Owner-occupied housing costs, policy communication, and inflation expectations*

Joris Wauters
National Bank of Belgium

Zivile Zekaite
Central Bank of Ireland

Garo Garabedian
Central Bank of Ireland

9th February 2024

Draft

Abstract

The ECB concluded its strategy review in 2021 with a plan to include owner-occupied housing (OOH) costs in its inflation measure in the future. This paper uses the Bundesbank's online household panel to study how household expectations would react to this change. We conducted a survey experiment with different information treatments and compared long-run expectations for euro area overall inflation, interest rates, and OOH inflation. Long-run expectations are typically higher for OOH inflation than overall inflation, and both are unanchored from the ECB's target at the time of the survey. We find significantly higher inflation expectations under the treatment where OOH costs are assumed to be fully included in the inflation measure. This information effect is heterogeneous as, among others, homeowners and respondents with low trust in the ECB react more strongly. However, inflation expectations remain stable when information about past OOH inflation is also given. Careful communication design could thus prevent expectations from becoming more de-anchored.

JEL classification: D83, D84, E31, E50
Keywords: Owner-occupied housing, survey experiment, inflation expectations, ECB.

*e-mails: giuseppe.corbisiero@centralbank.ie, garo.garabedian@centralbank.ie, gert.peersman@ugent.be, joris.wauters@nbb.be, zivile.zekaite@centralbank.ie. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Central Bank of Ireland, the National Bank of Belgium, or the Eurosystem. We thank Giuseppe Corbisiero, Bruno De Backer, Gabriele Galati, Gert Peersman, Cian Ruane, Reamonn Lydon, Fons van Overbeek, and participants at the CBI seminar, the IEA, EcoMod, and ifo Conference on Macroeconomics and Survey Data for their comments and suggestions.

1 Introduction

The European Central Bank (ECB) and euro area national central banks have recently completed an extensive strategy review of all aspects of monetary policy. One of its key findings is that housing costs are very important to households when thinking about inflation. According to surveys with citizens, increases in the cost of housing (i.e., purchase prices, accommodation costs, and rent) are the most salient price changes. Moreover, most respondents confirmed that housing costs are relevant when measuring inflation (ECB, 2021b; Wauters, 2021).

This finding contrasts with how the ECB's main harmonised index of consumer prices (HICP) is constructed. While the HICP includes rents, it excludes most *owner-occupied housing (OOH)* costs. These costs are associated with owning, maintaining, and living in one's home (see Section 3). Accordingly, the strategy review concluded with a recommendation to take into account all OOH costs in the main inflation measure. In addition, a roadmap was designed for a multi-year project to include OOH costs in the HICP, such that it better represents the inflation rate experienced by households (ECB, 2021c).

However, announcing the inclusion of OOH costs could affect inflation expectations. House prices have increased substantially in the years before our survey, which took place in July 2022, more so than overall and OOH cost inflation.[1] Economic agents might infer from house price dynamics that the ECB's OOH policy, i.e., fully incorporating OOH costs in the HICP, would raise overall inflation. Indeed, a special survey after the strategy review finds that most professional forecasters (about 60%) would raise the level and uncertainty of their long-term inflation expectations for the euro area in case OOH costs were fully included in the HICP (Meyler et al., 2021).

This evidence is worrying from a monetary policy perspective because it suggests that OOH policy could de-anchor inflation expectations from the (unchanged) inflation target of 2%. But while the above qualitative evidence gives a first indication, it lacks a quantitative measure of the impact. Moreover, it remains unclear whether households would adjust their expectations and if the central bank's communication design can play a role. Our paper aims to address these gaps.

To this end, we implemented a survey experiment using the Bundesbank's online household survey. During the July 2022 wave, we randomly divided the sample into four groups and presented each with different information treatments on OOH policy. The first treatment group, our 'baseline', only received general information about the ECB's inflation target and no information about OOH. The second group was informed of the current policy regarding OOH costs: it received the baseline text and was also told that most OOH costs are currently

[1] For example, during the five years before the survey (2017Q3-2022Q2), the average annual growth of euro area HICP was 2%, while for OOH costs and house prices, it was 4.1% and 5.8%, respectively.

not included in the HICP. The third treatment group received the same information as the second group but was instructed to assume that the ECB includes OOH costs in HICP as of today. Finally, the fourth group received the same text as the third group, as well as a sentence stating that the average OOH inflation was 2.2% in the ten years before the survey.

Next, all respondents received the same three questions. We asked them to convey the distribution of their long-term expectations for overall inflation and OOH cost inflation in the euro area ten years ahead (i.e., the year 2032) across six defined bins. Based on these distributions, we infer the implied mean and uncertainty for each individual. In addition, respondents were asked how they thought interest rates would be relative to today (much lower,..., much higher) at the same long-term horizon.

We use regression methods to estimate average treatment effects that compare the mean expectation and uncertainty across groups. In the next step, we use mediation analysis to gauge how much the differences in OOH inflation expectations explain the differences in overall inflation expectations. Intuitively, the long-run expectation for overall inflation can be considered a weighted average of long-run expectations for OOH and non-OOH inflation. The average treatment effect could thus come from different expectations for the subcomponents or a shift in the implicit weight on OOH inflation. Finally, we use subsample regressions to explore whether the average treatment effects are heterogeneous across different types of respondents.

We find four main results. First, at the time of the survey, inflation expectations of German households are poorly anchored at the ECB's target of 2%. Across the four treatment groups, about 20% probability weight is given to inflation outcomes above 5% in ten years. The average probability weights are also much lower for outcomes below 2% than above 2%. This finding echoes Galati et al. (2022b), who recently found that long-term inflation expectations of Dutch households are not anchored for the euro area or the Netherlands. We also provide novel evidence that households' long-term OOH inflation expectations tend to be above those for overall inflation, with more weight given to high inflation outcomes (close to 30%).

Second, providing information on OOH policy scenarios impacts long-term inflation expectations. Specifically, the third group, which is asked to assume the ECB includes OOH costs in the HICP as of today, has significantly higher long-term inflation expectations than the first two (baseline and current policy) groups. However, this effect is reversed for the fourth group, which receives the same information as the third group, plus the average of past OOH cost inflation. Relative to the third group, the fourth group has significantly lower averages for overall and OOH cost inflation and significantly lower uncertainty for overall inflation.

Third, our mediation analysis finds that variation in OOH inflation expectations explains

only a minor part of the differences in overall inflation expectations between treatment groups. Instead, the estimated 'direct' treatment effects, which hold OOH expectations constant, explain the bulk of the average treatment effect. We argue that between-group differences in inflation expectations for non-OOH components mainly drive this channel. Intuitively, respondents appear to interpret the implementation of OOH cost inclusion such that the 2% target becomes less credible, which impacts long-term inflation expectations for all HICP components.

Fourth, the treatment effects appear heterogeneous across the population. There are significant effects on overall inflation expectations for homeowners, those reporting before our survey to have low trust in the ECB's ability to meet its price stability objective, the low-educated, those with low income, and men. Homeowners' OOH inflation expectations also react significantly. Although we find no treatment effects on average for interest rate expectations, this changes in subgroup analyses. Respondents informed on OOH policy and average past OOH inflation show significantly higher long-term interest expectations (relative to baseline) when they are a homeowner, are highly educated, are high-income, have high trust in the ECB, or are male.

We contribute to the literature by being the first to study the potential impact of the ECB's OOH policy on households' long-term inflation expectations and measure households' OOH inflation expectations for the euro area. The policy implication of our results is that, at the time of the survey, households generally lack trust that the ECB will achieve its inflation target, and this de-anchoring could be worsened by announcing the inclusion of OOH costs in inflation measurement. Moreover, this effect depends on the respondent's characteristics. However, careful communication design could prevent further de-anchoring, as adding information on average past OOH inflation avoids an upward impact on inflation expectations when assuming the inclusion of OOH costs in the HICP measure.

The paper proceeds as follows. Section 2 reviews related literature. Subsequently, Section 3 provides background information on OOH cost inflation and the ECB's policy plans. Section 4 describes the methodology of our survey experiment. The following three sections describe our results. We first discuss the main treatment effects in Section 5, followed by the mediation analysis (Section 6) and an exploration of heterogeneity in the treatment effects (Section 7). Finally, Section 8 concludes.

2 Related literature

Our work, which centres around a novel survey experiment, connects to several strands of the literature studying inflation expectations with survey data (D'Acunto et al., 2022).

By focusing on long-term inflation expectations, we contribute to existing studies on the *anchoring of inflation expectations*. Galati et al. (2022b) report that Dutch consumers' long-term inflation expectations for the euro area and the Netherlands are elevated and not well anchored around the ECB's inflation target. However, providing information about current and past inflation and the ECB target may help influence long-run expectations. Using a German household survey, Hoffmann et al. (2022a) analyse the effects of ECB communication on inflation expectations. They show that while expected inflation tends to decline across horizons at the time of the survey (March 2022), longer-term expectations signal risks that inflation would remain above the ECB's target for some time. Similarly, US consumers are shown to have longer-term inflation expectations inconsistent with the Federal Reserve's inflation target. However, providing information about the inflation target and past inflation helps to align expectations better with the central bank's aim (Binder and Rodrigue, 2018).

We also contribute to the recent literature that analyses the effects of (both actual and hypothetical) *changes in the monetary policy strategy on consumers' economic expectations*. Coibion et al. (2021) show that US consumers were mostly unaware of the Federal Reserve's strategy change to the average inflation targeting (AIT). Even after being directly informed about it, they did not appear to be affected by the change. Similarly, Galati et al. (2022a) demonstrate that clarifying the symmetric ECB's inflation target at the end of its monetary policy strategy review had no impact on Dutch consumers' long-term expectations and only limited effects on their short-term expectations. However, as actual inflation rose well above the target, short-term and long-term expected inflation also increased.

In contrast, Ehrmann et al. (2023) show that even though the general public largely missed the announcement of the ECB's Strategy Review outcomes, communicating and explaining the inflation target and the ECB strategy can enhance its public credibility in achieving its inflation target. Hoffmann et al. (2022b) argue that German consumers can understand the difference between an AIT regime and the current ECB monetary policy strategy. They show that consumers revise their inflation expectations accordingly under the hypothetical switch to the AIT regime. Moreover, the change in the ECB's inflation target to 2% (previously 'below but close to 2%') may have raised medium-term inflation expectations among German consumers (Hoffmann et al., 2021).

Our findings are also relevant for *central bank communication with the general public*. Bholat et al. (2019) demonstrate that using simple language and relatable messages improves the public's understanding of central bank communications and establishes more trust in central banks. Communication about the medium-term inflation outlook by central banks influences the inflation expectations of households, especially over shorter horizons. Hoffmann et al. (2022a) show that the ECB's communication effectively lowers above-target inflation expectations, with qualitative information having a greater impact than quantitative inform-

ation. However, Dräger et al. (2022) find that providing numeric inflation forecasts from the ECB's Survey of Professional Forecasters has a greater impact on inflation expectations than the central bank (qualitative) communication about the temporary nature of inflation.

Finally, our empirical analysis also relates to the literature on *survey house price expectations* since we ask about OOH cost inflation expectations, which relate to price developments in housing markets. Kuchler et al. (2022) review determinants of house price expectations. Socio-demographic characteristics and geographic location can explain house price expectations only to some extent. Other important determinants are recent house price developments, personal experiences, homeownership status, and social network information. Armona et al. (2019) find that information about house price growth influences consumers' house price expectations. A comparison of revisions in short-term and long-term expectations shows that respondents do not expect a mean reversion in house prices. House price expectations are also found to influence investment decisions. Kindermann et al. (2021) show that housing tenure strongly predicts house price expectations, with renters having higher house price expectations than homeowners. They also highlight the role of geographic location, with higher expectations in large cities.

3 OOH cost inflation and euro area policy: a primer

The ECB's price stability objective is 2% inflation, measured as the year-on-year percentage change in the HICP price index over the medium term. While rents paid for housing are a part of the consumer basket, most owner-occupier housing (OOH) costs are not. OOH costs are expenses associated with owning, maintaining, and living in one's home.

The ECB's first strategy review in 2003 recognised the benefits of including OOH costs, concluding that "*the inclusion of owner-occupied housing services in the HICP is desirable*"; however, due to practical and conceptual challenges, the main inflation measure was not changed (Issing, 2003). The second strategy review from 2020-2021 reaffirmed this message using online 'listens portals' with citizens. Indeed, housing costs are critical to households: when asked for which types of goods and services citizens feel the effects of price changes the most, the modal reply was an increase in the cost of housing (i.e., purchase prices, accommodation costs, and rent). Moreover, an overwhelming majority confirmed that housing costs are a relevant component of inflation (ECB, 2021b; Wauters, 2021). As a result, the recent strategy review recommended including OOH costs in the HICP in the future.

Yet, the inclusion of OOH costs into the HICP faces challenges. First, the inclusion has to conform to the HICP framework, which exclusively considers *actual monetary transactions* for *consumption.* Although an owned dwelling offers consumable housing services (e.g., shelter),

it also contains an investment component in the form of the non-depreciable land on which the dwelling rests. Ideally, the cost of the asset component should not be present in the consumer price index. Second, the inclusion should meet the HICP requirements regarding its monthly frequency and timeliness of data release, with the flash estimate being available at the end of the reference months and the final release of data two weeks after.

The recent strategy review's work stream on inflation measurement considered candidate methods for OOH inclusion into the HICP (Nickel et al., 2021, Section 4). Based on this analysis, the ECB's latest monetary policy strategy recommended using the net acquisition (NA) method. This method covers the *costs associated with acquisition (or construction) and maintenance of an owner-occupied property, such as transaction fees and taxes, dwelling insurance, major renovations and repairs*.[2] It treats a dwelling as a durable good that is part asset (land) and part consumable (structure), and measures the costs using a market price at the point of purchase. The NA method's main strength is its congruence with the HICP framework: it is based on actual monetary transactions and excludes transactions between households by focusing on dwellings new to the household sector. By contrast, its main disadvantage is that it contains an asset price (or 'investment') component.

The ECB therefore supported further research to better isolate the consumption component and proposed a roadmap based on four main steps (ECB, 2021a). As the first step, an internal analytical HICP would be adopted, which includes OOH with approximated weights. This computation would use the quarterly owner-occupied housing costs price index (OOHPI), which Eurostat (i.e., the European Statistical Office) created based on the NA approach (European Commission, 2018).[3] Based on the existing OOHPIs, Eurostat would aim to deliver an experimental quarterly HICP that includes OOH costs in the second step. Once all necessary legal work has been completed in the third step, this index would become an official quarterly HICP that includes OOH costs. Finally, the fourth step would aim to include OOH costs in the HICP at a monthly frequency and in a timely manner.[4] Since achieving these four steps requires time, the ECB Governing Council's monetary policy assessments would, in the meantime, include OOH costs in its wider set of supplementary inflation indicators.

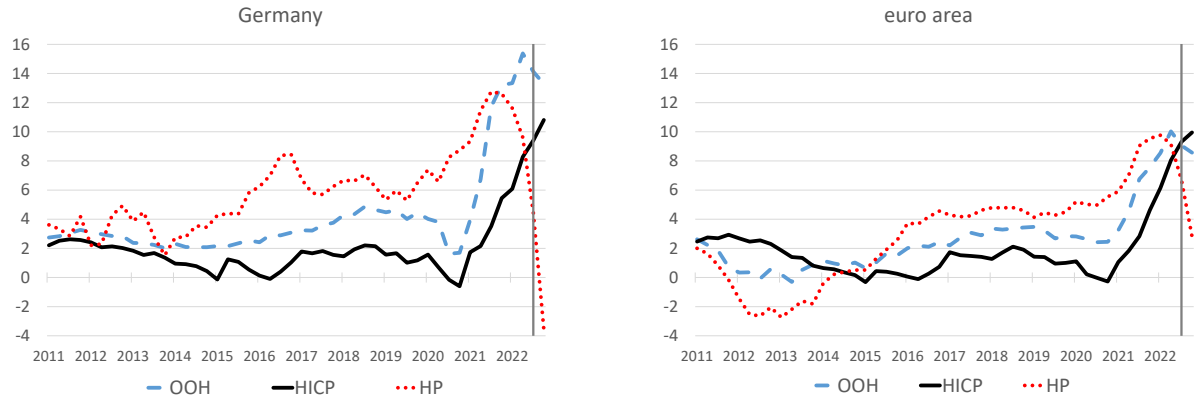
To what extent would the inclusion of OOH costs affect overall HICP inflation? Figure 1 shows inflation rates for HICP, OOH costs, and the house price index (HP) for Germany and the euro area. Between 2014 and 2022, house price inflation was highest in both regions, followed by OOH inflation and HICP inflation. OOH inflation lies closer to HICP inflation

[2]Note that the HICP currently covers routine maintenance, minor repairs and other running costs (e.g. water supply, refuse and sewage collection, electricity, gas, and other fuels.) for both tenants and owner-occupiers.

[3]All euro area countries except Greece currently compile quarterly OOHPIs, and a euro area index is available. The series is released around one quarter and one week after the end of the reference quarter, thus falling short of the high frequency and timeliness standards of the HICP.

[4]For more details on legal and practical implementation steps, see Eiglsperger et al. (2022).

Figure 1: Year-on-year inflation rates (%, quarterly frequency) of OOH costs, HICP, and house prices:



Notes: The figure shows the year-on-year growth (%, quarterly frequency) of the owner-occupied housing price index (OOH), the Harmonised Index of Consumer Prices (HICP), and the house price index (HP) for Germany (left-hand side panel) and the euro area (right-hand side panel). The vertical grey line marks the quarter in which our survey took place (2022Q3). Final observation: 2022Q4. Sources: ECB Statistical Data Warehouse and Eurostat.

than house price inflation because it includes items other than new house purchase prices (and excludes transactions between households of, e.g., existing dwellings). According to work from the inflation measurement work stream and ECB staff, over the past ten years, the average gap between HICP and HICP with OOH (using a 9% weight) would have been small, peaking at only 0.3 p.p. between 2011 and 2021 (Nickel et al., 2021; Eiglsperger et al., 2022).[5]

While OOH inclusion may have a relatively limited impact on inflation (partly due to the OOHPI's modest weight in the overall consumer basket), this may not hold for inflation *expectations*. For instance, our survey experiment took place in July 2022 following a bout of strong growth in German house price inflation and just before house prices started to decline in 2022Q4 (see Figure 1). So, if economic agents perceive house price inflation as representing OOH inflation, then the announcement of OOH cost inclusion might de-anchor inflation expectations.

Indeed, a recent special ECB survey of professional forecasters gave preliminary evidence on how the inclusion of OOH costs could affect expectations (Meyler et al., 2021). When asked how the inclusion of OOH costs in the HICP would affect their long-term inflation expectations for the euro area, most forecasters (about 60%) indicated raising its level and

[5]The largest difference for HICP excluding energy and food would be 0.6 p.p. The average gap is also likely to have been small even if looking further back until 1999 (using backcast OOHPI series from the inflation measurement work stream).

uncertainty. Hence, these results hint that the ECB might lack credibility to steer HICP augmented with OOH costs to its inflation target. However, the evidence is qualitative and lacks an estimate of the impact size. To the best of our knowledge, households' inflation expectations have also not yet been analysed on this matter. In the next sections, we aim to address these gaps.

4 Methodology

4.1 Deutsche Bundesbank survey on consumer expectations

Our survey was implemented using the Bundesbank Online Panel Households (BOP-HH), an online and rotating panel survey of individuals in Germany aged 16 years or older.[6] This survey started in 2019 and has been held monthly since April 2020. The questionnaires contain core questions, repeated in every wave, and wave-specific questions. The survey collects information on individuals' expectations regarding the development of inflation, house prices and interest rates in Germany, as well as their past and planned expenditures and socio-demographic characteristics.

Our questions were implemented in July 2022 (i.e., Wave 31).[7] In addition to the answers to our three proposal questions, we include household-level information from the standard questionnaire in our analyses to explore potential heterogeneity. Our full sample for that month contains 4,538 observations.

The Bundesbank provides survey weights to ensure that the sample is representative of the German population. All summary statistics and regressions reported below take into account these survey weights.

4.2 Survey experiment

Our survey experiment divides the sample randomly into four 'treatment' groups, labelled T1 to T4. Each group received a different information treatment before being asked to respond to our three questions, which are the same for all respondents. We thus implement a 'between-subjects' survey design to compare the average responses across different treatment groups.

[6]For more information, see https://www.bundesbank.de/en/bundesbank/research/survey-on-consumer-expectations and Beckmann and Schmidt (2020).

[7]The full questionnaires for all waves are available on the Bundesbank's consumer survey webpage in English and German, the latter being the language in which the survey was implemented.

Randomised information treatments. Our information treatments are based on four pieces of text, which are:

1. *The European Central Bank (ECB) is the central bank of the 19 countries in the euro area. It aims for an inflation rate*[8] *of 2% over the medium term. The main inflation rate in the euro area is determined by changes in the prices of goods and services in a representative consumption basket over time.*

2. *The calculation of this inflation rate does not take into account changes in most owner-occupied housing costs*[9]*.*

3. *The ECB recommends that these costs be taken into account in the future when calculating the inflation rate. For the following three questions, please assume that these costs will be taken into account from now on.*

4. *Over the past ten years, the average price increase in the costs of owner-occupied housing in the euro area was 2.2%.*

Group T1 is our 'baseline' group that receives only general information about the ECB and its inflation target in the first text segment. Group T2 receives the first two pieces of text and is told that OOH costs are only partially included in the HICP ('current policy'). By comparing the responses of T2 to T1, we can gauge whether the information that OOH costs are largely omitted in the current inflation measure is known to households, i.e., how it affects their expectations if it is new and relevant information to them.

Group T3 receives the first three pieces of information and is asked to assume that OOH costs are fully included in HICP as of today ('OOH policy'). In this scenario, the composition of the consumption basket changes, but the inflation target remains unchanged at 2%. Therefore, we expect that this scenario should not affect long-term inflation expectations if the achievement of the ECB's target is credible. By contrast, a shift in long-term inflation expectations due to a change in the price index composition would signal a loss in the central bank's credibility.

Finally, group T4 receives all four text segments ('OOH policy + mean'). Like group T3, these respondents are asked to assume that the OOH policy is in place. However, they also

[8] After the term 'inflation rate' an optional info box with the following definition is shown: "Inflation is the percentage increase in the general price level. It is mostly measured using the consumer price index. A decrease in the price level is generally described as deflation."

[9] After the term 'owner-occupied housing costs', another optional info box is shown: "The costs of owner-occupied housing comprise all expenditure on an apartment or house. In particular, these are the costs for the purchase or construction of a property and the maintenance of owner-occupied property (e.g. renovation and major repairs)." This info box is also available in our third question.

learn that OOH inflation was, on average, 2.2% in the euro area during the ten years before the survey's launch.[10] We conjecture that this value is lower than what respondents expected on average, which may reinforce the credibility of the ECB's ability to achieve its inflation target.

Survey questions. We ask all respondents the same three questions about long-term expectations for overall inflation, interest rates, and OOH cost inflation in the euro area. Similar to Galati et al. (2022b), the long term is defined as ten years ahead. The first question and its response categories (in bullets) are:

> ***Question 1:*** *How likely do you think it is that the* ***euro area*** *inflation rate will change as follows in ten years' time, i.e. in 2032?*

- Deflation or inflation of less than 1%
- Inflation between 1% and less than 2%
- Inflation between 2% and less than 3%
- Inflation between 3% and less than 4%
- Inflation between 4% and less than 5%
- Inflation of 5% or more

For this question and the third question on OOH cost inflation, respondents were asked to assign probability weights over the listed range of possible outcomes, which had to add up to 100%. By asking for a probability distribution rather than a point forecast, we can infer the uncertainty around the implied mean and the perceived probability that inflation would fall within (or outside) a range around the 2% target of the ECB. A potential drawback is that respondents might perceive this structure as complicated. Therefore, we limited the number of answer bins to six for simplicity.[11]

Our next two questions intend to study the transmission channels of the policy change: Is a treatment effect on inflation expectations driven by its induced changes in expected OOH cost inflation or expected interest rates (or both)? Question 2 focuses on interest rates and has a single-choice response option.

[10] Data on OOH cost inflation is available at the quarterly frequency and with a lag. The 2.2% average applies to 2012Q1-2021Q4 and reflects the latest available data when preparing the survey.

[11] In the end, response rates were high, namely 95% for the first and third questions focusing on the distribution of expected (OOH) inflation and 98% for the second question on interest rates, which has a more basic format.

Question 2: *Do you think that* ***euro area*** *interest rates will be lower, the same or higher than they are today in ten years' time, i.e. in 2032, as a result of monetary policy? They will be...?*[12]

- Significantly lower (- -)
- Somewhat lower (-)
- About the same (=)
- Somewhat higher (+)
- Significantly higher (+ +)

Our third question focuses on the distribution of OOH inflation expectations and has the same response categories as question 1:

Question 3: *How likely do you think it is that the costs of owner-occupied housing* ***in the euro area*** *will change as follows in ten years' time, i.e. in 2032?*

Our survey relates to Meyler et al. (2021), who asked professional forecasters *qualitatively* if they would lower, raise, or leave their long-term inflation expectations unchanged after the ECB includes OOH costs in HICP. We expect that professional forecasters were more aware of the current policy strategy at the time of the special ECB survey than households. Therefore, our information treatments include varying degrees of information on OOH policy to provide a *quantitative* measure of how much households react.

Our questions focus on the euro area, while the standard questions of the Bundesbank survey concern developments in Germany. Yet, as discussed in Section 5, we exploit the information from the standard questions in our analyses to enhance estimation precision. For example, people with above-average long-term inflation expectations for Germany also tend to have above-average long-term inflation expectations for the euro area. German inflation expectations can thus measure 'pre-treatment characteristics' (or proxy for their 'prior' belief about euro area inflation expectations), which can be used in a regression model.

4.3 Derivation of implied means and uncertainty

Our regression analyses below use implied means from the probabilistic responses to our questions on (OOH) inflation expectations. We derive these means using a simple 'mass at

[12]Respondents received the following note: 'Monetary policy influences the cost of borrowing. Higher interest rates mean higher borrowing costs. Lower interest rates mean that it is cheaper to borrow money.'

mid-point' method, which computes a weighted average of the central points of the intervals (see, e.g., Dovern and Kenny, 2020; Rondinelli and Zizza, 2020; D'Acunto et al., 2022). Specifically, each individual's mean (OOH) inflation expectation y_i is

$$y_i = \sum_{j=1}^{6} p_{ij} C_j \quad \forall i, \tag{1}$$

where p_{ij} denotes the subjective probability weight given by individual i to bin j, and C_j is the midpoint of bin j. We assume the tail intervals in the probability distributions are twice as wide as middle intervals, i.e., 2 percentage points. This adjustment accounts for the first bin potentially capturing negative values. Hence, the midpoints $(C_1, ..., C_6)$ for the six bins in Questions 1 and 3 are (0, 1.5, 2.5, 3.5, 4.5, 6).[13]

We calculate long-term (OOH) inflation uncertainty based on the variance of the subjective probability distribution, var_i, of each individual (e.g., Dovern and Kenny, 2020)[14]:

$$var_i = \sum_{j=1}^{6} p_{ij} \left(y_i - C_j\right)^2 \quad \forall i. \tag{2}$$

5 Average treatment effects

This section first provides a descriptive analysis of the average subjective probability distributions of long-term expectations for overall inflation, OOH cost inflation, and interest rate expectations across the four treatment groups. We then estimate the treatment effects using regression analyses.

5.1 Descriptive analysis

Overall inflation expectations. Figure 2a plots the average subjective probability distribution of euro area inflation expectations for the four treatment groups, with the 95% confidence intervals. The average probability of inflation falling between 1% and 3% is around 30%, while the average probability assigned to the inflation rate of 4% or above exceeds 40%. On average, long-term inflation expectations are inconsistent with the inflation target at the time of the survey, possibly due to the high inflation environment in the years before the

[13] As in D'Acunto et al. (2022), we find that the computed means are similar to those derived by fitting a generalised Beta distribution to the subjective density (see Engelberg et al., 2009). We used the R code of Krüger and Pavlova (2022) for this comparison. Their code is available at https://github.com/FK83/forecasthistogram.

[14] We obtain similar measures based on the Expected Ranked Probability Score (EPRS) method of Krüger and Pavlova (2022), which requires no functional form assumptions due to its ordinal interpretation of the survey outcome categories.

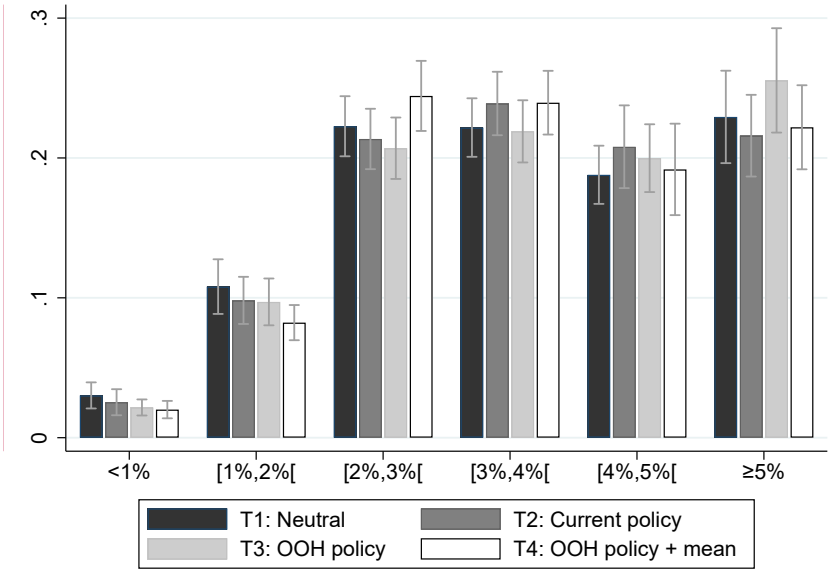
survey. Similarly, Galati et al. (2022b) find that Dutch consumers' expectations of euro area and Dutch inflation ten years ahead are not well anchored at the ECB's target (surveys from Dec 2019 to Sep 2020), while Hoffmann et al. (2022b) report German consumers' expectations to be well-anchored around the inflation aim (surveys in Oct 2020 and Jan-Feb 2021).

The probability assigned to high inflation outcomes (i.e., 5% or more) is the largest when respondents are asked to assume that OOH costs are included in the inflation measure as of today (treatment T3). However, additional information on average past OOH cost inflation (under treatment T4) lowers the probability of high inflation outcomes and increases the mass in the two central bins that include inflation rates between 2% and 4%. Following Hoffmann et al. (2022b), we test the joint and bin-by-bin differences between the probability distributions for all treatment pairs using the t-test and the Hotelling (1931) test. Overall, there is some tentative evidence of differences between groups T1, T3, and T4. These results are shown in Appendix Table A.1.

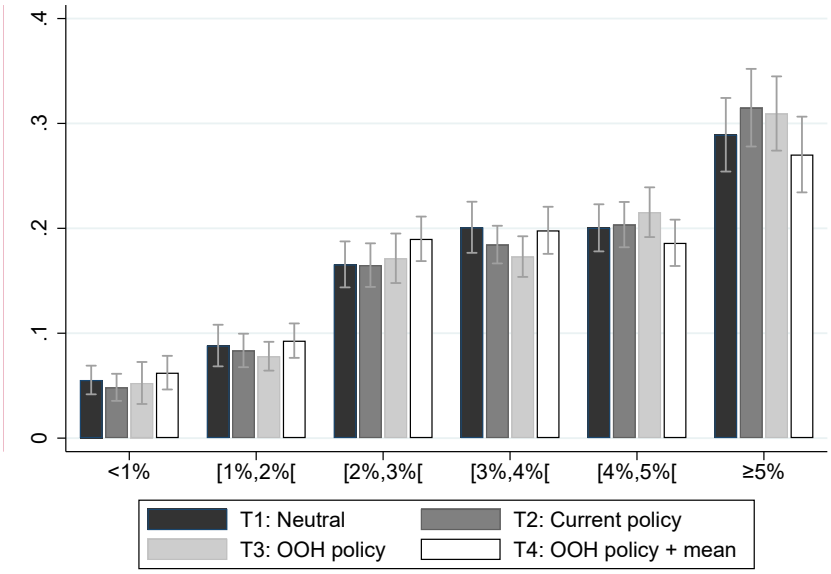
OOH inflation expectations. OOH inflation expectations are generally higher than overall inflation expectations for all the groups (Figure 2b). The range consistent with the 2% inflation target is given a probability of less than 30%, which is lower than in the case of inflation expectations. The highest probability is always assigned to rates of 5% or more, at around 30%. Again, under treatment T4 ('OOH policy + mean'), high inflation outcomes ($\geq 4\%$) are deemed less likely than under treatment T3, while 2%-4% OOH inflation rates are more likely. Based on the statistical tests, we find very little evidence of significant differences between treatment groups (see Appendix Table A.1).

Figure 2: Average distribution of long-term inflation expectations by treatment group

(a) Overall inflation expectations for 2032



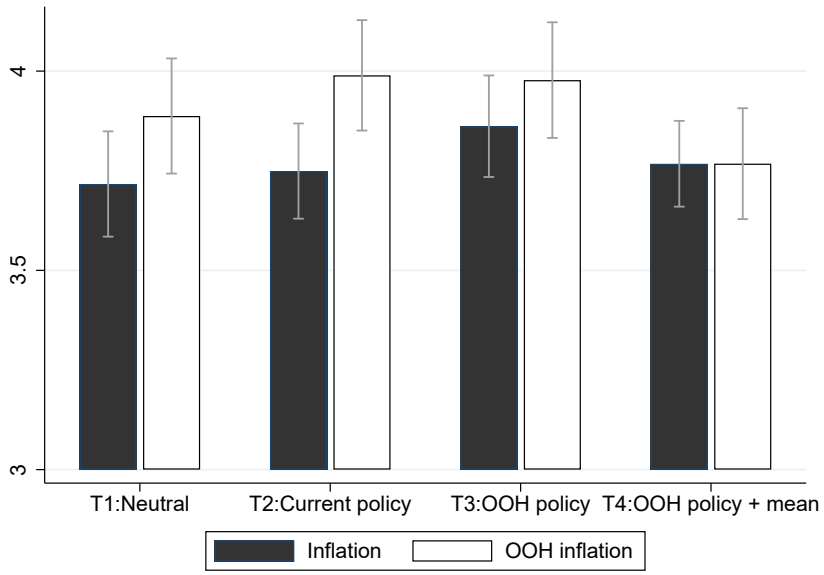
(b) OOH inflation expectations for 2032



Notes: Average subjective probability distributions of long-term expectations for overall inflation from Question 1 (panel a) and OOH inflation from Question 3 (panel B), together with 95% confidence intervals. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. The p-values for the t and *Hotelling* tests are provided in Appendix Table A.1.

Implied means for questions Q1 and Q3. We follow the methodology described in Section 4 to create the series of mean expected (OOH) inflation rates based on each individual's subjective probability distribution. Then, average treatment group expectations are derived from individual means. Figure 3 shows these mean expectations and their 95% confidence bands. Average inflation expectations are highest for group T3 ('OOH policy'), while for groups T2 ('current policy') and T4 ('OOH policy + mean'), the averages are only a bit above that from baseline group T1. Average OOH expectations increase from T1 to T2, are similar between groups T2 and T3, and decline for T4 to the lowest average. Average OOH inflation expectations are higher than average inflation expectations in the first three treatments but not in the T4 group, where they are the same.[15]

Figure 3: Mean expected inflation and OOH inflation by treatment group



Notes: Implied mean (OOH) inflation expectations are shown based on the computed averages from the individual probability distributions. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation.

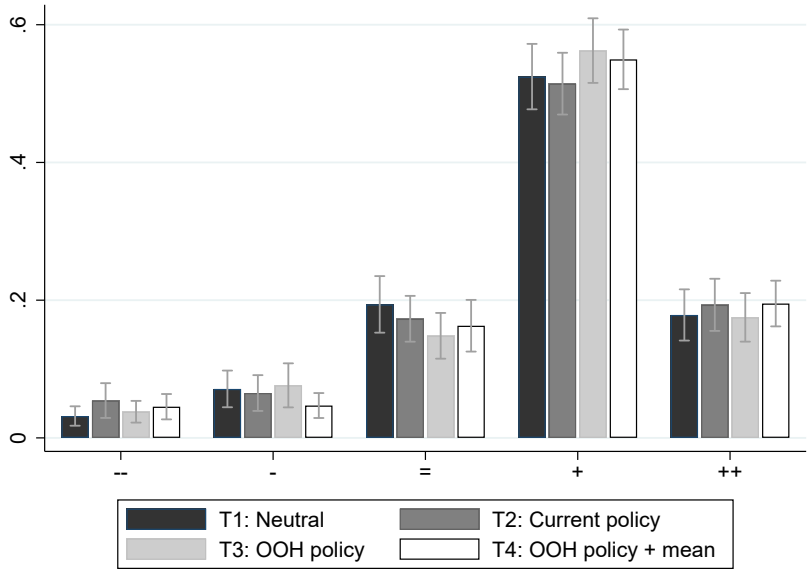
Interest rate expectations. Figure 4 plots the responses to the second question, which asks about interest rates in 2032 relative to today. This question may help explain differences in overall and OOH inflation expectations across the groups. For example, respondents with

[15]The gap between OOH and overall inflation expectations is statistically significantly different from zero for treatment groups T1 and T2 but not for groups T3 and T4.

lower expected (OOH) inflation may attribute a higher probability to higher interest rates due to their views on monetary policy.

Most respondents believe that interest rates will be higher ten years from now. In general, the average probability of interest rates being slightly higher exceeds 50%, while the probability of interest rates being much higher is just below 20%. Despite historically low interest rates preceding the survey, non-negligible probabilities are also assigned to lower and unchanged interest rates. The evidence based on the equality tests indicates that interest rate expectations are not significantly different across the groups.[16]

Figure 4: Average euro area interest rate expectations for 2032 by treatment group



Notes: Average subjective probability distributions of long-term interest rate expectations from Question 2, together with 95% confidence intervals. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. The p-values for the t and *Hotelling* tests are provided in panel C of Appendix Table A.1.

In sum, the second and third treatments appear to raise (OOH) inflation expectations compared to the baseline group (T1). Thus, the new OOH treatment in the inflation measure seems to be associated with higher (OOH) inflation expectations. Nevertheless, treatment T4

[16]For this question, we also calculate the balance statistic as a simple weighted average of a recoded variable taking values of -2 (significantly lower), -1, 0, 1, and 2 (significantly higher). We still find no significant differences in average expectations across the treatments.

reverses this increase as the fact that OOH inflation has been, on average, at 2.2% appears to lower both OOH and overall inflation expectations. There are no clear effects of the treatments on interest rate expectations.

5.2 Regression analyses

In this subsection, we use regression models to examine the average treatment effects on household expectations about overall inflation, OOH inflation, and interest rates.

5.2.1 Regression models

We estimate several linear regression models using OLS with robust standard errors. Our first model is an analysis of variance (ANOVA): we regress the average expected long-term inflation (π) or OOH inflation (π^{ooh}) on the treatment dummy variables:

$$\pi_i^{(ooh)} = \alpha + \sum_{j=2}^{4} \beta_j T_{ij} + \varepsilon_i, \tag{3}$$

where $\pi_i^{(ooh)}$ is the mean expected (OOH) inflation for individual i, and T_{ij} is a dummy variable that equals 1 if individual i was in treatment group j ($j = 2, 3, 4$) and 0 otherwise. Parameter α measures the mean for the baseline group T1, and the β_j parameters show the average treatment effect of treatment j relative to the baseline group.

Next, we estimate analysis of covariance (ANCOVA) models that add a continuous covariate to the above ANOVA model:

$$\pi_i^{(ooh)} = \alpha + \sum_{j=2}^{4} \beta_j T_{ij} + \gamma \left(X_i - \bar{X} \right) + \varepsilon_i, \tag{4}$$

where $(X_i - \bar{X})$ denotes the additional de-meaned covariate. The mean $\bar{X}$ accounts for the survey weights, and the de-meaning is done to maintain the interpretation of α as the unconditional mean under treatment T1.

Since the treatment groups were randomly assigned, there is no need to correct for confounding using additional control variables. Still, an ANCOVA specification can increase statistical power for detecting group differences (McKenzie, 2012). We consider a range of pre-treatment characteristics from the standard questionnaire based on their correlation with the left-hand-side variable. We used long-term German inflation expectations (5-year horizon) as a covariate (and as a proxy for prior expectations) in the estimations with overall expectations as the outcome variable (with a correlation of 0.4). For the estimations with expected

OOH inflation as the outcome variable, we used short-term German house price expectations (1-year horizon), with a correlation of 0.24.[17] Since these covariates are measured before our experimental questions, there is no risk of distorting the estimated treatment effect.[18]

Extension with socio-demographic controls. We also extend the above regression models in (3) and (4) with standard socio-demographic controls. These extensions include a component $\delta' \left(Z_i - \bar{Z} \right)$ on the right-hand side, where Z_i is a vector with individual characteristics including gender, income group, age group, region, a dummy for a Bachelor's degree or more, a dummy for living in a big city, and a dummy for being an owner-occupier.

More specifically, the income group measures the total net monthly household income, and is divided into the following four dummy variables: under 2500€, 2500€ to 3499€, 3500€ to 4999€, and 5000€ or more. The age group is divided into three dummy variables: under 30 years, 30 to 59 years, and 60 years and older. The region variable groups federal states into north, west, south, and east dummies. The homeownership dummy indicates households living in the dwelling they own. Renters who own other real estate are registered as 0.

Ordered logit model. Since our interest rate expectations (question Q2) are measured as a qualitative variable, we first recode by assigning values of -2 (significantly lower), -1 (somewhat lower), 0 (about the same), 1 (somewhat higher), and 2 (much higher). We then estimate ordered logit model with the same covariates as in the above equations. In terms of the $(X_i - \bar{X})$ covariate, we use short-term German expectations about lending rates from the main questionnaire, which is also a qualitative variable that we assign scores to.

5.2.2 Inflation and OOH inflation expectations

Table 1 reports the estimation results of equations (3) and (4) for overall inflation and OOH inflation expectations as response variables. The top of the table shows the estimate of α, the mean expected inflation for baseline group T1. Next, the table lists estimated treatment effects β_1, β_2, and β_3 for groups T2 to T4 relative to the baseline group, followed by differences in average inflation expectations between groups T2 to T4 (e.g., $\beta_3 - \beta_2$). Finally, coefficient estimates for the Ancova controls are shown at the bottom.

[17] The correlation with long-term German inflation expectations is slightly lower, so we choose house price expectations as a proxy instead. Our selected covariates are winsorised at 2.5 and 97.5 percentiles before de-meaning.

[18] Leppink (2018) raises the concern that ANCOVA assumes no interaction between treatment dummies and the X_i covariate, which may not hold. We followed his recommendation to check whether model selection criteria favour moderated regression models (MODREG) that include interactions. For both expected (OOH) inflation rates, we found evidence favouring the more parsimonious ANCOVA specification.

Columns (1)-(4) summarise the treatment estimates for long-term overall inflation expectations. Column 2 accounts for socio-demographic variables, column 3 for the Ancova control, and column 4 has both. Average inflation expectations for the baseline treatment (T1), receiving no information about OOH costs, are about 3.72% across models. The third treatment group (T3), which is asked to assume OOH costs are included in the inflation measure, has the highest average inflation expectations. Treatment effect β_3 is statistically significant at the 10% level in the ANOVA model with socio-demographic controls and at the 5% level in the ANCOVA models, reaching values close to 0.2 p.p.

While this coefficient may appear small, it is an economically important effect. First, this effect is larger (in absolute value) than the impact of female gender (0.14) or Bachelor's education or more (-0.17) on inflation expectations in the ANCOVA model with socio-demographic controls (column 4; p-values<5%; estimates not shown). These effects are typically reported in the literature. Second, our point estimate exceeds the treatment effect that Hoffmann et al. (2022b) report when German households are asked to assume the ECB adopts a hypothetical average inflation targeting (AIT) regime compared to the current regime (IT). They find an upward effect of 0.12 on inflation expectations five to ten years ahead and a similar-sized effect for expectations two to three years ahead. Using a DSGE model calibrated to match the latter gap under relatively well-anchored expectations, the AIT regime's higher inflation expectations result in significantly fewer occurrences at the zero lower bound and less volatile inflation. Third, although we don't measure the impact on short-term expectations in our study, those might be even larger.

Treatment T3 also raises inflation expectations relative to group T2, which is informed about the current policy that largely excludes OOH costs in the price index. Thus, using more precise inference, we confirm our previous finding in Section 5.1 that the average expected inflation in ten years is higher in group T3 than in groups T1 and T2. Interestingly, the fourth treatment, which also provides information about the long-term OOH inflation average, lowers average inflation expectations relative to the T3 group, and this effect is significant in the ANCOVA models. The T4 treatment thus largely reverses an increase in expectations caused by the treatment T3.

Columns (5)-(8) of Table 1 show the results for long-term OOH inflation expectations. Average expectations are around 3.88% for the baseline group, which is about 0.16 p.p. higher than their average overall inflation expectations. While groups T2 and T3 feature higher OOH expectations by about 0.10 p.p. relative to the baseline group, these differences are not statistically significant. However, treatment T4 has significantly lower OOH inflation expectations than treatments T2 and T3. This suggests that providing information about past OOH inflation, which is lower than average expectations, lowers OOH inflation expectations. In Section 6, we measure and discuss how much shifts in OOH expectations explain changes

in overall inflation expectations.

The additional covariate included in the ANCOVA models, i.e., either long-term inflation expectations for Germany or short-term local house price inflation expectations, has a significant coefficient with a positive sign. Intuitively, people with above-average inflation expectations for Germany also tend to show above-average inflation expectations for the euro area. Capturing this cross-sectional variation improves the model fit and increases precision. Hence, our favoured model specification for interpreting the estimation results is the ANCOVA model with socio-demographic controls.

Table 1: Average treatment effects on overall and OOH inflation expectations

	Inflation				OOH inflation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
α: Baseline mean (T1)	3.72***	3.74***	3.70***	3.72***	3.89***	3.88***	3.87***	3.88***
	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)	(0.08)	(0.07)	(0.07)
β_2: Current policy (T2)	0.03	0.02	0.04	0.04	0.10	0.10	0.13	0.10
	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)
β_3: OOH policy (T3)	0.14	0.16*	0.19**	0.20**	0.09	0.08	0.08	0.07
	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)
β_4: OOH policy + mean (T4)	0.05	0.03	0.05	0.03	-0.12	-0.11	-0.09	-0.11
	(0.09)	(0.09)	(0.08)	(0.08)	(0.10)	(0.10)	(0.10)	(0.10)
$\beta_3 - \beta_2$	0.11	0.14*	0.15*	0.16**	-0.01	-0.01	-0.04	-0.03
	(0.09)	(0.08)	(0.09)	(0.08)	(0.10)	(0.10)	(0.10)	(0.10)
$\beta_4 - \beta_2$	0.02	0.01	0.01	-0.01	-0.22**	-0.21**	-0.22**	-0.21**
	(0.08)	(0.08)	(0.08)	(0.07)	(0.10)	(0.10)	(0.10)	(0.09)
$\beta_4 - \beta_3$	-0.09	-0.13	-0.14*	-0.17**	-0.21**	-0.20**	-0.18*	-0.18*
	(0.09)	(0.08)	(0.08)	(0.08)	(0.10)	(0.10)	(0.10)	(0.10)
DE LT inflation exp.			0.12***	0.12***				
			(0.01)	(0.01)				
DE ST house price exp.							0.04***	0.04***
							(0.00)	(0.00)
Observations	4307	4158	4278	4132	4308	4164	4267	4128
Adjusted R2	0.00	0.04	0.16	0.19	0.00	0.03	0.06	0.09
Socio-demographic controls	No	Yes	No	Yes	No	Yes	No	Yes

Notes: OLS estimates of Equation 3 (4) are shown in columns 1-2 (3-4) for inflation expectations and columns 5-6 (7-8) for OOH inflation expectations. Additional controls are long-term inflation expectations for Germany (DE LT inflation exp.) and short-term house local price expectations (DE ST house price exp.). There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. Robust standard errors in parentheses. Significance as * p<0.10, ** p<0.05, *** p<0.01.

In Table A.2 of Appendix A, we show estimates using overall (OOH) inflation uncertainty measures as dependent variables. Treatment T4 significantly lowers inflation uncertainty relative to treatment groups T3 and T2. Thus, providing a past average of OOH inflation reduces not only inflation and OOH inflation expectations but also uncertainty surrounding overall inflation expectations. However, we find no evidence for treatment effects for OOH inflation uncertainty.[19]

In sum, announcing the inclusion of OOH costs in the main inflation measure raises long-term inflation expectations of households. However, providing additional information on the long-term average of OOH inflation reverses this effect, reduces uncertainty about overall inflation, and lowers OOH expectations.

5.2.3 Interest rate expectations

Table 2 reports the results for long-term interest rate expectations. We use two ordered logit models, with and without socio-demographic characteristics. German short-term expectations about lending interest rates serve as our ANCOVA control variable. Overall, we find no statistically significant effects of the treatments on interest rate expectations.

[19]Regarding meaningful covariates for the ANCOVA models, we use measures of uncertainty around one-year expectations for German inflation and local house price inflation, as long-term expectations are not available in a probabilistic distribution.

Table 2: Average treatment effects on interest rate expectations

	Interest rate expectations			
	(1)	(2)	(3)	(4)
β_2: Current policy	0.03	-0.03	-0.03	-0.06
	(0.14)	(0.14)	(0.13)	(0.13)
β_3: OOH policy	0.07	0.06	0.05	0.04
	(0.13)	(0.13)	(0.13)	(0.13)
β_4: OOH policy + mean	0.15	0.09	0.15	0.11
	(0.13)	(0.13)	(0.12)	(0.12)
$\beta_3 - \beta_2$	0.04	0.08	0.02	0.10
	(0.14)	(0.14)	(0.14)	(0.13)
$\beta_4 - \beta_2$	0.13	0.11	0.19	0.17
	(0.13)	(0.13)	(0.13)	(0.13)
$\beta_4 - \beta_3$	0.09	0.03	0.11	0.08
	(0.13)	(0.13)	(0.13)	(0.12)
ST DE lending rate exp.			0.71***	0.66***
			(0.07)	(0.07)
Observations	4465	4298	4458	4292
Pseudo R2	0.00	0.01	0.03	0.04
Socio-demographic controls	No	Yes	No	Yes

Notes: Ordered logistic regression results for Question 2. The additional control is short-term lending rate expectations for Germany (ST DE lending rate exp.). There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. Robust standard errors in parentheses. Significance as * p<0.10 , ** p<0.05, *** p<0.01.

6 Inspecting the mechanism using mediation analysis

Framework. In the previous section, we documented higher long-term inflation expectations due to a hypothetical new OOH policy implementation (treatment T3). Yet, this effect vanished when information on past average OOH inflation was also provided (treatment T4). In this section, we explore the mechanism behind these effects.

We assume that the average inflation expectation of a treatment group ($\bar{\pi}$) is based on a weighted average of average expected OOH inflation ($\bar{\pi}^{ooh}$) and average expected inflation for

the other (non-OOH) components ($\bar{\pi}^{other}$) using weight $\bar{\omega}$ ($0 \leq \bar{\omega} \leq 1$):

$$\bar{\pi} = \bar{\omega}\bar{\pi}^{ooh} + (1 - \bar{\omega})\bar{\pi}^{other}. \tag{5}$$

Hence, the difference between two treatment groups' average inflation expectations can arise through three (non-mutually exclusive) channels. That is, an information treatment can affect expected OOH inflation ($\bar{\pi}^{ooh}$), inflation expectations for the other (non-OOH) inflation components ($\bar{\pi}^{other}$), or the weight $\bar{\omega}$ that controls the relative importance of OOH inflation vs other components.

We use mediation analysis to identify the contributions from these three channels. Intuitively, this method decomposes the total effect of a treatment (X) to a response variable (Y), i.e. $X \implies Y$, in two parts. First, an *indirect effect* that passes through a mediator (M). Conceptually, this effect goes first from $X \implies M$, then from $M \implies Y$. Second, the remaining *direct effect* measures the impact from X to Y while holding mediator M constant. In our case, X is the random information treatment, M is expected OOH inflation, and Y is expected overall inflation. The indirect effect thus measures the part of the treatment effect on overall inflation expectations due to a variation in OOH inflation expectations between the two groups. By contrast, the direct effect measures the remaining effect due to changing inflation expectations for other components, a shift in the relative weight $\bar{\omega}$, or both. Building on (5), and labelling two treatment groups with subscripts 0 and 1, the difference between both groups' average inflation expectations can be expressed as:[20]

$$\begin{aligned}\bar{\pi}_1 - \bar{\pi}_0 &= \bar{\omega}_1\bar{\pi}_1^{ooh} + (1 - \bar{\omega}_1)\bar{\pi}_1^{other} - \bar{\omega}_0\bar{\pi}_0^{ooh} - (1 - \bar{\omega}_0)\bar{\pi}_0^{other} \\ &= \underbrace{\bar{\omega}_1(\bar{\pi}_1^{ooh} - \bar{\pi}_0^{ooh})}_{\text{Indirect effect}} + \underbrace{(1 - \bar{\omega}_1)\left(\bar{\pi}_1^{other} - \bar{\pi}_0^{other}\right) + (\bar{\omega}_1 - \bar{\omega}_0)\left(\bar{\pi}_0^{ooh} - \bar{\pi}_0^{other}\right)}_{\text{Direct effect}}.\end{aligned} \tag{6}$$

Estimation. The total treatment effect ($X \implies Y$) is measured using the π_i regressions from Section 5.2.[21] To identify the direct treatment effect, we estimate these models with individual OOH inflation expectations (π_i^{ooh}) as an additional right-hand side variable in (4). In a model without interactions between OOH inflation and treatment dummies, the coefficient for expected OOH inflation measures the average weight $\bar{\omega}$, and the regression coefficient for the treatment dummy captures the direct effect of the treatment while holding the mediator (i.e., expected OOH inflation) constant. However, interacting OOH expectations with the

[20] To obtain the second line of (6), add and subtract the terms $\bar{\omega}_1\bar{\pi}_0^{ooh}$ and $(1 - \bar{\omega}_1)\bar{\pi}_0^{other}$ to the right-hand side of the first line and re-arrange terms.

[21] Here, we include both long-term German inflation expectations and short-term German house price expectations as covariates in the regression of the total treatment effect. Doing so ensures that the total effect equals the sum of the indirect and direct effects — the latter of which is estimated with a different equation.

treatment dummies delivers group-specific weights $\bar{\omega}_j$ $(j = 1, ..., 4)$ and direct effects that depend on the value of the mediator.

We only report results from the regressions with interactions, as the results are almost identical without them. For each treatment pair comparison, we evaluate the direct treatment effect at the mean of expected OOH inflation of the baseline group ($\bar{\pi}_0^{ooh}$), as in (6).[22] Given the estimated total and direct effects, we derive the indirect effect by subtracting the latter from the former. The standard errors are computed based on 2000 bootstrap replications.

Accounting for confounding. In the previous subsection, the regression estimates from $X \implies M$ or Y posed no risk of confounding due to the randomisation of the treatment variable X. However, this need not be the case in mediation regressions of Y on X and M jointly. Indeed, pre-treatment conditions such as the respondent's characteristics and experience might affect both OOH and overall inflation expectations. Consequently, we focus on the ANCOVA regression models from Section 5.2 that include socio-demographic controls like gender and income as right-hand side variables (see Table 1, columns 4 and 8). We also experimented with the inclusion of additional controls, like inflation perceptions, but found the coefficient estimates for the mediator (or weights) to be about the same.

In principle, post-treatment conditions could also lead to confounding. For example, the random treatment might affect expected monetary policy conditions (our second question), which could jointly impact expected OOH and overall inflation. However, when we appropriately control for this post-treatment variable, we find that the estimated (direct) effects are the same.[23]

Results for OOH inflation as mediator. Table 3 reports the estimated average (total) treatment effects on inflation expectations in column (2) and their decomposition into indirect and direct effects in columns (3) and (4). Note that the total effects are essentially the same as those reported in Table 1 column (4).

The first key message is that when the total treatment effect is large and positive, as in the β_3 and $\beta_3 - \beta_2$ estimates, this is essentially fully driven by the direct effect. Indeed, the modest estimates for the treatment effect on OOH inflation expectations and the weight $\bar{\omega}$ (see below) make that the indirect effect is marginal after informing on OOH policy (treatment T3).

[22] Acharya et al. (2016, page 6) discuss the conditions under which regression estimates of the direct effect identify the indirect effect, with the latter being the difference between the overall treatment effect and the direct effect. Our assumptions comply with these conditions.

[23] Specifically, we use the sequential g-estimation procedure described in Acharya et al. (2016). These results, and those from the preceding paragraph, are available upon request.

Recall that the direct effect consists of the effects from a changing weight ($\bar{\omega}$) and changing expectations for other inflation components. Digging deeper, we find that higher inflation expectations for items other than OOH drive the large and positive direct effects.[24] Intuitively, it appears that respondents interpret information treatment T3 on OOH policy such that the 2% target becomes less credible. In Appendix B, we illustrate this notion using a Bayesian learning framework wherein respondents update their prior distribution for expected inflation given the information treatment. When asked to assume the policy on OOH inflation is in place (treatment T3), respondents lose their trust in the inflation target and update their prior distribution more weakly from high values toward the 2% inflation target. As a result, the average of their posterior distribution for long-term inflation is higher than in other treatment groups.

Table 3: Decomposition of average treatment effects on inflation expectations using mediation analysis

Compared treatment groups	**Total effect**	**Indirect effect**	**Direct effect**
(1)	(2)	(3)	(4)
β_2: Current policy vs. baseline	0.04	0.02	0.02
	(0.08)	(0.03)	(0.07)
β_3: OOH policy vs. baseline	0.20**	0.01	0.19**
	(0.08)	(0.03)	(0.08)
β_4: OOH policy + mean vs. baseline	0.03	-0.03	0.06
	(0.08)	(0.03)	(0.07)
$\beta_3 - \beta_2$: OOH policy vs. current	0.16**	-0.01	0.17**
	(0.08)	(0.02)	(0.07)
$\beta_4 - \beta_2$: OOH policy + mean vs. current	-0.02	-0.05**	0.04
	(0.07)	(0.03)	(0.07)
$\beta_4 - \beta_3$: OOH policy + mean vs. OOH	-0.18**	-0.04*	-0.13*
	(0.07)	(0.02)	(0.07)

Note: The table shows the decomposition of the total treatment effect (column 2) into the contributions from the indirect (column 3) and direct effects (column 4). Due to rounding, the sum of entries in columns (3) and (4) can differ from that in column (1). There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. Significance as * p<0.10 , ** p<0.05, *** p<0.01.

By contrast, the role of the changing weight for OOH inflation ($\bar{\omega}$) appears to be minor.

[24] Using (5), the expectation for other inflation components ($\bar{\pi}^{other}$) is identified given the estimated weight ($\bar{\omega}$) and the data on average expected overall inflation ($\bar{\pi}$) and expected OOH inflation ($\bar{\pi}^{ooh}$).

When we assume constant weights across groups, we find a weight of 0.27 for OOH inflation. Remarkably, this value is close to households' self-reported ratio of housing costs as a share of disposable income in Germany, which is between 25% and 30% (Wittekopf et al., 2022, Chart A). This large share underscores the importance of OOH inflation for consumers' overall inflation expectations. At the same time, it is sizably larger than the 9% OOH weight used by the ECB in their simulations for actual inflation (Section 3). When we allow the weights to vary using the regression with interactions, we estimate them to be $(\bar{\omega}_1, \bar{\omega}_2, \bar{\omega}_3, \bar{\omega}_4) = (0.36, 0.24, 0.24, 0.25)$. Therefore, informing respondents that most OOH items are excluded from the inflation basket reduces its weight for treatment group T2 compared to T1. While this is an intuitive result, it is surprising that the estimated weights for treatments T3 and T4 remain very close to that of T2 instead of increasing again after the news that the ECB wants to better account for OOH costs. Yet, as the differences are small relative to the average of 0.27, we find similar (in)direct estimates when assuming the same weight across groups.

Turning to treatment group T4, which was also informed on past average OOH inflation of 2.2%, we find the indirect effect to become negative and statistically significant in comparisons against T2 and T3 (p-values<10% or <5%). These significant effects are in line with those from column (8) in Table 1. As such, group T4's lower average OOH inflation expectations drives overall inflation expectations down. For instance, the large negative total effect of $\beta_4 - \beta_3$ (-0.18) is explained for about one quarter by the indirect effect (-0.04). Consistent with the notion of credibility of the inflation target from the previous paragraph, we see that the direct effect remains important but *negative* in this case (-0.13). Therefore, informing on average OOH inflation of 2.2% has spillover effects that lower inflation expectations for the other components.

In sum, we conclude that communication on OOH policy can affect consumers' inflation expectations by influencing their inflation expectations for OOH costs and other inflation components. We estimate implicit weights on OOH inflation of around 25%, which is close to households' self-reported ratio of housing costs to disposable income, yet sizably larger than the 9% used by the ECB in their simulations (Section 3). This large share underscores the importance of OOH inflation for consumers' overall inflation expectations.

Results for expected interest rates as mediator. We repeat this exercise with expectations for monetary policy rates as a mediator instead of expectations for OOH inflation. Overall, we find no evidence of important indirect effects, which means that monetary policy expectations are not a helpful channel for explaining changes in overall inflation expectations across treatments. This result resonates with the insignificant treatment effects found for monetary policy rates in Section 5.2.

7 Exploring heterogeneity

This section explores whether the average treatment effects from Section 5.2 are heterogeneous across selected socio-demographic characteristics. Specifically, we consider housing tenure, education, income, and gender. In addition to these standard characteristics, we exploit information from previous survey waves on trust in the ECB to deliver price stability. We thus aim to analyse whether trust can explain average treatment effects, as discussed in the previous sections.

For each of these characteristics, we define a dummy variable Z_i to split individuals into two groups (e.g., high vs low-income) and estimate an extension of the ANCOVA model (4) that includes interactions with dummy Z_i:

$$\pi_i^{(ooh)} = \alpha + \tilde{\alpha} Z_i + \sum_{j=2}^{4} T_{ij} \left(\beta_j + \tilde{\beta}_j Z_i \right) + \left(X_i - \bar{X} \right) \left(\gamma + \tilde{\gamma} Z_i \right) + \varepsilon_i. \tag{7}$$

The parameters with a $\sim$ symbol measure the interaction coefficients for the socio-demographic characteristic Z_i, and X_i represents the same control variable as in Table 1.[25] Note that the estimation of (7) gives the same results as split sample regressions of (4) under $Z_i = 0$ and $Z_i = 1$. Hence, we examine whether a treatment effect is conditional on the level of characteristic Z_i. For simplicity, we consider the characteristics one by one rather than jointly.

Characteristics. We use the dummy variable Z_i to split the sample into 1) owners and renters (housing tenure), and 2) men and women (gender). For the characteristics with more than two categories, we classify those with 3) a net household income of at least €3,500 per month as high-income respondents and 4) those with at least a bachelor's degree as highly educated.

We also use a measure of trust in the central bank by exploiting the panel structure of the database to match the anonymous survey respondents' responses over time. We do so because the February and June 2022 survey waves contained the following question on trust in the ECB: "*On a scale from 0 to 10, how much do you trust that the European Central Bank (ECB) is able to deliver price stability?*". Since the modal response is five, we label those with a score of five or above as having a high level of trust.[26] A caveat is that we treat trust as a pre-treatment characteristic, while, in principle, this can change after the information treatment. Hence, our measure acts as a proxy.

[25] Estimation using ANOVA models gives broadly the same results (available upon request).

[26] The respondents asked in February are not the same as those in June. Since trust can change over time, we also did a robustness check using only the information from the June 2022 survey wave and found the results to remain broadly robust.

7.1 Inflation expectations

Table 4 reports the estimation results of (4) using overall inflation expectations π_i as the response variable. We first compare the group asked to assume that the OOH policy is in place (T3) and the baseline treatment group (T1). Recall that the first main result from Table 1 is a significantly higher average inflation expectation for T3 than T1. Here, we find that this effect is only highly significant (p-value<5%) and economically relevant for homeowners, the low-educated, and those with low trust in the ECB. The effect is also significant at the 10% level for the high-income group and men, but the coefficients remain similar to those of their counterparts.

Focusing on the gap between T3 ('OOH policy') and the group informed on current policy (T2), we find the significantly positive effect from the full sample estimates to be repeated for the low-educated and the low-income group (p-value<5% or <1%).

Another main result from Table 1 is that informing on the average of past OOH cost inflation (T4) reduces inflation expectations compared to T3. Here, this negative effect is statistically significant at the 5% level for the low-educated and those with low trust in the ECB, and significant at the 10% level for homeowners, low-income households, and men. These significant negative effects reverse the positive impact of treatment T3. As a result, the inflation expectations of treatment T4 are not significantly different from the baseline group (T1).

Table 4: Heterogeneity of treatment effects on inflation expectations

		Treatment pairs					
		β_2	β_3	β_4	$\beta_3 - \beta_2$	$\beta_4 - \beta_2$	$\beta_4 - \beta_3$
Housing tenure	Owners	0.17	0.25**	0.09	0.09	-0.08	-0.16*
		(0.10)	(0.11)	(0.09)	(0.11)	(0.09)	(0.10)
	Renters	-0.14	0.09	-0.01	0.23	0.13	-0.10
		(0.17)	(0.16)	(0.16)	(0.15)	(0.14)	(0.13)
Education	High	0.11	0.08	0.03	-0.03	-0.07	-0.05
		(0.10)	(0.10)	(0.10)	(0.10)	(0.09)	(0.10)
	Low	0.02	0.23**	0.03	0.21**	0.01	-0.20**
		(0.11)	(0.11)	(0.10)	(0.11)	(0.10)	(0.10)
Income	High	0.31***	0.20*	0.16	-0.12	-0.16*	-0.04
		(0.12)	(0.12)	(0.12)	(0.09)	(0.09)	(0.09)
	Low	-0.20	0.19	-0.02	0.40***	0.18	-0.21*
		(0.14)	(0.14)	(0.12)	(0.14)	(0.13)	(0.13)
Trust in ECB	High	0.06	0.02	-0.08	-0.04	-0.14	-0.11
		(0.11)	(0.12)	(0.11)	(0.12)	(0.11)	(0.12)
	Low	0.14	0.36**	0.05	0.22	-0.09	-0.31**
		(0.13)	(0.15)	(0.12)	(0.14)	(0.12)	(0.13)
Gender	Male	0.10	0.20*	0.01	0.11	-0.09	-0.20*
		(0.10)	(0.12)	(0.10)	(0.11)	(0.09)	(0.11)
	Female	-0.02	0.14	0.09	0.15	0.10	-0.05
		(0.15)	(0.13)	(0.13)	(0.13)	(0.13)	(0.11)

Note: Heterogeneous treatment effect estimates from equation (7) are shown for overall inflation expectations. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. Robust standard errors in parentheses. Significance as * p<0.10 , ** p<0.05, *** p<0.01.

7.2 OOH inflation expectations

In the full sample results (Table 1), OOH inflation expectations were significantly lower when asked to assume OOH policy is in place *and* informing them on past OOH cost inflation (T4), compared to groups T2 ('current policy') and T3 ('OOH policy'). In Table 5, we show that these effects on OOH inflation expectations π_i^{ooh} are present for homeowners but not for renters.

Table 5: Heterogeneity of treatment effects on OOH inflation expectations

		Treatment pairs					
		β_2	β_3	β_4	$\beta_3 - \beta_2$	$\beta_4 - \beta_2$	$\beta_4 - \beta_3$
Housing tenure	Owners	0.22*	0.26**	-0.11	0.04	-0.33***	-0.37***
		(0.12)	(0.11)	(0.11)	(0.12)	(0.12)	(0.11)
	Renters	-0.02	-0.18	-0.08	-0.17	-0.06	0.10
		(0.17)	(0.19)	(0.18)	(0.16)	(0.16)	(0.18)
Education	High	-0.20	-0.25*	-0.43***	-0.05	-0.23	-0.18
		(0.13)	(0.14)	(0.14)	(0.14)	(0.14)	(0.15)
	Low	0.16	0.15	-0.01	-0.01	-0.17	-0.15
		(0.12)	(0.13)	(0.13)	(0.12)	(0.12)	(0.12)
Income	High	0.19	0.10	-0.08	-0.09	-0.28**	-0.19
		(0.14)	(0.123)	(0.12)	(0.13)	(0.13)	(0.12)
	Low	0.08	0.08	-0.08	0.00	-0.16	-0.16
		(0.15)	(0.16)	(0.16)	(0.14)	(0.14)	(0.15)
Trust in ECB	High	0.01	0.15	-0.14	0.14	-0.15	-0.29**
		(0.14)	(0.13)	(0.14)	(0.13)	(0.14)	(0.13)
	Low	-0.06	-0.01	-0.31**	0.05	-0.25	-0.29*
		(0.14)	(0.13)	(0.15)	(0.15)	(0.16)	(0.16)
Gender	Male	0.12	0.17	0.05	0.04	-0.07	-0.11
		(0.13)	(0.13)	(0.12)	(0.13)	(0.12)	(0.12)
	Female	0.12	-0.01	-0.26	-0.14	-0.38**	-0.24
		(0.15)	(0.16)	(0.16)	(0.14)	(0.15)	(0.16)

Note: Heterogeneous treatment effect estimates from equation (7) are shown for OOH inflation expectations. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. Robust standard errors in parentheses. Significance as * p<0.10 , ** p<0.05, *** p<0.01.

In contrast to the full-sample results, homeowners' OOH expectations increase significantly relative to the baseline (T1) with the treatments T2 and T3, though these effects are reversed by treatment T4. Moreover, a significantly negative $\beta_4 - \beta_1$ effect is present among those with higher education and low trust in the ECB, and $\beta_4 - \beta_2$ is also significantly negative for those with higher income and women.

Trust in the ECB does not appear to play a role in explaining the negative $\beta_4 - \beta_3$ effect, as it's negative and significant for both trust groups.

7.3 Interest rate expectations

Finally, Table 6 shows heterogeneous treatment effects on interest rate expectations.[27] Remember that average treatment effects were insignificant using the full sample. However, this result appears to hide some degree of heterogeneity. Treatment T4 significantly raises interest rate expectations (p-value<10% or lower) relative to both the baseline group (T1) and the group informed on current policy (T2) for high-income families, those with high trust in the ECB, and men. There is also a significant increase relative to T1 for homeowners and relative to T2 for the high-educated.

Summing up. The de-anchoring and re-anchoring effects on overall inflation expectations following, respectively, treatments T3 and T4 are heterogeneous across households. Information treatments on OOH particularly affect respondents who are low educated, have a low income, lacked trust in the ECB's ability to meet its price stability objective before our survey, and men.

In addition, we find a significant reaction of overall and OOH inflation expectations of homeowners but not of renters. In light of the mediation analysis from the previous section, this result is consistent with a role for the indirect treatment effect on the mediator (i.e., OOH inflation expectations) in explaining the total treatment effect on overall inflation expectations.

It is challenging to establish a link with expectations on future monetary policy. For example, we do not see that subgroups with insignificant $\beta_3 - \beta_1$ treatment effects on overall inflation have significantly more restrictive monetary policy expectations.

[27] Unlike the previous two tables, these estimates are based on an ordered logit model.

Table 6: Heterogeneity of treatment effects on interest rate expectations

		Treatment pairs					
		β_2	β_3	β_4	$\beta_3 - \beta_2$	$\beta_4 - \beta_2$	$\beta_4 - \beta_3$
Housing tenure	Owners	0.14	0.08	0.30**	-0.06	0.16	0.22
		(0.18)	(0.16)	(0.15)	(0.19)	(0.17)	(0.16)
	Renters	-0.18	0.06	0.01	0.24	0.19	-0.05
		(0.20)	(0.21)	(0.21)	(0.19)	(0.19)	(0.20)
Education	High	-0.33	-0.04	0.13	0.29	0.46**	0.17
		(0.21)	(0.20)	(0.22)	(0.19)	(0.21)	(0.21)
	Low	0.07	0.07	0.14	0.00	0.07	0.07
		(0.15)	(0.15)	(0.14)	(0.16)	(0.15)	(0.15)
Income	High	-0.17	0.14	0.40**	0.32	0.58***	0.26
		(0.20)	(0.19)	(0.18)	(0.21)	(0.20)	(0.19)
	Low	0.04	-0.04	-0.05	-0.08	-0.09	-0.02
		(0.18)	(0.18)	(0.17)	(0.18)	(0.17)	(0.17)
Trust in ECB	High	-0.20	0.18	0.33*	0.38*	0.53**	0.15
		(0.22)	(0.20)	(0.20)	(0.22)	(0.22)	(0.19)
	Low	0.03	0.06	0.15	0.03	0.11	0.09
		(0.21)	(0.19)	(0.20)	(0.20)	(0.21)	(0.19)
Gender	Male	-0.08	0.03	0.26*	0.11	0.35**	0.24
		(0.18)	(0.18)	(0.16)	(0.18)	(0.16)	(0.16)
	Female	0.02	0.07	0.08	0.05	0.06	0.01
		(0.19)	(0.18)	(0.18)	(0.20)	(0.19)	(0.19)

Note: Heterogeneous treatment effect estimates are shown for interest rate expectations based on an ordered logit model. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. Robust standard errors in parentheses. Significance as * p<0.10 , ** p<0.05, *** p<0.01.

8 Conclusion

Owner-occupied housing (OOH) costs are highly important to euro area households, yet they are lacking in the main consumer price inflation measure of the ECB. In response, the ECB concluded its 2021 strategy review with a plan to include OOH costs in its inflation measure in the future.

This paper measured whether implementing this policy would impact households' expectations. Specifically, we ran a novel survey experiment using the Bundesbank's online household panel, where we randomly divided respondents into four treatment groups receiving different

information concerning the ECB's policy on OOH costs. We then compared these treatment groups' long-run expectations for overall inflation, interest rates, and OOH inflation in the euro area ten years ahead.

Our results indicate that long-term inflation expectations for the euro area are de-anchored among German households at the time of the survey. Across the four treatment groups, respondents expect high inflation to persist ten years into the future and give low weight to outcomes close to the 2% target. Moreover, expectations for OOH inflation tend to exceed those for overall inflation.

The information provisions regarding the ECB's treatment of OOH costs impact these long-term expectations. Overall inflation expectations are significantly higher for those asked to assume the ECB's measure of inflation accounts for OOH costs as of today relative to a baseline group receiving only general information on the ECB's inflation target. However, this positive effect on long-term inflation expectations reverses when respondents also receive information that OOH inflation was 2.2% on average during the ten years before the survey. We also find this additional information on past OOH average inflation significantly lowers expectations for OOH cost inflation.

Using mediation analysis, we find a limited role for the variation in OOH inflation expectations in explaining differences in overall inflation expectations between treatment groups. Instead, the key role comes from inflation expectations for other (non-OOH) components. Intuitively, respondents find the 2% medium-term inflation target less credible when asked to assume OOH policy is in place, raising their inflation expectations for those non-OOH components. However, including information on average OOH inflation provides spillover effects that lower the expectations for both OOH and non-OOH inflation.

The information treatments have heterogeneous effects on overall inflation expectations: they are significant for homeowners, those reporting before our survey to have low trust in the ECB's ability to meet its price stability objective, the low-educated, those with low income, and men. Homeowners' OOH inflation expectations also react significantly. Although we find no treatment effects on average for interest rate expectations, this changes in subgroup analyses. Respondents informed on OOH policy and average past OOH inflation show significantly higher long-term interest expectations (relative to baseline) when they are a homeowner, are highly educated, are high-income, have high trust in the ECB, or are male.

The policy implication from our results is that households generally seem to lack trust that the ECB will achieve its inflation target, and communicating on OOH policy could further raise overall inflation expectations. Moreover, this effect depends on the respondent's characteristics. However, careful communication design that informs on past average OOH inflation being low could prevent inflation expectations from de-anchoring.

A caveat of our analysis is that we measured (OOH) inflation expectations following a sustained period of relatively high house price inflation, which could explain the gap between OOH and overall inflation expectations. Whether our results depend on a state of housing boom or bust could be interesting for future research.

References

Acharya, A., Blackwell, M., and Sen, M. (2016). Explaining Causal Findings Without Bias: Detecting and Assessing Direct Effects. *American Political Science Review*, 110(3):512–529.

Armona, L., Fuster, A., and Zafar, B. (2019). Home Price Expectations and Behaviour: Evidence from a Randomized Information Experiment. *Review of Economic Studies*, 86(4):1371–1410.

Beckmann, E. and Schmidt, T. (2020). Bundesbank online pilot survey on consumer expectations. Technical report, Deutsche Bundesbank. 01/2020.

Bholat, D., Broughton, N., Ter Meer, J., and Walczak, E. (2019). Enhancing central bank communications using simple and relatable information. *Journal of Monetary Economics*, 108(C):1–15.

Binder, C. and Rodrigue, A. (2018). Household Informedness and Long-Run Inflation Expectations: Experimental Evidence. *Southern Economic Journal*, 85(2):580–598.

Coibion, O., Gorodnichenko, Y., Knotek II, E. S., and Schoenle, R. (2021). Average Inflation Targeting and Household Expectations. NBER Working Papers 27836, National Bureau of Economic Research, Inc.

D'Acunto, F., Malmendier, U., and Weber, M. (2022). What Do the Data Tell Us About Inflation Expectations? Technical Report 29825, NBER Working Paper.

Dovern, J. and Kenny, G. (2020). Anchoring Inflation Expectations in Unconventional Times: Micro Evidence for the Euro Area. *International Journal of Central Banking*, 16(5):309–347.

Dräger, L., Lamla, M. J., and Pfajfar, D. (2022). How to Limit the Spillover from the 2021 Inflation Surge to Inflation Expectations? Hannover Economic Papers (HEP) dp-694, Leibniz Universität Hannover, Wirtschaftswissenschaftliche Fakultät.

ECB (2021a). An overview of the ECB's monetary policy strategy. `https://www.ecb.europa.eu/home/search/review/html/ecb.strategyreview_monpol_strategy_overview.en.html`. Accessed: 30 March 2023.

ECB (2021b). ECB Listens - Summary report of the ECB Listens Portal responses. `https://www.ecb.europa.eu/home/search/review/html/ecb.strategyreview002.en.html`. Accessed: 30 March 2023.

ECB (2021c). The ECB's monetary policy strategy statement. `https://www.ecb.europa.eu/home/search/review/html/ecb.strategyreview_monpol_strategy_statement.en.html`. Accessed: 30 March 2023.

Ehrmann, M., Georgarakos, D., and Kenny, G. (2023). Credibility gains from communicating with the public: evidence from the ECB's new monetary policy strategy. Working paper, ECB Working Paper Series.

Eiglsperger, M., Arioli, R., Goldhammer, B., Gonçalves, E., and Kouvavas, O. (2022). Owner-occupied housing and inflation measurement. *ECB Economic Bulletin*, Issue 1.

Engelberg, J., Manski, C. F., and Williams, J. (2009). Comparing the Point Predictions and Subjective Probability Distributions of Professional Forecasters. *Journal of Business and Economic Sttaistics*, 27(1):30–41.

European Commission (2018). Report from the Commission to the European Parliament and the Council: on the suitability of the owner-occupied housing (OOH) price index for integration into the harmonised index of consumer prices (HICP) coverage. `https://op.europa.eu/en/publication-detail/-/publication/605d8916-f3db-11e8-9982-01aa75ed71a1`. Accessed: 30 March 2023.

Galati, G., Moessner, R., and van Rooij, M. (2022a). Reactions of household inflation expectations to a symmetric inflation target and high inflation. Working Papers 743, DNB.

Galati, G., Moessner, R., and van Rooij, M. (2022b). The anchoring of long-term inflation expectations of consumers: insights from a new survey. *Oxford Economic Papers*.

Hoffmann, M., Moench, E., Pavlova, L., and Schultefrankenfeld, G. (2021). The effects of the ECB's new inflation target on private households' inflation expectations. Technical report. Deutsche Bundesbank Research Brief.

Hoffmann, M., Moench, E., Pavlova, L., and Schultefrankenfeld, G. (2022a). Words speak louder than numbers: Central bank communication in times of high inflation. VOXEU, CEPR Policy Portal.

Hoffmann, M., Moench, E., Pavlova, L., and Schultefrankenfeld, G. (2022b). Would households understand average inflation targeting? *Journal of Monetary Economics*, 129(S):52–66.

Hotelling, H. (1931). The Generalization of Student's Ratio. *The Annals of Mathematical Statistics*, 2(3):360–378.

Issing, O., editor (2003). *Background Studies for the ECB's Evaluation of its Monetary Policy Strategy*. European Central Bank, Kaiserstrasse 29 60311 Frankfurt am Main Germany.

Kindermann, F., Le Blanc, J., Piazzesi, M., and Schneider, M. (2021). Learning about Housing Cost: Survey Evidence from the German House Price Boom. CEPR Discussion Papers 16223, C.E.P.R. Discussion Papers.

Krüger, F. and Pavlova, L. (2022). Quantifying subjective uncertainty in survey expectations. Technical report.

Kuchler, T., Piazzesi, M., and Stroebel, J. (2022). Housing Market Expectations. CESifo Working Paper Series 9665, CESifo.

Leppink, J. (2018). Analysis of covariance (ANCOVA) vs. moderated regression (MODREG): Why the interaction matters. *Health Professions Education*, 4(3):225–232.

McKenzie, D. (2012). Beyond baseline and follow-up: The case for more T in experiments. *Journal of Development Economics*, 99(2):210–221.

Meyler, A., Moreno, M. S., Arioli, R., and Fischer, F. (2021). Results of a special survey of professional forecasters on the ECB's new monetary policy strategy. *Economic Bulletin Boxes*, 7.

Nickel, C., Fröhling, A., Álvarez, L., and Zevi, G. (2021). Inflation measurement and its assessment in the ECB's monetary policy strategy review. *ECB Occasional Paper Series*, (265).

Rondinelli, C. and Zizza, R. (2020). Spend today or spend tomorrow? The role of inflation expectations in consumer behaviour. Technical report, Bank of Italy Working Papers.

Wauters, J. (2021). Summary Report on the NBB Listens Portal. *Economic Review*, (iii):24–42.

Wittekopf, D., Kuik, F., Kouvavas, O., and Koester, G. (2022). Housing costs: survey-based perceptions and signals from price statistics. *Economic Bulletin Boxes*, 1.

Appendix

A. Additional results

Table A.1: Test results for the equality of average subjective probabilities

Panel A: Inflation expectations							
Bin/Treatment pair	<1%	[1%; 2%)	[2%; 3%)	[3%; 4%)	[4%; 5%)	≥5%	Joint
T1=T2	0.47	0.45	0.56	0.27	0.28	0.55	0.70
T1=T3	0.12	0.40	0.32	0.86	0.47	0.30	0.50
T1=T4	**0.08**	**0.03**	0.20	0.26	0.85	0.75	**0.04**
T2=T3	0.50	0.93	0.67	0.22	0.68	**0.10**	0.60
T2=T4	0.36	0.14	**0.07**	0.97	0.47	0.78	0.20
T3=T4	0.72	0.16	**0.03**	0.21	0.70	0.17	**0.08**
Panel B: OOH inflation expectations							
Bin/Treatment pair	<1%	[1%; 2%)	[2%; 3%)	[3%; 4%)	[4%; 5%)	≥5%	Joint
T1=T2	0.47	0.72	0.96	0.28	0.85	0.32	0.83
T1=T3	0.82	0.41	0.72	**0.08**	0.37	0.42	0.34
T1=T4	0.52	0.72	0.12	0.86	0.37	0.46	0.67
T2=T3	0.73	0.61	0.68	0.40	0.47	0.83	0.83
T2=T4	0.18	0.42	**0.10**	0.35	0.27	**0.09**	0.27
T3=T4	0.45	0.17	0.25	**0.10**	**0.08**	0.13	0.13
Panel C: interest rate expectations							
Bin/Treatment pair	'- -'	'-'	'='	'+'	'+ +'		Joint
T1=T2	0.13	0.75	0.44	0.76	0.59		0.46
T1=T3	0.56	0.81	**0.09**	0.27	0.89		0.49
T1=T4	0.25	0.14	0.27	0.44	0.51		0.27
T2=T3	0.28	0.60	0.30	0.15	0.49		0.42
T2=T4	0.58	0.26	0.69	0.27	0.94		0.66
T3=T4	0.55	0.12	0.57	0.70	0.42		0.39

Notes: P-values are shown for t- and Hotelling tests. Values below or equal to 0.1 are shown in bold. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation.

Table A.2: Average treatment effects on (OOH) inflation uncertainty

	Inflation uncertainty				OOH inflation uncertainty			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
α: Baseline mean (T1)	0.82***	0.80***	0.80***	0.79***	0.84***	0.83***	1.03***	1.02***
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.08)	(0.08)
β_2: Current policy	-0.02	-0.02	0.05	0.04	-0.02	-0.02	-0.10	-0.10
	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)	(0.07)	(0.11)	(0.11)
β_3: OOH policy	0.04	0.05	0.04	0.04	0.00	0.02	-0.13	-0.12
	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.11)	(0.110)
β_4: OOH policy + mean	-0.09	-0.09	-0.06	-0.08	-0.05	-0.05	-0.19*	-0.16
	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)	(0.11)	(0.11)
$\beta_3 - \beta_2$:	0.06	0.07	0.00	0.01	0.02	0.04	-0.03	-0.03
	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)	(0.07)	(0.10)	(0.10)
$\beta_4 - \beta_2$:	-0.07	-0.07	-0.11**	-0.11**	-0.03	-0.03	-0.09	-0.06
	(0.06)	(0.06)	(0.06)	(0.05)	(0.07)	(0.06)	(0.10)	(0.10)
$\beta_4 - \beta_3$:	-0.13*	-0.15**	-0.11*	-0.12**	-0.05	-0.07	-0.06	-0.04
	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)	(0.06)	(0.10)	(0.09)
DE inflation uncertainty			0.02***	0.02***				
			(0.00)	(0.00)				
DE house price uncertainty							0.05***	0.04***
							(0.00)	(0.00)
Observations	4307	4158	4243	4094	4308	4164	1407	1362
Adjusted R2	0.00	0.03	0.16	0.20	0.00	0.04	0.27	0.28
Socio-demographic controls	No	Yes	No	Yes	No	Yes	No	Yes

Notes: This table summarises main estimation results for inflation uncertainty. OLS estimates of Equation 3 (Equation 4) are shown in columns 1-2 (3-4) for uncertainty in inflation expectations and columns 5-6 (7-8) for uncertainty in OOH inflation expectations. There are four treatment groups (T1 to T4): Baseline group T1 receives information about the ECB's target and the main inflation measure in the euro area; group T2 also learns that most OOH costs are currently excluded from euro area HICP; groups T3 and T4 are asked to assume that OOH costs are included in HICP as of today, but only T4 is informed about past average OOH inflation. Robust standard errors in parentheses. Significance as * p<0.10 , ** p<0.05, *** p<0.01.

B. A Bayesian learning framework

This section complements the mediation analysis from Section 6 by discussing a Bayesian learning framework to interpret the results. In short, the framework shows how, starting from high inflation expectations before the survey, respondents might 'update' their expectations differently downward to 2%, depending on the information treatment they received.

Priors. We use prior distributions to capture respondents' average long-term inflation expectations before receiving an information treatment. As in Section 6, we denote expected

OOH inflation with $\bar{\pi}^{ooh}$ and expected inflation for other components with $\bar{\pi}^{other}$. For simplicity, the framework considers shifts in aggregate probability distribution across respondents within a treatment group (as if an 'average' respondent is used). The long-term expectations for the two inflation subcomponents are treated as unknown parameters, $\theta = (\bar{\pi}^{ooh}, \bar{\pi}^{other})'$, such that the aggregate distributions have normally distributed priors $\theta \sim N(\underline{\mu}, \underline{\Omega})$, where $\underline{\mu} = \left(\underline{\mu}^{ooh}, \underline{\mu}^{other}\right)'$ and $\underline{\Omega} = \begin{pmatrix} \sigma^2_{ooh} & \sigma \\ \sigma & \sigma^2_{other} \end{pmatrix}$. Hence, underbar symbols refer to prior parameters, and upperbar symbols below refer to posterior parameters.

On average, people have a prior weight $\bar{\omega}$ in mind for the importance of OOH costs in the consumer basket. Taken together, the prior distribution for overall inflation $\bar{\pi}$ is normally distributed as $\bar{\pi} \sim N(\underline{\mu}^{\pi}, \underline{\sigma}^2_{\pi})$, with $\underline{\mu}^{\pi} = \begin{pmatrix} \bar{\omega} & (1-\bar{\omega}) \end{pmatrix} \underline{\mu}$, and $\underline{\sigma}^2_{\pi} = \begin{pmatrix} \bar{\omega} & (1-\bar{\omega}) \end{pmatrix} \underline{\Omega} \begin{pmatrix} \bar{\omega} & (1-\bar{\omega}) \end{pmatrix}'$.

Data. For ease of exposition, we consider group T4, which receives all information. The first piece of text on the ECB's 2% inflation target can be expressed as a data equation (numbers as 100%) to update the priors:

$$2 = \bar{\pi} + \epsilon_1, \tag{8}$$

where error term ϵ_1 is normally distributed as $\epsilon_1 \sim N(0, \sigma_1^2)$. Given the new information on ECB policy, we consider the prior OOH inflation weight $\bar{\omega}$ to be rescaled using a parameter δ (with $0 \leq \delta \leq 1$) as $\bar{\omega}^* = \delta\bar{\omega}$. Therefore, the above equation translates to the following data equation for the θ components:

$$2 = \bar{\omega}^* \bar{\pi}^{ooh} + (1 - \bar{\omega}^*)\bar{\pi}^{other} + \epsilon_1. \tag{9}$$

Intuitively, the 2% number provides information on the potential location of long-term inflation in the euro area. The variance σ_1^2 measures the ECB's perceived credibility. The more credible the ECB, the smaller σ_1^2 is, and the stronger the prior means of the θ parameters will be 'shrunk' to 2%.

Unlike groups T1 to T3, group T4 also receives information on average OOH inflation over the past ten years. This information can be written into a second data equation:

$$2.2 = \bar{\pi}^{ooh} + \epsilon_2, \tag{10}$$

where error term $\epsilon_2 \sim N(0, \sigma_2^2)$. Variance parameter σ_2^2 controls the degree of 'shrinkage' of $\bar{\pi}^{ooh}$ to the 2.2% figure. If the information is considered relevant, the variance will be low, and the updating will be strong. All else equal, $\bar{\pi}^{other}$ will also be updated due to this equation when the priors are correlated.

Updating the priors to posteriors. The prior equations allow us to write $\theta = \underline{\mu} + \epsilon_\theta$, where $\epsilon_\theta \sim N(0_{2\times 1}, \underline{\Omega})$. The data equations can be written as

$$Y = X\theta + \epsilon_y,$$

where $\epsilon_y \sim N(0_{2\times 1}, \Omega_y)$. The structure of Y, X, and Ω_y depends on the treatment. For treatment group T4, we have that

$$X = \begin{pmatrix} \delta\bar{\omega} & (1-\delta\bar{\omega}) \\ 1 & 0 \end{pmatrix}$$
$$Y = \begin{pmatrix} 2 & 2.2 \end{pmatrix}'$$
$$\Omega_y = \begin{pmatrix} \sigma_1^2 & 0 \\ 0 & \sigma_2^2 \end{pmatrix}.$$

Combining the priors and data leads to the posterior distribution $\theta \sim N\left(\bar{\mu}, \bar{\Omega}\right)$, where $\bar{\Omega} = (\underline{\Omega}^{-1} + X'\Omega_y^{-1}X)^{-1}$ and $\bar{\mu} = \bar{\Omega}\left(\underline{\Omega}^{-1}\underline{\mu} + X'\Omega_y^{-1}Y\right)$. For groups T1 to T3, we only use the first row of X and the top left corner of Ω_y. Based on the posterior means for the subcomponents, the posterior distribution of overall inflation will be normally distributed as $\bar{\pi} \sim N(\bar{\mu}^\pi, \bar{\sigma}_\pi^2)$, with $\bar{\mu}^\pi = \begin{pmatrix} \delta\bar{\omega} & (1-\delta\bar{\omega}) \end{pmatrix}\bar{\mu}$, and $\bar{\sigma}_\pi^2 = \begin{pmatrix} \delta\bar{\omega} & (1-\delta\bar{\omega}) \end{pmatrix}\bar{\Omega}\begin{pmatrix} \delta\bar{\omega} & (1-\delta\bar{\omega}) \end{pmatrix}'$.

Interpretation of the average treatment effects. We consider each treatment group to have its own parameters δ and σ_1^2. That is, the text snippets could have spillover effects such that the overall effect of the information treatments is more than the sum of its parts. For example, the information that average OOH inflation was 2.2% over the past ten years could raise the ECB's credibility as perceived by the respondent. This would imply a lower σ_1^2 in the equation corresponding to the first text snippet.

Our survey does not measure prior expectations for euro area inflation. Instead, we compare posterior expectations after the respondents receive some information. Therefore, there are different channels through which the posterior means $\bar{\mu}$ can differ across groups, and more information (or restrictions) is needed to pin down all relevant parameters. As an illustration, we compute the means of $\bar{\pi}$ and $\bar{\pi}^{ooh}$ using the above Bayesian learning model for all four treatment groups and use an optimiser to find the Bayesian model parameters that deliver the smallest sum of squared deviations between (i) the learning model implied means and (ii) the means from the regression estimates in columns (4) and (8) from Table 1. The prior means and variances for θ are assumed to be equal across treatment groups. Since individual OOH inflation expectations tend to be significantly above overall inflation expectations, we restrict the prior means as $\underline{\mu}^{ooh} \geq \underline{\mu}^{other}$. In addition, all variance parameters were restricted

to be above 0.5 and below 12. The weights $\bar{\omega}_1$ to $\bar{\omega}_4$ were calibrated based on the estimated weights from Section 6.

Table A.3 shows the minimisation procedure's starting and estimated parameter values for the Bayesian learning parameters. Based on the estimated parameters, the means from Table 1 can be replicated up to one basis point. The estimated prior means and variances are about the same for the θ parameters. However, there is important variation for the σ_1^2 parameter across groups. The T3 respondents would attach close to no credibility to the 2% value under the announced ECB policy. However, the additional information in T4 helps restore credibility about the target and lowers σ_1^2. In addition, the σ_2^2 value indicates that the information on average OOH inflation is used to some extent to update the priors on $\bar{\pi}^{ooh}$.

The model also provides intuition for why OOH inflation expectations increase for group T2 (current policy) vs. baseline group T1 while overall inflation expectations remain similar between both groups. Since the estimated weight $\bar{\omega}$ drops from T1 to T2, there is a weaker updating of the prior distribution for OOH inflation, which has a relatively high mean, toward the lower value of the 2% inflation target. As a result, the posterior distribution for expected OOH inflation is higher for T2. Yet, the impact of higher OOH inflation expectations is offset by a lower weight $\bar{\omega}$ for OOH inflation, making the posterior mean of overall inflation similar between both groups.

In sum, the shifts in σ_1^2 parameters in combination with the majority weight $(1 - \bar{\omega}^*)$ are consistent with the result from the mediation analysis that direct effects are key. Nevertheless, we caution that this is just one numerical example for interpreting the results. Indeed, applying different restrictions and starting values for the minimisation procedure can deliver different parameter estimates that replicate the main treatment effects from Table 1.

Table A.3: Estimated Bayesian learning parameters

Parameters	$\underline{\mu}^{ooh}$	$\underline{\mu}^{other}$	σ^2_{ooh}	σ^2_{other}	$\sigma^2_{1,T1}$	$\sigma^2_{1,T2}$	$\sigma^2_{1,T3}$	$\sigma^2_{1,T4}$	σ_2^2
Starting values	6	4	2	2	2	2	2	2	2
Estimated values	3.95	3.95	0.54	0.5	1.30	2.22	11.99	1.93	4.04