one of the three categories (hawkish, dovish or neutral) by the language model originally trained on the US Federal Reserve with at least 90 percent classification confidence. Notably, less than nine percent of ECB statements had to be eliminated from the data set. This suggests a high level of similarity in the communication styles of the US Federal Reserve and the ECB, at least in regard to key messages about monetary policy.

The remaining 49,000 or so sentences were then used to further train and refine the model with the aim of improving the model's ability to capture the linguistic nuances that are typical of the ECB and to optimally adapt the model to the European context.

1 Yinhan Liu et al., "RoBERTa: A Robustly Optimzed BERT Pretraining Approach," *arXiv:1907.11692* (2019) (online verfügbar).

2 Agam Shah, Suvan Paturi, and Sudheer Chava, "Trillion dollar words: A new financial dataset, task & market analysis," Proceedings of the 61st Annual Meeting of the Association for Computational Linguistics 1: Long Papers (2023): 6664–6679.

3 This word calatog is based on Gorodnichenko et al., "The Voice of Monetary Policy," *American Economic Review* 113, no. 2 (2013): 548-584 and was supplemented with ECB-specific terms.

development of inflation are outlined and economic risks are assessed. Finally, the ECB describes the current financial and monetary conditions and provides an outlook on possible future economic developments as well as possible monetary policy changes.

Using modern artificial intelligence (AI) text analysis methods, it is possible to precisely investigate the tone of ECB communications and filter out signals regarding monetary policy orientation. Previously, this was performed manually and required great effort. Today, it is much easier: Pretrained algorithms can analyze significantly larger amounts of text and are less prone to error.

This Weekly Report systematically evaluates the official ECB monetary policy statements that accompanied monetary policy decisions taken between January 2019 and March 2025. Using a language model trained on ECB communications, each individual sentence is evaluated to see if it is sending a signal for monetary policy tightening or easing. The ECB Communication Stance Indicator is calculated from these individual evaluations and shows how restrictive, expansionary, or neutral the tone of ECB communications currently is and was at a certain time overall.

Using a statistical forecast model, it is also investigated if the tone of the ECB communications contains additional information that can improve the forecasting of future interest rate decisions made by the ECB Governing Council.

Finally, based among other things on the forecast model and the current macroeconomic environment, an assessment is made of the ECB's monetary policy direction in the coming months.

A new language model for measuring monetary policy tone

The analysis of the monetary policy stance in the ECB's communication is based on a natural language processing sentiment model.[4] This model is specially designed for evaluating central bank communications (Box 1). The model categorizes individual sentences as "hawkish" (indicating tightening), "dovish" (indicating easing), or neutral, depending on the monetary policy signal the sentence is sending.

4 Agam Shah, Suvan Paturi, and Sudheer Chava, "Trillion dollar words: A new financial dataset, task & market analysis," *Proceedings of the 61st Annual Meeting of the Association for Computational Linguistics 1: Long Papers* (2023): 6664–6679.

Table 1

Tone of ECB communications

Example sentence	Tone
In particular, the decision to lower the deposit facility rate – the rate through which we steer the monetary policy stance – is based on our updated assessment of the inflation outlook, the dynamics of underlying inflation and the strength of monetary policy transmission.	Expansionary
The upward revision in headline inflation for 2025 reflects stronger energy price dynamics.	Restrictive
For inflation excluding energy and food, staff project an average of 2.2 per cent in 2025, 2.0 per cent in 2026 and 1.9 per cent in 2027.	Neutral
Domestic inflation remains high, mostly because wages and prices in certain sectors are still adjusting to the past inflation surge with a substantial delay.	Restrictive
The economy faces continued challenges and staff have again marked down their growth projections – to 0.9 per cent for 2025, 1.2 per cent for 2026 and 1.3 per cent for 2027.	Expansionary
The assumption of higher energy price inflation led staff to revise up the headline inflation projection for 2025.	Restrictive
Especially in current conditions of rising uncertainty, we will follow a data-dependent and meeting-by-meeting approach to determining the appropriate monetary policy stance.	Neutral
We are not pre-committing to a particular rate path.	Neutral
The risks to economic growth remain tilted to the downside.	Expansionary

Notes: Selection of sentences from the monetary policy statement of March 2025.

Source: ECB.

Originally, the model was trained on the language usage of the US Federal Reserve. As it can be assumed that the ECB's communication style differs from that of the US Federal Reserve, the model was further developed for this analysis and adjusted to the distinctive features of ECB communications.

This new natural language processing sentiment model analyzes monetary policy signals in the monetary policy statements following ECB Governing Council meetings from January 2019 to March 2025. Each individual sentence in these statements is evaluated to see if it indicates a tightening of monetary policy, an easing of monetary policy, or a neutral position (Table 1).

These assessments are used to calculate an overall value per meeting: the ECB Communication Stance Indicator. This is calculated using the following formula:

$$ECB\ Communication\ Stance\ Indicator_t = \frac{Amount\ Hawkish_t - Amount\ Dovish_t}{Amount\ TotalSentences_t}$$

A positive indicator suggests an overall restrictive tone in ECB communications. In contrast, a negative value suggests an expansionary tone.

The tone of the ECB's monetary policy statements has changed considerably over time (Figure 1). In 2019, communication was slightly dovish initially, indicating a more expansionary monetary policy. With the outbreak of the coronavirus pandemic in early 2020, this tone became even more dovish. This development coincided with an inflation rate that was moving toward zero and was even negative at times. At the same time, the EU Industrial Confidence Indicator (ICI), which measures how industrial companies estimate their current business situation and their expectations for the future and is considered an early indicator for economic development in the euro area, declined sharply.

From the end of 2020, inflation in the euro area rose continually. At the same time, the economic situation improved noticeably, as can be seen from the growing confidence in industry, among other things. Nevertheless, the tone of monetary policy statements remained dovish at the time and continued to be so until the end of 2021, even though inflation had already significantly exceeded the target of two percent by then.

This shows a certain harmony between words and actions, or, more precisely, the absence of action: The ECB has been often criticized for having reacted to the increase in inflation too late and not having tightened monetary policy at the right time.[5]

Only at the end of 2021 did the ECB Communication Stance Indicator turned positive and thus into the restrictive range. It reached its peak in the second half of 2022, coinciding with the start of a series of policy rate hikes. Since then, the indicator, while still positive, has been on a downward trend, and since mid-2024, the tone of ECB communications has increasingly approached a neutral stance. This could be indicating that the interest rate may soon reach the level currently considered appropriate by the ECB.

Inflation, economic policy uncertainty, and previous interest rate moves influence probability of interest rate changes

In the next step, we investigate if the tone in the ECB's monetary policy statements is related to the probability of key interest rate changes.

As the ECB generally adjusts the interest rate in discrete steps, a multinominal ordered probit model is used. This model estimates the probability of the different interest rate decisions: increase, decrease, or no change.

The explanatory variables selected reflect the classic Taylor rule, according to which monetary policy decisions are primarily based on inflation trends and the economic situation. Moreover, two further influencing factors that have become more important in recent years are considered: economic policy uncertainty and geopolitical risks.[6] Including these variables makes it possible to see whether they also influence the ECB's interest rate decisions. And finally, the previous interest rate decision is also included in the model, as the ECB frequently adjusts its course gradually.

The analysis also focuses on the period of January 2019 to March 2025. First, it is investigated to which extent *current*

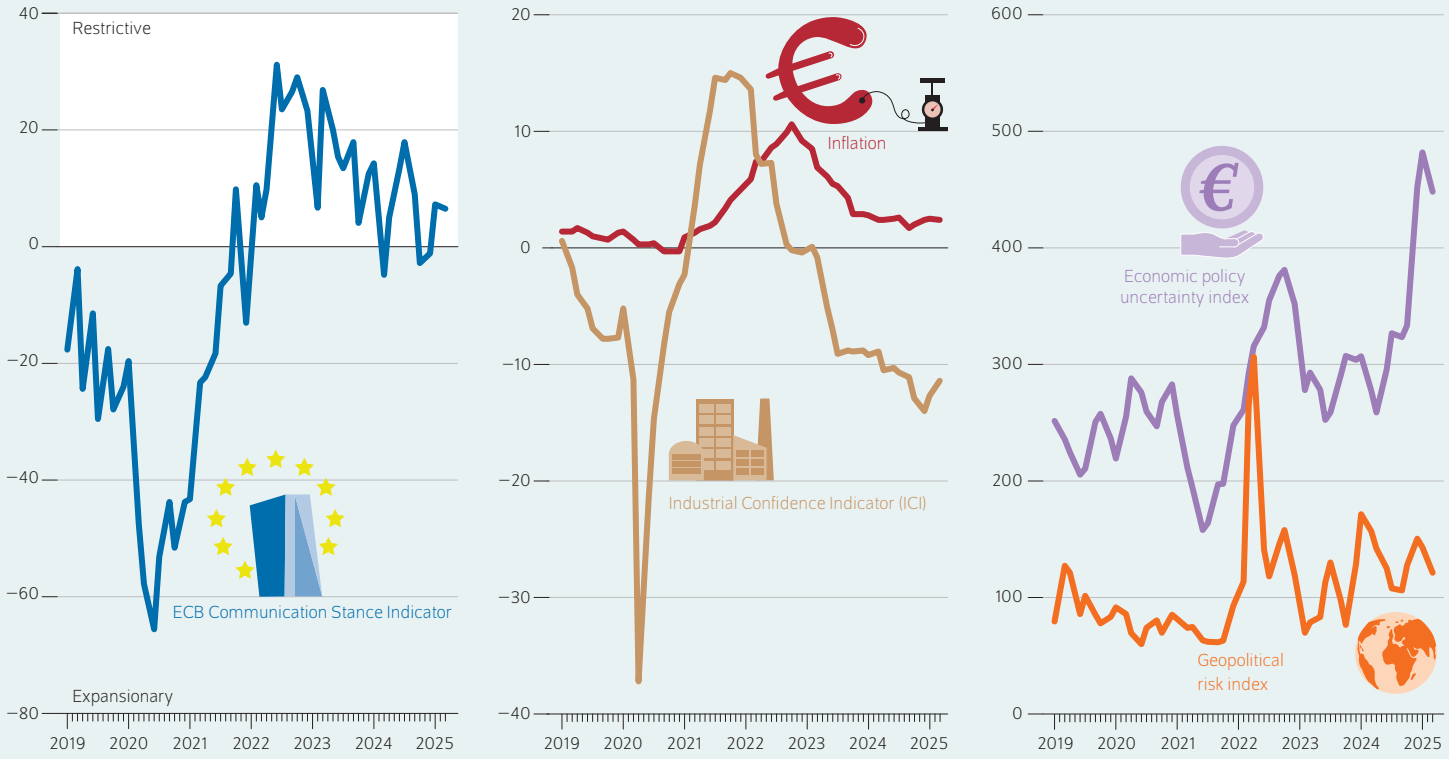
5 Bernoth, "ECB Communication and Policy Responses."

6 Economic policy uncertainty is measured using the European Economic Policy Uncertainty Index. This index is calculated by couting the frequency of key terms relating to fiscal, monetary, or trade policy uncertainty appearing in newspaper articles..

Figure 1

ECB Communication Stance Indicator and other factors

In percent (ECB Communication Stance Indicator, inflation); in points (industrial confidence indicator, geopolitical risk index)



Notes: The economic policy uncertainty index is based on a text analysis of newspapers and other media sources. It measures the frequency of terms that indicate economic policy uncertainty in certain areas, such as financial, regulatory, or trade policy. The geopolitical risk index is based on the number of articles about negative geopolitical events that appear monthly in ten observed newspapers (measured as a share of all published articles).

Both indices are calculated as sliding three-month averages.

Sources: Macrobond, author's calculations.

The tone of ECB communications fluctuates over time and correlates noticeably with macroeconomic factors such as inflation.

interest rate decisions can be explained by inflation, the economic situation, and the tone of ECB communications (Table 1, first column).[7]

The estimates confirm an intuitive correlation: Higher inflation increases the probability that the ECB Governing Council decides on an interest rate hike.

In addition, the probability of an interest rate hike increases if a hike was decided on in the previous meeting. This reflects the ECB's preference of adjusting key interest rates in small steps.

In contrast, the higher the economic policy uncertainty—in regards to future fiscal policy measures, for example, or regulatory conditions—the lower the probability of an interest rate increase. One plausible explanation is that policy uncertainty dampens investments and thus economic growth, which weakens inflationary pressure. Geopolitical risks, on the other hand, do not show any statistical influence on ECB interest rate decisions. The tone of monetary policy statements offers no additional explanatory power for current interest rate decisions, which confirms the ECB's position of primarily basing their decisions on macroeconomic data.

ECB communications contain information that improves prediction of future interest rate decisions

However, the analysis shows that the tone of the ECB statements delivers information on *upcoming* interest rate decisions.

The Granger causality test proves that the ECB Communication Stance Indicator has predictive power for the interest rate decision at the next ECB Governing Council meeting.[8]

7 The models are estimated using all possible combinations of the explanatory variables and the model fits are compared using the Akaike information criterium (AIC).

8 The Granger causality test is a statistical process that determines if there is a relationship between two variables in which one influences the other.

Box 2

Probit model and one-step ahead forecast

The multinominal ordered probit model is a statistical procedure for analyzing discrete, categorical variables using various explanatory factors. This Weekly Report investigates if the key interest rate decreases (–1), remains unchanged (0) or increases (+1). Thus, it only counts the direction of the change and not its magnitude.

The model assumes that the observed categorical change in the key interest rate is based on a latent, continual variable that reflects the desired change in the key interest rate. This latent variable (Δi_t^*) is thus modeled as a linear function of the ECB Communication Stance Indicator (CI) and further explanatory factors such as inflation, EU industrial confidence, economic policy uncertainty, geopolitical risks, and the lagged change in interest rates—summarized as X_t—as well as a normally distributed error term:

$$\Delta i_t^* = \beta\, KI_t + X_t\gamma + \epsilon_t,$$

The key interest rate is lowered if Δi_t^* is smaller than a lower threshold value (τ_1) and raised if it is larger than an upper threshold value (τ_2). If Δi_t^* is between τ_1 and τ_2, the interest rate remains unchanged. The probabilities of the three possible interest rate decisions are:

$$\begin{aligned} P(\Delta i_t = -1 | KI_t) &= \Phi(\tau_1 - \beta\, KI_t - X_t\gamma)\,, \\ P(\Delta i_t = 0 | KI_t) &= \Phi(\tau_2 - \beta\, KI_t - \gamma X_t) - \Phi(\tau_1 - \beta\, KI_t - X_t\gamma)\,, \\ P(\Delta i_t = 1 | KI_t) &= 1 - \Phi(\tau_2 - \beta\, KI_t - X_t\gamma)\,, \end{aligned}$$

with Φ representing the cumulative standard normal distribution. The threshold values τ_1 and τ_2 as well as the parameters β and γ are estimated by a maximum likelihood estimation.

In a one-step ahead forecast model, the estimate is repeated by shifting the explanatory variables one time period into the past. This ultimately results in the prediction probabilities for the three possible interest rate decisions by multiplying the most recently observed factors by the estimated model parameters.

A one-step ahead forecast model (Table 1, third to fifth columns) confirms a positive correlation between the current inflation rate and the probability of an interest rate hike at the next ECB Governing Council meeting. The probability of a further interest rate hike is greater when an increase has been decided upon in the current Governing Council meeting. Conversely, the probability of an upcoming interest rate hike decreases when economic policy uncertainty increases.

Without including inflationary development, the ECB Communication Stance Indicator does not have any significant predictive power for future interest rate changes (see column 4 in Table 2). When inflation is included in the model, however, it can be seen that more restrictive communication correlates with a higher probability of interest rate cuts, which goes against theoretical expectations. This may be due to multicollinearity: The Communication Stance Indicator correlates strongly with the inflation rate. Therefore, the model is not suitable for reliably separating the effects of the variables from each other.

Despite this, the tone of ECB communications improves the predictive power for future interest rate decisions. Measured by the average recall rate, the predictive accuracy for interest rate changes at the next ECB Governing Council meeting increases from around 70 percent to 80 percent.[9]

The model predicts 11 of the last 14 interest rate decisions correctly in advance; without the Communication Stance Indicator, it only predicts 10 correctly (Figure 2).

Overall, it can be seen that careful observation of the tone of the ECB's monetary policy statements is quite useful. The tone of the statements is a valuable additional source of information that improves the ability to predict monetary policy decisions.

Conclusion: ECB carefully continuing path of monetary easing

What does the forecast model tell us about future interest rate developments in the euro area? With a high level of probability, the model predicts a further interest rate cut at the upcoming ECB Governing Council Meeting on April 17, 2025, which is in line with financial market expectations. In light of declining inflation, stagnating economic growth, and pessimism in industrial confidence, a further easing of monetary policy in the coming months seems to be justified.

However, this forecast is subject to uncertainty. Economic and political events of significance for monetary policy have taken place in recent weeks that could not yet be taken into account by the forecast model as they are not yet reflected in the data used by the model. Long-term stability and competitiveness in the euro area require comprehensive investments, especially in military defense capabilities and in the often neglected infrastructure. Multiple countries, including Germany, have recently agreed to swiftly implement appropriate measures, which they plan on financing through more government debt. The impact of these investments on inflation in the coming years is difficult to estimate at present, but is likely to have a price-driving effect. Furthermore, US President Donald Trump has announced increases in import tariffs on important industrial goods, which could strongly impact global trade, European industry, and thus price development in the euro area, if implemented. If implemented, the tariffs could result in the interest rate change that was expected as a given back in February/March being postponed.

9 Measured by the average recognition rate.

Table 2

Effect of various factors on the probability of an ECB interest rate change
Effect of a change of one standard deviation on the latent interest rate change decision

	Probit model		One-step ahead forecast model		
	With ECB Communication Stance Indicator	Without ECB Communication Stance Indicator	Without inflation	Without ECB Communication Stance Indiactor	With ECB Communication Stance Indicator and inflation
ECB Communication Stance Indicator		−0.30	−0.02		−1.62**
Inflation	1.75**	1.94		2.73**	4.60**
Industrial confidence indicator	−0.8*	−0.78*	0.46	−5.8	−0.89
Economic policy uncertainty index	−1.33*	−1.25**	0.24	−1.26*	−1.58*
Geopolitical risk index			−0.12	−0.87	−0.71
Previous interest rate change	1.74**	1.81**	2.42**	2.02**	3.01**

Notes: One (*) or two (**) stars designate the statistical significance at the ten and five percent levels. The multinominal probit model models the probability of various interest rate decisions: either an increase in, decrease in, or maintenance of the interest rate. In the one-step ahead forecast, the correlation between the observed factors and the interest rate decision in the following period is estimated. While the probit model uses ECB communications to analyze previous interest rate changes, the one-step ahead forecast model models future changes. The period observed is January 2019 to March 2025. A positive value, around 1.75 in the probit model, means that the probability of an interest rate change—from an interest rate cut to a rate pause or from a rate pause to an interest rate hike—increases when inflation increases. A negative value, around −1.33 in the probit model for economic policy uncertainty, means that the probability of an interest rate change—from an interest rate hike to an interest rate pause or from an interest rate pause to an interest rate cut—increases.

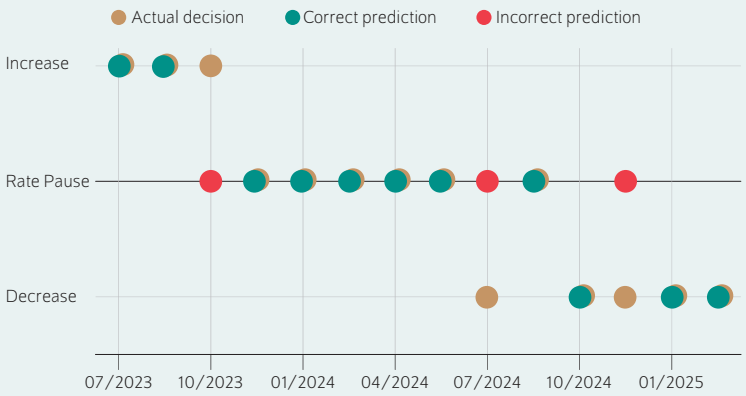
Source: Author's calculations; Macrobond.

The ECB's tone in its most recent monetary policy statement is now moving toward a comparably neutral level, indicating that the ECB will pursue its future course more cautiously than it did a few months ago. One significant reason for this may be that the ECB's monetary policy orientation is gradually approaching its neutral level. In addition, political and economic uncertainty are currently high, making reliable macroeconomic forecasts considerably more difficult.

Therefore, it is imperative that the ECB continues to gradually ease its monetary policy with caution. A pause may be necessary to carefully assess the impact of global economic policy developments, both within and outside the EU.

Figure 2

Predicted and actual interest rate changes



Source: Author's calculations.

The forecast model can correctly predict 11 of the 14 past interest rate decisions.

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