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The pass-through from inflation perceptions to inflation expectations

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Non-technical summary

Research Question

In this paper we analyse the link between individual's perceptions about inflation in the past 12 months and their inflation expectations for the next 12 months. We are interested in understanding how strong the pass-through from perceptions to expectations is in times of high inflation compared to times of low inflation and whether the strength of the pass-through differs across groups of individuals.

Contribution

We contribute to the literature on the expectation formation of households and individuals. Using an information provisioning experiment in the Bundesbank Online Panel Households (BOP-HH), we are not only able to investigate the relationship between the two concepts, but also establish a causal link from perceptions to expectations. Our paper also goes beyond existing studies, by looking at short- and long-term inflation expectations (5 to 10 years ahead). Using the panel structure of the BOP-HH and data until December 2022, we are able to compare the strength of the pass-through in high- and low-inflation periods.

Results

We document a strong and statistically significant pass-through from inflation perceptions to inflation expectations of individuals in Germany. The relationship is stronger for short-term than for long-term expectations and during periods of low inflation compared to periods of high inflation. We furthermore show that the strength of the pass-through varies by sociodemographic groups. We identify two critical moderating factors for this heterogeneity; differences in individual uncertainty about future inflation and information acquisition.

Nichttechnische Zusammenfassung

Fragestellung

In dieser Arbeit untersuchen wir den Zusammenhang zwischen der von Privatpersonen wahrgenommenen Inflationsrate in den zurückliegenden 12 Monaten und der erwarteten Inflationsrate in den kommenden 12 Monaten. Uns interessiert dabei, wie stark der Zusammenhang zwischen Wahrnehmungen und Erwartungen in Zeiten hoher Inflation im Vergleich zu Zeiten mit geringen Inflationsraten ist. Außerdem untersuchen wir, ob der Zusammenhang über unterschiedliche Gruppen von Privatpersonen hinweg variiert.

Beitrag

Unsere Analysen leisten einen Beitrag zur wissenschaftlichen Literatur über die Erwartungsbildung von Haushalten und Personen. Wir zeigen mithilfe eines Experiments im Bundesbank-Online-Panel-Haushalte (BOP-HH), bei dem Befragten die tatsächliche Inflationsrate in der Vergangenheit genannt bekommen, einen kausalen Effekt von wahrgenommenen auf erwartete Inflationsraten. Ein weiterer Beitrag unserer Arbeit ist, dass wir neben Inflationserwartungen für die kurze Frist auch Erwartungen für die lange Frist (nächste 5 bis 10 Jahre) betrachten. Mithilfe der Paneldaten des BOP-HH, die bis einschließlich Dezember 2022 reichen, können wir Zeiten mit hohen und geringen Inflationsraten vergleichen.

Ergebnisse

Wir finden, dass es für Privatpersonen in Deutschland einen starken und statistisch signifikanten Effekt der wahrgenommenen auf die erwartete Inflationsrate gibt. Der Wirkungszusammenhang ist stärker für kurzfristige als für langfristige Inflationserwartungen sowie in Zeiten geringer Inflation im Vergleich zu Zeiten hoher Inflation. Wir finden auch, dass die Stärke des Zusammenhangs über sozio-demographische Gruppen variiert und dass dies zumindest zum Teil der Tatsache geschuldet ist, dass bestimmte Gruppen von Personen eine höhere Unsicherheit hinsichtlich der zukünftigen Inflationsrate an den Tag legen oder unterschiedlich gut über die aktuelle Inflationsrate informiert sind als andere.

The pass-through from inflation perceptions to inflation expectations

Stefanie J. Huber^{*} Daria Minina[§] Tobias Schmidt[‡]

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Abstract

This paper documents a strong relationship between *households' perceptions* about inflation over the past 12 months and households' *short- and long-term expectations* about future inflation. This relationship is strong during periods of high-inflation but even stronger during low-inflation periods. We establish a causal relationship by implementing a randomized information provision experiment in a large and representative survey to generate an exogenous variation in inflation perceptions. Our results show that household perceptions about past inflation drive their expectations about future inflation rates. The strength of the pass-through from perceptions to expectations varies across socioeconomic groups. We identify two critical moderating factors for this heterogeneity; differences in individual uncertainty about future inflation and information acquisition. Further, we show that the large majority of households rely on their shopping experience when forming their perceptions about past inflation and pay particular attention to food and fuel prices. The shopping experience affects inflation expectations indirectly—through perceptions.

Keywords: inflation dynamics, expectations, perceptions, uncertainty, household finance, monetary policy, randomized control trial.

JEL Classifications: D10, D84, D90, E31, E52, G40, G50.

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1 Introduction

“Perception precedes reality.” (Andy Warhol)

After decades of low inflation in the developed world, inflation has been increasing significantly over the past months in many countries. Various reasons are cited for this increase, including supply shortages, the Ukraine-Russian war, and stronger demand due to exceptionally high savings accumulated by households during the Covid-19 pandemic. Academics and central bankers alike emphasize the critical role of inflation expectations for actual inflation (Fiore et al., 2022).¹ Already in the time of the effective lower bound, managing inflation expectations was seen as one of the few ways to influence inflation. Nowadays, in times of high inflation rates, central banks globally aim to “anchor” and manage inflation expectations through communication. However, it is still a perennial question of whether and how households’ expectations react to communication and more generally, how households form their inflation expectations.²

The existing research focuses primarily on expectation biases and heterogeneity based on socioeconomic characteristics (Arioli et al. (2017); Del Giovane et al. (2008); Weber et al. (2022)). The literature documents non-rationality, substantial forecast errors (Binder (2017); Cavallo et al. (2017)), high disagreement, and the influence of personal experiences (Angelico and Di Giacomo (2019); Malmendier et al. (2021)). Hence, a large body of empirical work documents pronounced deviations from full-information rational expectations (Coibion et al. (2018a)). Recent research shows that households use simple heuristics to form expectations, involving a significant backward-looking component (Hommes (2021), Petersen and Mokhtarzadeh (2021)).

This paper aims to investigate what role inflation perceptions play in the expectation formation process. If households rely heavily on their own perception of the past developments of prices, managing perceptions may be a way to influence expectations. The influence of perceptions about the development of past inflation on inflation expectations has attracted little attention in the literature. Only a handful of papers document a positive correlation between household’s perceived and expected (twelve months ahead) inflation (Gautier and Montornès (2022) for France, D’Acunto

¹Inflation expectations are nowadays central for the analysis of monetary policy in macroeconomic models (Galí (2008)). On the policy relevance of inflation expectations, the current ECB-president Christine Lagarde, stated in 2020 that “for the actual process of setting wages and prices, it is the expectations of the public that matter most.” While the empirical evidence is mixed, recent empirical work supports this view. Vellekoop and Wiederholt (2019a) find that households with higher inflation expectations save less and are more likely to buy expensive cars and Duca-Radu et al. (2021) provide evidence that European consumers increase their readiness to spend when they anticipate an increase in inflation.

²See for example Fed Chairwoman Janet Yellen (2016) speech: “Perhaps most importantly, we need to know more about the manner in which inflation expectations are formed and how monetary policy influences them”. ECB Vice-President Vitor Constancio (2017) has expressed a similar view: “For policy-makers, this [recent research] seems to suggest that there is an important role of the central bank in shaping the expectations of the general public, not only that of financial markets. It also suggests that more research is needed to understand the different factors that shape the inflation expectations of individual households.”

et al. (2021a) and Cavallo et al. (2017) for the US, Arioli et al. (2017) for the EU, Bosch et al. (2015) for South Africa). Using Swedish data, Jonung (1981) and Dräger (2015) specifically look at the relationship between perceptions and expectations. Our paper follows the latter two papers and investigates the relationship between inflation perceptions and short-term expectations. It goes beyond those, in investigating the relationship between inflation perceptions and long-term expectations as well. A topic particularly relevant for monetary policymakers worried about second-round effects and the de-anchoring of inflation expectations.

We use micro-data from the Bundesbank Online Panel Households (BOP-HH) on individuals in Germany. This survey contains rich data on inflation perceptions and various measures for short- and long-term inflation expectations. The panel dimension allows studying how the within-person variation in inflation perceptions feeds into expectations. To establish a causal relationship, we implement a randomized control trial (RCT) approach in the August 2022 wave of the BOP-HH survey to induce exogenous variation in households' inflation perceptions. To shed more light on how households form inflation perceptions about current and past inflation, we implement new survey questions in the April 2022 and July 2022 survey waves.

This paper contributes to the literature on inflation expectation formation by highlighting six main results. First, we build on the literature on the perception-expectation link (D'Acunto et al. (2021a), Cavallo et al. (2017), Arioli et al. (2017), Bosch et al. (2015), Dräger (2015)), and confirm a strong positive and significant correlation between households' inflation perceptions and short-term inflation expectations (next 12 months), as was identified in the seminal paper by Jonung (1981).³ Our paper is the first to establish evidence that households' *perceptions* about past inflation *causally drive* households' *expectations* about future inflation. We randomly assign the survey participants to information treatments and study the causal effects of the resulting change in inflation perceptions on their inflation expectations. More generally, our paper contributes by expanding the literature that uses large-scale surveys to study information provision on inflation expectations.⁴ To the best of our knowledge, we are the first to do this in the context of inflation perceptions.

Second, the existing literature has focused exclusively on the relationship between perceptions and short-term inflation expectations. Our paper goes beyond this by investigating the relationship between households' inflation perceptions and their policy-relevant long-term inflation expectations (5 and 10 years ahead). We find that households use their subjective assessment of the development

³A one percentage point increase in inflation perceptions is associated with an approx. 0.8 pp increase in short-term inflation expectations—independent of the model specification considered.

⁴These survey experiments investigate drivers for inflation expectations, covering information treatments on countries' fiscal outlooks (debt, deficit) by Coibion et al. (2021), monetary policy communication by Coibion et al. (2022), and professional forecasts by Armantier et al. (2016).

of inflation over the last twelve months (i.e., inflation perceptions) not only to form their short-term expectations, but also consider it when forming their long-term expectations. Long-term expectations are directly and indirectly, via the effect on short-term expectations, influenced by households' inflation perceptions.

Given our result of a causal and economically meaningful effect of perceptions on expectations, it is essential to understand how households form their perceptions about past inflation. We contribute to the field by adding several novel questions to the BOP-HH survey. We find that prices of frequently bought products (especially food and fuel) are at the forefront of respondents' minds when assessing average inflation over the last 12 months. The overwhelming majority (90%) based their inflation perceptions on their shopping experience (and not on information they have heard or read). This result holds independent of whether the respondent has read or read something about inflation recently.⁵ Our third contribution relates to the literature on the importance of salient prices of frequently bought goods for households' inflation expectations (D'Acunto et al. (2021a); Kaplan and Schulhofer-Wohl (2017)). We show evidence that the *shopping experience effect on expectations* is an *indirect effect* as it works through perceptions.

Fourth, we add to the literature by showing that the strength of the pass-through from inflation perceptions to inflation expectations depends on the inflation environment. The existing literature, e.g., Cavallo et al. (2017) investigates empirically whether the expectation formation process differs depending on the inflation context (by comparing a low-inflation environment, the US, with a high-inflation environment, Argentina). Cavallo et al. (2017) argue that individuals in low inflation contexts have significantly weaker priors about the inflation rate (e.g., rely more on their perceptions of past inflation when forming expectations). We investigate the role of the inflation environment by focusing on one country using panel data. In Germany, we find that the pass-through from inflation perceptions to short-term expectations (and long-term expectations) is quantitatively important in periods of high inflation (after July 2021), and even stronger during periods of low inflation (before July 2021).⁶

⁵In July 2021, 44% of the respondents had heard or read something about inflation over the past four weeks. The inflation rate increased significantly over 2022—by the end of 2022, the overall CPI inflation was more than six percentage points higher than in July 2021. Consequently, the topic *inflation* appeared much more frequently in the news. As a result, in November 2022, almost 90% of the survey participants report to had heard or read some information about inflation in the last month. It is striking that the fraction of households using the shopping experience instead of media/news remained the same over this time. In July 2021 and November 2022, almost 90% of the interviewees reported using their shopping experience to form perceptions about past inflation.

⁶Our result is consistent with the theory of rational inattention. During times of low and stable inflation, households do not search for information about the current and future inflation rate (searching for information is costly) and rely on their shopping experience. They simply extrapolate from their perceptions of current and past inflation to form inflation expectations. However, in times of high or varying inflation, the cost-benefit analysis changes. The cost of acquiring information about inflation decreased significantly as news coverage increased significantly. Households might collect more information to form inflation expectations and rely less on their perceptions about past inflation.

Fifth, this paper contributes to the literature studying expectation biases and heterogeneity based on socioeconomic characteristics (Arioli et al. (2017); Del Giovane et al. (2008); Weber et al. (2022)). We find heterogeneity in the strength of the pass-through—the strength differs across socioeconomic groups. Women, residents of East Germany, the employed, and individuals younger than 60 years old rely to a larger extent on their inflation perceptions when forming inflation expectations than other groups.

Finally, this paper investigates the underlying reasons for this heterogeneity in the strength of the pass-through among socioeconomic groups. We discover that individual uncertainty about future inflation affects the pass-through from perceptions to expectations. The more uncertain the household, the more the household relies on perceptions about past inflation when forming expectations about future inflation. In addition, we find that households with a more substantial pass-through report using their shopping experience to form inflation perceptions (instead of using information they have heard or read).

There is an extensive debate in the literature on which type of theoretical model best describes the expectation formation of economic agents. A model from the noisy information class can explain most of our findings (Coibion and Gorodnichenko, 2012; Sims, 2003; Vellekoop and Wiederholt, 2019b; Woodford, 2003). In particular, we take the model described in Vellekoop and Wiederholt (2019b) with minor modifications and show that the results of our paper fit naturally within this framework.

In summary, this paper shows that perceived inflation plays a crucial role in forming inflation expectations. Individual inflation uncertainty is an essential determinant of the strength of this relationship. The results of our RCT survey experiment show that providing information about the inflation rate over the past twelve months leads households to adjust their inflation perceptions; this change in inflation perceptions leads households to revise their expectations about future inflation. These findings are relevant for policy. They suggest that in seeking to manage and anchor inflation expectations, central bankers could beneficially spend further effort in monitoring, understanding, and managing inflation perceptions. Central banks might profit from creating a new communication tool by which they address households to "correct" perceptions of past inflation (and, by that, influence inflation expectations). However, it might be challenging for a central bank to reach and provide households with information about past and current inflation. In such a case, our result that households' shopping experience and prices of frequently bought products are critical for households' inflation perceptions seems essential. It suggests that households' inflation perception would increase if current inflation is predominantly driven by food and energy prices. As households' expectations are extrapolated from perceptions, we conclude that an inflation environ-

ment that is driven by salient price changes provides risks for de-anchoring households' short-term and long-term expectations from the inflation target.

The remainder of this paper is organized as follows. Section 2 describes the data. Section 3 investigates the relationship between households' inflation perceptions and short- and long-term expectations. Section 4 discusses the implementation of the RCT information experiment and summarizes the main results. Section 5 sheds light on how households form their perceptions about inflation over the past twelve months and investigates the moderating factors for the heterogeneity in the pass-through among different socio-economic groups. Finally, Section 6 discusses the policy implications of our findings and concludes.

2 Data

We use micro-data from the Bundesbank Online Panel Households (BOP-HH) on individuals in Germany. The survey collects monthly data on individuals' expectations regarding a large variety of economic indicators, among them inflation.⁷ We use data from all 36 waves of the survey, spanning a period from April 2019 to June 2019 and April 2020 to December 2022. In total, more than 48,000 individuals participated in the survey, some of them several times, yielding around 143,000 observations. Given that not all questions we need for our analysis are asked to all respondents in all waves, our estimation sample reduces to 75,000 observations.

The goal of the paper is to study the link between inflation perceptions and inflation expectations of consumers. The BOP-HH survey is particularly suited for our analysis for several reasons:

First, it not only contains several measures of inflation expectations (qualitative, quantitative, probabilistic)⁸, but also a measure of inflation perceptions. This question appeared in the survey every quarter before 2021 and since January 2021 every month. In particular, respondents are asked the following question about their perceptions "What do you think the rate of inflation or deflation in Germany was over the past twelve months?" and the corresponding quantitative inflation expectations question: "What do you think the rate of inflation or deflation in Germany will be over the next twelve months?".

⁷The respondents are randomly selected from an access panel of individuals who are 16 years or older with internet access. The gross sample is drawn to be representative along the dimensions age, gender, education and region. At least 2,000 respondents participate in the survey every month. For details on the methodology see Beckmann and Schmidt (2020).

⁸The survey includes several measures for inflation expectations. First, respondents report if they expect inflation or deflation in the next twelve months. Second, BOP-HH asks consumers about the development of the inflation rate over the next twelve months on a scale from "decrease significantly" to "increase significantly". Third, respondents report point inflation forecast over the next twelve months. Fourth, respondents are asked to assign probabilities to pre-determined intervals of inflation. There is also a quantitative measure of the long-term inflation expectations (5 and 10 years ahead). The exact wording of the survey questions is presented in Appendix A.

Second, the BOP-HH has a panel dimension, which allows us to study the relationship between inflation perceptions and expectations taking into account fixed unobserved individual characteristics. Third, the survey offers a wide variety of socio-economic characteristics of each respondent (gender, region of residence, age, employment status, income, education, etc). Fourth, it allows to add specific questions and modules with randomised control trials (RCT) approaches to selected waves.

We enrich the survey data with aggregate information and collect monthly CPI indices; the overall Harmonized Index of Consumer Prices, the CPI on energy, the CPI excluding food and energy, and the CPI on net rent.⁹

Construction of the key variables

Our key variables of interest are the perceptions about the inflation rate in the past twelve months, the short-term inflation expectations for the next twelve months, and the long-term expectations for the next five/ten years. We take the responses from the questions listed in Appendix A, and correct the measures for outliers. To be more precise, observations with inflation expectations and perceptions greater than 30 or lower than -5 percent are excluded from the analysis.

To measure uncertainty about future inflation at the individual level, we use the probabilistic inflation expectation question. Respondents have to assign a probability to ten distinct intervals of inflation. We compute the variance from the answers as a measure of uncertainty. We use this indicator to study the effect of individual-specific inflation uncertainty on the pass-through from inflation perceptions to expectations.

To study potential differences in information acquisition between individuals, we contributed three questions to wave 17 (July 2021) of the BOP-HH survey. The first question asks consumers to state how the prices for nine main categories of goods and services changed over the past 12 months. The scale for this question consists of five categories from "decreased significantly" to "increased significantly". The second question is a follow-up question that picks up the previous answer on respondents' perception of the development of prices for essential goods over the last 12 months. The question then asks households whether they based this assessment more on their own shopping experience or more on things they have heard or read (e.g., in the media). The last question asks if consumers obtained any information about inflation recently. We repeated the second and third questions in survey wave 35 (November 2022). The exact wording of the added information questions is provided in Section 5 and Appendix A.

To further understand how households form their perceptions of inflation over the past twelve

⁹These indices are taken from the Germany Federal Statistical Office, and presented in Appendix Table B1; the indicators reflect inflation relative to the same month of the previous year.

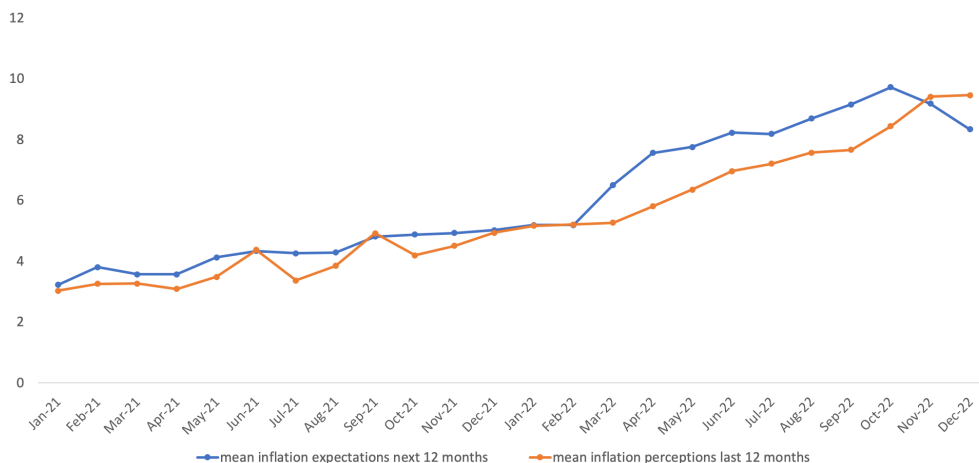
months, we contributed a question to wave 28 (April 2022) of the BOP-HH survey. This question is a follow-up question to a question on respondents' perception of the inflation/deflation rate over the past twelve months. The follow-up question asks respondents to rate the importance of nine factors for their previously given point estimate of inflation perceptions, including factors like the development of food, fuel or house prices and discussions with friends or colleagues (See Appendix A for details).

Finally, we conducted an information provision experiment in survey wave 32 (August 2022) to establish the causal effect of short-term inflation perceptions on inflation expectations. The RCT survey experiment is discussed in detail in Section 4. Appendix 6 provides the exact wording of the information treatments as well as the post-treatment inflation perceptions and expectations questions. Appendix B provides descriptive and summary statistics of the variables used in this paper; see Appendix Tables B1 and B2.

3 The Perception-Expectation Link

Figure 1 displays the time series of inflation perceptions and short-term inflation expectations. Inflation expectations exceed perceptions in all but the last two waves. It is striking how closely perceptions and expectations move together; the time series look very similar.¹⁰

Figure 1: Dynamics of mean inflation expectations and perceptions



Sources: Bundesbank Online Panel Households (BOP-HH). Expectations and perceptions: Weighted means, observations truncated to interval [-5;+30].

¹⁰Appendix Table B1 reports summary statistics for these variables, as well as for long-term inflation expectations over the next 5 and 10 years. Appendix Figure B1 shows the time series of median inflation perceptions and median short-term expectations. Appendix Figure B3 displays the sample distribution for the key variables of interest: inflation perceptions over the last 12 months, short-term inflation expectations over the next 12 months, and long-term inflation expectations over the next 5 and next 10 years. For each variable, Appendix Figure B4 shows the disagreement among the respondents (measured by the standard deviation) for each survey wave. Appendix Figure B5 shows the distribution of households' perception errors (i.e., the difference between inflation perceptions and actual overall CPI inflation).

3.1 Short-term Inflation Expectations

To analyze the link between households' inflation perceptions and households' expectations, we estimate the following baseline model by OLS (ordinary least squares):

$$\mathbb{E}(\pi_{i,t \rightarrow t+12}) = \beta_0 + \beta_1' X_{i,t} + \beta_2 \tilde{P}_{i,t} + F_t + \varepsilon_{i,t} \quad (3.1)$$

where $\mathbb{E}(\pi_{i,t \rightarrow t+12})$ denotes the inflation rate household i surveyed in wave t expects for the next 12 months; measured in percentage points. $X_{i,t}$ denotes a vector of controls for individual i , which varies with the specification considered. In the baseline specification, the individual characteristics included are gender, age, age squared, household income deciles, educational attainment, employment status, and a dummy for residence in East Germany. The East dummy absorbs unobserved time-invariant differences between East and West Germany.¹¹ $\tilde{P}_{i,t}$ is our variable of interest, household's i perceived average inflation rate over the last 12 months; measured in percentage points. F_t denotes the survey-wave fixed effects to control for systematic time trends. These fixed effects capture differences between survey waves that are identical for all participants within one wave (e.g., the ordering of the questions within the survey), but also capture potentially relevant events and shocks that occurred in Germany in a given month (e.g., monetary policy announcements, statistical data release, etc). Note that these fixed effects control for the monthly actual CPI inflation rate, the inflation rate is identical for all survey respondents within one wave but varies across waves. Hence, it is not surprising that including the actual CPI inflation rate in specification (3.1) instead of the fixed effects does not change our results (Appendix Table B4). The error term is denoted by $\varepsilon_{i,t}$. The results presented throughout the paper use the Eicker-Huber-White (EHW) method to estimate standard errors, but are robust to using clustered standard errors at the individual level instead.

Columns 1-4 of Table 1 report the estimation results. We find a significant positive relationship ($p < 0.001$) between households' expected short-term inflation over the next 12 months and households' perceived inflation over the last 12 months. Adding sequentially our control variables does not change this result; the size and significance level of this relationship remains unchanged (Cols 1-4).¹² A one percentage point increase in households' perceptions is associated with a 0.74-pp increase in expected short-term inflation (Col. 4). This effect is quantitatively large.

¹¹Goldfayn-Frank and Wohlfart (2020a) show that East Germans expect higher inflation than West Germans decades after reunification.

¹²Appendix Figure B6 displays the OLS regression coefficients of model (3.1) for each survey-wave individually and shows that the relationship between inflation perceptions and short-term inflation is positive and sizable in all waves.

In the second specification, we exploit the panel dimension of our data and estimate the model (3.1) using a fixed-effects as well as a random-effects regressions. The panel dimension allows studying how the within-person variation in inflation perceptions feeds into expectations, and thus provides stronger evidence for a causal relationship. The panel specifications are advantageous as unobserved time-invariant differences across individuals are controlled for. Columns 5–6 of Table 1 show the estimation results. The panel regressions confirm that inflation perceptions have a positive, sizable, and statistically significant impact on short-term inflation expectations. In a third specification, we conduct a difference-in-difference (DiD) panel regression:

$$\Delta \mathbb{E}(\pi_{i,t \rightarrow t+12}) = \beta_1' \Delta X_{i,t} + \beta_2 \Delta \tilde{P}_{i,t} + \varepsilon_{i,t}, \quad (3.2)$$

where $\Delta \mathbb{E}(\pi_{i,t \rightarrow t+12})$ denotes the change in household’s i short-term inflation expectations (difference between household’s i point estimate in wave $t + 1$ and in wave t) and $\Delta \tilde{P}_{i,t}$ denotes the change in household’s i perceived average inflation rate over the last 12 months. Potential changes in households’ socioeconomic characteristics are captured by $\Delta X_{i,t}$. The drawback of this DiD regression (Col. 7) is the loss of 87 percent of observations compared to our baseline specification shown in Column 4, because we require respondents to be observed in two subsequent waves.

Finding 1 (Inflation Perceptions and Short-term Expectations.). *Households’ inflation perceptions $\tilde{P}_{i,t}$ over the last 12 months have a positive, large, and significant effect on households’ inflation expectations over the next 12 months $\mathbb{E}(\pi_{i,t \rightarrow t+12})$.*

Dependent variable: Short-term Inflation Expectations (next 12 months)							
	OLS	OLS	OLS	OLS	panel FE	panel RE	panel Δ on Δ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
perceptions (past 12 months)	0.831*** (0.00554)	0.759*** (0.00818)	0.820*** (0.00563)	0.736*** (0.00836)	0.749*** (0.00730)	0.786*** (0.00653)	0.525*** (0.0256)
Wave dummies	-	+	-	+	-	-	-
Controls	-	-	+	+	-	-	-
N	74733	74733	70816	70816	50852	50852	8366
R^2	0.515	0.545	0.515	0.547	0.457	0.458	0.197

Notes: Columns 1-4 report OLS estimates. The estimates from the panel fixed effect regression are shown in Column 5, the estimates from the panel random effect regression in Column 6. Column 7 reports the estimates from the panel change-on-change regression. Panel fixed- and random-effects regressions are estimated on the sample of households who participate in the survey more than once. Robust standard errors (Eicker-White) are reported in parentheses. For the panel regressions we report within R^2 . Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Wave controls include a dummy for each wave. Socio-demographic controls include gender, household income, education, current employment status, East residence dummy, age, age squared. The dependent variable (short-term inflation expectations) are measured by the quantitative survey question: “What do you think the rate of inflation will roughly be over the next 12 months?”. Perceptions are measured by the quantitative survey question: “What do you think the rate of inflation or deflation in Germany was over the past 12 months?”. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 of the survey (April - June 2019, April 2020 - December 2022)

Table 1: Inflation Perceptions on Short-term Expectations

A strong link between perceived current inflation and expected future inflation is consistent with noisy information model (e.g., [Vellekoop and Wiederholt \(2019b\)](#); [Coibion and Gorodnichenko \(2012\)](#); [Woodford \(2003\)](#); [Sims \(2003\)](#)).

To rationalize our findings, we use and extend the model of [Vellekoop and Wiederholt \(2019b\)](#). According to this model, households form inflation expectations every period, following a perceived law of motion of inflation:

$$\pi_t = (1 - \rho)c + \rho\pi_{t-1} + u_t, \quad (3.3)$$

where π_t denotes the inflation rate in period t , and ρ denotes the autocorrelation coefficient ranging from $(-1, 1)$. The constant is denoted by $c \in \mathbb{R}$ and $u_t \sim i.i.d.N(0, \sigma_u^2)$ denotes the inflation shock in period t . Such an AR(1) form of the perceived law of motion is often used in the rational inattention literature. In addition, it is supported by multiple laboratory experiments investigating the expectation formation of economic agents (e.g., [Petersen and Mokhtarzadeh \(2021\)](#); [Anufriev and Hommes \(2012\)](#); [Heemeijer et al. \(2009\)](#)).¹³

At the time of forming an expectation, current inflation is not yet known. Instead, household i receives a noisy signal $s_{i,t}$, with

$$s_{i,t} = \pi_t + \epsilon_{i,t}, \quad (3.4)$$

where π_t denotes the actual inflation rate in period t , and $\epsilon_{i,t} \sim i.i.d.N(0, \sigma_\epsilon^2)$ denotes the noise in the signal, which consists of an aggregate and an individual component, $\epsilon_{i,t} = \bar{\epsilon}_t + \hat{\epsilon}_{i,t}$. The aggregate component, $\bar{\epsilon}_t$, could be interpreted as the noise resulting from e.g. media reports about inflation. The idiosyncratic noise, $\hat{\epsilon}_{i,t}$, might stem from individual differences in limited attention or different information sources used to receive a signal (i.e., varying individual consumer baskets).¹⁴

Current inflation π_t is unknown in period t . Household i uses the steady-state Kalman filter to nowcast inflation in period t . Hence, household i expects current inflation to be given by

$$E[\pi_t | I_{i,t}] = E[\pi_t | I_{i,t-1}] + K(s_{i,t} - E[\pi_t | I_{i,t-1}]), \quad (3.5)$$

where K denotes the Kalman gain, $I_{i,t}$ denotes consumer i 's information set in period t , and $s_{i,t} - E[\pi_t | I_{i,t-1}]$ is the difference between the actual signal and the expected signal. Using equations (3.3) and (3.5), it follows that household i 's expectations about future inflation are given by

$$E[\pi_{t+1} | I_{i,t}] = (1 - \rho)c + \rho E[\pi_t | I_{i,t}]. \quad (3.6)$$

Plugging the nowcast of the current inflation (3.5) into equation (3.6), we can finally describe the

¹³[Hommes \(2021\)](#) provides an excellent review of this literature.

¹⁴In the original model of [Vellekoop and Wiederholt \(2019b\)](#), the aggregate noise has a non-zero subjective mean μ_i . We set μ_i equal to zero because it does not affect the mechanisms described in our paper.

formation of inflation expectations by

$$E[\pi_{t+1}|I_{i,t}] = (1 - \rho)c + \rho(1 - K)E[\pi_t|I_{i,t-1}] + \rho K s_{i,t}. \quad (3.7)$$

Note that the regression equation (3.1) corresponds to the model equation (3.6). In the context of the model, inflation perceptions $P_{i,t}$ equal the nowcast of inflation, and the inflation expectations are formed using the perceived law of motion of inflation. Our key coefficient of interest in Table 1 corresponds to the persistence parameter of the perceived law of motion of households (ρ).

3.2 The Low versus High Inflation Environment

During the time period April to June 2019 and April 2020 to July 2021, the German economy experienced a stable and low inflation rate equal to 1.1 on average and with a standard deviation of 0.83. For the time period from July 2021 to December 2022, the average inflation rate was much higher and equaled 6.7 with a standard deviation of 2.2. We split the sample into a low-inflation (before July 2021) and high-inflation environment (after July 2021) and run the estimation for both sub-samples separately. Columns 1–2 of Table 2 show the estimation results. We confirm that the relationship is in both scenarios sizable and highly significant. However, the pass-through from inflation perceptions to short-term expectations is stronger in low- versus high-inflation environments¹⁵.

Instead of splitting the sample, Columns 3–5 of Table 2 report the estimation results using all survey waves. For convenience, Column 3 reports the baseline specification of model (3.1). To investigate the differential effect of perceptions in high- versus low-inflation environments, we include a dummy variable in Column 4 that is equal to one for the high-inflation periods, and zero otherwise. In Column 5, we add the interaction term between this dummy and perceptions. We again find that households place more weight on their perceptions when forming inflation expectations in the low- versus high-inflation environment.

Finding 2 (Low versus High Inflation Environment). *The pass-through from households' inflation perceptions $\tilde{P}_{i,t}$ over the last 12 months to households' inflation expectations over the next 12 months $\mathbb{E}(\pi_{i,t \rightarrow t+12})$ is stronger during low- compared to high-inflation periods.*

¹⁵Tables B6 and B7 show that the pass-through from inflation perceptions to long-term inflation expectations is also weaker in high-inflation environment.

Dependent variable: Short-term Inflation Expectations					
	before July 2021	after July 2021	full sample		
	(1)	(2)	(3)	(4)	(5)
perceptions (past 12 months)	0.872*** (0.0153)	0.665*** (0.0100)	0.736*** (0.00836)	0.736*** (0.00836)	0.860*** (0.0150)
high inflation				0.391*** (0.106)	1.370*** (0.131)
perceptions \times high inflation					-0.193*** (0.0180)
constant	+	+	+	+	+
wave dummies	+	+	+	+	+
controls	+	+	+	+	+
N	20702	50114	70816	70816	70816
R^2	0.578	0.452	0.547	0.547	0.551

Notes: Columns 1-5 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The dependent variable (short-term inflation expectations) is measured by the quantitative survey question: “What do you think the rate of inflation will roughly be over the next 12 months?”. Perceptions are measured by the quantitative survey question: “What do you think the rate of inflation or deflation in Germany was over the past 12 months?”. High inflation is the dummy equal to 1 for periods starting from July 2021 and 0 otherwise. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 of the survey (April - June 2019, April 2020 - December 2022)

Table 2: The Role of Perceptions in Low- vs High-Inflation Environments

Next, we investigate this second finding through the lens of the model sketched above. A smaller regression coefficient on inflation perceptions in equation (3.1) during high-inflation times corresponds to a lower perceived inflation persistence in model equation (3.6) during that period. Consider the regression coefficient

$$\hat{\beta}_{OLS} = \frac{Cov(\mathbb{E}(\pi_{i,t \rightarrow t+12} \tilde{P}_{i,t}))}{Var(\tilde{P}_{i,t})}. \quad (3.8)$$

For the coefficient to become smaller, either the variance of the perception has to increase and/or the covariance between perceptions and expectations has to decrease. The model suggests that a change in the persistence parameter is related to the variance of the signal. Hence, we can rationalize our finding in the following way. In high-inflation times, the news coverage on inflation has increased significantly, i.e. the variance of the signals increased, which leads to a decrease in the estimated OLS coefficient in (Eq 3.8). This explanation is supported by our data. Compared to low-inflation periods, the variance of perceptions is higher and the covariance between perceptions and expectations is smaller in high-inflation periods.¹⁶

¹⁶The variance of inflation perceptions increased from from 13.40 (low-inflation periods April 2020 – June 2021) to 13.72 (high-inflation periods July 2021 – December 2022). The covariance between perceptions and expectations decreased from 9.80 to 9.27. Empirically, both the numerator and the denominator in (3.8) contribute to the decrease in the pass-through observed in the high-inflation environment. Intu-

3.3 Long-term Inflation Expectations

The previous section established a strong and robust link between short-term inflation perceptions and short-term inflation expectations. Households' inflation expectations may directly affect consumption decisions and wage demands, which in turn underpin firms' price-setting. However, if households perceive high inflation rates as temporary, they may be less likely to demand higher wages or adjust their consumption plans fundamentally. In contrast, the opposite is likely to be true if they expect high inflation rates to persist. Monetary policymakers, worried about these second-round effects and de-anchoring of expectations, are thus especially concerned about agents' medium- and long-term inflation expectations.

The Bundesbank survey has two quantitative questions measuring long-term inflation expectations, and the respondents are randomly split between them:

Question 1 (inflation over the next five years): “What value do you think the rate of inflation or deflation will take on average over the next five years? Answer: [...] percent

Question 2 (inflation over the next ten years): “What value do you think the rate of inflation or deflation will take on average over the next ten years? Answer: [...] percent

Appendix Figure B2 shows the time series of mean (and median) long-term inflation expectations. Long-term expectations have been relatively stable and anchored until January 2022. Since then we observe significant increases in both (mean and median) long-term inflation expectations in Germany.

To analyze the impact of households' inflation perceptions regarding inflation in the last 12 months on households' long-term expectations, we estimate the following model by OLS (ordinary least squares):

$$\mathbb{E}(\pi_{i,t}^L) = \beta_0 + \beta_1' X_{i,t} + \beta_2 \tilde{P}_{i,t} + \beta_3 \mathbb{E}(\pi_{i,t \rightarrow t+12}) + F_t + \varepsilon_{i,t} \quad (3.9)$$

where $\mathbb{E}(\pi_{i,t}^L)$ denotes the long-term inflation rate household i surveyed in wave t expects for the next L years with $L \in \{5, 10\}$; measured in percentage points. Hence, we consider two time-horizons, the expected inflation rate 5 and 10 years ahead. The remaining variables are identical to the baseline specification (3.1). The specification (3.9) investigates whether inflation perceptions $\tilde{P}_{i,t}$ have a direct impact on long-term expectations.

itively, it means that when inflation is high, it also becomes more volatile. As a result, the dispersion in individual consumer baskets increases, causing the variance of inflation perceptions to go up and the covariance of perceptions and expectations to go down.

Dependent variable: Long-term Inflation Expectations				
	5-Years		10-Years	
	(1)	(2)	(3)	(4)
perceptions (past 12 months)	0.529*** (0.0132)	0.190*** (0.0139)	0.545*** (0.0151)	0.249*** (0.0166)
expectations (short-term)		0.514*** (0.0107)		0.421*** (0.0135)
constant	+	+	+	+
wave dummies	+	+	+	+
controls	+	+	+	+
N	35491	35066	26898	26574
R^2	0.232	0.366	0.190	0.255

Notes: Columns 1-4 report OLS estimates. Robust standard errors (Eicker-
Huber-White) are reported in parentheses. Significance levels: *** $p < 0.001$,
** $p < 0.01$, * $p < 0.05$. Wave controls include a dummy for each wave. Socio-
demographic controls include gender, household income, education, employment
status, region, age, age squared. The dependent variables (long-term inflation
expectations) are measured by quantitative survey question: “What value do
you think the rate of inflation or deflation will take on average over the next
five (ten) years?”. Short-term expectations are measured by quantitative survey
question “What do you think the rate of inflation will roughly be over the next
12 months?”. Perceptions are measured by quantitative survey question: “What
do you think the rate of inflation or deflation in Germany was over the past 12
months?”. Perceptions and expectations truncated [30;-5]. The data span sur-
vey waves 1-36 (April - June 2019, April 2020 - December 2022).

Table 3: Inflation Perceptions on Long-term Expectations

Table 3 reports the estimation results. Column 1 and 3 show that inflation perceptions play also a crucial role for long-term inflation expectations. The size of the relationship is moderately smaller compared to the relationship between perceptions and short-term expectations. A one percentage point increase in households’ perceptions is associated with a 0.53 (0.55)-pp increase in expected long-term inflation over the next 5 (10) years.¹⁷ Unsurprisingly, the magnitude of the perception effect on long-term expectations is reduced when we control for short-term expectations (Cols. 2 and 4). However, a positive, sizable, and highly significant impact remains. The households use their subjective assessment of the development of inflation over the last twelve months not only to form their short-term expectations, but also consider it when forming their long-term expectations.

Long-term expectations are thus directly and indirectly, via the effect on short-term expecta-
tions, affected by households’ inflation perceptions. In line with the related literature, we also find a positive association between short-term and long-term inflation expectations.

Finding 3 (Inflation Perceptions and Long-term Expectations). *Households’ inflation perceptions $\tilde{P}_{i,t}$ regarding the last 12 months have a direct positive, sizable, and significant effect on households’ long-term inflation expectations $\mathbb{E}(\pi_{i,t}^L)$, with $L \in \{5, 10\}$ years.*

¹⁷This result is robust to various specifications and estimation methods (Appendix Table B5).

4 Impact of Information Treatments about past Inflation on Inflation Expectations

Section 3 documents a strong and quantitatively important relationship between households' inflation perceptions and their expectations about future inflation. This Section is dedicated to identify a clear causal relationship.

4.1 Randomized Control Trial Design

As discussed in Section 2, the survey collects various measures of inflation expectations and perceptions about past inflation. Following these initial measurements, we implemented three information treatments in August 2022 (survey wave 32).¹⁸ Respondents were randomly allocated to one of four groups. The first group is the control group, which receives no information. Groups 2–4 denote the information treatment groups. Each group receives information about the official inflation rate for Germany for the past twelve months.

Within each information treatment (groups 2-4), each respondent receives a reminder of his/her point prediction about the inflation rate over the past twelve months—elicited prior to the experiment and one of the following texts:

Group 2 - Treatment 1: The Federal Statistical Office reported the official inflation rate for Germany for the past twelve months, *for the definition excluding energy and food, as being 3.2%* in July 2022. You indicated that you believe the overall inflation rate, i.e. including energy and food, was [...] over the past twelve months.

Group 3 - Treatment 2: The Federal Statistical Office reported the official inflation rate for Germany for the past twelve months, *as measured by the consumer price index, as being 7.5%* in July 2022. You indicated that you believe the inflation rate was [...] over the past twelve months.

Group 4 - Treatment 3: The Federal Statistical Office reported the official inflation rate for Germany for the past twelve months, *as measured by the Harmonised Index of Consumer Prices, as being 8.5%* in July 2022. You indicated that you believe the inflation rate was [...] over the past twelve months.

¹⁸Survey participants receive information regarding how inflation is defined. Before any question on inflation is asked, respondents receive the following information on a separate screen: The inflation rate 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”.

Following these texts respondents from all four groups (including the control group) were asked the two follow-up questions below to measure the treatment effects on inflation expectations.¹⁹ To avoid survey fatigue and a potential anchoring on previously reported numbers, we chose to not ask the exact same inflation expectation questions, included in the survey prior to the treatment, again. Instead, we ask for the min, max, most likely expected inflation rate. This is standard practice in information provision experiments on inflation expectations. Assuming a triangular distribution allows us to compute the mean, median, and standard deviation of post-treatment inflation expectations; for a detailed explanation, see e.g. Coibion et al. (2023).

Question 1: What are the minimum and maximum values you expect for the rate of inflation over the next twelve months?

Note: If you assume there will be deflation, please enter a negative value. Values may have one decimal place. Please ensure that the minimum is not greater than the maximum.

Question 2: In your opinion, how likely is it that the rate of inflation will be above $[(\text{min} + \text{max})/2]$ over the next twelve months?

Note: The aim of this question is to determine how likely you think it is that something specific will happen in the future. You can rate the likelihood on a scale from 0 to 100, with 0 meaning that an event is completely unlikely and 100 meaning that you are absolutely certain it will happen. Use values between the two extremes to moderate the strength of your opinion.

While treatment 1 provides information about the core inflation rate (excluding energy and food), treatments 2 and 3 focus on the overall inflation rate, measured as the consumer price index (CPI) and harmonized consumer price index (HICP) respectively.²⁰ In the inflation perception question prior to the treatment, we ask about the overall inflation rate over the last 12 months. We argue, that the respondents receiving either treatment 2 or 3 will update their perceptions to the number given in the treatment text.²¹ We thus only elicit posterior inflation perceptions for respondents receiving treatment 1. For respondents receiving treatment 1, it is not obvious whether and to which number they will update their inflation perceptions of the overall inflation rate, given that

¹⁹Subsequently, respondents were asked feedback questions and questions eliciting their socioeconomic characteristics.

²⁰The CPI and HICP numbers are published by the German Statistical Office. The main difference between the two indices are that the CPI includes the prices for owner-occupied residential property. Also, the CPI weights are only updated every 5 years, but annually for the HICP. For more details see: https://www.destatis.de/EN/Themes/Economy/Prices/Consumer-Price-Index/Methods/HVPI_e.html

²¹Note that for treatments 2 and 3, providing official information about the overall inflation rate over the past twelve months, together with the respondents' prior point estimate, ensures that respondents can easily interpret the official information as "good" or as "bad" news—and adjust their assessment (perception) about the overall inflation rate over the past twelve months accordingly.

they were provided with the core inflation rate in the treatment text and not the overall inflation rate, over the past twelve months. To measure the extent of the adjustments, we ask the following additional questions to respondents receiving treatment 1.

Question 3: In your opinion, what minimum and maximum value has the overall inflation rate, i.e. including energy and food, reached over the past twelve months?

Note: If you assume there was deflation, please enter a negative value. Values may have one decimal place. Please ensure that the minimum is not greater than the maximum.

Question 4: In your opinion, how likely is it that the overall inflation rate, i.e. including energy and food, was above $[(\text{min} + \text{max})/2]$ over the past twelve months?

Note: The aim of this question is to determine how likely you think it is that something specific happened in the future. You can rate the likelihood on a scale from 0 to 100, with 0 meaning that you are absolutely certain an event did not happen and 100 meaning that you are absolutely certain it did happen. Use values between the two extremes to moderate the strength of your opinion.

4.2 Randomized Control Trial Results

We designed the RCT to investigate whether perceptions about past inflation causally drive inflation expectations about future inflation. For this, we implemented exogenous variation in inflation perceptions using different types of information about the inflation rate in Germany over the last twelve months.

We run the following regressions, for each treatment, to test the causal effect of the change in inflation perceptions on the change in inflation expectations.

$$\mathbb{E}(\pi_{i,t \rightarrow t+12}^{post}) - \mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior}) = \alpha + \beta(\tilde{P}_{i,t}^{post} - \tilde{P}_{i,t}^{prior}) + \psi X_i + \varepsilon_i, \quad (4.1)$$

where $\mathbb{E}(\pi_{i,t \rightarrow t+12}^{post})$ denotes the inflation rate household i expects for the next 12 months; measured in percentage points, and collected after the treatment (i.e., posterior expectation), and $\mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior})$ denotes the corresponding inflation rate household i expects, collected before the treatment (i.e., prior expectation). $\tilde{P}_{i,t}^{prior}$ denotes the household's i perceived inflation rate over the last 12 months elicited before the treatment (i.e., prior perceptions) and $\tilde{P}_{i,t}^{post}$ denotes the household's i perceived inflation rate over the last 12 months elicited after the treatment (i.e., posterior perceptions), and X_i denotes a vector of controls for individual i .

The regression results of (4.1) are reported in Table 4. In Column 1, we present the results for the “core inflation” (excluding food and energy) Treatment 1. Columns 2-3 show the regression results for the “overall inflation” Treatments 2 and 3 (CPI and HICP), and in Column 4 we pool

all treatment groups. We find a positive and significant effect of the change in perceptions on the change in expectations ($p < 0.001$) for all treatment groups.²²

Dependent variable: $\pi_i^{e,post} - \pi_i^{e,pre}$				
Treatment	#1	#2	#3	1-3
	$CPI_{core} = 3.2\%$	$CPI = 7.5\%$	$HICP = 8.5\%$	Pooled
$\pi_i^{perc,post} - \pi_i^{perc,pre}$	0.258*** (0.0587)	0.362*** (0.0883)	0.347*** (0.0840)	0.326*** (0.0430)
Controls	+	+	+	+
N	580	612	608	1800
R^2	0.133	0.137	0.149	0.119

Notes: Columns 1-4 report OLS estimates. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Robust standard errors (Eicker-White) reported in parentheses. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. Perceptions and expectations truncated [30;-5]. The data span survey wave 32 (August 2022).

Table 4: The causal effect of inflation perceptions on expectations (by treatment)

To visualize this result in Figure 2, we restrict the sample to respondents with pre-treatment inflation perceptions higher than 8.5%. We choose 8.5% as the cutoff because, for these respondents, all information treatments unambiguously present “good” news about the actual current inflation rate (i.e, the inflation rate was lower over the past twelve months than the respondents thought).

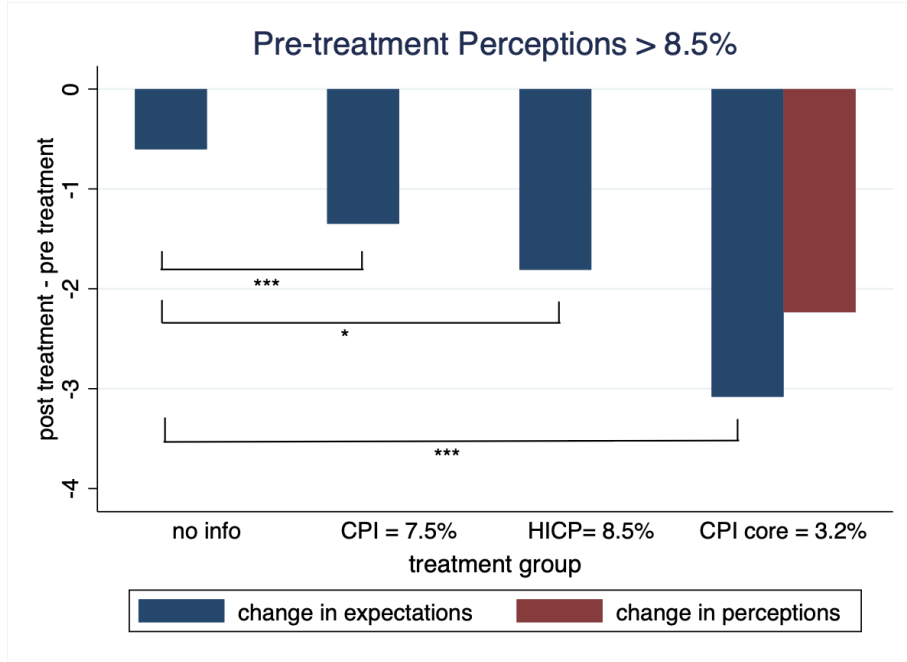
Figure 2 illustrates the treatment effect on inflation perceptions in red and the treatment effect on inflation expectations in blue. Figure 2 shows respondents react to the information treatment and adjust their perceptions about past inflation (red bar, Treatment 1). The Figure also highlights that consumers, who overestimated actual inflation in Germany over the past twelve months, adjust their expectations about future inflation downwards—once they learn that the inflation rate over the past twelve months was lower than they thought (Figure 2, blue bars, Treatments 1–3).²³

These results indicate a causal effect of perceptions, which are altered through the treatments, on expectations. This interpretation is particularly supported by the results for the respondents receiving information about the core inflation rate (excluding food and energy; Treatment 1). We

²²In addition, we follow the approach of Coibion et al. (2018b) and Coibion et al. (2023) to assess the effects of the different information treatments on inflation expectations. Appendix Table B12 reports the results in Column 1. In summary, we find that our treatments are successful in creating variation in households’ inflation expectations. After having received information about the actual inflation rate over the past twelve months, households revise their expectations about future inflation significantly.

²³Appendix Figures B7 and B8 show the inflation expectations post-treatment for different levels of pre-treatment inflation perceptions and expectations. These Figures illustrate that larger information shocks to consumers’ inflation perceptions cause larger shifts in their inflation expectations. Figure 2 shows that the consumers in the control group change their expectations slightly. Given that this group received no information, one might expect no effect. However, because the prior and posterior expectations are measured using different questions, the mode effect introduced by this approach leads to this minor change in reported inflation expectations. As Treatments 1–3 lead to much larger revisions in expectations, we conclude that the treatments successfully generate variation in households’ inflation perceptions.

Figure 2: Treatment effect on consumers' perceptions and expectations



Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Stars denote statistically significant differences between the control treatment (no information) and the information treatment groups (MWU Tests). Sample restricted to respondents with pre-treatment inflation perceptions higher than 8.5%. For these respondents, all information treatments present good news about actual inflation.

explicitly measure posterior perceptions for respondents in that group (see Section 4.1) and show that consumers' inflation perceptions react strongly to the information treatment and that the adjustment in expectations closely matches the adjustment in perceptions (Figure 2). We also show that inflation expectations adjust in the expected direction for treatment groups 2 and 3. However, we do not explicitly measure posterior perceptions for these groups but assume they adjust to the level mentioned in the treatment texts. It is highly unlikely, but we cannot rule out, that the information treatments these two groups receive do not affect their perceptions but other factors linked to expectations.²⁴

Finding 4 (Causal Effect of Perceptions on Inflation Expectations). *Households' inflation perceptions $\tilde{P}_{i,t}$ over the last 12 months have a direct positive, sizable, and significant causal effect on households' short-term inflation expectations for the next twelve months $\mathbb{E}(\pi_{i,t \rightarrow t+12})$.*

The results of our information provision experiment (Finding 4) align with the simple model presented in Section 3. In Treatments 1-3, households receive a signal about the current inflation

²⁴Treatments 2 and 3 provide direct information on the overall inflation rate over the past twelve months. Asking respondents right after this information about their perception of the overall inflation rate over the past twelve months was not feasible. However, as the treatment information only included information on the past overall inflation rate, we assume that posterior inflation perceptions are equal to the information provided in the RCT experiment.

rate. These signals causally change households' inflation perceptions, and hence, expectations as equations 3.5 and 3.7 predict. Our findings of the RCT suggest that noisy information models might provide an accurate representation of consumers' expectation formation process.

5 Determinants and Heterogeneity

The previous sections showed that households' short- and long-term inflation expectations are causally driven by their perceptions about inflation (over the past twelve months). Therefore, it is crucial to understand how different households form their perceptions about current and past inflation and what drives the heterogeneity in the strength of the link across certain groups. Heterogeneity regarding the perception-expectation link can originate from several factors. Already the way perceptions are formed and which information they are based on can be a source for variation of the strength of the link (across different socio-demographic groups).

5.1 What drives Inflation Perceptions?

To shed light on how households form their perceptions of inflation over the past twelve months, we added a question to wave 28 (April 2022) of the BOP-HH survey.

Question (*Factors driving Perceptions*): “At the start of the survey, you estimated the inflation or deflation rate over the past twelve months to have been [...]. In your opinion, how important are the following factors for your expectations regarding the average inflation or deflation rate over the past twelve months?” Answers: 5-point scale, from “very important” to “not at all important”.

This question is a follow-up question that picks up the previous answer on respondents' perception of the inflation/deflation rate over the past twelve months. The follow-up question provides nine potential factors respondents might have used to form perceptions. The respondents are asked to rate the importance of each factor for their previously given point estimate of inflation perceptions (see Appendix A for the exact wording of the question and the nine factors).

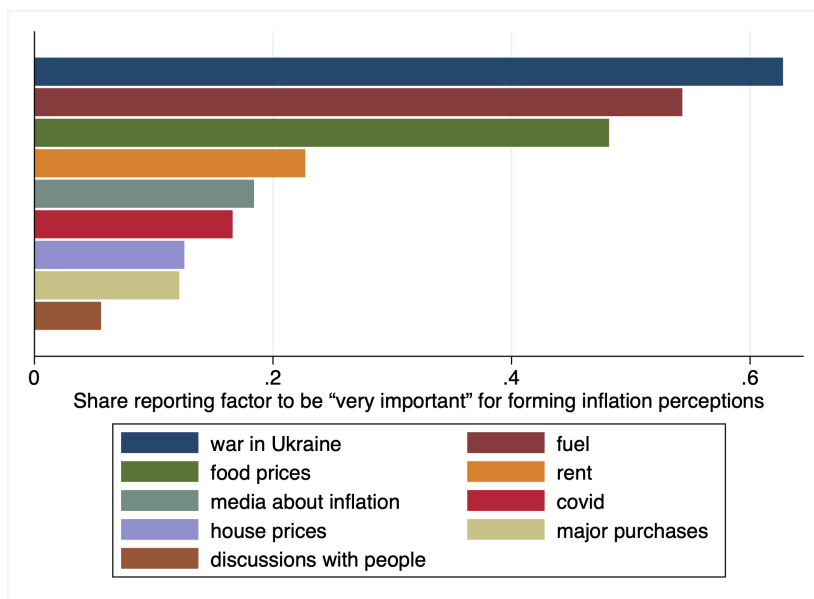
For each factor, Figure 3 shows the share of respondents reporting “very important”. The top 3 factors are the following: “The development of the geopolitical situation over the past two months, particularly the war in Ukraine”, “the development of fuel prices over the past twelve months”, and “the development of food prices over the past twelve months”.

Hence, perceptions seem to be strongly influenced by unexpected events like the war and personal shopping experiences. Frequently bought products such as fuel and food are at the forefront of households' minds when assessing the inflation rate over the past twelve months. In

addition, households consider macroeconomic uncertainty, such as the Ukrainian war, an essential factor. In contrast, price developments of infrequently bought goods (house prices or the prices of major purchases) are rated much less often as a “very important” factor. Interestingly, less than twenty percent of the respondents considered “media reports on the inflation rate” to be a very important factor in their assessment of the inflation rate over the previous twelve months.

Finding 5 (Factors driving Inflation Perceptions). *Prices of frequently bought goods (food and fuel) as well as uncertainty are the key factors households rely on when forming inflation perceptions over the previous twelve months.*

Figure 3: Self-reported drivers for inflation perceptions.



Sources: Bundesbank Online Panel households (BOP-HH). Survey Wave 28 (April 2022).

5.2 Heterogeneity in the Perception-Expectation Link

This and the next section explore factors, which may drive the strength of the link between perceptions and expectations. Understanding which socio-economic characteristics intensify the pass-through from inflation perceptions to inflation expectations helps uncover the role of inflation perceptions and potential mechanisms underlying the formation of inflation expectations.

Therefore, we first analyse heterogeneity along socio-demographic characteristics, to establish whether different groups of individuals rely to a different degree on perceptions when forming expectations.²⁵ We estimate the baseline specification (3.1) using sample splits. Appendix Table B9 reports the corresponding estimation results. Our results suggest that women, residents of East

²⁵Appendix Table B8 reports the average inflation perceptions and expectations by socio-demographic characteristics.

Germany, the employed, the low-educated, and the individuals younger than 60 years old rely to a larger extent on their inflation perceptions when forming expectations.

Second, we estimate an alternative specification using the complete sample. We use the baseline model (3.1) and add as controls an interaction term between perceptions and the socio-economic characteristics:

$$\mathbb{E}(\pi_{i,t \rightarrow t+12}) = \beta_0 + \beta_1' X_{i,t} + \beta_2 \tilde{P}_{i,t} + \beta_3' \tilde{P}_{i,t} \times X_{i,t} + F_t + \varepsilon_{i,t} \quad (5.1)$$

where $\mathbb{E}(\pi_{i,t \rightarrow t+12})$ denotes the inflation rate household i surveyed in wave t expects for the next 12 months; measured in percentage points. $X_{i,t}$ denotes a vector of controls for individual i as specified in the baseline specification (3.1). $\tilde{P}_{i,t}$ denotes household's i perceived average inflation rate over the last 12 months; measured in percentage points. $\tilde{P}_{i,t} \times X_{i,t}$ denotes the interaction term, and F_t denotes the survey-wave fixed effects. The EHW error term is denoted by $\varepsilon_{i,t}$.

Table 5 reports the results and shows a remarkable strong and stable perception effect across the five Columns. In addition, Table 5 provides evidence that women, residents of East Germany, the employed, the low-educated, and the individuals younger than 60 years old rely to a larger extent on their inflation perceptions when forming expectations. The heterogeneity result is particularly striking for age; see Column 3 of Table 5. Individuals that are older than 60 years expect a higher inflation rate over the next twelve months and rely significantly less on their inflation perceptions of the previous twelve months. This generation's formative years were characterized by much higher and more volatile inflation rates—compared to younger generations in Germany. In contrast, the younger generations experienced their formative years during stable low inflation rates: a period where "rational" behavior is consistent with not searching for costly information on small inflation rate changes and expecting that the inflation rate over the next twelve months roughly stays the same as over the previous twelve months. Hence, this result is consistent with theories of experience effects (Malmendier and Nagel (2016), Malmendier et al. (2021), Malmendier (2021)) combined with rational inattention.

Our result that women systematically expect higher future inflation (see Col. 1) is consistent with the existing literature (Bruine de Bruin et al. (2010); Armantier et al. (2013)) as well. D'Acunto et al. (2021b) argue that women do most of the grocery shopping for their households and hence observe and experience different price signals than men and, therefore, might expect higher future prices. Our results provide evidence for this conjecture, as we show in Column 1 that women rely more on their perceptions when forming inflation expectations than men.

Dependent variable: Short-term Inflation Expectations (next 12 months)					
	(1)	(2)	(3)	(4)	(5)
Perceptions (past 12 months)	0.678*** (0.0101)	0.727*** (0.00885)	0.758*** (0.00948)	0.707*** (0.0105)	0.709*** (0.0109)
Female (dummy)	0.108* (0.0505)				
Perception × Female	0.103*** (0.0111)				
East (dummy)		0.134* (0.0680)			
Perception × East		0.0466** (0.0155)			
Old (dummy)			0.163** (0.0581)		
Perception × Old			-0.0587** (0.0109)		
Employed (dummy)				-0.206* (0.0819)	
Perception × Employed				0.0499*** (0.0110)	
Low-educated (dummy)					-0.00739 (0.0491)
Perception × Low-Educated					0.0411*** (0.0110)
Constant	+	+	+	+	+
Wave dummies	+	+	+	+	+
Controls	+	+	+	+	+
N	70816	70816	70816	70816	71158
R^2	0.549	0.548	0.548	0.548	0.547

Notes: OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Wave controls include a dummy for each wave. Socio-demographic controls include gender, household income, education, current employment status, East residence dummy, age, age squared. In Col.3, we include a dummy for being 60 years or older, and drop the variables age and age squared. In Col. 4, we include a dummy for being employed, and drop the categorical variable (employed, unemployed, retired). In Col. 5, we include a dummy for being low-educated, and drop the categorical variable (low, medium, high education). The dependent variable (short-term inflation expectations) are measured by the quantitative survey question: “What do you think the rate of inflation will roughly be over the next 12 months?”. Perceptions are measured by the quantitative survey question: “What do you think the rate of inflation or deflation in Germany was over the past 12 months?”. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 of the survey (April - June 2019, April 2020 - December 2022).

Table 5: Socio-demographic Heterogeneity in Perception-Expectation Link

Finding 6 (Heterogeneity in Strength of Perception–Expectation Pass-through). *The perception effect is large and significant for all socioeconomic groups. Women, residents of East Germany, the employed, the low-educated, and the individuals younger than 60 years old place a significantly larger weight on inflation perceptions when forming short-term inflation expectations.*

Combining Result 6 on heterogeneity with the Result 5 on the most critical reported factors for perception formation allows two conjectures on potential drivers for the strength of the pass-through. First, our results suggest that the heterogeneity in the pass-through could be explained by different information sources used to form perceptions (e.g., media versus own shopping experience). Second, different levels of uncertainty between various socio-economic groups could explain the

differences in the pass-through from perceptions to expectations. In the next section, we investigate these two conjectures and relate them to the model.

5.3 Information Acquisition

To analyze whether different socio-economic groups consume different inflation related information to form inflation perceptions, we add two questions to the survey wave 19 in July 2021 and to the survey wave 35 in November 2022.

Question 1 (inflation information): *Aside from this survey, have you, over the past four weeks, heard or read anything about inflation in Germany?* Answers: 1 = Yes; 2 = No.

Question 2 (information source): *You said you think prices for essential goods have [...] over the past twelve months. Is that based more on things you have heard or read or on your own experiences when shopping?* Answers: 1 = more media; 2 = more own experience.²⁶

Figure 4 illustrates the distribution of answers to both questions. In July 2021, 44% of the respondents had heard or read something about inflation over the past four weeks. It is not surprising that the distribution of answers changed dramatically in November 2022. The inflation rate increased significantly over 2022—by the end of 2022, the overall CPI inflation was more than six percentage points higher than in July 2021. Consequently, the topic *inflation* appeared much more frequently in the news. As a result, in November 2022, almost 90% of the survey participants report to have heard or read some information about inflation in the last month. However, it is striking that the distribution of answers to question 2 remained the same over this time. In July 2021 and November 2022, almost 90% of the interviewees reported using their own shopping experience to form perceptions about past inflation.

The answers to both questions vary across socio-economic groups. Appendix Table B2 shows that individuals from low-income households, the low-educated, women, the young (less than 30 years old), and individuals living in East Germany are less likely to have heard or read about inflation. Further, we find that women, the low-educated, and individuals aged 30 years or older, are more likely to base their perceptions about past price changes on their own shopping experience.

These differences in information usage may be behind the heterogeneity we observe in the strength of the link between perceptions and expectations between certain socio-demographic groups. And indeed we find that the pass-through from perceptions to inflation expectations

²⁶[...] denotes the placeholder for the previously given answer: decreased significantly; decreased slightly; stayed roughly the same; increased slightly; increased significantly. The corresponding survey question is described in Section 3.

is stronger for those that rely on their own shopping experience than for those that don't and for those that heard news about inflation in the past four weeks. Table 6 shows the estimation results, using interaction terms of the information variables with inflation perceptions.

Figure 4: Information Acquisition



These results contribute to and extend the findings by [D'Acunto et al. \(2021a\)](#) and [D'Acunto et al. \(2021b\)](#), who show that the primary grocery shopper of the household reports higher expectations about future inflation than the non-grocery shopper. Our paper finds that the shopping experience affects inflation expectations *only indirectly via households' inflation perceptions* (Table 6, Col. 2). We also find that being informed about inflation has a direct negative effect on inflation expectations.

Dependent variable: Short-term Inflation Expectations (next 12 months)		
	(1)	(2)
inflation info (dummy)	-0.597** (0.197)	
base perceptions on shopping experience		-0.157 (0.243)
Perceptions (last 12 months)	0.706*** (0.0608)	0.498*** (0.107)
Perceptions × inflation info	0.0245 (0.0471)	
Perceptions × base perceptions on shopping experience		0.130* (0.0564)
Constant	+	+
Controls	+	+
N	4370	4364
R^2	0.485	0.485

Notes: Columns 1-2 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The dependent variable (short-term inflation expectations) is measured by the quantitative survey question: “What do you think the rate of inflation will roughly be over the next 12 months?”. Perceptions and expectations truncated [30;-5]. The data span wave 19 (July 2021) and wave 35 (November 2022).

Table 6: Information Acquisition, a Driver for Heterogeneity (I)

Finding 7 (Shopping Experience: A Determinant for Inflation Perceptions and Expectations). *Socio-economic groups differ in the (i) extent of being informed about inflation and (ii) choice of information source used to form perceptions about past inflation. The shopping experience (salient prices of frequently bought products) affects inflation expectations indirectly through inflation perceptions. The shopping experience determines the pass-through strength from inflation perceptions to inflation expectations.*

To rationalize Findings 6 and 7, we extend the model of [Vellekoop and Wiederholt \(2019b\)](#) by incorporating our results on information acquisition. The answers to our novel survey questions suggest that the large majority of consumers use their shopping experience to form inflation perceptions—during the high- and the low-inflation environment (see Figure 4). Hence, for most households, their consumption baskets serve as a signal.²⁷ It is a surprising finding because in times of high and volatile inflation, the quantity and the frequency of media reports on the topic increase substantially. Nevertheless, even in the presence of inflation news in easy access, households continue to use their shopping experience (i.e., individual consumer baskets) as the primary

²⁷Around 90% of households report basing their inflation perceptions on their shopping experience, while only 10% use media reports.

information source to form their inflation perceptions (i.e., estimating current inflation). The answer to the question of whether households have heard or read about inflation recently can inform us how frequently they might update inflation expectations (see Figure 4).

In order to incorporate these empirical facts on information acquisition, we introduce heterogeneity in the model of [Vellekoop and Wiederholt \(2019b\)](#). We start by splitting households into two types. The first type uses the signal from the media, while the second type receives a noisy signal from their personal consumption basket. We assume that the former type knows the actual current inflation rate, and the latter type uses the Kalman filter to nowcast it. As a result, the estimate of the current inflation rate (i.e., inflation perceptions) and inflation expectations can be described as follows

$$E[\pi_t|I_{i,t}] = \gamma\pi_t + (1 - \gamma)(E[\pi_t|I_{i,t-1}] + K(s_{i,t} - E[\pi_t|I_{i,t-1}])) \quad (5.2)$$

$$E[\pi_{t+1}|I_{i,t}] = (1 - \rho)c + \gamma\rho\pi_t + (1 - \gamma)\rho E[\pi_t|I_{i,t}] \quad (5.3)$$

where $(1 - \gamma)$ denotes the share of households who use their own consumption baskets as signal and γ refers to the share of households who use the media to form inflation perceptions. The assumption that the first household type learns the current inflation rate through the media channel is a simplification. The argument's logic also holds when both household types would receive noisy signals, as long as the first type is assumed to receive a signal with a lower variance of noise.

We introduce a second dimension of heterogeneity by using the answer to the survey question "Have you heard or read anything about inflation recently?". We introduce two groups of consumers: the informed and the uninformed. The share of the informed is denoted by λ and the share of the uninformed by $(1 - \lambda)$. The informed households receive signals about the current inflation rate in the form of news or by their own shopping experience in period t , while the uninformed receive no signals in period t . Hence, we describe the estimate of the current inflation rate (e.g., inflation perceptions) and inflation expectations as follows:

$$E[\pi_t|I_{i,t}] = \gamma\lambda\pi_t + (1 - \gamma)\lambda(E[\pi_t|I_{i,t-1}] + K(s_{i,t} - E[\pi_t|I_{i,t-1}])) + (1 - \lambda)E[\pi_t|I_{i,t-1}] \quad (5.4)$$

$$E[\pi_{t+1}|I_{i,t}] = (1 - \rho)c + \gamma\lambda\rho\pi_t + (1 - \gamma)\lambda\rho E[\pi_t|I_{i,t}] + (1 - \lambda)E[\pi_t|I_{i,t-1}] \quad (5.5)$$

Introducing these two sources of heterogeneity, allows us to rationalize Finding 6; that e.g., women, the residents of East Germany, the young, and the low-educated have stronger pass-through from inflation perceptions to inflation expectations. Regarding the source of information (media or shopping experience), women and the residents of East Germany are more likely to base their perceptions on their own shopping experiences (Table B10). When we run regression (5.1) with

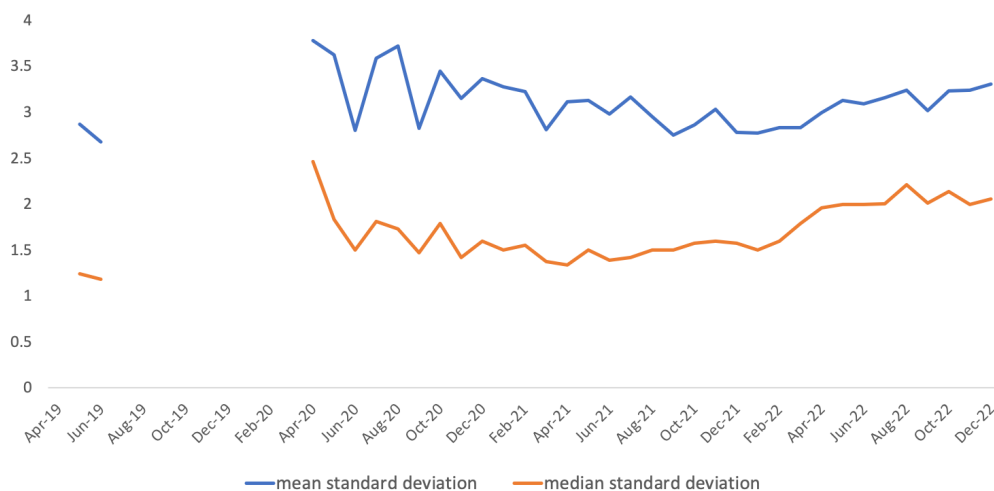
gender as well as the East Germany dummy and add the interaction terms of inflation perceptions with these dummies, we may compare the coefficients on inflation perceptions of two groups of consumers each, one with a larger share basing their estimates of inflation on own consumer baskets and the other with a smaller share of such households. So, for women and the residents of East Germany, the coefficient on inflation perceptions in (5.3) is more likely to be $(1 - \gamma)\rho$ than $\gamma\rho$. According to our empirical results, γ is equal to 90%, while $1 - \gamma$ is 10%. This means a stronger pass-through for these consumers.

Regarding being informed about inflation developments our results show that the young, women, and the low-educated tend to be less informed (Table B2). Hence, they are less likely to receive a signal about the current inflation. Consumers, who get no signal, do not update their estimates using the Kalman filter (eq 5.4). As a result, their inflation perceptions do not contain extra noise from the latest signals and thus the variance in their nowcast of the current inflation is lower. This naturally leads to the higher persistence coefficient for these individuals.

5.4 Individual Uncertainty about Inflation Dynamics

This section investigates the impact of uncertainty on the pass-through from inflation perceptions to expectations. We use the probabilistic inflation expectation question to measure the uncertainty about inflation for each respondent.²⁸ Figure 5 shows the time series of the average level of individual uncertainty (as well as the median).

Figure 5: Uncertainty about Inflation (next 12 months)

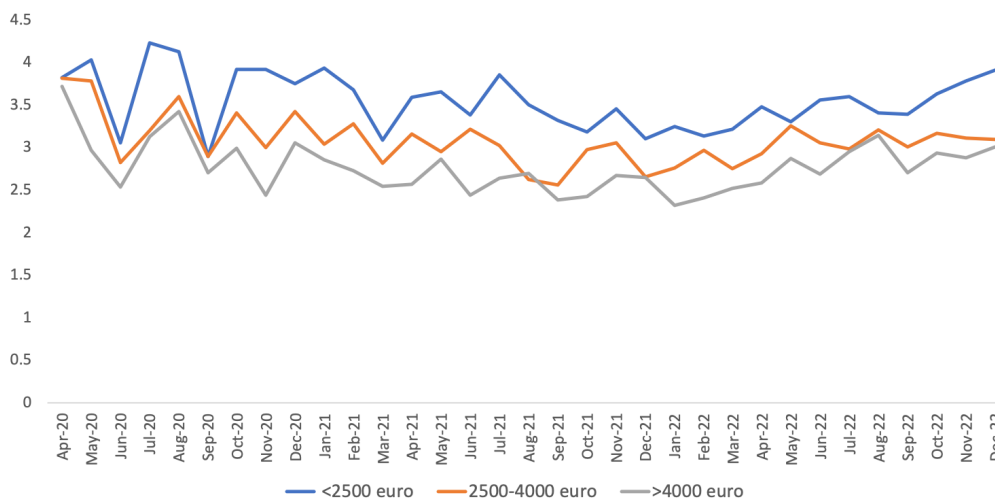


Sources: Bundesbank Online Panel households (BOP-HH). Uncertainty is measured by the standard deviation of the subjective probability distribution of the probabilistic question regarding inflation expectations. Question: In your opinion, how likely is it that the rate of inflation will change as follows over the next twelve months? Participants are asked to distribute a probability of 100% over ten categories between a deflation rate $\geq 12\%$ and an inflation rate $\leq 12\%$.

²⁸ Appendix A documents the exact wording of the survey question and answer categories.

We find that the level of individual uncertainty varies significantly across socio-economic groups. Women, the young, individuals from low-income households, the low-educated, and respondents living in East Germany show higher levels of uncertainty.²⁹ Figure 6 illustrates this finding for the income dimension using three household income bins (low, medium, and high) over time. Respondents from low-income households have the highest level of uncertainty in each survey wave.

Figure 6: Inflation Uncertainty by Household Income



Sources: Bundesbank Online Panel households (BOP-HH). Uncertainty is measured by the standard deviation of the subjective probability distribution of the probabilistic question regarding inflation expectations. Question: In your opinion, how likely is it that the rate of inflation will change as follows over the next twelve months? Participants are asked to distribute a probability of 100% over ten categories between a deflation rate $\geq 12\%$ and an inflation rate $\leq 12\%$.

Next, we investigate whether the heterogeneity in inflation uncertainty explains the discovered heterogeneity in the strength of the pass-through from inflation perceptions to expectations. To do so, we use the baseline model (3.1) and add as controls the uncertainty measure and an interaction term between perceptions and uncertainty. Table 7 illustrates the results.

For convenience, column 1 presents the baseline specification. Column 2 shows that individual's inflation uncertainty has a significant and positive effect on households' short-term inflation expectations. The more uncertain, the higher the expected inflation rate. In Column 3, we add the interaction term between perceptions and individual uncertainty. The interaction term is significant and positive; the more uncertain the household, the more the household relies on perceptions about past inflation when forming expectations about future inflation.

²⁹Appendix Table B3 documents the uncertainty level for socio-economic groups separately. Appendix Table B11 reports corresponding regression results. These socio-economic characteristics are highly significant factors for the individual level of inflation uncertainty.

Dependent variable: Short-term Inflation Expectations			
	(1)	(2)	(3)
perceptions	0.736***	0.573***	0.543***
last 12 months	(0.00836)	(0.00961)	(0.0107)
uncertainty		0.0321***	0.0199***
		(0.00126)	(0.00207)
<i>perceptions × uncertainty</i>			0.00182***
			(0.000330)
Constant	+	+	+
Controls	+	+	+
Wave dummies	+	+	+
<i>N</i>	70816	64536	64536
<i>R</i> ²	0.547	0.646	0.647

Notes: Columns 1-3 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The variable uncertainty is measured as the variance of the subjective probability distribution from the probabilistic question regarding inflation expectations (Appendix A). We also control for the mean inflation expectations derived from the subjective probability distribution from the probabilistic question. The dependent variable (short-term inflation expectations) is measured by the quantitative survey question: “What do you think the rate of inflation will roughly be over the next 12 months?”. The independent variable (short-term inflation perceptions) are measured by the quantitative survey question: “What do you think the rate of inflation or deflation in Germany was over the past 12 months?”. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 (April 2020 - June 2020, April 2021 - December 2022).

Table 7: Inflation Uncertainty and Inflation Expectations

Finding 8 (Uncertainty: A Determinant of the Pass-Through Strength). *Reported uncertainty about future inflation varies significantly across households. The differential perceived uncertainty is one determinant of the heterogeneity observed in the strength of the pass-through from inflation perceptions to inflation expectations.*

The model of [Vellekoop and Wiederholt \(2019b\)](#) does not incorporate uncertainty about future inflation. A link to the model can potentially be established through how well people are informed and the strength of the signal they receive about inflation (see discussion in previous section). Appendix Table [B13](#) shows informed households are less uncertain. This fact holds in both high- and low-inflation environments. The information channel might explain the stronger pass-through from perceptions to expectations for the more uncertain individuals. In other words, more uncertain households are less likely to be informed, thus, less likely to receive a noisy signal about current inflation. This relationship might explain the more vital perceptions-expectations link for these households.

6 Conclusion and Policy Implications

This paper studies how and why households' perceptions about past inflation (last 12 months) and expectations about future inflation (next 12 months) are related and what factors influence the strength of their relationship. We use the Bundesbank Online Panel Households survey, which is representative of the online population of Germany and provides rich data on short- and long-term inflation expectations and perceptions.

While the related literature has established a positive correlation between perceived past inflation and short-term inflation expectations, this paper provides clear causal evidence that households' inflation perceptions affect their expectations about future inflation. We conduct an RCT information provision experiment in the August 2022 survey wave to generate exogenous variation in inflation perceptions. Using different information treatments, we can study the causal effect of the resulting changes in households' inflation perceptions on their inflation expectations.

This paper shows that households' inflation perceptions are the crucial determinant of their short-term inflation expectations. The magnitude of the perception effect on short-term expectations is quantitatively large. A one percentage point increase in households' perceptions is associated with a 0.74-pp increase in expected short-term inflation. The relationship between perceptions and expectations is robust to various estimation specifications and controls. In addition, this paper provides causal evidence that inflation perceptions affect expectations about future inflation.

Especially relevant for central bankers, we show that inflation perceptions do not only influence short-term inflation expectations. Perceptions have a direct, significant, and sizable impact on long-term inflation expectations over the next five years and long-term inflation expectations over the next ten years. Moreover, the effect of perception on long-term expectations survives when controlling for short-term expectations. That is to say that inflation perceptions, directly and indirectly (through short-term expectations), affect long-term inflation expectations.

Given the large impact of perceptions on expectations, it is crucial to understand how households form their inflation perceptions over the previous twelve months. We contribute to this question in several ways. First, we investigate whether the inflation environment matters for pass-through from inflation perceptions to expectations. After decades of low and stable inflation, the substantial increase in the inflation rate in Germany, starting in the summer of 2021, allows us to investigate how the link between inflation perceptions and inflation expectations changes in a high-inflation environment. While the pass-through remains sizable, consumers rely less on their perception during periods of high- compared to low-inflation inflation periods.

Second, we contribute to the question of how households form their inflation perceptions by generating novel data. We asked respondents a follow-up question on which factors they considered

essential for their assessment of inflation over the past twelve months. Frequently bought products such as fuel and food are on households' minds when predicting the inflation rate over the past twelve months. Interestingly, less than twenty percent of the respondents considered "media reports on the inflation rate" an essential factor when assessing the inflation rate over the previous twelve months. Using an additional set of novel questions, we find that the overwhelming majority (90%) of households based their inflation perceptions mainly on their shopping experience—and not on media reports. This finding is independent of whether the household is informed about inflation.

These results contribute to the literature studying the importance of salient prices of frequently bought products for the formation of households' inflation expectations. We show that the shopping experience's effect on inflation expectations is indirect, as it works exclusively through perceptions.

While perceptions play a crucial role when forming inflation expectations for all socio-economic groups, we document heterogeneity in the strength of the link between inflation perceptions and inflation expectations. For example, women, residents of East Germany, the low-educated, and individuals younger than 60 years old put a significantly larger weight on inflation perceptions when forming short-term inflation expectations.

This paper tests the hypothesis that information and uncertainty moderate the pass-through strength from perceptions to inflation expectations. In other words, we investigate whether differential usage of information to form perceptions and differing levels of uncertainty can explain the observed heterogeneity in the strength of the link between inflation perceptions and inflation expectations across socio-economic groups. We find that individual uncertainty about future inflation affects the pass-through from perceptions to short-term expectations. The more uncertain the household, the more she relies on inflation perceptions when forming inflation expectations.

In summary, inflation perceptions are one of the most important determinants of short-term and long-term inflation expectations (5 and 10 years ahead). Our paper helps identify what type of inflation matters for consumers' inflation perceptions and why this matters for inflation expectations. Our findings suggest that monitoring inflation perceptions of households would be valuable. Central banks might profit from creating a new communication tool by which they address households to "correct" households' perceptions of past and current inflation (and, by that, influence inflation expectations). The RCT information provision experiment results show that providing households with information about current and past inflation leads households to adjust their inflation perceptions, resulting in changes in their expectations about future inflation.

However, it might be challenging for a Central Bank to reach households and provide them with information. In such a situation, our finding that households' shopping experience and prices of frequently bought products (food and fuel) are the critical determinants of households' inflation

perceptions seems essential. It suggests that households' perceptions could increase further—as current inflation is predominantly driven by food and energy prices. As households' inflation expectations are extrapolated from inflation perceptions, we conclude that the current inflation environment provides risks for de-anchoring households' short-term and long-term expectations from the inflation target.

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Appendix A: Survey Questions

1. **Inflation perceptions:** *What do you think the rate of inflation or deflation in Germany was over the past twelve months?*

Note: If you assume there was deflation, please enter a negative value. Values may have one decimal place.

Please enter a value here: [...] percent

2. **Qualitative inflation expectations:** *What developments do you expect in the inflation rate over the next twelve months? Will the inflation rate:*

1 - decrease significantly

2 - decrease slightly

3 - stay roughly the same

4 - increase slightly

5 - increase significantly

3. **Inflation/deflation:** *Do you think inflation or deflation is more likely over the next twelve months?*

Note: 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”.

Please select one answer.

1 - Inflation more likely

2 - Deflation more likely

4. **Quantitative inflation expectations:** *What do you think the rate of inflation/deflation will roughly be over the next twelve months?*

Note: 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”.

Please enter a value in the input field (values may have one decimal place). [...] percent

5. **Probabilistic inflation expectations:** *In your opinion, how likely is it that the rate of inflation will change as follows over the next twelve months?*

Note: The aim of this question is to determine how likely you think it is that something specific will happen in the future. You can rate the likelihood on a scale from 0 to 100, with 0 meaning that an event is completely unlikely and 100 meaning that you are absolutely certain it will happen. Use values between the two extremes to moderate the strength of

your opinion. Please note that your answers to the categories have to add up to 100.

- The rate of deflation (opposite of inflation) will be 12% or higher.
- The rate of deflation (opposite of inflation) will be between 8% and less than 12%.
- The rate of deflation (opposite of inflation) will be between 4% and less than 8%.
- The rate of deflation (opposite of inflation) will be between 2% and less than 4%.
- The rate of deflation (opposite of inflation) will be between 0% and less than 2%.
- The rate of inflation will be between 0% and less than 2%.
- The rate of inflation will be between 2% and less than 4%.
- The rate of inflation will be between 4% and less than 8%.
- The rate of inflation will be between 8% and less than 12%.
- The rate of inflation will be 12% or higher.

6. Detailed qualitative inflation perceptions: *How do you think prices for the following items have changed over the past twelve months?*

- Major purchases (e.g. car, furniture, electrical appliances, etc.)
- Essential goods (e.g. food and beverages, non-food items such as cleaning products or similar)
- Clothing and footwear
- Entertainment/recreation (e.g. restaurant visits, cultural events, gym)
- Mobility (e.g. fuel, car loans and running costs, bus and train tickets)
- Services (e.g. hairdresser, childcare, medical costs)
- Travel, holidays
- Housing costs (e.g. rent, mortgage, ancillary costs)
- Financial reserves

Please select one answer for each row.

1 - decreased significantly

2 - decreased slightly

3 - stayed roughly the same

4 - increased slightly

5 - increased significantly

7. **Source of information for inflation perceptions:** *You said you think prices for essential goods have "[...]" over the past twelve months. Is that based more on things you have heard or read or on your own experiences when shopping?*

1 - It is more something that I have read or heard in the media.

2 - It is more something that I myself or a member of my household have/has experienced in my/their own shopping.

[...] denotes placeholder for previously given answer: decreased significantly; decreased slightly; stayed roughly the same; increased slightly; increased significantly.

8. **Obtaining information about inflation:** *Aside from this survey, have you, over the past four weeks, heard or read anything about inflation in Germany?*

1 - Yes

2 - No

9. **Perception Factors:** *At the start of the survey, you estimated the inflation or deflation rate over the last twelve months to have been [...]. In your opinion, how important are the following factors for your expectations regarding the average inflation or deflation rate over the past twelve months?*

1 - Very important

2 - Fairly important

3 - Neither important nor unimportant

4 - Fairly unimportant

5 - Not at all important

- Development of **food prices** over the past 12 months
- Development of **fuel prices** over the past 12 months
- Development of **house prices** in your region over past 12 months
- Development of **rent** and ancillary costs in your region over the past 12 months
- Development of **prices of major purchases** over past 12 months
- **Media** reports on the inflation rate
- **Discussions** about inflation with colleagues, friends or relatives
- Development of the **COVID-19 pandemic** over past 12 months

- Development of the geopolitical situation over past 2 months, particularly the **war in Ukraine**

[...] denotes placeholder for previously given point estimate (Q1: Inflation Perception).

RCT

1. Information provision treatments:

Control: no information provided.

Treatment 1: The Federal Statistical Office reported the official inflation rate for Germany for the past twelve months, as *measured by the consumer price index, as being 7.5%* in July 2022. You indicated that you believe the inflation rate was [...] over the past twelve months.

Treatment 2: The Federal Statistical Office reported the official inflation rate for Germany for the past twelve months, as *measured by the Harmonised Index of Consumer Prices, as being 8.5%* in July 2022. You indicated that you believe the inflation rate was [...] over the past twelve months.

Treatment 3: The Federal Statistical Office reported the official inflation rate for Germany for the past twelve months, *for the definition excluding energy and food, as being 3.2%* in July 2022. You indicated that you believe the overall inflation rate, i.e. including energy and food, was [...] over the past twelve months.

2. Post-treatment elicitation of inflation expectations:

Question 1: What are the minimum and maximum values you expect for the rate of inflation over the next twelve months?

Note: If you assume there will be deflation, please enter a negative value. Values may have one decimal place. Please ensure that the minimum is not greater than the maximum.

Question 2: In your opinion, how likely is it that the rate of inflation will be above $[(\min + \max)/2]$ over the next twelve months?

Note: The aim of this question is to determine how likely you think it is that something specific will happen in the future. You can rate the likelihood on a scale from 0 to 100, with 0 meaning that an event is completely unlikely and 100 meaning that you are absolutely certain it will happen. Use values between the two extremes to moderate the strength of your opinion.

3. Post-treatment elicitation of inflation perceptions³⁰:

Question 3: In your opinion, what minimum and maximum value has the overall inflation rate, i.e. including energy and food, reached over the past twelve months?

Note: If you assume there was deflation, please enter a negative value. Values may have one decimal place. Please ensure that the minimum is not greater than the maximum.

Question 4: In your opinion, how likely is it that the overall inflation rate, i.e. including energy and food, was above $[(\text{min} + \text{max})/2]$ over the past twelve months?

Note: The aim of this question is to determine how likely you think it is that something specific happened in the future. You can rate the likelihood on a scale from 0 to 100, with 0 meaning that you are absolutely certain an event did not happen and 100 meaning that you are absolutely certain it did happen. Use values between the two extremes to moderate the strength of your opinion.

³⁰Group 4 only.

Appendix B: Descriptive Statistics & Results

Descriptive Statistics

	N obs	Mean	St. Dev	25th	Median	75th
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Socio-economic characteristics</i>						
Gender	143095	0.41	.49	0	0	1
Income	143104	7.03	2.09	5	8	9
Education	140300	1.68	0.85	1	1	3
East	143104	0.17	0.37	0	0	0
Age	143104	56.34	15.37	45	58	70
Household size	142670	2.20	1.06	2	2	3
Have children	102566	0.25	0.44	0	0	1
<i>Inflation expectations</i>						
1-year	135153	5.53	4.33	2.5	5	8
5-year	57926	5.57	4.31	3	5	7
10-year	41428	5.19	4.66	2.6	4	6
<i>Inflation perceptions</i>						
1-year	75900	4.99	3.98	2	4	7
<i>CPI inflation</i>						
food	143104	7.67	6.84	1.51	4.76	12.7
energy	143104	19.03	17.07	4.64	18.65	35.7
excluding food and energy	143104	2.80	1.39	1.43	2.92	3.8
overall	143104	4.84	3.34	1.70	4.89	7.9

Notes: Gender dummy is equal to 0 for men and 1 for women. Income is a categorical variable with the following categories: 1 - Less than €500; 2 - €500 to €999; 3 - €1,000 to €1,499; 4 - €1,500 to €1,999; 5 - €2,000 to €2,499; 6 - €2,500 to €2,999; 7 - €3,000 to €3,499; 8 - €3,500 to €3,999; 9 - more than €4,000. Education is a categorical variable with the following categories: 1 - High school or less; 2 - Bachelor or equivalent; 3 - Higher than bachelor. East is a dummy equal to 1 if a household lives in East Germany and 0 otherwise. Have children is a dummy equal to 1 if a household has children and 0 otherwise. The data span waves 1-36 of the survey (April 2019 - June 2019, April 2020 - December 2022).

Table B1: Summary statistics

	Obtained information about inflation recently	Base inflation perceptions on own shopping experiences
	(1)	(2)
Females	71.3%	93.3%
Males	82.6%	91.6%
Low income	64.0%	93.6%
Medium income	76.8%	92.9%
High income	80.2%	91.4%
Education high school or lower	75.3%	93.9%
Education bachelor certificate	80.2%	92.8%
Education high than bachelor	82.2%	88.7%
East	76.0%	93.9%
West	78.8%	93.0%
North	77.5%	91.9%
South	78.4%	91.6%
Young	65.4%	82.9%
Middle age	73.0%	91.9%
Old	84.8%	93.7%
Have children	71.7%	93.6%
Have no children	80.7%	92.7%
Employed	74.0%	91.3%
Unemployed	69.4%	94.9%
Retired	85.1%	93.7%
Not in labor force	63.0%	89.2%

Notes: Low income refers to the monthly income less than 1000 euro. Medium income refers to the monthly income level from 1000 euro to 3999 euro. High income refers to the monthly income level higher than 4000 euro. East (West/North/South) is a dummy equal to 1 if a household lives in Eastern (Western/Northern/Southern) Germany and 0 otherwise. Young is a dummy variable equal to 1 if a consumer is 30 years old or less and 0 otherwise. Middle age is the dummy variable equal to 1 if the age of the consumer is greater than 30 but less than 61 and 0 otherwise. Old is the dummy variable equal to 1 if the age of the consumer is greater than 60 and 0 otherwise. Have children is a dummy equal to 1 if a household has children and 0 otherwise. The data span wave 19 (July 2021) and wave 25 (November 2022) of the survey .

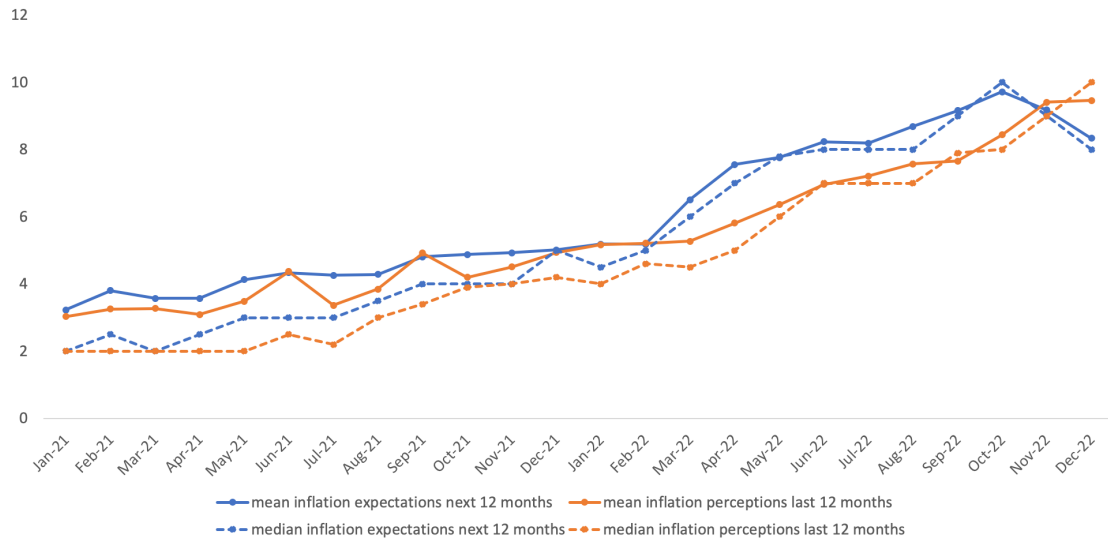
Table B2: Summary statistics for information acquisition

Uncertainty about future inflation	
	(1)
Females	8.78
Males	6.53
Low income	11.53
Medium income	8.33
High income	5.96
Education	8.28
high school or lower	
Education	7.21
bachelor certificate	
Education	5.66
high than bachelor	
East	8.08
West	7.58
North	7.34
South	6.96
Young	10.99
Middle age	7.16
Old	7.17
Have children	7.30
Have no children	7.17
Employed	7.30
Unemployed	7.96
Retired	7.19
Not in labor force	10.78

Notes: Uncertainty is measured as the variance of the subjective probability distribution from the probabilistic inflation expectations question. Low income refers to the monthly income less than 1000 euro. Medium income refers to the monthly income level from 1000 euro to 3999 euro. High income refers to the monthly income level higher than 4000 euro. East (West/North/South) is a dummy equal to 1 if a household lives in Eastern (Western/Northern/Southern) Germany and 0 otherwise. Young is a dummy variable equal to 1 if a consumer is 30 years old or less and 0 otherwise. Middle age is the dummy variable equal to 1 if the age of the consumer is greater than 30 but less than 61 and 0 otherwise. Old is the dummy variable equal to 1 if the age of the consumer is greater than 60 and 0 otherwise. Have children is a dummy equal to 1 if a household has children and 0 otherwise. The data span waves 1-36 of the survey (April 2019 - June 2019, April 2020 - December 2022).

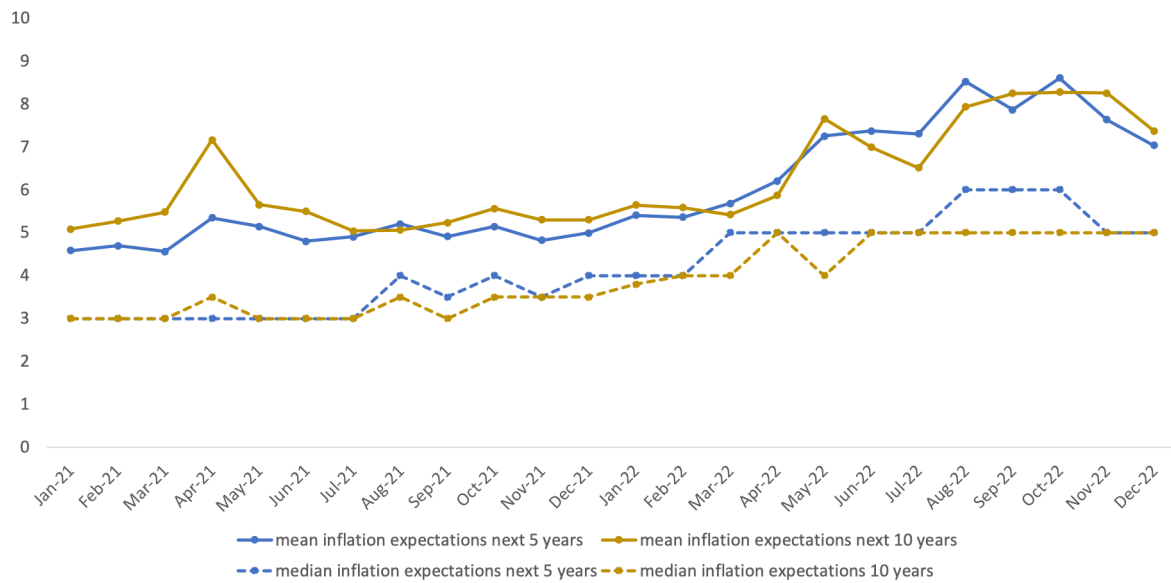
Table B3: Summary statistics for uncertainty

Figure B1: Short-term Expectations and Perceptions over time



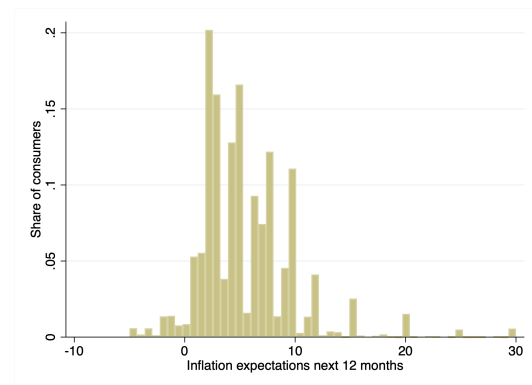
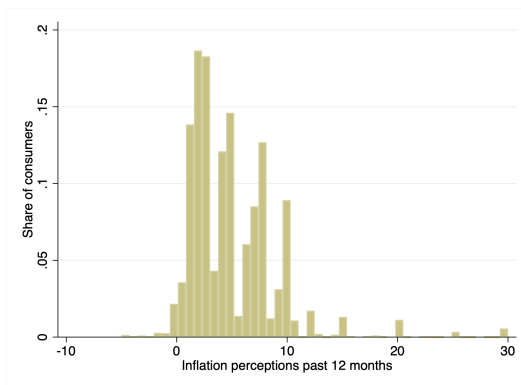
Sources: Bundesbank Online Panel households (BOP-HH). Short-term inflation expectations and perceptions: Weighted means/medians, observations truncated to interval [-5;+30].

Figure B2: Long-term expectations over time (mean and median)



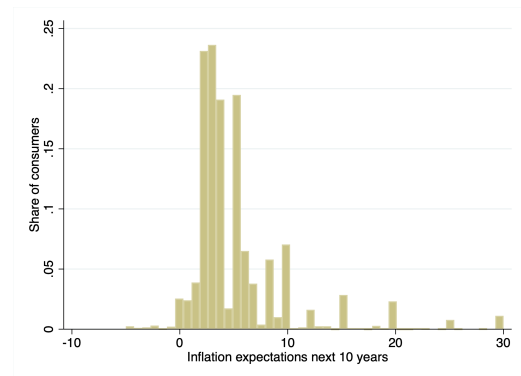
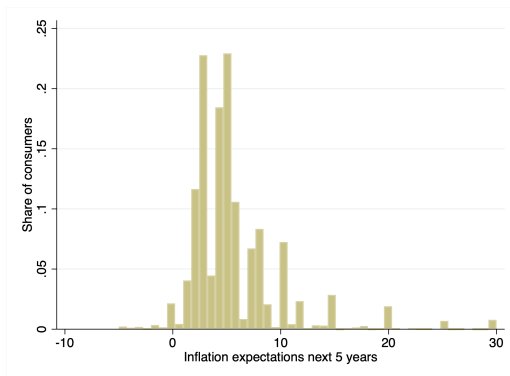
Sources: Bundesbank Online Panel households (BOP-HH). Long-term inflation expectations (5 years and 10 years ahead): Weighted means/medians, observations truncated to interval [-5;+30].

Figure B3: The distribution of inflation perceptions and expectations



(a) Inflation perceptions, next 12 months

(b) Inflation expectations, next 12 months



(c) Inflation expectations, next 5 years

(d) Inflation expectations, next 10 years

Figure B4: Inflation Expectation and Perception Disagreement over survey waves

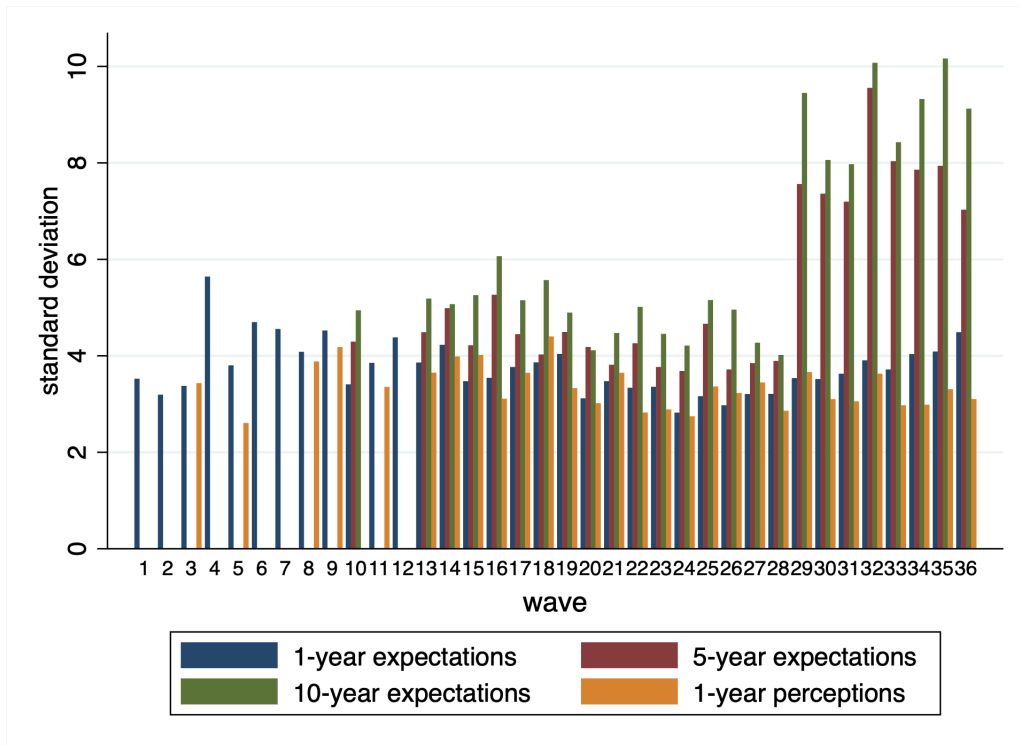
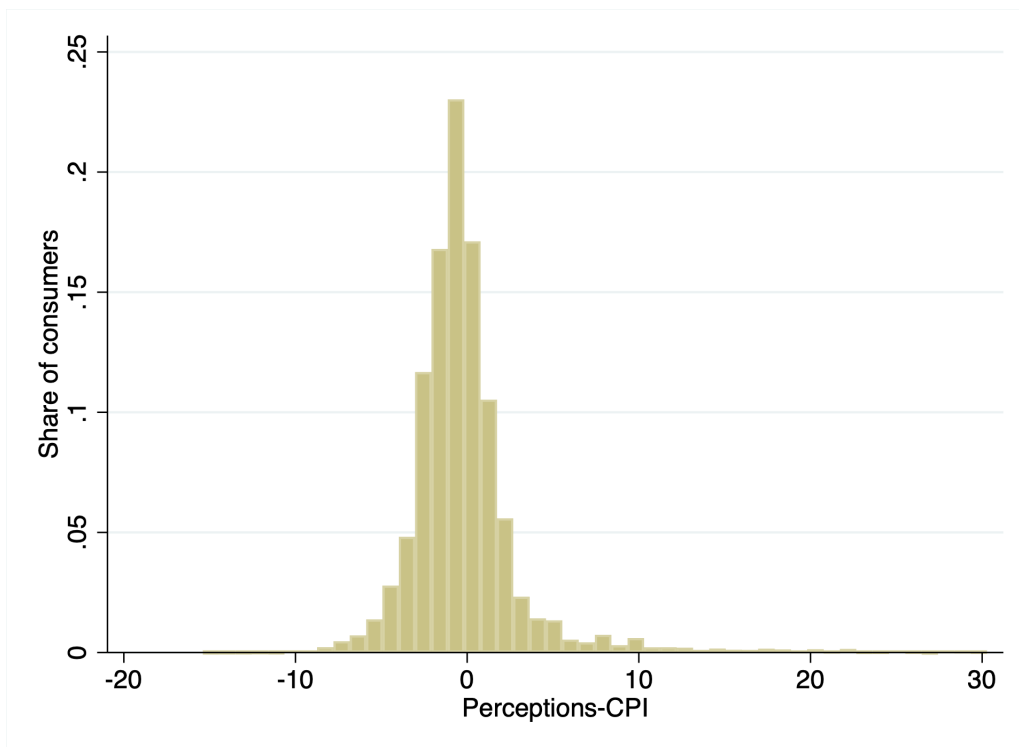
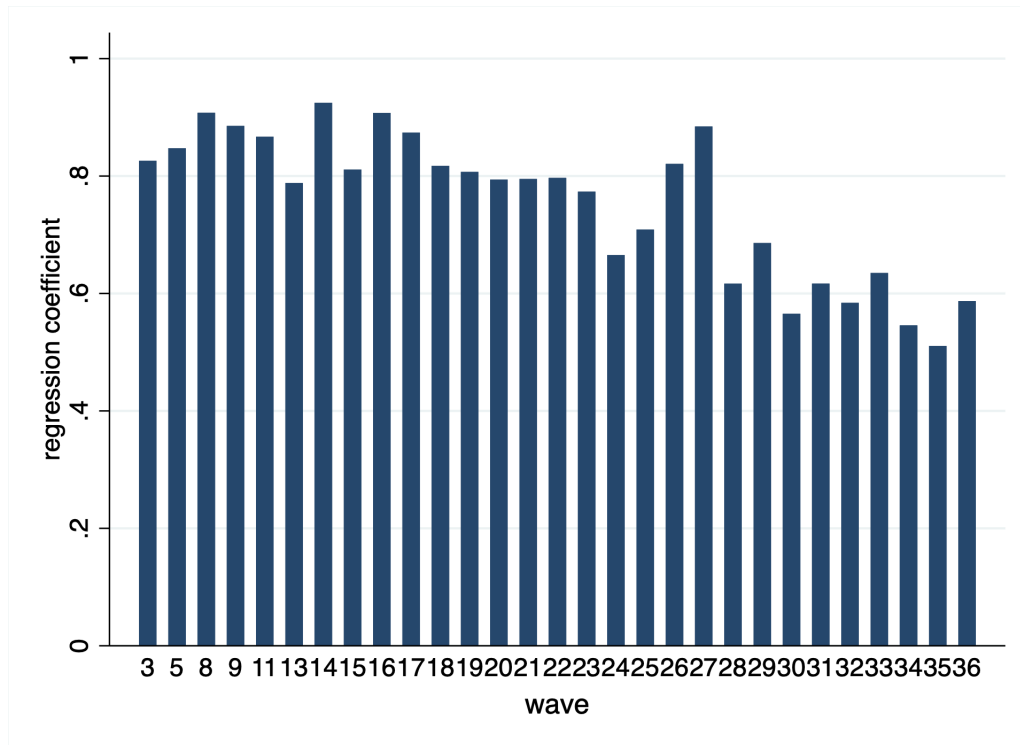


Figure B5: Inflation Perception Error Distribution



Additional Estimation Results

Figure B6: Correlation of short-term expectations and perceptions (by wave)



Note: The correlation is measured as the coefficient from regression of the short-term expectations on the short-term perceptions and socioeconomic controls.

Dependent variable: Short-term Inflation Expectations (1Y)							
	OLS	OLS	OLS	OLS	panel FE	panel RE	panel Δ on Δ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
perceptions last 12 months	0.831*** (0.00554)	0.740*** (0.00773)	0.820*** (0.00563)	0.717*** (0.00786)	0.567*** (0.0113)	0.651*** (0.00984)	0.528*** (0.0256)
constant	1.503*** (0.0244)	0.974*** (0.0187)	0.905*** (0.228)	0.358 (0.222)	1.124*** (0.0326)	1.084*** (0.0258)	0.0820 (0.0789)
CPI	-	+	-	+	+	+	+
Controls	-	-	+	+	-	-	-
N	74733	74733	70816	70816	50852	50852	8366
R^2	0.515	0.529	0.515	0.532	0.499	0.499	0.198

Notes: Columns 1-4 report OLS estimates. The estimates from the panel fixed effect regression are shown in Column 5, the estimates from the panel random effect regression in Column 6. Column 7 reports the estimates from the panel change-on-change regression. Panel fixed- and random-effects regressions are estimated on the sample of households who participate in the survey more than once. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Socio-demographic controls include gender, household income, education, current employment status, East residence dummy, age, age squared. The dependent variable (short-term inflation expectations) is measured by the quantitative survey question: “What do you think the rate of inflation will roughly be over the next twelve months?”. The independent variable (short-term inflation perceptions) are measured by the quantitative survey question: “What do you think the rate of inflation or deflation in Germany was over the past 12 months?”. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 (April 2020 - June 2020, April 2021 - December 2022).

Table B4: Inflation Perceptions and Short-term Inflation Expectations

Dependent variable: Long-term Inflation Expectations (10Y)							
	OLS	OLS	OLS	OLS	panel FE	panel RE	panel Δ on Δ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
perceptions last 12 months	0.438*** (0.0101)	0.587*** (0.0148)	0.415*** (0.0103)	0.545*** (0.0151)	0.242*** (0.0145)	0.333*** (0.0136)	0.221*** (0.0517)
constant	2.776*** (0.0522)	3.209*** (0.163)	2.519*** (0.444)	2.689*** (0.461)	3.633*** (0.0862)	3.112*** (0.0789)	-0.519*** (0.125)
Wave dummies	-	+	-	+	-	-	-
Controls	-	-	+	+	-	-	-
N	28759	28759	26898	26898	13986	13986	1130
R^2	0.131	0.164	0.165	0.190	0.059	0.059	0.027

Notes: Columns 1-4 report OLS estimates. The estimates from the panel fixed effect regression are shown in Column 5, the estimates from the panel random effect regression in Column 6. Column 7 reports the estimates from the panel change-on-change regression. Panel fixed- and random-effects regressions are estimated on the sample of households who participate in the survey more than once. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Socio-demographic controls include gender, household income, education, current employment status, East residence dummy, age, age squared. The dependent variable (long-term inflation expectations) is measured by the quantitative survey question: “And what value do you think the rate of inflation or deflation will take on average over the next ten years?”. The independent variable (short-term inflation perceptions) are measured by the quantitative survey question: “What do you think the rate of inflation or deflation in Germany was over the past 12 months?”. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 (April 2020 - June 2020, April 2021 - December 2022).

Table B5: Inflation Perceptions and Long-term Inflation Expectations

Dependent variable: Long-term Inflation Expectations (5Y)					
	before July 2021	after July 2021	full sample		
	(1)	(2)	(3)	(4)	(5)
perceptions (past 12 months)	0.722*** (0.0380)	0.490*** (0.0140)	0.529*** (0.0132)	0.529*** (0.0132)	0.706*** (0.0370)
high inflation				-1.607*** (0.168)	-0.837*** (0.200)
perceptions \times high inflation					-0.215*** (0.0395)
constant	3.135** (1.197)	2.427*** (0.440)	2.594*** (0.429)	2.594*** (0.429)	2.151*** (0.432)
Wave dummies	+	+	+	+	+
controls	+	+	+	+	+
N	4620	30871	35491	35491	35491
R^2	0.359	0.204	0.232	0.232	0.235

Notes: Columns 1-5 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The dependent variable (long-term inflation expectations) is measured by the quantitative survey question: "What do you think the rate of inflation will roughly be on average over the next 5 years?". Perceptions are measured by the quantitative survey question: "What do you think the rate of inflation or deflation in Germany was over the past 12 months?". High inflation is the dummy equal to 1 for periods starting from July 2021 and 0 otherwise. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 of the survey (April - June 2019, April 2020 - December 2022)

Table B6: The Role of Perceptions in low- vs high-inflation environments I

Dependent variable: Long-term Inflation Expectations (10Y)					
	before July 2021	after July 2021	full sample		
	(1)	(2)	(3)	(4)	(5)
perceptions (past 12 months)	0.659*** (0.0386)	0.511*** (0.0164)	0.545*** (0.0151)	0.545*** (0.0151)	0.651*** (0.0375)
high inflation				-2.753*** (0.215)	-2.190*** (0.240)
perceptions \times high inflation					-0.139*** (0.0409)
constant	3.684** (1.134)	2.161*** (0.482)	2.689*** (0.461)	2.689*** (0.461)	2.432*** (0.462)
Wave dummies	+	+	+	+	+
controls	+	+	+	+	+
N	4506	22392	26898	26898	26898
R^2	0.258	0.173	0.190	0.190	0.191

Notes: Columns 1-5 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The dependent variable (long-term inflation expectations) is measured by the quantitative survey question: "What do you think the rate of inflation will roughly be on average over the next 10 years?". Perceptions are measured by the quantitative survey question: "What do you think the rate of inflation or deflation in Germany was over the past 12 months?". High inflation is the dummy equal to 1 for periods starting from July 2021 and 0 otherwise. Perceptions and expectations truncated [30;-5]. The data span waves 1-36 of the survey (April - June 2019, April 2020 - December 2022)

Table B7: The Role of Perceptions in low- vs high-inflation environments II

Additional RCT results

Figure B7: The effect of information treatments on inflation expectations

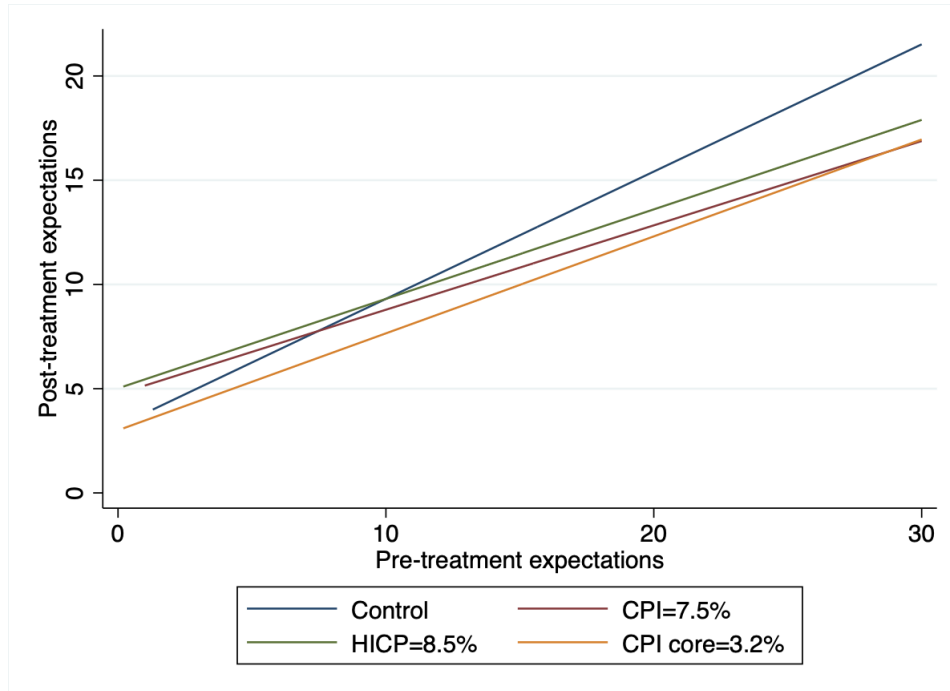
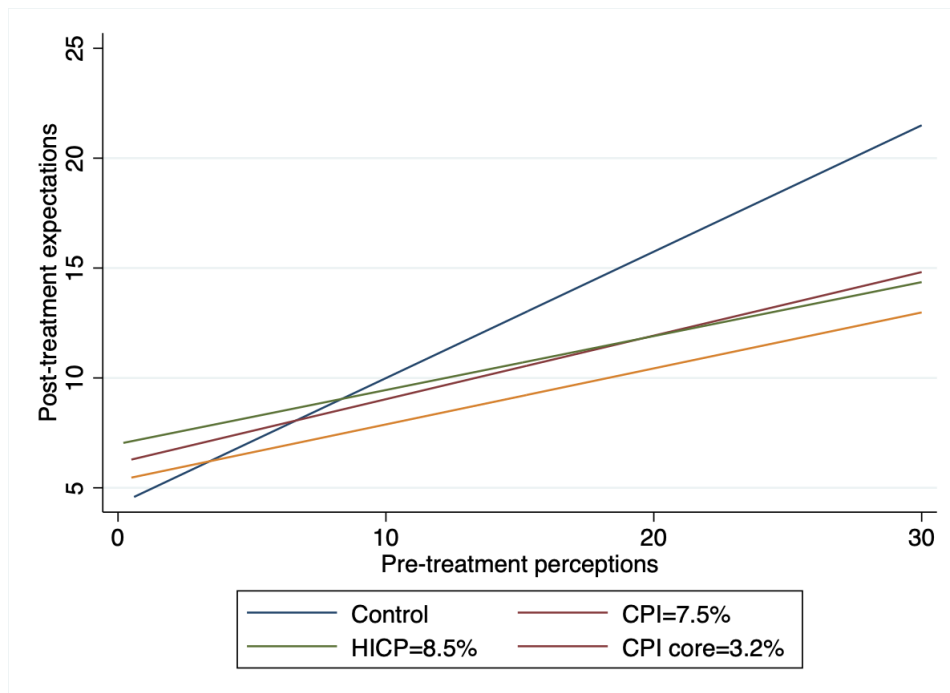


Figure B8: The effect of information treatments on inflation expectations



Heterogeneity in inflation perceptions and expectations

This section documents households' average inflation perceptions, expectations, perception errors, and individual uncertainty about future inflation—along socio-economic characteristics (Table B8).

We confirm findings of considerable heterogeneity in inflation perceptions and expectations among individuals (Table B8). In Germany, women have on average higher inflation perceptions and expectations than men (i.e., consistent with findings by [Jonung \(1981\)](#) and [D'Acunto et al. \(2021b\)](#) for the US; [Takahashi and Tamanyu \(2022\)](#) for Japan; [Arioli et al. \(2017\)](#) for the European Union). As documented by [Goldfayn-Frank and Wohlfart \(2020b\)](#), we find that respondents who (i) lived in East Germany during 1989 and (ii) those who live in East Germany nowadays, have on average higher inflation perceptions and expectations than their Western counterparts. In addition, we find that individuals have higher inflation perceptions, perception errors and expectations when living in larger German cities compared to smaller cities. In line with [Christelis et al. \(2020\)](#), we find that consumers with lower trust in the ECB tend to have higher inflation expectations and perceptions, perception errors, and uncertainty about future inflation.

We contribute to this related literature by documenting that besides the standard sociodemographic characteristics, additional characteristics are relevant to explaining inflation perception and expectation heterogeneity among households. The differences discussed in this section are statistically significant ($p < 0.001$) using non-parametric MWU-tests. First, the homeownership status matters. Renters report higher perceptions, expectations, perception errors, and uncertainty about future inflation than homeowners.³¹ Second, households intending to buy a real estate property over the next ten years have higher perceptions, expectations, perception errors, and uncertainty about future inflation—than households that are not planning on embarking on this endeavor. Third, information matters. Households reporting to have heard or read information about inflation in the past four weeks have lower inflation perceptions, perception errors, and uncertainty about future inflation. Fourth, the information source matters. Households that form inflation perceptions more on their shopping experiences than media reports reveal higher inflation expectations, perception, and perception error. Fifth, individuals who expect difficulties paying their current expenditures over the following months have higher inflation expectations, perceptions, perception errors, and uncertainty. Finally, we find that households reporting to generally have a pessimistic outlook for the next 12 months have higher inflation expectations, perceptions, perception errors, and uncertainty about future inflation.

³¹This finding is especially important for the ECB, as the currency union consists of countries that differ significantly in aggregate homeownership rates ([Huber and Schmidt, 2022](#)).

A: gender, location of residence (East/West), income, unemployment status												
	Gender			Current residence			Income			Unemployed		
	M	F	Δ	West	East	Δ	Low	Medium/High	Δ	No	Yes	Δ
Expectations	5.11	6.15	-1.04***	5.44	5.98	-0.54***	6.28	5.51	0.77***	5.64	4.26	1.38***
Perceptions	4.75	5.34	-0.59***	4.98	5.02	-0.36	5.61	4.97	0.64**	5.09	4.59	0.51***
Perc error	-0.36	0.27	-0.63***	-0.16	0.19	-0.35***	0.74	-0.13	0.86***	-0.16	1.04	-1.20***
Uncertainty	6.53	8.78	-2.24***	7.30	8.08	-0.78	11.53	7.34	4.19***	7.41	7.96	-0.55***

B: education, city size, age, trust in ECB												
	Education			City Size			Age			Trust inflation		
	Medium/High	Low	Δ	Small	Medium/Big	Δ	≤ 60	> 60	Δ	No	Yes	Δ
Expectations	5.18	5.81	-0.64***	5.67	5.49	0.17***	5.51	5.55	-0.04***	4.17	2.53	1.64***
Perceptions	4.73	5.19	-0.45***	5.05	4.98	0.07***	4.96	5.02	-0.06***	3.79	2.55	1.25***
Perc error	-0.40	0.12	-0.52***	-0.02	-0.04	0.02	-0.03	-0.21	0.19**	3.98	2.73	1.25***
Uncertainty	6.37	8.28	-1.91***	7.11	7.66	-0.55***	7.62	7.17	0.45***	7.32	6.29	1.03**

C: rent/own; liquidity constraint; outstanding loans; intention to buy property												
	Renters			Liquidity constrained			Outstanding loans			Intention to buy		
	Yes	No	Δ	Yes	No	Δ	Yes	No	Δ	Yes	No	Δ
Expectations	5.50	5.08	0.42***	5.12	3.25	1.88***	3.59	3.15	0.44***	2.76	2.98	-0.22***
Perceptions	5.22	4.88	0.35***	3.45	2.39	1.06***	3.37	3.03	0.34	2.73	3.06	-0.33**
Perc error	0.40	0.04	0.36***	2.88	1.82	1.06***	3.56	3.22	0.34	1.09	1.42	-0.33**
Uncertainty	9.36	7.25	2.11***	17.65	10.53	7.12***	8.48	7.53	0.95	6.81	6.04	0.77**

D: inflation information; source of inflation information; pessimism; income loss due to Covid-19												
	Informed about inflation			Information source			Pessimistic			Covid-19 Income loss		
	Yes	No	Δ	Media	Shopping	Δ	Yes	No	Δ	Yes	No	Δ
Expectations	7.47	5.38	2.09***	5.67	7.14	-1.47***	5.42	4.00	1.43***	3.25	3.37	0.12
Perceptions	5.84	4.18	1.66***	4.43	5.41	-0.98***	4.48	3.81	0.67***	2.55	2.38	0.17*
Perc error	-0.97	-0.31	-0.66	-1.08	-0.74	-0.34*	0.42	-0.26	0.67***	1.99	1.81	0.17*
Uncertainty	7.21	9.93	-2.72*	8.82	7.71	1.11	5.77	5.18	0.58	10.94	12.36	-1.42*

Notes: This table reports averages (means). Gender is the dummy variable equal to 1 if the respondent is a woman and 0 otherwise. Low income refers to the monthly income level lower than 1000 euro, medium/high income - higher than 1000 euro. Unemployed is a dummy variable equal to 1 if an individual is currently unemployed and 0 otherwise. Low education is a dummy variable equal to 1 if the highest education level a respondent is high-school diploma and 0 otherwise. Medium/high level of education refers to bachelor certificate and higher. Small city is a dummy variable equal to 1 for the city with population less than 5000 people. Trust inflation is a dummy equal to 1 if a consumer chose "Yes, the rate of inflation experienced by my household is roughly in line with the official rate of inflation" as an answer to the survey question "According to the official statistics of the Federal Statistical Office, the rate of inflation averaged ... between May 2019 and June 2020. What are your thoughts? Is this rate of inflation roughly in line with the rate of inflation your household has experienced over the past twelve months?" Renters is a dummy variable equal to 1 if an individual rents a house/flat and 0 otherwise. Liquidity constrained variable if equal to 1 if a consumer expects difficulties with covering current expenditures in the next month and 0 otherwise. Outstanding loans is a dummy variable equal to 1 if an individual has not yet fully repaid loans and 0 otherwise. Intention to buy equals to 1 for consumers who plan to buy property in the next 10 years and 0 otherwise. Informed about inflation is a dummy equal to 1 if an individual answered "yes" to the survey question: "Aside from this survey, have you, over the past four weeks, heard or read anything about inflation in Germany?" and 2 if "no" was chosen. Inflation source variable is equal to 1 if "more media" is the answer to the survey question: "You said you think prices for essential goods have [...] over the past twelve months. Is that based more on things you have heard or read or on your own experiences when shopping?" and 2 if "more own shopping experience" is chosen. Pessimistic is a dummy variable equal to 1 if a respondent chose "rather pessimistic" or "very pessimistic" answer to the survey question: "Thinking for a moment about your current circumstances, do you generally have an optimistic or pessimistic outlook for the next twelve months?" and 0 otherwise. Covid-19 income loss is a variable equal to 1 if an individual suffered income loss due to the covid-19 pandemic and 0 otherwise. Δ denotes the differences between the left and the right columns. The statistical significance of the differences in means is based on Mann-Whitney U tests. The significance level for the differences is denoted by * p<0.1, ** p<0.05, *** p<0.01. The data span waves 1-36 of the survey (April - June 2019, April 2020 - December 2022).

Table B8: Heterogeneity along socio-demographic characteristics

Dependent variable: Short-term Inflation Expectations (next 12 months)																
	female	male	east	non-east	young	middle age	old	education			income			employed	unemployed	retired
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Perceptions (past 12 months)	0.776*** (0.0113)	0.684*** (0.0125)	0.783*** (0.0191)	0.724*** (0.00930)	0.794*** (0.0293)	0.760*** (0.0115)	0.682*** (0.0133)	0.750*** (0.0103)	0.735*** (0.0202)	0.672*** (0.0200)	0.706*** (0.0470)	0.751*** (0.0104)	0.707*** (0.0146)	0.767*** (0.0109)	0.715*** (0.0515)	0.679*** (0.0141)
Constant	-0.0763 (0.408)	0.509 (0.272)	-1.088* (0.538)	0.342 (0.253)	-0.420 (0.364)	1.236*** (0.291)	1.041** (0.395)	-0.192 (0.284)	0.235 (0.581)	-0.00496 (0.526)	-1.426 (0.843)	-0.0635 (0.214)	0.185 (0.257)	0.758* (0.353)	1.898* (0.933)	2.549* (1.123)
Wave dummies	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Controls	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>N</i>	28440	42376	11484	59332	4702	35377	30737	39561	12734	18521	1503	40500	28813	39854	1377	27040
<i>R</i> ²	0.554	0.533	0.552	0.546	0.519	0.548	0.558	0.545	0.554	0.547	0.529	0.552	0.540	0.547	0.590	0.554

Notes: Columns 1-116 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** p<0.001, ** p<0.01, * p<0.05. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The dependent variable (short-term inflation expectations) is measured by the quantitative survey question: "What do you think the rate of inflation will roughly be over the next 12 months?". Perceptions are measured by the quantitative survey question: "What do you think the rate of inflation or deflation in Germany was over the past 12 months?". Perceptions and expectations truncated [30;-5]. The data span waves 1-36 of the survey (April-June 2019, April 2020 - December 2022).

Table B9: Heterogeneity in the Pass-through

Dependent variables:		
	informed about inflation	base perceptions on own shopping experience
	(1)	(2)
female	0.0815*** (0.00865)	0.0183** (0.00590)
medium level of income	-0.0529 (0.0353)	-0.0191 (0.0181)
high income	-0.0888* (0.0356)	-0.0177 (0.0185)
medium level of education	-0.0436*** (0.0111)	-0.00467 (0.00775)
high level of education	-0.0497*** (0.00954)	-0.0480*** (0.00769)
employed	-0.0138 (0.0270)	-0.000299 (0.0195)
unemployed	-0.00384 (0.0497)	0.0131 (0.0283)
retired	-0.0565 (0.0292)	0.00271 (0.0204)
east	0.0162 (0.0108)	0.0155* (0.00737)
age	-0.00662** (0.00216)	0.00917*** (0.00172)
age ²	0.0000282 (0.0000207)	-0.0000714*** (0.0000158)
constant	1.808*** (0.0646)	1.642*** (0.0489)
<i>N</i>	8211	8196
<i>R</i> ²	0.217	0.024

Notes: Columns 1-2 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. The dependent variable ("informed about inflation") is measured by the survey question: "Aside from this survey, have you, over the past four weeks, heard or read anything about inflation in Germany?". The dependent variable ("base perceptions on own shopping experience") are measured by the survey question: "You said you think prices for essential goods have "[...]" over the past twelve months. Is that based more on things you have heard or read or on your own experiences when shopping?". Low income refers to the monthly income less than 1000 euro. Medium income refers to the monthly income level from 1000 euro to 3999 euro. High income refers to the monthly income level higher than 4000 euro. Low level of education refers to high school education or less. Medium level of education refers to Bachelor degree. High level of education denotes education level higher than Bachelor degree. East (West/North/South) is a dummy equal to 1 if a household lives in Eastern (Western/Northern/Southern) Germany and 0 otherwise. Survey wave dummies are included in the regressions. The data span wave 19 (July 2021) and wave 35 (November 2022).

Table B10: Socio-economic Heterogeneity in Information Acquisition

Dependent variable: Uncertainty about future inflation	
female	1.926*** (0.0971)
high income	-4.095*** (0.455)
medium level of income	-2.263*** (0.454)
low level of education	1.872*** (0.0915)
medium level of education	1.160*** (0.117)
employed	-0.387 (0.296)
unemployed	0.0963 (0.477)
retired	-1.149*** (0.325)
east	0.776*** (0.134)
age	-0.447*** (0.0240)
age ²	0.00398*** (0.000242)
constant	18.48*** (0.749)
<i>N</i>	118874
<i>R</i> ²	0.027

Notes: The table reports OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Survey wave dummies are included. The dependent variable (uncertainty about future inflation) uncertainty is measured as the standard deviation of the subjective probability distribution from the probabilistic question regarding inflation expectations (Appendix A). Low income refers to the monthly income less than 1000 euro. Medium income refers to the monthly income level from 1000 euro to 3999 euro. High income refers to the monthly income level higher than 4000 euro. Low level of education refers to high school education or less. Medium level of education refers to Bachelor degree. High level of education denotes education level higher than Bachelor degree. East (West/North/South) is a dummy equal to 1 if a household lives in Eastern (Western/Northern/Southern) Germany and 0 otherwise. The regression includes survey wave dummies. The data span waves 1-36 (April 2020 - June 2020, April 2021 - December 2022).

Table B11: Socio-economic Heterogeneity in Inflation Uncertainty

Dependent variable: Post-treatment Inflation Expectations		
	(1)	(2)
$\mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior})$	0.564*** (0.0541)	0.406*** (0.0682)
$Treatment_1$	1.318** (0.671)	0.205 (0.620)
$Treatment_2$	1.297** (0.553)	1.778** (0.715)
$Treatment_3$	0.0203 (0.601)	0.667 (0.778)
$Treatment_1 \times \mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior})$	-0.158** (0.0715)	-0.290*** (0.104)
$Treatment_2 \times \mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior})$	-0.126* (0.0664)	-0.211** (0.0957)
$Treatment_3 \times \mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior})$	-0.173** (0.0803)	-0.0646 (0.0863)
Controls	+	+
N	2484	2301
R^2	0.329	0.148

Notes: Columns 1-2 report OLS estimates. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust standard errors (Eicker-Huber-White) are reported in parentheses. The data span wave 32 of the survey (August 2022). Expectations are truncated [30;-5]. In Column 1 (2), we use the quantitative (probabilistic) question to measure inflation expectations over the next twelve months. To assess the effects of the different information treatments on inflation expectations, we follow Coibion et al. (2018b) and Coibion et al. (2023) and run regressions of the following form: $\mathbb{E}(\pi_{i,t \rightarrow t+12}^{post}) = \alpha \mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior}) + \sum_{k=1}^3 \beta_k \times Treat_i^k + \sum_{k=1}^3 \gamma_k \times Treat_i^k \times \mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior}) + \psi X_i + \varepsilon_i$, where $\mathbb{E}(\pi_{i,t \rightarrow t+12}^{post})$ denotes the inflation rate household i expects for the next 12 months; measured in percentage points, and collected after the treatment (i.e., posterior expectation), and $\mathbb{E}(\pi_{i,t \rightarrow t+12}^{prior})$ denotes the corresponding inflation rate household i expects, collected before the treatment (i.e., prior expectation), and X_i denotes a vector of controls for individual i . Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The treatment dummy $Treat_i^k$ is equal to one if individual i received treatment $k \in \{1, 2, 3\}$ and zero otherwise. Treatment 1 provides information about the core inflation rate over the past twelve months. Treatment 2 (3) provide information about the overall inflation rate over the past twelve months, measured by the CPI (HICP), respectively. For the exact wording of the information treatment texts, refer to Section 4.1. The omitted category is the control treatment, and hence, we can interpret the coefficients $\{\beta_k\}_{k=1}^3$ and $\{\gamma_k\}_{k=1}^3$ as being relative to the control group that received no information. Note that this specification is consistent with Bayesian learning. Households base their expectations on two components: their prior beliefs and the signals (i.e., information) they receive. Our treatments are successful in creating variation in households' inflation expectations. After having received information about the actual inflation rate over the past twelve months, households revise their expectations about future inflation significantly.

Table B12: RCT results

Dependent variable: Uncertainty about future inflation		
	(1)	(2)
heard or read about inflation	-3.376*** (0.621)	
base perceptions on shopping experience		-1.267* (0.747)
constant	21.22*** (3.989)	29.69*** (4.134)
Controls	+	+
Wave dummies	+	+
N	7724	7713
R^2	0.028	0.023

Notes: Columns 1-2 report OLS estimates. Robust standard errors (Eicker-White) are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Socio-demographic controls include gender, household income, education, current employment status, region, age, age squared. The dependent variable is measured as the variance of the subjective probability distribution from the probabilistic question regarding inflation expectations. The data span waves 19 and 35 (July 2021, November 2022).

Table B13: Uncertainty and information acquisition