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Household expectations and dissent among policymakers[☆]

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ABSTRACT

This paper studies the impact of dissent in the ECB's Governing Council on uncertainty surrounding households' inflation expectations. We conduct a randomized controlled trial using the Bundesbank Online Panel Households. Participants are provided with alternative information treatments concerning the vote in the Council, e.g. unanimity and dissent, and are asked to submit probabilistic inflation expectations. The results show that the vote is informative. Households revise their subjective inflation forecast after receiving information about the vote. Information about unanimity or dissent causes a wider individual distribution of future inflation for those households that were relatively certain before the treatment. For the remaining 60% of households, this information reduces uncertainty. Information about dissent increases uncertainty more than information about a unanimous vote, though the difference is not statistically significant. A unanimous vote unambiguously reduces inflation uncertainty for households with anchored inflation expectations.

1. Introduction

In recent years, central banks such as the Federal Reserve (Fed) or the European Central Bank (ECB) provide an array of information to the public. This involves press releases about monetary policy decisions, regular post-meeting press conferences, projections about future macroeconomic variables, speeches by senior central bankers and analytic reports about economic developments. Central banks acknowledged the adjustment of public expectations as a key transmission channel of monetary policy and try to manage these expectations. The provision of information by the central bank is seen as a stabilization and coordination device for private expectations. This aim became all the more relevant when many advanced economies hit the effective lower bound on nominal interest rates. When the conventional short-term interest rate was no longer available in order to implement further stimulus, central banks engaged in forward guidance to raise inflation expectations. Recently, central banks broadened their communication efforts and not just address investors and professional central bank watchers, but also households.¹

One important piece of information is the vote in the decision making body of the central bank. In case of the ECB, this is the Governing Council (GovC). While the Fed and the Bank of England (BoE) are very transparent about the vote in their committees

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¹ See [Haldane et al. \(2021\)](#) and [Ehrmann and Wabitsch \(2022\)](#) for analyses of central bank communication with a broader audience as opposed to a small group of experts.

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and publish the formal vote together with the post-meeting press release, the ECB remains opaque.² The press release and the ECB president's Introductory Statement to the press conference remain silent on the vote. When asked by journalists, the ECB president only communicates a thin assessment of his or her reading of the GovC's majority using codewords such as "consensus" or "overwhelming support" to communicate the fact that some members dissented. The ECB does not reveal information about the direction of dissent or the name(s) of the dissenting member(s). At the same time, disagreement among members of the GovC is often headline news in the media.

In this paper, we study the effect of the vote in the GovC on the inflation expectations of households. For that purpose, we use a randomized controlled trial (RCT) design, which mimics the information provision during ECB press conferences. The RCT is implemented using the Bundesbank Online Panel Households (BOP-HH), a monthly household survey conducted by the Deutsche Bundesbank among more than 3000 households. The design of the Bundesbank survey resembles the Survey of Consumer Expectations run by the Federal Reserve Bank of New York (Armantier et al., 2013, 2017).

The survey experiment is the following: survey participants receive information about an ECB decision to keep interest rates unchanged at 0%. In a first stage, each participant is asked to submit her minimum and maximum inflation forecast. In a second step, we provide three information treatments and request participants to submit their probabilistic inflation projections. Each participant assigns probabilities to alternative inflation bins. Besides a control group, which receives no additional information, one group receives the information that the ECB decision was unanimous. Another group receives the information that there was dissent in the GovC. A fourth group learns that the decision was unanimous despite different views in the council. We use the method introduced in Engelberg et al. (2009) and Manski (2018) to infer the second moments of each participant's individual distribution of future inflation. This set-up allows us to derive the *causal* effect of unanimity and dissent, respectively, on the second moments such as the interquartile range or the standard deviation of individual distributions about future inflation, which are reflecting individual uncertainty about the inflation outlook.

We obtain four findings. First, information about the vote among policymakers is informative. Households receiving information about the vote revise their first-stage inflation forecasts more strongly relative to the control group which receives no information about the vote. A potential mechanism could be that the vote is informative about future monetary policy, which is why respondents change their assessment of future inflation.

Second, the effect of the information about the vote on uncertainty depends on the degree of pre-treatment uncertainty. Receiving information about either unanimity or dissent increases inflation uncertainty for the bottom 40% of households in the distribution of pre-treatment uncertainty. Hence, household which were relatively certain before being informed about the vote face higher uncertainty after the information treatment. For the remaining 60% of households, inflation uncertainty falls upon receiving the information. The change in individual inflation uncertainty caused by the treatment among policymakers should have real economic consequences: as all survey participants face the same interest rate, differences in individual distributions of expected inflation translate into different subjective distributions of real interest rates.

Third, when receiving information about dissent, relatively certain households revise their inflation projections more strongly than households receiving information about a unanimous vote. Households receiving information about dissent have a wider distribution of future inflation as reflected in the interquartile range or the standard deviation of their probabilistic forecast. However, the effect between receiving information about a unanimous vote and about dissent, respectively, is not statistically significant. This suggests that it is the revelation of the fact that there is a vote in the GovC that causes inflation uncertainty to increase, not the nature of the votes cast. Hence, stressing the unanimous nature of the policy decision does not generally lead to a lower inflation uncertainty.

Some of these findings are rather complex and not easy to interpret in light of specific economic mechanisms. This is why we shed light on the role of inflation anchoring, which gives rise to our fourth result: we infer participants' long run inflation forecast from another question in the same survey round. This allow us to distinguish between respondents with anchored and unanchored inflation expectations, i.e. with long-run forecasts aligned with the ECB's inflation target or not. We use this anchoring dummy to construct interaction terms. Interestingly, we find an unambiguous effect of unanimity reducing inflation uncertainty of participants with anchored expectations.

Our results remain unchanged if we make different assumptions about the shape of individual probability distributions in the first stage of the survey. While in the baseline model we assume an isosceles triangle spanned between the minimum and maximum inflation expectation, we also allow for asymmetric distributions in our robustness section. Specifically, we impose the skewness from a question earlier in the survey, which is routinely asked by the Bundesbank, or the average skewness from the control group.

Our results shed light on the role of the vote in GovC for the ability of the ECB to manage household expectations. Communicating a unanimous decision does not reduce the uncertainty of households around the inflation path for all participants. In fact, relative to remaining opaque about the vote, releasing *any* information about the vote, i.e. either information about unanimity or dissent, can indeed reduce uncertainty for households with high prior uncertainty.

In our survey, we deal with the inflation expectations of households. Though households might not be as well informed about the details of monetary policy as experts, they are aware of rifts in the GovC. This is particularly true for households in Germany, where the disagreement between the president of the Bundesbank, who is a member of the GovC, and the ECB president was headline news for more than a decade.

² See Rieder (2022) for a survey on central bank decision-making by committees.

The remainder of this paper is organized as follows: Section 2 surveys the related literature. Section 3 provides some background on the vote in central bank decision making bodies. Section 4 introduces the survey and Section 5 presents the regression model. The results are discussed in Section 6 with the robustness of the findings analyzed in Section 7. Section 8 draws conclusions. An online appendix contains additional material.

2. Related literature

This paper contributes to multiple strands of the literature. First, we add to the large literature on information provision experiments in RCTs, e.g. Coibion et al. (2024, 2022, 2023), Hoffmann et al. (2022) and many others.³ In particular, researchers use RCT designs in order to understand the impact of policy communication on expectations. Coibion et al. (2022) use data from the Nielsen Homescan Panel and provide participants with eight different information treatments, each of which contains a specific piece of information about monetary policy. The authors establish that policy communication has a significant effect on expectations and also on households' willingness to spend. In contrast to this paper, the authors focus on the first moments of the probability distributions of inflation only. Our focus lies on the second moments of the distributions.

Coibion et al. (2023) estimate the causal effect of the Fed's forward guidance on inflation expectations. The paper finds that the pass-through of forward guidance to real interest rates is limited. Coibion et al. (2024) study the effect of uncertainty on household spending. The authors confront participants with exogenous variation in individual uncertainty and ask participants to submit their spending intentions. As a key result, they find that higher uncertainty reduces spending. Other papers confirm that consumers with a higher degree of idiosyncratic inflation uncertainty have a lower attitude towards spending on durable goods (Binder, 2017; Kostyshyna and Petersen, 2024; Georgarakos et al., 2024).

Second, this paper adds to the literature on central bank communication and inflation expectations of households and firms. Hubert (2015) argues that central bank forecasts do indeed affect private inflation forecasts. Anderes et al. (2021) argue that ECB communication during the press conference adds valuable information to market participants. In contrast, Lustenberger and Rossi (2020) cannot establish firm evidence of an effect of central bank communication on forecast accuracy and forecast dispersion of professional forecasters. Likewise, Jain and Sutherland (2020) show that central bank projections do not cause a smaller dispersion of private-sector forecasts.

Lamla and Vinogradov (2019) conduct a survey among UK households before and after decisions of the Bank of England. This design allows a clean identification of the effects of central bank communication. The authors show that announcements have small effects on the first moments of macroeconomic variables. However, the effects of central bank announcements differ in the cross-section of households. Upon receiving the information from the central bank, better informed survey participants make smaller forecast errors. Lewis et al. (2020) use a daily survey of U.S. households from Gallup. They show that household are attentive to monetary policy decisions. Their economic confidence falls after a positive monetary policy surprise. However, this effect mostly stems from interest rate decisions. Changes in forward guidance are much less effective. As in Lamla and Vinogradov (2019), the authors find large cross-sectional differences in the effectiveness of policy communication. Conrad et al. (2022) support the notion of cross-sectional variation in the responses to policy. They use survey data from Germany and condition the effect of central bank information on idiosyncratic characteristics. In particular, the authors find that individual lifetime experiences affect the adjustment of expectations in light of new information. Kryvtsov and Petersen (2021) conduct a laboratory experiment, which allows a clean identification. Central bank communication has a stabilizing effect on forecasts. Again the authors find evidence for cross-sectional heterogeneity in the responsiveness of participants to policy communication.

De Fiore et al. (2021) trace the responses of households to decisions of the Fed's Federal Open Market Committee (FOMC) using the Survey of Consumer Expectations. Comparing responses before and after the policy announcements, the authors find little evidence of an effect of policy decisions on inflation expectations. Rast (2021) designs a survey among German households that elicits expectations before and after ECB announcements. He finds that households respond to the release of information about conventional monetary policy, i.e. about interest rates, but remain insensitive to information about forward guidance and asset purchase programs, respectively. Brouwer and de Haan (2022) conduct an RCT among Dutch households. Households which receive information about the central bank's actions, in particular the ECB choice of policy instruments, expect inflation to be closer to the ECB's inflation target.

In contrast to this literature, which looks mostly on first moments of households' inflation expectations, we concentrate on second moments such as the interquartile range of the individual distributions of inflation projections. Using micro data from the ECB's Survey of Professional Forecasters, Fernandes (2021) is one of the few papers studying second moments. She shows that ECB communication about forecasts reduces individual forecast uncertainty.

Third, this paper is related to the literature that studies the effect of dissenting votes and cacophonous communication of policy makers on market participants. This literature applies event-study and time series model rather than RCTs. Ehrmann and Fratzscher (2013) shed light on the role of dispersed communication by committee members. Their evidence suggests that speaking with one voice reduces the prediction errors of the public. The effect of formal dissent in the FOMC is studied by Madeira and Madeira (2019). Their findings show that the response of the stock market differs between unanimous policy decisions and decisions with dissent. Equity prices increase if a policy decision of the FOMC is unanimous and decrease if dissenting votes are cast. Tillmann (2021) constructs an index of dissent for the ECB and shows that dissent weakens the transmission of monetary surprises on long-term interest rates. These papers infer the consequences of dissent from time series data. Our paper suggests a much cleaner identification of the effect of the vote in an RCT setting.

³ Coibion et al. (2020) stress the role of policy communication for inflation expectations and underline the importance of household expectations.

3. Dissent in monetary policy committees

In this paper, we concentrate on dissent in the ECB's GovC. On a meeting day of the GovC, the ECB publishes a press release at 13:45 CET, which contains the latest policy decision. At 14:30 CET, the ECB president opens the press conference. After reading the Introductory Statement, which summarizes the Council's assessment of the economic situation and the policy change, both the ECB president and the vice-president are available for questions from journalists. The press conference is very informative: [Ehrmann and Fratzscher \(2009\)](#) find that information revealed during the ECB press conferences has a larger impact on asset prices than information revealed through the policy announcement. Information from the Q&A part of the press conference is particularly informative during volatile periods.

In the Q&A part, journalists often ask whether the policy decision was unanimous. Normally, the president responds by giving his or her assessment of the support the policy enjoys in the GovC. The president does not, however, reveal the name of the dissenter(s), nor the direction of dissent. Thus, the public can learn about the vote from information given to the press. Often the president gives a straightforward answer such as on July 06, 2006:

Question: "Was the decision unanimous today?"

Trichet: "Yes, very much".

In many other instances, the president reflects on the decision being supported "overwhelmingly" (e.g. August 03, 2006) or was taken "by consensus" (e.g. June 05, 2008).⁴ These characterizations imply that some members voted against the policy proposal. In addition, the president sometimes uses a sharper formulation, e.g. on September 06, 2012, when the exchange with a journalist reads as follows:

Question: "My question regards the vote today. Was it unanimous and, if not, what does it mean?"

Draghi: "Well, it was not unanimous. There was one dissenting view. We do not disclose the details of our work. It is up to you to guess".

In our survey experiment introduced below, we provide participants with information treatments that mimic the information about unanimity and dissent given in the press conference. In some press conferences, the ECB president stresses the unanimous vote but at the same time acknowledges different opinions among GovC members, e.g. in the following quote from February 05, 2009:

Trichet: "We were unanimous in taking our decision, which does not mean that we all have the same view".

Consistently, we allow for another treatment in our RCT which we label "unanimity despite different views".

[Tillmann \(2021\)](#) studies the transcripts of the ECB press conferences and constructs a binary index of dissent from the president's answers to journalists. In the 123 meetings considered in the analysis, he finds 25 meetings with at least one dissenting member. The frequency of dissent in the GovC is lower than for the Federal Open Market Committee (FOMC), the policy-making body of the Fed. Using the data set compiled by [Thornton and Wheelock \(2014\)](#) and [Tillmann \(2021\)](#) reports a share of at least one dissenting vote of 40% for the 202 meetings between February 1994 and September 2018. For the BoE's Monetary Policy Committee, [Riboni and Ruge-Murcia \(2014\)](#) calculate a frequency of dissent of 63%. For the Swedish Riksbank, the authors find a dissenting vote in 38% of all policy meetings. [Ruge-Murcia and Riboni \(2017\)](#) study the decision making procedure at the bank of Israel and find a probability of at least one dissenting member of 31% between 2011 and 2015.

Thus, compared to other central banks dissent in the GovC is relatively infrequent. This diagnosis reflects the nature of policy making at the ECB as being highly consensual. In fact, ECB president Draghi argued that "Given the peculiar nature of the ECB, one of my objectives is that we have as much consensus as possible".⁵ Consequently, [Blinder \(2007\)](#) characterizes the GovC as a "genuinely-collegial committee". The relatively low frequency of dissent also implies that dissent is particularly noteworthy. In contrast, [Blinder \(2007\)](#) argues that there is "no (or negligible) public disagreement" among members of the GovC. However, the fierce disagreement between the presidents of the Bundesbank and the ECB in the decade after the 2008 financial crises indicates that the nature of the committee might have changed over time.⁶

[Gerlach-Kristen \(2004\)](#), [Gerlach-Kristen and Meade \(2010\)](#), [Horváth et al. \(2012\)](#), [Neuenkirch \(2013\)](#) and [Riboni and Ruge-Murcia \(2014\)](#) provide evidence for different central banks which is consistent with the notion that the vote in the decision making committee helps the public forecast future policy. This implies that dissent is an important piece of information that observers take into account when forming expectations.

⁴ The quotes from the press conferences are taken from the transcripts, which are available on the ECB's website at <https://www.ecb.europa.eu/press/pressconf/html/index.en.html>.

⁵ See <https://www.ecb.europa.eu/press/key/date/2012/html/sp120224.en.html>.

⁶ [Baerg and Krainin \(2022\)](#) present a model in which members of the monetary policy committee bargain over the communication of the committee.

4. The survey

We study the impact of the vote in the GovC on inflation expectations in a Randomized Controlled Trial (RCT). For that purpose, we contributed two questions to wave 19 (July 2021) of the BOP-HH. This survey is conducted regularly since 2020 as an online panel of several thousand households in Germany. Each month between 2,500 and 5,000 households, which are representative for the German population, are asked about their expectations of inflation, property prices and interest as well as their planned expenditures. The survey also collects information on the respondents' socio-demographic characteristics. Researchers have the chance to submit one-off questions in order to augment the set of regular questions.⁷

4.1. Design of the RCT

The RCT is conducted in two stages. In the first stage, the pre-treatment stage, households are prompted to submit their minimum and maximum inflation expectation. In the treatment stage, participants are randomly assigned to four groups: a control group and three treatment groups. In the following, we explain the survey design in detail.

Pre-treatment stage. We provide participants with the following information:

“Assume that the European Central Bank (ECB) is aiming for an annual inflation rate of 2% over the medium term. Please also assume that the inflation rate is 1% in 2021. The ECB Governing Council decides to keep the policy rate at 0%”.

Participants could click on two information boxes in order to acquire additional information about the meaning of “Governing Council” and the “policy rate”. At the time of the survey (July 2021), the latest available inflation rate was 1.9% (June 2021) and the interest rate was effectively at zero. We then ask the following question:

“In your opinion, how high will the inflation rate be at least over the next one to two years? And at most?”.

Figure (C.1) shows a screen shot of the survey question. The answers provide us with the minimum and maximum expected inflation rate for each participant.

Treatment stage. We repeat the information about the inflation target, the current inflation rate and the policy decision from the pre-treatment stage. We then randomly assign each participant to one of four alternative groups, three of which correspond to a specific information treatment. After receiving the information treatment, participants are asked the following probabilistic question:

“In your opinion, how likely is it that the rate of inflation will be as follows over the next one to two years? Note: The aim of this question is to determine how likely you think it is that something specific will happen in the future. You can rate the likelihood on a scale from 0 to 100, with 0 meaning that an event is completely unlikely and 100 meaning that you are absolutely certain it will happen. Use values between the two extremes to moderate the strength of your opinion. Please note that your answers to the categories have to add up to 100”.

Participants are offered ten bins ranging from a deflation rate of 12% or higher to an inflation rate of 12% or higher. The width of the outer bins is four percentage points, while the width of the inner bins is two percentage points. The number of bins and the varying width of bins is identical to the Survey of Consumer Expectations run by the Federal Reserve Bank of New York. From these answers, we obtain the individual probability distribution of future inflation as explained below. We write “one or two years” because this is the typical horizon over which monetary policy affects inflation. We randomly allocate participants into groups and provide the treatments (T) given in Table 1.⁸ The first group ($T = 1$) corresponds to our control group. We do not provide any additional information to participants in this group. Survey participants in the first treatment group ($T = 2$) receive the following information:

“The ECB President informs the media that this was a unanimous decision”.

As discussed before, this treatment corresponds to the information provided during several press conferences in the past. In the regression model below, we index this treatment by *una*.

The second treatment group ($T = 3$) receives the following information:

“The ECB President informs the media that this was a majority decision, i.e. there were dissenting votes”.

This is the treatment we are most interested in. In the regression model below, we index this treatment by *dis*.

Finally, the last group ($T = 4$) receives the following information:

“The ECB President informs the media that this was a unanimous decision despite different opinions”.

⁷ Details about the survey are available at <https://www.bundesbank.de/en/bundesbank/research/survey-on-consumer-expectations>. The survey is conducted in German. Here, we use the translation available on the Bundesbank website.

⁸ Screenshots of these survey questions are available in Figures (C.2) to (C.5).

Table 1

Groups.	
$T = 1$	Control group
$T = 2$	Unanimity (<i>una</i>)
$T = 3$	Dissent (<i>dis</i>)
$T = 4$	Unanimity despite different views (<i>unadis</i>)

In the regression model below, we index this treatment by *unadis*. We include this specific treatment for two reasons. First, as mentioned before, we find ECB press conferences during which the president classifies a decision as unanimous and at the same time mentions different opinions of GovC members. Second, it could be argued that unanimity despite different views is particularly informative as this implies that the full range of arguments has been put forward during the meeting. As a consequence, households could interpret such a decision as particularly thoughtful and, hence, informative for inflation expectations.

Our treatments closely reflect the provision of information during the ECB press conferences. We confront participants with alternative treatments, each of which is hypothetical. We do not replicate one specific ECB meeting day, but rather the range of information sets of ECB observers on meeting days over the past two decades. The hypothetical statements of the ECB president we mention in the treatments have all been made before during other ECB press conferences. Thus, we provide survey participants with hypothetical, but well-known scenarios. Because the treatment are familiar from previous press conference, we think the treatments are not too complex. Nevertheless, asking hypothetical questions might affect the external validity of the results.

In our robustness analysis, we also draw on survey question CM004, which is routinely asked by the Bundesbank. In this question, participants are asked:

In your opinion, how likely is it that the rate of inflation will be as follows over the next twelve months?

Participants are offered the identical set of bins that we use in our questions from the treatment stage and are asked to allocate 100 points across the bins. This question is very similar to our question from the treatment stage. There are two main differences, though: the first difference is that the horizon of the inflation forecast is specified as one year, while in our question the horizon is “the next one to two years”. The second difference is that in question CM004, participants are not provided with information about the inflation target, the current inflation rate and the current policy rate.

2927 participants completed the survey. Survey participants also provide socio-demographic information about gender, age, household income, their employment status, the years of schooling and much more. We use this information as control variables in our regression model.

4.2. Inferring individual probability distributions

In order to estimate the effect of dissent on individual inflation uncertainty, we first need to fit distributions to the respondents' answers. We fit a triangular distribution to the answers from the pre-treatment stage. Fig. 1 shows that the triangular distribution is defined by its lower limit a , upper limit b and mode c . We set a and b to the minimum and maximum expectation elicited from the survey. Because we do not know c , we assume the triangular distributions to be symmetric. This implies that the mean, median and mode of the triangular distribution equal $\frac{a+b}{2}$. Below, we show that the results are robust with respect to assuming a symmetric distribution at the pre-treatment stage.

In order to fit distributions to the histograms of the answers from the treatment stage, we follow the method used in the Survey of Consumer Expectations from the Federal Reserve Bank of New York. This approach in turn is based on Engelberg et al. (2009). The distribution of respondents who use two bins is assumed to be a symmetric triangular distribution. Either the upper limit a or the lower limit b is set to the outer limit of the bin in which the forecaster places more than 50% probability mass. The remaining parameters must be fitted by taking the height and center of the triangle into account. For example, if a respondent puts 10% probability in the interval [0%, 2%] and 90% in the interval [2%, 4%], the upper limit b of the distribution is fixed to 4. a is fitted to 1.42. Because the distribution is symmetric, c equals $\frac{a+b}{2} = 2.71$. Note that this procedure can only be applied to respondents using two adjacent bins.

If a forecaster places weights in more than two bins, a generalized β distribution is fitted. This distribution is not necessarily symmetric. The bins, moreover, do not have to be adjacent. For a more detailed description of the method, see Armantier et al. (2017). We deviate from this method by fitting symmetric triangles to histograms with only one bin instead of fitting a uniform distribution. This is in line with Engelberg et al. (2009) and consistent with our method used in the pre-treatment step. The parameters a and b of the triangular distribution are then set to the limits of the interval. Once we fitted these distributions to the individual responses, we can compute the mean, the standard deviation and the interquartile range, which we use as dependent variables in our regression model.

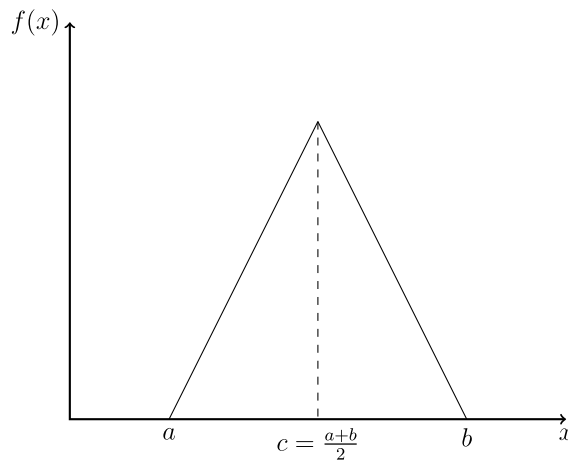


Fig. 1. Probability density function of a symmetric triangular distribution. Notes: The lower (upper) limits are denoted by a (b). The mode is given by c .

5. Empirical model

Coibion et al. (2023) suggest that regressing the change of a variable between the pre-treatment and treatment stage on a dummy variable for each treatment may not always be feasible to investigate treatment effects. Since our treatments are very specific, one might expect little variation in average effects. Accordingly, we find no significant effects of the treatments on average effects when estimated as described (Table 2). Therefore, we follow the literature (e.g. Coibion et al., 2024, 2023) and test the updating of information in light of a noisy public signal. Suppose the expectation formation of forecaster i can be described by the Bayesian updating rule:

$$x_i^{post} = (1 - G) \times x_i^{pre} + G \times signal \tag{1}$$

Here, the expectation x_i^{post} is a weighted average of the prior expectations x_i^{pre} and a new signal. When applied to our survey, this signal corresponds to information from the treatments. If the treatment provides information that is informative relative to the prior expectation, the respondent should increase their Kalman gain G i.e. assign more weight to this new information and thereby less weight to prior information. This effect can be measured by comparing the weight on prior expectations between respondents from the control group, who do not receive any new information, and respondents from the treatment groups. We estimate:

$$x_i^{post} = c + \alpha x_i^{pre} + \sum_{T=2}^4 \beta_T I_i^{(T)} + \sum_{T=2}^4 \gamma_T (I_i^{(T)} \times x_i^{pre}) + \omega_i, \tag{2}$$

where x_i^{post} is the individual expectation in the treatment stage, x_i^{pre} denotes expectations from the pre-treatment stage, I_i^T is an indicator variable equal to one if respondent i receives treatment T and zero otherwise. x_i^{pre} and x_i^{post} , respectively, denote the interquartile range or the standard deviation of the individual distribution. The control group ($T = 1$) is our reference category such that we include three treatments. The error term is ω_i . The coefficients are denoted α , β and γ . We will also estimate a specification with an additional vector of respondent-specific control variables.

α can be interpreted as the weight the control group attaches to prior information. Because the control group is not provided with any new information, we expect α to be close to one. For a given T , $\alpha + \gamma_T$ is the weight attached to prior information, which corresponds to $1 - G$ from Eq. (1). The coefficient γ_T should be more negative for more informative treatments. If the treatment is informative, the respondent should place less weight on x_i^{pre} and more weight on the treatment. The “level effects” (Coibion et al., 2023) β_T can be positive or negative.

We expect $T = 3$ to be particularly informative. If the respondent receives information on dissent in the Governing Council, she should most strongly revise her expectations. Hence, we expect γ_{dis} to be the most negative of the three γ coefficients. We follow Coibion et al. (2024, 2023) and estimate the equation using robust Huber regressions.

In every wave of the Bundesbank Survey, participants are asked about their point estimate of the inflation rate for either the next five or the next ten years (question CQ006A/B). This question is included in the core part of the survey, i.e., before our submitted questions, ensuring that their responses are not influenced by our interventions. This setup allows us to examine whether the effect of our treatments varies depending on whether respondents have well-anchored long-term inflation expectations. We define inflation expectations as anchored if a participant’s five- or ten-year estimate corresponds exactly to 2%, the ECB’s inflation target.⁹ We

⁹ Although the robust mean of the 5-year inflation expectations is slightly higher than that of the 10-year expectations, the difference is not statistically significant. Therefore, we consider it appropriate to combine these expectations into a common anchoring variable.

estimate:

$$x_i^{post} = c + \alpha x_i^{pre} + \sum_{T=2}^4 \beta_T I_i^{(T)} + \sum_{T=2}^4 \gamma_T \left(I_i^{(T)} \times x_i^{pre} \right) + \delta anc_i + \alpha^{anc} \left(x_i^{pre} \times anc_i \right) + \sum_{T=2}^4 \beta_T^{anc} \left(I_i^{(T)} \times anc_i \right) + \sum_{T=2}^4 \gamma_T^{anc} \left(I_i^{(T)} \times x_i^{pre} \times anc_i \right) + \omega_i, \quad (3)$$

where anc_i is a dummy variable equal to one if respondent i has anchored long-term inflation expectations and zero otherwise. For individuals in group T with unanchored expectations, the level effect is β_T and γ_T represents the weight these respondents place on prior expectations relative to the control group. Thus, for those with anchored expectations, the level effect becomes $\beta_T + \beta_T^{anc}$ and the weight they place on their prior relative to the control group equals $\gamma_T + \gamma_T^{anc}$.

6. Results

We report our results for two alternative corrections of outliers. In the first correction, we drop responses that put 100% probability on either of the outer bins in the treatment stage, i.e. more than 12% inflation or deflation, and responses of inflation or deflation of more than 100% in the pre-treatment stage. Further, we noticed there are participants whose responses are inconsistent. There are some respondents in the control group who have expectations from the pre-treatment stage that are very different from those from the treatment stage. This may be due to general difficulties with formulating density forecasts in the treatment stage or by simply confusing inflation and deflation. Inconsistent answers could bias our results. Therefore, we additionally exclude respondents in our second correction whose change in the interquartile range between the pre-treatment and the treatment stage is larger than the 95th percentile of all changes. While we present the main results for both alternative corrections of outliers, we use only the first outlier correction in the discussion of the pre-treatment results in the next subsection.

6.1. Pre-treatment expectations

We study the determinants of the prior expectations of our respondents in Table 3.¹⁰ For that purpose, we employ Huber robust regression models, using the interquartile range, the standard deviation, and the mean expectation from the pre-treatment stage as dependent variables.

We group the participants based on age, household income, and city size. A dummy variable is equal to one if a respondent belongs to a particular group and zero otherwise. The first group for each variable is used as the omitted variable. Additionally, we employ separate dummy variables for the employment status and residency in East Germany. While we build groups for the variables age, income, and city size, we include household size and years of education as continuous variables. Since participants are not asked directly about the number of years of their education, but rather about their highest level of educational attainment and their level of vocational training or university degree, we must calculate the years of education. We follow the procedure outlined in the German Socio-Economic Panel conducted by the German Institute for Economic Research (DIW Berlin).¹¹ We will later employ all these variables as controls in our baseline regressions.

Our findings, see Table 3, indicate that the interquartile range and standard deviation are significantly smaller for respondents aged 35 and older compared to younger respondents. Hence, older respondents express less uncertainty in their inflation expectations. The absolute value of the coefficients increases for older respondent groups. Moreover, uncertainty is significantly higher for respondents living in larger households and those residing in East Germany.

Regarding mean inflation expectations, age groups comprising respondents aged 45 and older are associated with higher mean expectations relative to younger groups. Furthermore, the coefficients for household size and East Germany are significantly positive. The coefficient for years of education is marginally significant and negative, though the value is relatively small. All other coefficients are insignificant.

6.2. Predictability of treatment status

We report our findings both with and without the aforementioned set of respondent-specific control variables. Since the allocation of respondents into groups is random, the group-specific coefficients should not be systematically affected by respondent-specific characteristics. Table 5 examines whether the allocation into groups can be predicted by a probit regression based on our control variables, which should not be the case if the randomization has been successful.

The table reveals that only for those respondents that receive the *una* treatment, two groups within the city variable are significant at the 10% level. All other control variable remain insignificant. We take this as strong evidence that the treatment has indeed been randomly assigned. Nonetheless, we will demonstrate in our baseline results that the inclusion of control variables does not significantly alter our findings. However, incorporating control variables into our regression specification should reduce the standard errors of the estimates.

¹⁰ We present further descriptive statistics in Table 4.

¹¹ You can find this procedure here: https://www.diw.de/documents/dokumentenarchiv/17/diw_01.c.410636.de/pgen-v28.pdf.

6.3. The effect on the uncertainty of forecasters

We now present the main results of the paper: the effects of the treatments on the uncertainty of forecasters measured as either the interquartile range or the standard deviation of the individual probabilistic forecasts. As dissent in the GovC should primarily affect the second moments of forecasts, these results are our baseline findings. In the second step, we report the results for the mean of the individual probabilistic forecasts. That is, we assess whether dissent effects first moments as well.

In our baseline model, we employ the interquartile range of the individual probabilistic distribution for each forecaster i as our dependent variable x_i^{post} . x_i^{pre} is the corresponding interquartile range from the pre-treatment stage. The estimated coefficients are reported in Table 6. We obtain an estimated α which is positive and relatively close to one. All four estimates of α are larger than 0.8. Hence, respondents in the control group put a large weight on their prior.

For our research question, the estimated β and γ coefficients are the most interesting coefficients. We find that β_{una} and β_{dis} are significantly positive across all four specifications, with β_{dis} consistently larger than β_{una} . This difference, however, lacks statistical significance.

It is important to note that using only the level effects, i.e. the estimated β coefficients, to discuss the average effect of our treatments is insufficient. Since we also account for prior uncertainty, the total effect of treatment T on uncertainty can be expressed as

$$\frac{\partial x_i^{post}}{\partial T_i^{(T)}} = \beta_T + \gamma_T x_i^{pre}. \quad (4)$$

Hence, β_T represents the unconditional effects of the treatment on uncertainty, i.e. the impact on respondents with zero prior uncertainty. In that case, a positive β_T can be interpreted as the corresponding treatment T increasing uncertainty. To gauge the full effect of the treatment, we need to look at the unconditional effect plus the effect conditional on prior uncertainty. Informative treatments exhibit a negative γ_T , implying that despite a positive β_T treatments can reduce uncertainty for respondents with high prior uncertainty.

Generally, the treatment effect is positive if $\beta_T + \gamma_T x_i^{pre} > 0$. With $\gamma_T < 0$, this implies a critical level of

$$x_{i,crit,T}^{pre} < -\frac{\beta_T}{\gamma_T}. \quad (5)$$

For specification I in Table 6, the critical value for the treatment *una* is 0.54, and 42.04% of respondents have a prior level of uncertainty below this value. This implies that the treatment *una* increases uncertainty for this proportion of respondents, while it reduces uncertainty for the remaining 60%. Importantly, no significant differences exist between the treatments *una* and *dis*.¹² This observation remains consistent across other specifications as well, with both treatments *una* and *dis* increasing uncertainty for around 40% of the participants. The last rows of each regression table reports the critical value of prior uncertainty at which the effect of the treatments change sign.

Fig. 2 illustrates that there is a critical value for prior expectations where the sign of the treatment effect changes. Each of the three lines maps pre- into post-treatment uncertainty for the *una* and *dis* treatment as well as the control group. The estimated γ coefficients show the impact of the information treatment on the dependent variable conditional on the extent of uncertainty in the pre-treatment stage. For all four specifications, the estimated γ_{una} and γ_{dis} are significantly negative. This means that individuals with a high degree of uncertainty in the pre-treatment stage relative to the control group are particularly sensitive to the provision of information. Put differently, the treatments are informative such that respondents put significantly less weight on their prior. The information about dissent in the GovC is more informative than information about a unanimous vote. We can reject the hypothesis $\gamma_{una} = \gamma_{dis}$ at high levels of significance. Upon receiving information about a unanimous vote despite opposing views among council members, survey respondents increase rather than reduce the weight attached to the distribution in the pre-treatment stage. Hence, this treatment is the least informative. We can conclude that dissenting votes in the GovC have an effect on inflation uncertainty among households. The households subject to information about dissent put less weight on their interquartile range from the first-stage relative to the control group. We also include a large set of control variables ranging from gender, age, income to the employment status and the years of education. The results show that older survey participants aged 45 and above exhibit less uncertainty about the evolution of inflation compared to their younger counterparts. Additionally, respondents residing in cities with over 5000 inhabitants display greater uncertainty than those living in cities with fewer than 5000 inhabitants. Participants with a higher number of years of schooling submit a significantly wider distribution of inflation expectations. Hence, inflation uncertainty increases with education. Most of the other control variables remain insignificant.

In an alternative regression model, we use the standard deviation of individual forecast distributions as the dependent variable. The results are shown in Table 7. The results are very similar to the baseline findings in Table 6. Among the “level effects”, the information about dissent in the GovC is most powerful. This effect remains stable across all four alternative specifications reported in the table. In line with the baseline model, both unanimous decision and dissent treatments lead to an increase in uncertainty for approximately 40% of the respondents.

¹² The treatment effect of T is given by $\beta_T + \gamma_T x_i^{pre}$. Consequently, the test for differences between treatments *una* and *dis* assesses whether $\beta_{una} - \beta_{dis} + (\gamma_{una} - \gamma_{dis})x_i^{pre} = 0$. Since this difference depends on prior uncertainty, we test the hypothesis for various levels of prior uncertainty. As shown in Table 8, the hypothesis $una = dis$ cannot be rejected for all specifications where the interquartile range is the dependent variable.

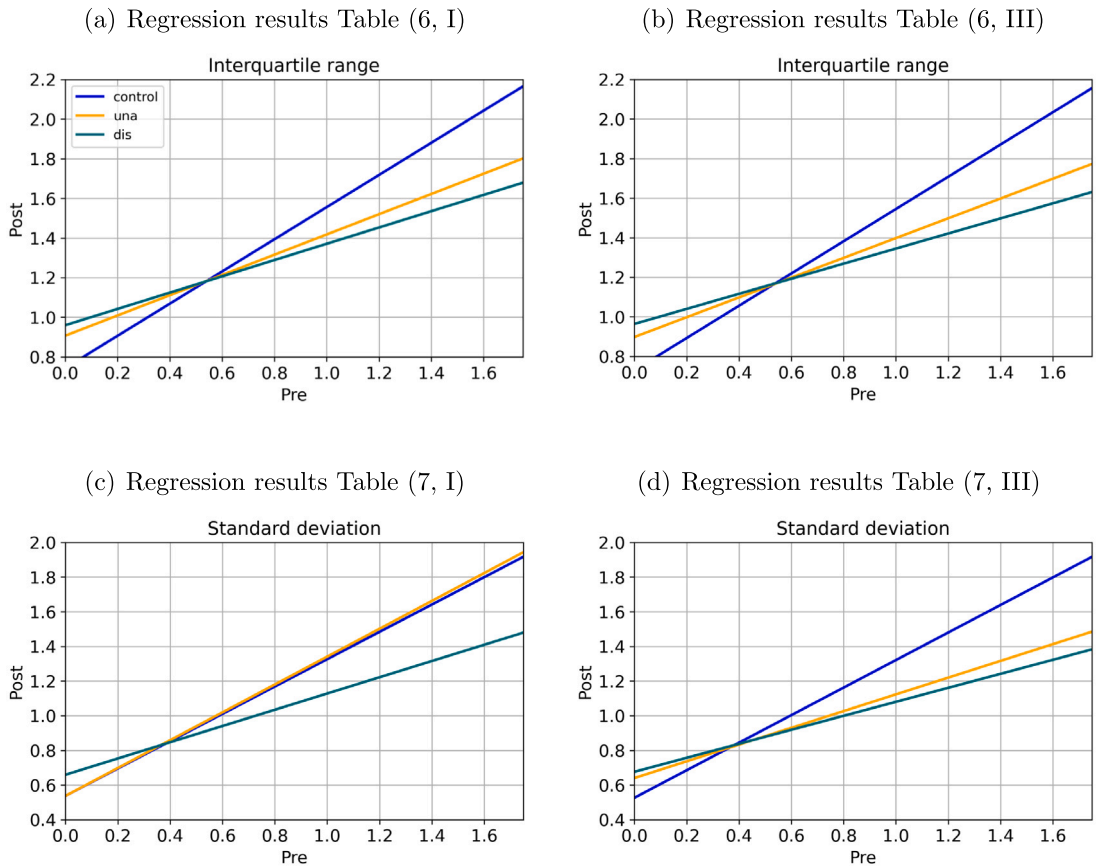


Fig. 2. The effects of the treatments on inflation uncertainty. *Notes:* The graphs show visualizations of our regression results for the control group and the informative treatments (*una*, *dis*) as presented in Tables 6 and 7. The horizontal (vertical) axis scales inflation uncertainty before (after) the informative treatments.

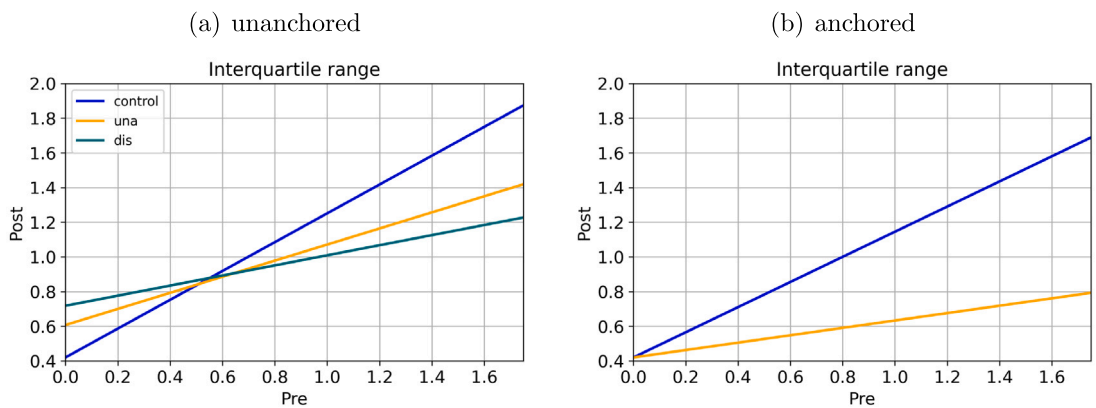


Fig. 3. The effects of the treatments on inflation uncertainty: anchored vs. unanchored expectations. *Notes:* The graphs visualize our regression results for respondents with anchored and unanchored expectations, as presented in Table 9.II. We only include coefficients that are significant at the 10% level. The horizontal (vertical) axis scales inflation uncertainty before (after) the informative treatments.

Again, the information about dissent is most informative across treatments. Agents receiving information about dissent revise their individual probability distribution more strongly compared to all other treatments. Hence, our finding remains unchanged: information about dissent and unanimity is informative for households, with dissenting views carrying greater informative value.

There is, however, no significant difference between the average effects of the two treatments.¹³ Both treatments increase uncertainty for 40% respondents. As expected, all findings remain unchanged if we include control variables.

Table 9 shows the regression results when we estimate Eq. (3) to study whether our results depend on the anchoring of long-term inflation expectations. We use the interquartile range and the standard deviation as dependent variables and employ two methods of outlier correction. For unanchored respondents ($anc_i = 0$), the effect is very similar to our baseline results: the level effects for *una* and *dis* are significantly positive, whereas no significant effect is observed for the *unadis* treatment. Further, only the treatments *una* and *dis* can be considered informative, as the corresponding γ coefficients are significantly negative. Fig. 3 depicts the overall treatment effects resulting from specification I. As in the baseline model, information about a unanimous decision and dissent increases inflation uncertainty for 40% of the unanchored respondents, with the difference between the treatments not being statistically significant.

However, when examining participants with anchored expectations, the picture is different: they appear to react only to information about a unanimous decision. Specifically, $\gamma_{una} + \gamma_{una}^{anc}$ is significantly negative at the 10% level while $\gamma_{dis} + \gamma_{dis}^{anc}$ is not significantly different from zero. Since the level effect ($\beta_{una} + \beta_{una}^{anc}$) is insignificant, the sign of the overall effect for these participants does not depend on prior uncertainty. Fig. 3 illustrates that unanimity leads to less uncertainty for survey participants with anchored long-term expectations.

7. Robustness

The baseline regression model compares second moments of individual distributions from the treatment-state to the distribution in the first stage. The first stage distribution, however, is based on the assumption of the inflation distribution being described by an isosceles triangle between the minimum and maximum future inflation rate. We now relax the assumption that the individual triangular distributions in the pre-treatment stage are symmetric. Thus, we allow for a skewed distributions. We replace the assumed isosceles triangle by two alternatives. The details of these computations are explained in the online appendix.

First, we draw on a question on the individual probabilistic inflation forecast asked earlier in the sample (question CM004). This question is routinely included in each wave of the BOP-HH survey. We assume the individual prior distributions in our pre-treatment stage to have the same skewness as the distributions in question CM004. The advantage of using answers to this question to infer the skewness of the distributions of inflation expectations is that the design of the answer categories is identical to our survey question: participants can allocate 100 points to ten bins of future inflation rates. The drawback is that the verbal framing of the question differs slightly from our question. Participants are not provided with information about current inflation and the recent policy decision and are asked to provide a probabilistic assessment of inflation over the next 12 months rather than over the next one to two years as in our survey questions. Hence, there are advantages and disadvantages of using answers to this question in order to infer the skewness of the prior distribution of expectations. We need to keep these limitations into account when interpreting the results. As we interpret the coefficients relative to the control group, however, the slight difference in the framing of the questions should not matter much.

In the second alternative, we assume the prior distribution between the minimum and maximum to have the average skewness of the control group. The control group is not provided any new information in the treatment stage, such that the skewness of their prior and posterior distributions should not differ. The advantage of this approach is consistency: we use the skewness based on exactly the same survey design. The disadvantage is that we have to rely on average skewness rather than the skewness of the individual distribution.

Table 10 shows the results for the interquartile range when we impose the skewness from survey question CM004. Our key findings remain unchanged: the estimated β_{dis} is significantly positive across all four specifications and is larger than β_{una} or β_{unadis} . Moreover, participants put less weight on their prior distribution as the information about dissent is highly informative. Receiving information about dissent reduces the impact of the prior distribution much more than receiving information about a unanimous vote. For the standard deviation of the individual inflation distribution, see Table 11, the results also remain unchanged. Again, the “level effect” of dissent is positive and highly statistically significant. The “slope effect”, i.e. the estimated γ coefficients, are significantly negative for participants provided with information about dissenting votes.

We now turn to the second alternative to model the prior distribution based on the mean skewness of the control group. Table 12 contains the estimated coefficients when the interquartile range is used as a dependent variable. Information about dissent raises participants’ inflation uncertainty. This treatment is more effective than the provision of information about a unanimous vote. Again we find that participants put less weight on their prior distribution when receiving information about dissent compared to information about unanimity. These findings also prevail when we replace the dependent variable by the standard deviation of individual distributions as shown in Table 13.

We can conclude that the key results of this paper remain robust with respect to the modeling of the pre-treatment stage.¹⁴ For individual skewness from survey question CM004 or for average skewness from the control group, dissenting votes raise inflation uncertainty for about 40% of the survey participants.

¹³ We can only reject the hypothesis $una = dis$ for specification I (see Table 8).

¹⁴ This robustness also holds for our model that partitions participants into anchored and unanchored expectations.

8. Conclusions

Over the past decades, central banks have intensified their communication with professional market participants. Recently, central banks go beyond financial professionals and also try to reach private households. One element of the vast array of information provided by central banks is the vote on monetary policy. In the case of the ECB, the voting outcome is not officially announced. Rather, the ECB president characterizes her or his assessment of the views among committee members.

In this paper, we studied the impact of information about the vote in the GovC on inflation expectations. We run a survey with an RCT in order to elicit the causal effect of unanimity or dissent, respectively, on households' distributions of expected future inflation. Our first result suggests that the vote is very informative for households. Households revise their subjective distribution of inflation upon receiving information about the vote. A second result is that dissent raises households' uncertainty about inflation for the 40% of households with the lowest uncertainty before the information treatment. We further find that unanimity does not reduce the uncertainty of all households around the inflation path, but only for the 60% of households with high pre-treatment uncertainty. A unanimous decision unambiguously lowers inflation uncertainty for participants with anchored long-run inflation expectations. Hence, the vote in the GovC is a significant determinant of inflation uncertainty. To the extent that individual inflation uncertainty translates into uncertainty about the real interest rate, higher inflation uncertainty has real economic consequences.

Our findings underline the difficulty of designing the optimal degree of transparency about the vote. Whether or not information about the vote increases or reduces inflation uncertainty depends on the prior degree of uncertainty before the information is received. Relative to remaining opaque about the vote, releasing *any* information about the vote, i.e. either information about unanimity or dissent, can indeed reduce uncertainty for households with high prior uncertainty.

The current way the ECB communicates the vote in the GovC should be overhauled. Whether or not the ECB president mentions the vote in the GovC during the press conference and how she assesses the views of GovC members lies in the discretion of the president. This discretionary nature adds to the uncertainty about the vote. In addition, households and market participants have to wait for the release of the Monetary Policy Accounts three weeks after the meeting in order to get a glimpse of the potential reasons for dissenting views.

CRedit authorship contribution statement

Moritz Grebe: Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Peter Tillmann:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Tables

See [Tables 2–13](#).

Appendix B. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.ejpoleco.2024.102638>.

Table 2
Average effects.

	Interquartile range	Standard deviation
β_{una}	0.012 [0.040]	0.001 [0.025]
β_{dis}	-0.006 [0.040]	-0.007 [0.024]
β_{unadis}	0.029 [0.040]	0.006 [0.025]
Female	-0.020 [0.030]	-0.012 [0.018]
Age (under 25 omitted)		
25–34	-0.037 [0.122]	0.011 [0.075]
35–44	-0.128 [0.118]	-0.059 [0.072]
45–54	-0.221 [0.116*]	-0.103 [0.071]
55–64	-0.232 [0.115*]	-0.105 [0.070]
65–74	-0.279 [0.115**]	-0.130 [0.070*]
Over 74	-0.254 [0.120**]	-0.108 [0.073]

(continued on next page)

Table 2 (continued).

	Interquartile range	Standard deviation
Income (under 1500 omitted)		
1500–3000	0.139 [0.064**]	0.062 [0.039]
3000–6000	0.156 [0.065**]	0.070 [0.040*]
Over 6000	0.127 [0.071*]	0.043 [0.043]
City (under 5000 omitted)		
5000–20,000	0.098 [0.047**]	0.060 [0.029**]
20,000–100,000	0.131 [0.047***]	0.081 [0.029***]
100,000–500,000	0.178 [0.053***]	0.118 [0.033***]
Over 500,000	0.109 [0.052**]	0.078 [0.031**]
Household size	0.018 [0.016]	0.014 [0.010]
Employed	–0.052 [0.046]	–0.023 [0.028]
Years of education	0.028 [0.009***]	0.011 [0.006**]
East Germany	–0.022 [0.039]	0.001 [0.024]
# obs.	2338	2338

Notes: We regress changes in the interquartile range and the standard deviation between the pre-treatment and treatment stages on a dummy for each treatment and demographic control variables. We drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at 1%, 5% and 10% levels.

Table 3

Pre-expectations.

	Interquartile range	Standard deviation
Female	–0.020 [0.013]	–0.014 [0.009]
Age (under 25 omitted)		
25–34	–0.021 [0.056]	–0.005 [0.039]
35–44	–0.108 [0.053**]	–0.063 [0.037*]
45–54	–0.118 [0.052**]	–0.069 [0.036*]
55–64	–0.109 [0.051**]	–0.065 [0.036*]
65–74	–0.209 [0.052***]	–0.132 [0.036***]
Over 75	–0.210 [0.054***]	–0.130 [0.038***]
Income (under 1500 omitted)		
1500–3000	–0.045 [0.028]	–0.027 [0.020]
3000–6000	–0.041 [0.029]	–0.028 [0.020]
Over 6000	–0.046 [0.032]	–0.035 [0.022]
City (under 5000 omitted)		
5000–20,000	0.017 [0.022]	0.011 [0.015]
20,000–100,000	–0.006 [0.022]	–0.003 [0.015]
100,000–500,000	0.022 [0.024]	0.012 [0.017]
Over 500,000	0.024 [0.024]	0.015 [0.016]
Household size	0.017 [0.008**]	0.011 [0.005**]
Employed	0.002 [0.003]	0.001 [0.002]
Years of education	0.004 [0.004]	0.003 [0.003]
East Germany	0.045 [0.077**]	0.031 [0.012**]
# obs.	2520	2518

Notes: Dependent variables are the interquartile range and the standard deviation from the pre-treatment stage. Independent variables are respondent-specific factors, which are further explained in the text. We drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at 1%, 5% and 10% levels.

Table 4
Descriptive statistics for household characteristics.

	Mean	Percentiles			Std. Dev.
		P25	P50	P75	
Female	0.440	0	0	1	0.496
Age	56.858	46	58	70	14.840
Income					
Under 1500	0.068	0	0	0	0.252
1500–3000	0.298	0	0	1	0.457
3000–6000	0.379	0	0	1	0.485
Over 6000	0.176	0	0	0	0.381
City					
Under 5000	0.142	0	0	0	0.349
5000–20,000	0.257	0	0	1	0.437
20,000–100,000	0.278	0	0	1	0.448
100,000–500,000	0.150	0	0	0	0.357
Over 500,000	0.173	0	0	0	0.378
Household size	2.227	2	2	3	1.047
Employed	0.536	0	1	1	0.499
Years of education	11.379	10	13	13	1.683
East Germany	0.165	0	0	0	0.372

Notes: This table presents summary statistics of the socio-economic variables we use in our analysis.

Table 5
Predictability of treatment status.

	Control	una	dis	unadis
Female	0.077 [0.056]	0.019 [0.057]	−0.036 [0.057]	−0.059 [0.057]
Age (under 25 omitted)				
25–34	−0.019 [0.243]	0.144 [0.245]	−0.050 [0.228]	−0.087 [0.243]
35–44	0.051 [0.230]	0.243 [0.234]	−0.322 [0.220]	0.038 [0.229]
45–54	0.054 [0.227]	0.093 [0.231]	−0.165 [0.215]	0.022 [0.227]
55–64	0.176 [0.224]	−0.004 [0.229]	−0.275 [0.213]	0.110 [0.224]
65–74	0.141 [0.225]	0.128 [0.230]	−0.307 [0.214]	0.048 [0.225]
Over 74	0.187 [0.233]	0.156 [0.237]	−0.351 [0.223]	0.015 [0.233]
Income (under 1500 omitted)				
1500–3000	−0.118 [0.118]	0.084 [0.122]	0.130 [0.122]	−0.087 [0.119]
3000–6000	−0.111 [0.120]	0.077 [0.124]	0.079 [0.124]	−0.034 [0.122]
Over 6000	−0.112 [0.133]	0.111 [0.138]	−0.054 [0.138]	0.071 [0.135]
City (under 5000 omitted)				
5000–20,000	0.092 [0.092]	−0.187 [0.090]	0.035 [0.092]	0.067 [0.092]
20,000–100,000	0.075 [0.092]	−0.206 [0.090]	0.062 [0.091]	0.076 [0.092]
100,000–500,000	0.140 [0.102]	−0.123 [0.101]	−0.029 [0.103]	0.018 [0.104]
Over 500,000	0.053 [0.101]	−0.099 [0.098]	−0.047 [0.101]	0.100 [0.100]
Household size	0.042 [0.032]	−0.017 [0.032]	−0.017 [0.032]	−0.010 [0.032]
Employed	0.036 [0.087]	−0.054 [0.089]	0.059 [0.088]	−0.043 [0.087]
Years of education	0.018 [0.018]	−0.010 [0.018]	0.014 [0.018]	−0.023 [0.018]
East Germany	0.090 [0.074]	−0.080 [0.076]	−0.033 [0.075]	0.023 [0.074]
# obs.	2495	2495	2495	2495

Notes: The table reports results for estimating a linear-probability regression with each treatment T as the dependent variable. The estimates also include a constant. ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 6
The effect on the interquartile range in the baseline model.

	I	II	III	IV
α	0.812 [0.033***]	0.831 [0.033***]	0.815 [0.033***]	0.828 [0.032***]
β_{una}	0.163 [0.049***]	0.193 [0.049***]	0.168 [0.050***]	0.195 [0.048***]
β_{dis}	0.216 [0.052***]	0.240 [0.052***]	0.234 [0.054***]	0.265 [0.050***]
β_{unadis}	-0.146 [0.050***]	-0.049 [0.050]	-0.082 [0.054]	-0.023 [0.050]
γ_{una}	-0.309 [0.042***]	-0.384 [0.041***]	-0.315 [0.048***]	-0.388 [0.041***]
γ_{dis}	-0.401 [0.049***]	-0.452 [0.048***]	-0.407 [0.049***]	-0.492 [0.048***]
γ_{unadis}	0.296 [0.045***]	0.141 [0.044***]	0.291 [0.052***]	0.104 [0.046**]
Female		-0.019 [0.028]		-0.017 [0.028]
Age (under 25 omitted)				
25–34		-0.040 [0.119]		-0.061 [0.117]
35–44		-0.137 [0.114]		-0.114 [0.113]
45–54		-0.220 [0.112**]		-0.228 [0.111**]
55–64		-0.248 [0.111**]		-0.249 [0.110**]
65–74		-0.313 [0.111**]		-0.323 [0.110**]
Over 74		-0.290 [0.116**]		-0.298 [0.114***]
Income (under 1500 omitted)				
1500–3000		0.078 [0.061]		0.067 [0.062]
3000–6000		0.105 [0.063*]		0.096 [0.062]
Over 6000		0.068 [0.069]		0.063 [0.068]
City (under 5000 omitted)				
5000–20,000		0.089 [0.046*]		0.090 [0.044**]
20,000–100,000		0.123 [0.046***]		0.124 [0.044***]
100,000–500,000		0.167 [0.052***]		0.165 [0.050***]
Over 500,000		0.107 [0.050**]		0.102 [0.048**]
Household size		0.023 [0.016]		0.019 [0.015]
Employed		-0.047 [0.044]		-0.054 [0.043]
Years of education		0.030 [0.009***]		0.030 [0.009***]
East Germany		-0.001 [0.038]		0.001 [0.036]
Below critical value (<i>una</i>)	42.04%	41.89%	39.94%	41.89%
Below critical value (<i>dis</i>)	40.87%	40.87%	38.18%	40.87%
# obs.	2520	2338	2388	2218

Notes: Dependent variable is the posterior interquartile range. For specifications (I) and (II) we drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. For (III) and (IV) we additionally exclude respondents whose change in the interquartile range is larger than the 95th percentile. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at 1%, 5% and 10% levels.

Table 7
The effect on the standard deviation in the baseline model.

	I	II	III	IV
α	0.789 [0.033***]	0.814 [0.033***]	0.795 [0.033***]	0.825 [0.032***]
β_{una}	-0.002 [0.035]	0.135 [0.035***]	0.114 [0.034***]	0.142 [0.037***]
β_{dis}	0.122 [0.036***]	0.156 [0.036***]	0.150 [0.038***]	0.184 [0.035***]
β_{unadis}	-0.044 [0.035]	-0.013 [0.038]	-0.036 [0.038]	-0.001 [0.035]
γ_{una}	0.014 [0.042]	-0.381 [0.041***]	-0.312 [0.045***]	-0.403 [0.041***]
γ_{dis}	-0.320 [0.049***]	-0.428 [0.049***]	-0.390 [0.056***]	-0.487 [0.048***]
γ_{unadis}	0.127 [0.045***]	0.072 [0.044]	0.115 [0.058**]	0.049 [0.047]
Female		-0.015 [0.020]		-0.016 [0.020]
Age (under 25 omitted)				
25–34		-0.016 [0.083]		-0.025 [0.083]
35–44		-0.094 [0.080]		-0.087 [0.080]
45–54		-0.144 [0.078*]		-0.144 [0.079*]
55–64		-0.160 [0.078**]		-0.158 [0.078**]
65–74		-0.207 [0.077***]		-0.213 [0.078***]
Over 75		-0.193 [0.081**]		-0.197 [0.081**]
Income (under 1500 omitted)				
1500–3000		0.042 [0.043]		0.035 [0.044]
3000–6000		0.070 [0.044]		0.065 [0.044]
Over 6000		0.037 [0.048]		0.034 [0.038]
City (under 5000 omitted)				
5000–20,000		0.058 [0.032*]		0.060 [0.031*]
20,000–100,000		0.084 [0.032***]		0.085 [0.031***]
100,000–500,000		0.120 [0.036***]		0.119 [0.035***]
Over 500,000		0.076 [0.035**]		0.072 [0.034**]
Household size		0.018 [0.011]		0.015 [0.011]
Employed		-0.032 [0.031]		-0.037 [0.031]
Years of education		0.020 [0.006***]		0.020 [0.006***]
East Germany		0.006 [0.026]		0.005 [0.026]
Below critical value (<i>una</i>)	42.04%	41.70%	39.94%	41.70%
Below critical value (<i>dis</i>)	40.87%	39.07%	38.18%	39.07%
# obs.	2520	2338	2388	2218

Notes: Dependent variable is the posterior standard deviation. For specifications (I) and (II) we drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. For (III) and (IV) we additionally exclude respondents whose change in the interquartile range is larger than the 95th percentile. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 8
Coefficient restrictions for the baseline results.

	Interquartile range				Standard deviation			
	I	II	III	IV	I	II	III	IV
$H_0 : una = dis$ for x_{p25}^{pre}	0.556	0.539	0.464	0.335	0.062	0.615	0.529	0.408
$H_0 : una = dis$ for x_{p50}^{pre}	0.961	0.875	0.939	0.800	0.652	0.839	0.910	0.734
$H_0 : una = dis$ for x_{p75}^{pre}	0.462	0.724	0.343	0.590	0.004	0.888	0.635	0.708

Notes: This table reports p -values for the hypothesis that the treatment effects of *una* and *dis* in the baseline specifications are equal. Formally, we test whether $\beta_{una} - \beta_{dis} + (\gamma_{una} - \gamma_{dis})x^{pre} = 0$. We test this for different percentiles of prior uncertainty.

Table 9
The effect on uncertainty (anchoring).

	Interquartile range		Standard deviation	
	I	II	III	IV
α	0.833 [0.033***]	0.831 [0.032***]	0.816 [0.033***]	0.828 [0.033***]
β_{una}	0.186 [0.053***]	0.187 [0.052***]	0.123 [0.037***]	0.135 [0.037***]
β_{dis}	0.270 [0.056***]	0.298 [0.054***]	0.187 [0.039***]	0.207 [0.038***]
β_{unadis}	-0.050 [0.055]	-0.022 [0.054]	-0.010 [0.038]	0.004 [0.038]
γ_{una}	-0.364 [0.042***]	-0.366 [0.041***]	-0.363 [0.042***]	-0.385 [0.042***]
γ_{dis}	-0.501 [0.049***]	-0.540 [0.049***]	-0.495 [0.049***]	-0.540 [0.049***]
γ_{unadis}	0.147 [0.045***]	0.106 [0.047**]	0.064 [0.045]	0.039 [0.048]
δ	0.041 [0.152]	0.59 [0.143]	0.011 [0.106]	0.027 [0.101]
α^{anc}	-0.085 [0.256]	-0.105 [0.241]	-0.073 [0.256]	-0.103 [0.244]
β_{una}^{anc}	0.070 [0.194]	0.061 [0.184]	0.066 [0.136]	0.051 [0.130]
β_{dis}^{anc}	-0.341 [0.218]	-0.349 [0.206*]	-0.225 [0.153]	-0.233 [0.146]
β_{unadis}^{anc}	-0.006 [0.216]	-0.037 [0.205]	-0.037 [0.151]	-0.055 [0.145]
γ_{una}^{anc}	-0.153 [0.306]	-0.146 [0.289]	-0.145 [0.307]	-0.120 [0.293]
γ_{dis}^{anc}	0.693 [0.307*]	0.683 [0.346*]	0.667 [0.369*]	0.670 [0.351*]
γ_{unadis}^{anc}	-0.004 [0.372]	0.059 [0.356]	0.120 [0.374]	0.170 [0.361]
Controls	✓	✓	✓	✓
Coefficient restrictions				
$\alpha + \alpha^{anc}$	0.749 [0.253***]	0.725 [0.238***]	0.743 [0.254***]	0.724 [0.242***]
$\beta_{una} + \beta_{una}^{anc}$	0.255 [0.186]	0.248 [0.176]	0.193 [0.131]	0.186 [0.124]
$\beta_{dis} + \beta_{dis}^{anc}$	-0.072 [0.211]	-0.051 [0.199]	-0.039 [0.148]	-0.026 [0.141]
$\beta_{unadis} + \beta_{unadis}^{anc}$	-0.056 [0.209]	-0.059 [0.198]	-0.047 [0.146]	-0.051 [0.141]
$\gamma_{una} + \gamma_{una}^{anc}$	-0.517 [0.303*]	-0.512 [0.286*]	-0.508 [0.305*]	-0.505 [0.290*]
$\gamma_{dis} + \gamma_{dis}^{anc}$	0.192 [0.364]	0.143 [0.343]	0.172 [0.365]	0.130 [0.347]
$\gamma_{unadis} + \gamma_{unadis}^{anc}$	0.143 [0.369]	0.166 [0.353]	0.185 [0.371]	0.209 [0.358]
# obs.	2338	2218	2388	2218

Notes: Dependent variables are the posterior interquartile range (I and II) and the standard deviation (III and IV). For all specifications we drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. For (II) and (IV) we additionally exclude respondents whose change in the interquartile range is larger than the 95th percentile. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at 1%, 5% and 10% levels.

Table 10
The effect on the interquartile range with skewness from question CM004.

	I	II	III	IV
α	0.628 [0.040***]	0.809 [0.030***]	0.788 [0.031***]	0.811 [0.030***]
β_{una}	0.079 [0.054]	0.192 [0.050***]	0.167 [0.050***]	0.192 [0.048***]
β_{dis}	0.163 [0.057***]	0.268 [0.049***]	0.264 [0.048***]	0.294 [0.048***]
β_{unadis}	-0.133 [0.056***]	0.008 [0.050]	-0.037 [0.050]	0.031 [0.049]
γ_{una}	-0.144 [0.051***]	-0.368 [0.039***]	-0.308 [0.045***]	-0.370 [0.039***]
γ_{dis}	-0.294 [0.059***]	-0.490 [0.040***]	-0.477 [0.041***]	-0.531 [0.040***]
γ_{unadis}	0.260 [0.057***]	0.034 [0.041]	0.094 [0.045**]	-0.001 [0.042]
Female		-0.022 [0.029]		-0.023 [0.028]
Age (under 25 omitted)				
25–34		-0.046 [0.119]		-0.069 [0.118]
35–44		-0.151 [0.114]		-0.146 [0.114]
45–54		-0.236 [0.113**]		-0.244 [0.112**]
55–64		-0.264 [0.112**]		-0.264 [0.111**]
65–74		-0.338 [0.112***]		-0.350 [0.111***]
Over 75		-0.319 [0.117***]		-0.327 [0.115***]
Income (under 1500 omitted)				
1500–3000		0.083 [0.062]		0.072 [0.062]
3000–6000		0.108 [0.063*]		0.100 [0.063]
Over 6000		0.073 [0.070]		0.068 [0.069]
City (under 5000 omitted)				
5000–20,000		0.100 [0.046**]		0.098 [0.045**]
20,000–100,000		0.127 [0.046***]		0.128 [0.045***]
100,000–500,000		0.169 [0.052**]		0.167 [0.051***]
Over 500,000		0.114 [0.050**]		0.109 [0.049**]
Household size		0.024 [0.016]		0.020 [0.016]
Employed		-0.053 [0.045]		-0.054 [0.044]
Years of education		0.033 [0.009***]		0.033 [0.009***]
East Germany		0.002 [0.038]		0.004 [0.037]
Below critical value (<i>una</i>)	n.a.	41.32%	41.32%	41.32%
Below critical value (<i>dis</i>)	39.19%	39.19%	39.19%	39.19%
# obs.	2520	2388	2388	2,2181

Notes: Dependent variable is the posterior interquartile range. We assume the prior distributions to have the same skewness as in question CM004. For specifications (I) and (II) we drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. For (III) and (IV) we additionally exclude respondents whose change in the interquartile range is larger than the 95th percentile. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 11
The effect on the standard deviation with skewness from question CM004.

	I	II	III	IV
α	0.787 [0.033***]	0.811 [0.032***]	0.793 [0.033***]	0.822 [0.032***]
β_{una}	-0.001 [0.035]	0.136 [0.035***]	0.114 [0.034***]	0.144 [0.035***]
β_{dis}	0.130 [0.037***]	0.167 [0.036***]	0.159 [0.038***]	0.189 [0.035***]
β_{unadis}	-0.040 [0.035]	-0.008 [0.035]	-0.031 [0.054]	0.003 [0.034]
γ_{una}	0.101 [0.042]	-0.379 [0.041***]	-0.311 [0.044***]	-0.399 [0.041***]
γ_{dis}	-0.341 [0.047***]	-0.444 [0.046***]	-0.417 [0.044***]	-0.499 [0.046***]
γ_{unadis}	0.114 [0.044**]	0.060 [0.044*]	0.102 [0.056*]	0.003 [0.035]
Female		-0.016 [0.020]		-0.017 [0.020]
Age (under 25 omitted)				
25–34		-0.016 [0.083]		-0.025 [0.083]
35–44		-0.094 [0.080]		-0.088 [0.080]
45–54		-0.145 [0.079*]		-0.146 [0.079*]
55–64		-0.162 [0.078**]		-0.159 [0.078**]
65–74		-0.210 [0.078***]		-0.214 [0.078***]
Over 75		-0.196 [0.081***]		-0.198 [0.081***]
Income (under 1500 omitted)				
1500–3000		0.041 [0.043]		0.034 [0.044]
3000–6000		0.069 [0.044]		0.063 [0.044]
Over 6000		0.036 [0.048]		0.033 [0.048]
City (under 5000 omitted)				
5000–20,000		0.059 [0.032*]		0.061 [0.031**]
20,000–100,000		0.084 [0.032***]		0.086 [0.031***]
100,000–500,000		0.120 [0.036***]		0.119 [0.036***]
Over 500,000		0.078 [0.055**]		0.074 [0.034**]
Household size		0.018 [0.011]		0.015 [0.011]
Employed		-0.032 [0.031]		-0.037 [0.031]
Years of education		0.020 [0.006***]		0.020 [0.006***]
East Germany		0.006 [0.026]		0.006 [0.026]
Below critical value (<i>una</i>)	41.70%	41.70%	41.70%	41.70%
Below critical value (<i>dis</i>)	39.82%	39.87%	39.18%	39.82%
# obs.	2520	2518	2388	2391

Notes: Dependent variable is the posterior standard deviation. We assume the prior distributions to have the same skewness as in question CM004. For specifications (I) and (II) we drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. For (III) and (IV) we additionally exclude respondents whose change in the interquartile range is larger than the 95th percentile. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 12
The effect on the interquartile range with skewness from the control group.

	I	II	III	IV
α	0.812 [0.033***]	0.831 [0.032***]	0.815 [0.033***]	0.830 [0.032***]
β_{una}	0.163 [0.049***]	0.193 [0.050***]	0.168 [0.050***]	0.195 [0.048***]
β_{dis}	0.216 [0.052***]	0.240 [0.052***]	0.234 [0.054***]	0.265 [0.050***]
β_{unadis}	-0.146 [0.056***]	-0.049 [0.050]	-0.082 [0.054]	-0.023 [0.050]
γ_{una}	-0.309 [0.042***]	-0.383 [0.041***]	-0.315 [0.048***]	-0.388 [0.041***]
γ_{dis}	-0.401 [0.049***]	-0.452 [0.048***]	-0.434 [0.056***]	-0.492 [0.048***]
γ_{unadis}	0.296 [0.045***]	0.141 [0.044]	0.184 [0.058**]	0.104 [0.047**]
Female		-0.016 [0.029]		-0.017 [0.028]
Age (under 25 omitted)				
25–34		-0.040 [0.119]		-0.061 [0.117]
35–44		-0.137 [0.114]		-0.134 [0.113]
45–54		-0.220 [0.112**]		-0.228 [0.111**]
55–64		-0.248 [0.111**]		-0.249 [0.110**]
65–74		-0.313 [0.111***]		-0.326 [0.110***]
Over 75		-0.287 [0.116***]		-0.297 [0.114***]
Income (under 1500 omitted)				
1500–3000		0.078 [0.062]		0.067 [0.061]
3000–6000		0.105 [0.063*]		0.096 [0.062]
Over 6000		0.068 [0.069]		0.063 [0.068]
City (under 5000 omitted)				
5000–20,000		0.089 [0.046*]		0.089 [0.044**]
20,000–100,000		0.124 [0.046***]		0.124 [0.044***]
100,000–500,000		0.166 [0.052***]		0.166 [0.050***]
Over 500,000		0.107 [0.050**]		0.102 [0.048**]
Household size		0.023 [0.016]		0.019 [0.015]
Employed		-0.047 [0.044]		-0.054 [0.043]
Years of education		0.030 [0.009***]		0.030 [0.009***]
East Germany		-0.001 [0.038]		0.004 [0.037]
Below critical value (<i>una</i>)	41.29%	41.29%	41.29%	41.29%
Below critical value (<i>dis</i>)	38.92%	38.92%	38.92%	38.92%
# obs.	2520	2518	2388	2391

Notes: Dependent variable is the posterior interquartile range. We assume the prior distributions to have the average skewness of our control group. For specifications (I) and (II) we drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. For (III) and (IV) we additionally exclude respondents whose change in the interquartile range is larger than the 95th percentile. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 13
The effect on the standard deviation with skewness from the control group.

	I	II	III	IV
α	0.789 [0.033***]	0.813 [0.033***]	0.795 [0.033***]	0.825 [0.033***]
β_{una}	-0.002 [0.035]	0.135 [0.035***]	0.114 [0.034***]	0.142 [0.034***]
β_{dis}	0.122 [0.036***]	0.159 [0.036***]	0.149 [0.038***]	0.184 [0.035***]
β_{unadis}	-0.044 [0.035]	-0.013 [0.035]	-0.036 [0.038]	-0.000 [0.035]
γ_{una}	0.139 [0.042]	-0.381 [0.041]	-0.312 [0.045***]	-0.403 [0.041***]
γ_{dis}	-0.320 [0.049***]	-0.428 [0.048***]	-0.391 [0.056***]	-0.487 [0.048***]
γ_{unadis}	0.127 [0.045**]	0.072 [0.044*]	0.115 [0.058*]	0.049 [0.047]
Female		-0.015 [0.020]		-0.016 [0.020]
Age (under 25 omitted)				
25-34		-0.016 [0.083]		-0.025 [0.083]
35-44		-0.093 [0.080]		-0.087 [0.080]
45-54		-0.144 [0.078*]		-0.145 [0.079*]
55-64		-0.160 [0.078**]		-0.157 [0.078**]
65-74		-0.207 [0.078***]		-0.213 [0.077***]
Over 75		-0.193 [0.081**]		-0.196 [0.081**]
Income (under 1500 omitted)				
1500-3000		0.042 [0.043]		0.035 [0.044]
3000-6000		0.070 [0.044]		0.065 [0.044]
Over 6000		0.037 [0.048]		0.034 [0.048]
City (under 5000 omitted)				
5000-20,000		0.058 [0.032*]		0.060 [0.031*]
20,000-100,000		0.084 [0.032***]		0.085 [0.031***]
100,000-500,000		0.120 [0.036***]		0.119 [0.035***]
Over 500,000		0.076 [0.035**]		0.072 [0.034**]
Household size		0.018 [0.011]		0.015 [0.011]
Employed		-0.032 [0.031]		-0.037 [0.031]
Years of education		0.020 [0.006***]		0.197 [0.006***]
East Germany		0.006 [0.026]		0.005 [0.026]
Below critical value (<i>una</i>)	41.70%	41.70%	41.70%	41.70%
Below critical value (<i>dis</i>)	39.97%	39.97%	39.97%	39.97%
# obs.	2520	2518	2388	2391

Notes: Dependent variable is the posterior standard deviation. We assume the prior distributions to have the average skewness of our control group. For specifications (I) and (II) we drop responses that put 100% probability on the outer bins (more than 12% inflation/deflation) and responses of more than 100% deflation and inflation for the min and max expectations. For (III) and (IV) we additionally exclude respondents whose change in the interquartile range is larger than the 95th percentile. The estimates are based on Huber robust regressions and also include a constant. ***, ** and * denote significance at the 1%, 5% and 10% level.

Data availability

The authors do not have permission to share data.

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