Central Bank Communication as Public Opinion: Experimental Evidence [*]

Nicole Baerg[†]   Dominik Duell[‡]   Will Lowe [§]

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Abstract

Political institutions increasingly communicate complex ideas to the public byway of press releases or social media. When asked directly, members of the public often report that they do not understand economic policy and find it complicated or unintelligible; this is especially true for monetary policy. Embedding a vignette experiment into two waves of a panel survey on German households, we examine the influence of monetary policy communications on households' inflation expectations. We find that when presented with more precise information, households down-weight their priors and update in line with given information. We also examine whether those that are more news savvy, those who have favorable opinions of the European Central Bank (ECB), and those with closer policy preferences respond more (or less) to monetary signals. We find evidence that business news readers have stickier priors, while those with more favorable opinions of the ECB are most likely to be influenced by ECB communications. Finally, in examining the persistence of effects one year later, we find that, the conditioning on prior forecasts one-year ago, shorter and more precise statements exert a larger influence on inflation expectations. Our results are important for understanding the ways in which governmental actors inform the public on complicated policy topics and demonstrates how political opinions condition the effectiveness of central bank communications.

1   Introduction

Political institutions such as courts, international organizations, and central banks increasingly communicate complex policy information through news and social media outlets. Monetary policy – or actions taken by a monetary authority that determine the size and rate of growth of the money supply – is thought to be particularly difficult for average citizens to understand. The complexity of monetary policy has be blamed, for example, on why we rarely see societal cleavages over monetary policy preferences as well as the lack of political mobilization of those interests (Bearce, 2003). Yet, citizens' individual expectations of the economy are crucial in explaining economic performance (Bernanke, 2007; Bodea and Hicks, 2015; Bachmann, Berg and Sims, 2015). This leads to a conundrum such that successful monetary policy depends on the central bank's ability to inform the mass public and yet, the public shows limited confidence in their financial literacy. In this paper, we examine how citizens learn about the economy from monetary news and test whether and how political predispositions interact with institutional signals.

Recent research in economics investigates whether or not citizens' daily experiences, such as their consumer behavior, shapes their expectations about the future economy. Using survey experiments, economists have both posited and tested how citizens' views about inflation are formed (Cavallo, Cruces and Perez-Truglia, 2017). Citizens' responses to central bank information are often modeled using Bayesian learning. In these models, individuals update their perceptions of the economy based on some combination of their prior beliefs and signals from the empirical world. An individual's inflation expectations are modeled as the (weighted) average of her previous inflation beliefs plus new information, gathered from either the private sector or public signals sent by the central bank. Unfortunately, previous literature studies the determinants of inflation expectations yet presupposes that citizens are similar in their willingness to incorporate economic information from political institutions. Evidence from political science, and especially studies on public opinion, however, demonstrates that political factors such as political sophistication, trust in institutions, and policy congruence may condition respondents' willingness to accept public information in the first place (Tverdova, 2012; Zaller, 1992; Hobolt and Wratil, 2015; Hayo and Neuenkirch, 2014). Thus in this paper, we combine these two approaches and test whether or not households' evaluations of future inflation depends both on how monetary news is presented as well as test whether respondents' political predispositions

matter for the adoption of monetary news.

In order to empirically investigate these claims, we embed two different vignette experiments into a panel survey of German households. Methodologically, our paper contributes to the literature that examines the origins of households' inflation expectations using survey experiments (Armantier et al., 2016; Cavallo, Cruces and Perez-Truglia, 2017; Roos and Schmidt, 2012). Different from these studies is that we specifically focus on the variation in the content of monetary information, examining how citizens respond to differences in the precision and length of monetary news. To assess whether or not respondents are actually learning, we exploit the panel nature of the survey and respondents political predispositions. We find evidence that respondents who receive a more precise news item update more than those respondents who receive less precise monetary news. Interestingly, we also find some evidence that political factors condition how citizens' form inflation expectations – at least over the short term.

Our paper contributes an understanding of the origins of inflation expectations and the role of central bank communication in public opinion formation. We find that shorter and more precise information moves respondents closer to the ECB's taregt, however, we also find that those citizens with political dispositions against the central bank or avid consumers of outside information are less likely to be moved. Our findings are important because how citizens learn about inflation policy has implications for how central banks should communicate as well as has implications for macroeconomic policy. For example, if financial market stability depends on citizens making calculated market adjustments, and if only a sub-section of citizens learn about inflation from the central bank, financial recovery might be longer and more painful than the case when central bank information informs everyone. Conversely, heterogeneity in citizens' behaviors may protect against communicated mistakes, which might be beneficial. Finally, while many studies have examined how non-elected political elites change citizens' opinion (Iyengar and Kinder, 1987; Broockman and Butler, 2017), new to this study is testing whether or not non-majoritarian institutions, such as central banks, change citizens' understanding of the economy, which also has important knock-on effects for other models of politics, for example, models of economic voting.

1.1 Inflation learning and financial literacy

Financial knowledge – or the ability to understand how money works, is necessary for undertaking many daily activities, such as following news about the economy, managing debt, and buying

a home. A basic understanding of financial concepts and the ability to apply numeracy skills can ensure that citizens can manage their own financial affairs and react to news and events in ways that benefit households' own financial well-being. Previous studies find that those with higher levels of financial knowledge are associated with better investment and retirement decisions and are less likely to accumulate debt (Hastings et al, 2013, Clark et al, 2015). Central banks have recently tried to capitalize on the links between information and financial literacy by paying closer attention to how they provide information. According to Cavallo, "All these efforts may help central banks increase the speed which which individuals react to monetary policy" (Cavallo, Cruces and Perez-Truglia, 2017, p.4).

Given that financial knowledge is important for understanding changes to the economy, it is essential to understand how financial knowledge is acquired by citizens in the first place and our particular attention is on the origins of inflation expectations and the causal role information plays, especially when disseminated by a non-elected, public institution. Previous literature on the origins of households' inflation expectations can be loosely organized into two groups, one which focuses on Bayesian learning and another that focuses on public opinion and elite cues.

Bayesian Learning: Bayesian models of learning depict citizens as optimally combining prior beliefs with information based on new observations or data using Bayes' rule. Applied to inflation, Bayesian learning assumes that citizens have prior beliefs about monetary policy outcomes and that citizens update their knowledge by taking new information into account and then revising their prior beliefs, forming posterior inflation expectations. For example, if someone thinks that inflation will be 1% and then is given information that it will actually be 2%, using Bayes' rule, the individual's posterior will be some weighted average of the two, with both the prior and the data contributing to the individual's posterior belief. The empirical evidence on Bayesian learning and inflation has been extensively studied and the empirical evidence is somewhat mixed, however. Some authors find that individuals fail to incorporate all the available information (e.g., Mankiw et al., 2003; Armantier et al., 2016), yet others interpret the evidence in favour of rational inattention. Still other research suggests that individuals use inaccurate sources when forming their inflation expectations (e.g., Bruine de Bruin et al., 2011; Malmendier and Nagel, 2016), which some authors interpret as evidence of cognitive limitations.

Political Opinion: Citizens may also incorporate economic information conditional on political variables such as their policy preferences, policy sophistication, and the level of trust they have in economic institutions. Rather than be calculated inputs, inflation expectations

might follow something more akin to Zaller's Receive-Accept-Sample model of opinion formation (Zaller, 1992). According to this model, an individual's inflation expectations depends on what they have heard or read about and whether and to what extent they accept this information because it is consistent with their personal political beliefs. Inflation expectations, therefore, might be merely sampled opinions more akin to other kinds of opinions rather than computed statistical quantities. As public opinions, inflation expectations may then depended on political support for the regime (Tverdova, 2012), the formation of policy opinions (Mondak, 1993), and the perception of institutional credibility (Hobolt and Wratil, 2015; Hayo and Neuenkirch, 2014).

According to Bayesian learning, an individual with weak priors about inflation will be more persuaded by elite cues about the economy than an individual without. But in a model of political opinion formation, public support for the central bank sophisticated respondents might respond more rather than less strongly. For example, individuals with strong support for the ECB might be even *more* persuaded by elite cues (Zaller, 1992), especially if those cues emanate by sources they align with politically. However if political predispositions vary across or within countries, a supranational central bank, such as the ECB, may find that communicating effectively is particularly challenging.

In order to evaluate the effects of information and political political predispositions on inflation expectations, we adopt the formal logic of a reduced form model from Cavallo, Cruces and Perez-Truglia (2017). Different from their model, we alter the specification of an individual's prior such that households' priors can be (but are not necessarily) conditional on political factors that we think matter for expectations as well as past economic realizations of inflation. More formally, let $\pi_{i,t}^0(X_{i,t}^0)$ denote perceptions of inflation before new information is sent and $\pi_{i,t}^T$ the signal of information received by respondents by the survey experiment. $X_{i,j}^0$ represents a matrix of an individual's political and economic predispositions that are thought to influence their prior.

$$\pi_{i,t} = g(\pi_{i,t}^0(X_{i,t}^0), \pi_{i,t}^T) \tag{1}$$

As in Cavallo, Cruces and Perez-Truglia (2017), if we assume that respondents are Bayesian with a Gaussian distribution of priors, then the individual updates her prior perception based on some average of her priors and the new information she received from the experiment.

$$\pi_{i,t} = (1 - \alpha_{i,t})\pi_{i,t}^0(X_{i,t}^0) + \alpha_{i,t}\pi_{i,t}^T \tag{2}$$

In the above equation, $\alpha_{i,t}$ is the weight given to new information and $(1 - \alpha_{i,t})$ the weight given to her prior. If we assume that all respondents are the same, then the weight $\alpha_{i,t}$ should increase as the accuracy of the signal sent by the central bank increases. In this case, $\pi_{i,t}^T - \pi_{i,t}^0$ is the difference between the prior and the posterior belief after the treatment. If we first assume no variation across individuals, or $\alpha_{i,t}$ is constant across individuals, our first expectation is that,

H1: As information precision in central bank news increases, information weights more heavily on the expression of respondents posterior expectations of future inflation.

Because we change information directly through the survey manipulation, we can assure that $\pi_{i,t}^T$ is constant across all individuals that receive a particular treatment, at least in the short term. However, $\pi_{i,t}^0$ and therefore $\alpha_{i,t}$ likely varies across individuals and in ways that are systematic due to respondents having different levels of receptivity to political information as well as different monetary policy preferences. Thus, our next set of tests considers the role of information conditional on political opinion formation. We test the hypotheses that, *H2: As information precision in central bank news increases, information weights more heavily on the expression of respondents' posterior expectations of future inflation and this is even more so when respondents have more favorable impressions of the ECB.* Similarly, we also expect that *H3: As information precision in central bank news increases, information weights more heavily on the expression of respondents' posterior expectations of future inflation and this is more so when respondents are more financially sophisticated.* Finally, we expect that policy congruence between the respondent and the ECB's stated policy matters. Accordingly, the last hypothesis reads *H4: As information precision in central bank news increases, information weights more heavily on the expression of respondents posterior expectations of future inflation when respondents hold more similar inflation preferences to the announced ECB policy rate.*

2 Research design

2.1 Case selection

In order to evaluate the effect of monetary information on inflation expectations formation, we conducted a 2-wave survey experiment on a panel of respondents in Germany in 2014 and 2015. Germany offered an interesting study environment to examine inflation expectations for two reasons. First, inflation rates during the experimental period were very low in Germany and less than the ECB's target rate of 2%. In low inflation environments, it is relatively cheap

for citizens to pay scant attention to the economy, which might make their priors more diffuse. According to our theory more diffuse priors might lead to citizens making larger updates to their expectations when presented with new information. Therefore, as a consequence of low inflation, Germany acts as an "easy" case to test the theory. On the other hand, however, the timing of our experiment occurs during a historical period when Germany, as well as other European countries, are experiencing disinflation – or inflation is slowing down. Disinflation generates significant uncertainties for consumers, especially if they think that prices will be substantially lower in the future, leading them to postpone consumption. Under conditions of disinflation, it might be more rather than less costly for citizens to ignore important economic signals. The low inflation environment might then motivate households to pay closer attention to economic news, thus making Germany a "hard" case to test our theory. Also important is the political context. During the duration of the study, the German and European news media was engaged in a lively debate about whether or not the ECB should engage in asset purchases of euro-area government bonds in order to help re-inflate struggling European economies. Opinions in Germany on euro-bond purchases varied enormously, with some citizens feeling that by purchasing assets, the ECB was over-extending its legal reach, yet other citizen argued in support of more activist policies geared towards re-inflating Europe. Important for us, ECB and inflation-related news was salient and politicized during our survey time period, making it a good opportunity to ask survey respondents' opinions on inflation and monetary policy. We especially exploit the timing of this political debate in wave 2 of our study where we encourage citizens to think about the asset purchase program directly and link the policy to possible consequences for inflation outcomes.

2.2 Panel

In order to examine the effects of monetary policy communications on individual's inflation expectations, we ran experimental treatments on German households participating in two waves of the German Internet Panel (GIP). GIP respondents are German residents in private households between 16 and 75 years of age. Sampling is based on multistage proportionate stratified random sampling, including equipping previously offline individuals and making them online. Our survey experiments were fielded in November 2014 (Wave 14) and November 2015 (Wave 20). In order to keep things simple, in this paper, we refer to these two runs as waves 1 and 2.

2.3 Experimental design

We incorporate two sets of information treatments, one in each wave, in order to identify the causal effects of institutional signals on citizens' inflation expectations. In both waves, we implement two information manipulations that vary the level of information precision (wave 1 and wave 2) as well as vary the length of information given to respondents (wave 2). The next section outlines the research design in more detail.

In the first wave, we first elicit respondents' prior expectations of inflation. Respondents are asked to give an estimate of expected inflation over the next 12 months, $\pi_{i,t}^0$. Rather than being asked directly about the annual rate of inflation, respondents are given a hypothetical scenario in which a person is said to have spent 1500 Euros per month on typical purchases for food, goods, and services such as groceries, clothes and a hair-cut. Respondents are then asked by how much they think the same person would spend on the same items over the next 12 month. As response options, respondents are given a list of different Euro amounts ranging from "less than 1500 Euros" to "1650 Euros or more." Each response option is measured in increments of 1 percent inflation, forcing respondents to consider the same scale, but panelists are not told the interval lengths at the time of answering.

On the next screen, respondents are then asked to consider inflation in Germany in general. Respondents are given a short explanation what inflation means and about the role of the ECB with respect to inflation in the Eurozone. Then, respondents receive either a vignette with a text snippet that gives information about inflation and also the ECB's policy goals, with explicit numerical anchors (*Precise Information*) or a similar text that uses more vague language and without numerical anchors (*Vague Information*). The treatment vignettes read as follows:

Vague Information: The European Central Bank expects the important interest rates to remain at the current level or below for a longer period of time. This assessment rests on the general expectation of low inflation. The expected inflation for the Eurozone is in line with the objective of the Central Bank to keep inflation at an appropriate level.

Precise Information: The European Central Bank expects the important interest rates to remain at the current level or below for a longer period of time. This assessment rests on the general expectation of low inflation of 1 percent per year. The expected inflation for the Eurozone is in line with the objective of the Central Bank to keep inflation at 2 percent.

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Finally, respondents are reminded of their answer to the previous question and told how their initial response translates into an annual inflation rate, thus making their prior computationally comparable to the information presented in the text.

We then measure the main outcome variable, 12-month ahead inflation expectations, to assess the effect of the information treatment. Again respondents are asked to estimate the current inflation rate but adds up front: "considering these expectations by the ECB [...]". We denote their answer to this question as, $\pi_{i,1}$.

In wave 2, which occurs exactly 12 months later and, because it is a panel, has the same respondents, a similar treatment is again used. Here we vary again the information about the ECB and the 2% inflation target, only this time, in addition to varying the level of detail in the policy statement, we also vary its length. As mentioned in the case information, we also "tap into" the controversy of the ECB asset purchase program, which was highly salient in the German media. For example, German politicians and right-wing figures legally challenged the ECB's emergency bond-buying scheme in a number of prominent court-cases. While Germany's constitutional court ruled that the bond-program was legal, Jens Weidmann, the president of Germany's central bank, frequently criticized the program publicly.[1] The four treatment conditions read as follows:

> *Precise, long text*: The ECB extents its purchase of bonds to those issued by Eurozone governments, issuers with development objects, and issued by European institutions. Overall, monthly purchases of a total value of 60 million Euros are planned. These purchases will continue until September 2016 at a minimum. The program serves to fulfill the ECB mandate to ensure price stability and reach a medium-term inflation rate close to 2%.

> *Vague, long text*: The ECB extents its purchase of bonds to those issued by Eurozone governments, issuers with development objects, and issued by European institutions. Overall, monthly purchases of high total value are planned. These purchases will continue until the middle of next year at a minimum. The program serves to fulfill the ECB mandate to ensure price stability and reach a medium-term inflation rate close to an appropriate level.

> *Precise, short text*: The ECB extents its purchase of bonds. Purchases of a total value of 60 million Euros will continue until September 2016 and serve to fulfill the ECB mandate

to ensure price stability and reach a medium-term inflation rate close to 2%.

Vague, short text: The ECB extents its purchase of bonds. Purchases of high total value will continue until the middle of next year and serve to fulfill the ECB mandate to ensure price stability and reach a medium-term inflation rate close to an appropriate level.

As before, we again ask respondents for their posterior inflation expectations using the same text as in wave 1, and we denote wave two expectations as $\pi_{i,2}$.

As mentioned, the main outcome variable we are interested in respondent's prior beliefs about the rate of annual inflation over the next 12 months, which we elicit in wave 1, $\pi_{i,1}^0$, as well as their posterior beliefs after receiving the treatment $\pi_{i,1}, \pi_{i,2}$. As we are interested in respondents' "fundamental priors," and we want to protect against transitory responses, we use respondents' priors in wave 1 to proxy their priors in wave 2 as well. In doing so, however, we implicitly assume that panelists have not structurally changed their true inflation beliefs across the year. While we see some evidence that respondents are lowering their expectations in line with actual movements in inflation, we prefer to assume as a baseline that nothing can move people across the waves.[2]

In addition to the information treatment, we also ask respondents a number of other questions and we use answers to these questions in our analysis as well. In wave 1, in addition to measuring the 12-month ahead inflation expectations, we also ask respondents for their 5-year and 10-year ahead inflation expectations, $\pi_{i,1}^5, \pi_{i,1}^{10}$. In order to elicit their opinions on monetary policy more broadly, we also ask panelists to rank the performance of the ECB on a Likert scale of 1 to 5 ranging from very good (1) to very bad (5). Similarly, we ask respondents to self report how much news in general and how much business news in particular they consume.

In wave 2, we also elicit respondents' preferred inflation rate, $p_{i,t}$. To do this, we deploy a number of techniques. Rather than consider only their self-reported preferences when asked directly, respondents also indicate their inflation preferences by completing a number of small interactive tasks:

1. Respondents decide between either a scenario of high unemployment and low inflation in Germany (or the Eurozone) or the converse with an additional comprehension questions about those relationships.

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[2] Questionnaire items are given verbatim in Section B.1 in the supporting information (SI).

2. Respondents move interconnected sliders for interest rate, inflation, unemployment rate, and growth rate (order of sliders is randomized) in Germany (or the Eurozone, or for personal situation) and choose their favoured outcome.

3. Respondents report an opinion on their favoured weighting that the ECB (or the German federal government) should apply to lowering inflation vs reducing unemployment with an additional check for comprehension of the relationship

In terms of manipulation checks of the main treatment, in wave 1, after respondents receive the information treatment and after recording the outcome measure, we ask subject whether they thought the information they received was precise or not. Figure 1 shows variation in responses to the manipulation check across treatment groups. The question asked respondents to indicate the level of detail contained in the news item. Answers ranged from not very detailed (1) to very detailed (5). We see some indication on separation across groups, for example, those that received the more precise treatment are more likely to say that the item was precise as well as the converse, with the mean response for those in the precise group higher than the mean response of those in the vague group ($2.60 > 2.40$), however the difference in means is not statistically significant.
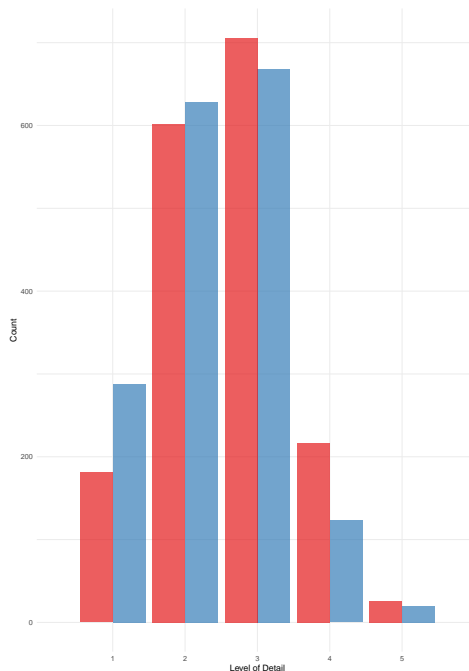

Figure 1: Manipulation Check: Self Reported Level of Detail in the policy statement by Treatment Group

Table 1 summarizes the treatment and outcome measures. The time-line indicates in which

of the two waves of the survey and at which point within the wave an outcome was measured as well as when the treatment intervention happened.

			Wave 1			Wave 2		
			$\longrightarrow$ Time $\longrightarrow$					
Treatments		$\pi_{i,1}^T$			$\pi_{i,2}^T$			
Outcome measures	$\pi_{i,t}^0$		$\pi_{i,1}, \pi_{i,1}^5, \pi_{i,1}^{10}$			$\pi_{i,2}$		
Manipulation checks				✓				X
Additional measures			ECB, News, Business News				$p_{i,2}$	

Table 1: Time-line of treatments and outcome measures within and across the two waves of the GIP

3 Results

This study sets out to learn how citizens turn publicly disseminated information about monetary policy into inflation expectations. We want to know to what extent citizens incorporate central bank communications into their economic forecasts. In the next section, we examine both differences in behavior *between* treatment groups as they get different sources of information and differences *within* respondents across the two waves of the panel study.

3.1 Average treatment effects

For valid claims based on our experimental manipulations we need to ensure balance across treatment groups in relevant observables. In particular, we want to ensure that there are no significant differences in respondents' reported prior inflation expectations. Figure 2 shows little evidence that respondents across treatment groups start off with any significant variation in their prior expectations of future inflation.

Next, we examine the posterior inflation expectations across treatment groups in wave 1, measured after respondents received the information manipulation. Recall the two different types of signals: half of the respondents receive more precise information about past observed inflation where the other half are shown more vague information. Figure 3 shows the effect of the different information treatment conditions on posterior expectations graphically. As is apparent from the figure, more precise information substantially reduces respondents' average posterior inflation expectations as well as lowers the variance in expected inflation. The variance also declines for all respondents, suggesting that respondents updated their forecasts as a consequence of errors made in the earlier hypothetical scenario.
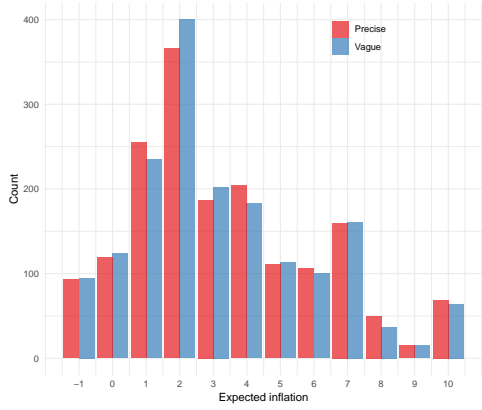
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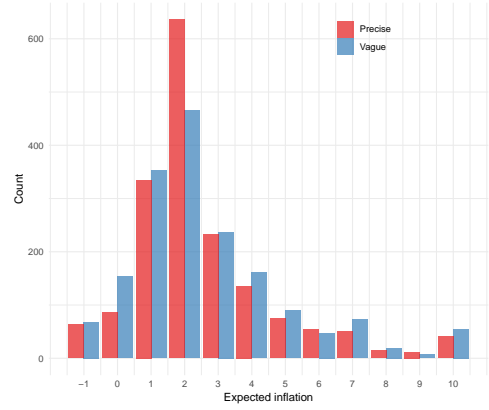Figure 2: Respondents Prior Inflation Expectations

Figure 3: Respondents Posterior Inflation Expectations

We observe that those respondents who received more precise information are more likely to tighten around the ECB's inflation target than those respondents that are given less precise information. Figure 4 illustrates the relationship between the prior and the posterior inflation expectations, for all respondents, grouped by the information treatment. We observe that those individuals who receive more precise information show larger attenuation in how much weight is given to their prior expectations than those that receive monetary policy statements that are more vague.
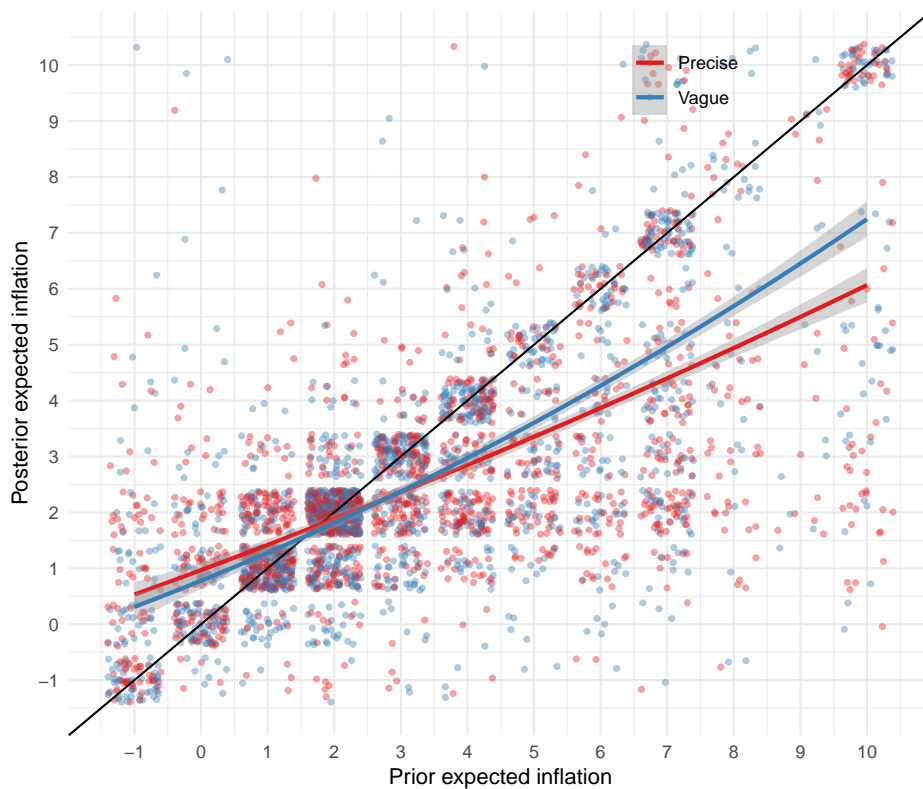

Figure 4

Naturally, the largest treatment effect arises for respondents who reported prior beliefs about past inflation that are furthest away from the true inflation rate in the past 12 month ($> 5\%$). Such individuals with more mistaken prior beliefs about the expected inflation have more room to correct their expectations than those individuals who have more correct priors. We examine the difference in updating between treatment groups over different values of prior inflation expectation in Figure 5; the figure shows the treatment effect across groups of respondents with the same prior inflation expectation. We observe that respondents with prior beliefs just below or at the the ECB target rate of 2%, update positively by a small amount. Individuals with prior inflation expectations above the ECB's target rate update negatively, though the error bars on these estimates cross the 0 line at most values of prior inflation expectation.
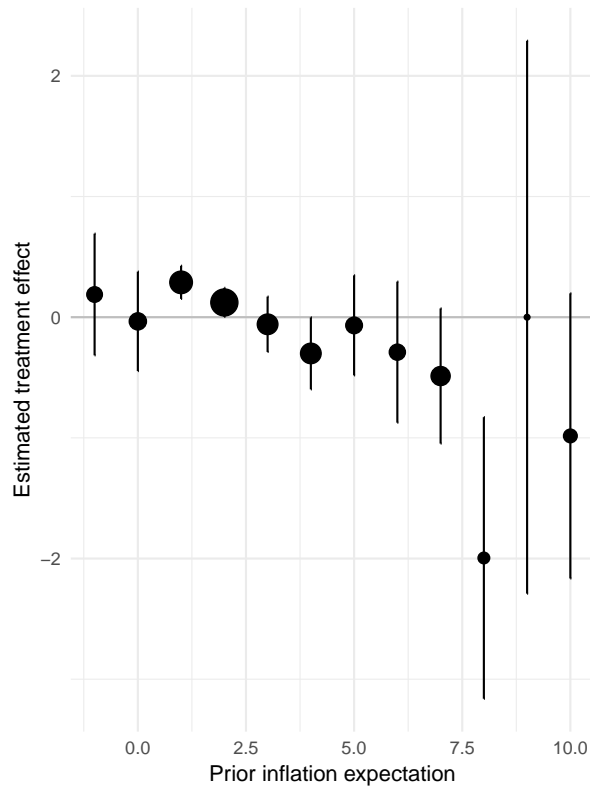

Figure 5: Estimated treatment effect on posterior inflation expectation over prior inflation expectation

In order to better understand how information about monetary policy is processed given respondents priors, we examine whether the marginal effect of prior inflation expectation (as elicited in wave 1) on posterior inflation expectation differs when respondents receive precise in contrast to vague information. The marginal effects are estimated from a linear regression of posterior inflation expectation on prior inflation expectation, dummy variables for the different treatment condition (vague or precise information in wave 1; vague/short, vague/long,

precise/short, or precise/long information in wave 2), as well as individual-level controls (See Table 2). These marginal effects on wave 1 posterior inflation expectations are presented in Figure 6 and speak to our first hypothesis. On average, those respondents that receive the precise information treatment place a significantly lower weight on their priors (and therefore a higher weight on new data) than those respondents that receive vague information.
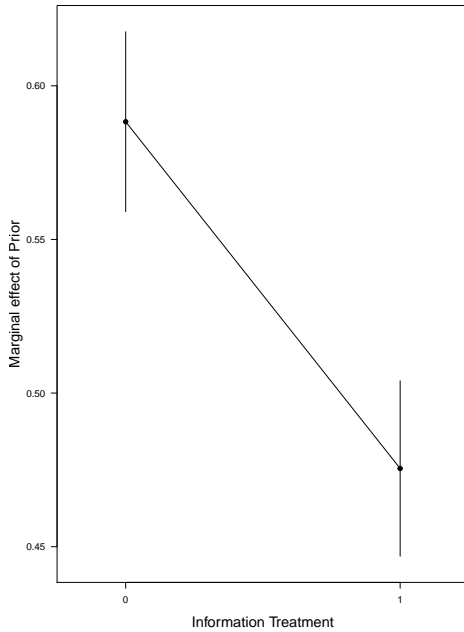

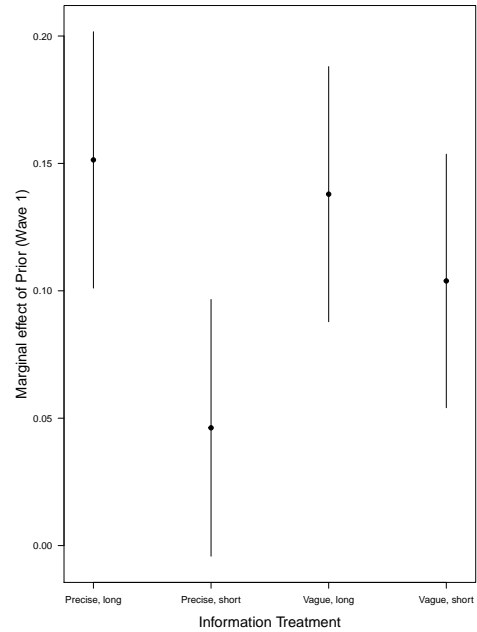Figure 6: Marginal Effect of Vague (0) and Precise (1) Information on Priors (Wave 1)

Figure 7: Marginal Effect of Information (Wave 2) on Priors (Wave 1) by content and length

Investigating the marginal effect of wave 1-priors on wave 2-posteriors further elaborates on the effect of the information treatment. Recall, the information treatment in wave 2 varies the length of the statement given to respondents in addition to precision. Figure 7 indicates that a shorter treatment with precise information generates the weakest link between prior and posterior inflation expectations in comparison with longer precise information or vague information.

A range of important conclusions can be drawn from the results of the experiment. First, we find evidence that when the monetary authority communicates in a more precise or detailed matter, especially with the use of numerical anchors, on average, individuals' inflation expectation will adjust to the target rate – with those inflation priors just below 2% adjusting up to the target and those with inflation priors just above 2% adjusting down to the target. Second, we also find that the length of information also matters, and this is true even if we consider individuals'

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priors from one-year previously. Second, we find that monetary news moves citizens' inflation expectations. These findings confirm observational studies, primarily in economics, that show that central banks can alter agents' beliefs in ways that they intend (Ehrmann and Fratzscher, 2009, 2007). In particular, we find that the marginal effect of prior on posterior inflation expectation is larger when respondents receive vague information than when they receive precise information, and that monetary policy news that is long has similar effects as vague news. In contrast, information that is short weakens respondents' priors more significantly and therefore up-weighting the effects of central bank news. Our findings, however, must be predicated by the observation that substantive effects of the information on prior beliefs are relatively small. For example, going from a precise long piece of information to a precise short text lowers the estimated weight of the prior on posterior inflation expectation by $\approx 0.10(.05, 0.15)$.

Table 2: Regression Results

	Dependent variable:			
	Posterior wave 1			
	(1)	(2)	(3)	(4)
Prior	0.619*** (0.590, 0.648)	0.542*** (0.484, 0.599)	0.644*** (0.559, 0.729)	0.374*** (0.293, 0.455)
Precise information treatment	0.278*** (0.104, 0.452)	0.295*** (0.121, 0.469)	0.278*** (0.103, 0.452)	0.272*** (0.100, 0.444)
newsConBusiness		-0.059** (-0.107, -0.011)		
newsCon			-0.001 (-0.066, 0.064)	
performanceECB				0.064 (-0.050, 0.177)
Prior × Precise information treatment	-0.120*** (-0.161, -0.079)	-0.128*** (-0.169, -0.087)	-0.119*** (-0.160, -0.078)	-0.113*** (-0.153, -0.073)
Prior × newsConBusiness		0.017*** (0.006, 0.028)		
Prior × newsCon			-0.004 (-0.018, 0.009)	
Prior × performanceECB				0.074*** (0.049, 0.099)
Constant	0.628*** (0.505, 0.751)	0.912*** (0.652, 1.173)	0.635*** (0.228, 1.041)	0.502*** (0.162, 0.841)
Observations	3,464	3,438	3,457	3,457
R^2	0.457	0.457	0.460	0.474
Adjusted R^2	0.457	0.456	0.459	0.473
Note:				*p<0.1; **p<0.05; ***p<0.01

3.2 Individual-level effects

Estimated treatment effects show substantial individual-level heterogeneity. In particular, we examine the influence of political predispositions and media consumption on treatment effects (conditional on respondents' prior inflation expectation). The political predispositions are operationalized as respondent's opinions of the ECB. We further consider respondent's self-reported consumption of news media and self-reported consumption of financial news media.

The regression reported in Table 2 (Model 2) tests for a relationship between respondent's inflation expectation and respondent's attitudes towards the ECB speaking to our hypothesis 2. Respondents' opinions of the ECB are measured on a Likert-type scale (1= very good to 5=very bad). If political predispositions have an effect on the receptivity of central bank communications, then we should expect that respondents with more favourable opinions of the ECB should also be more likely to up-weight information given by the ECB and down-weight their prior inflation expectations in forming posterior inflation expectations. Examining the marginal effect of prior on posterior inflation expectation at each realization of the Likert-scale of attitudes towards the ECB, as shown in Figure 8, we find evidence that such pattern indeed exists. Respondents who view the ECB favourably are also more likely to down-weight their priors and conversely, those less likely to view the ECB are more likely to have sticky information priors. Going from a rating of the ECB is doing a good job to the ECB is doing a bad (from scale 2 to 4 on the Likert scale), which is where most of the data is located, reduces the weight of the prior around 0.15, which is similar in magnitude to shifting the ECB precise text from long to short.
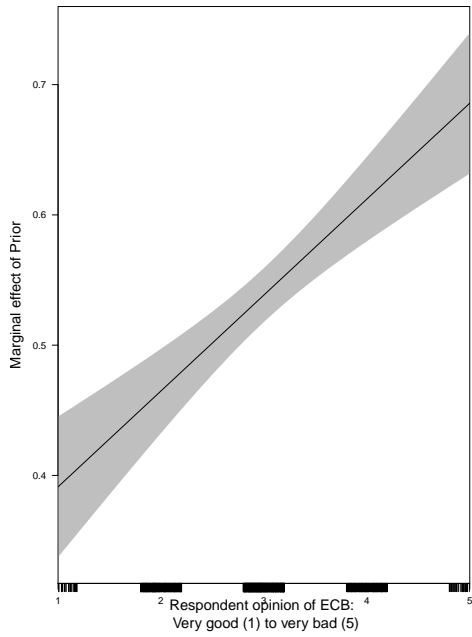
Figure 8: Marginal Effect of Prior on posterior Inflation Expectation by Attitudes towards the ECB
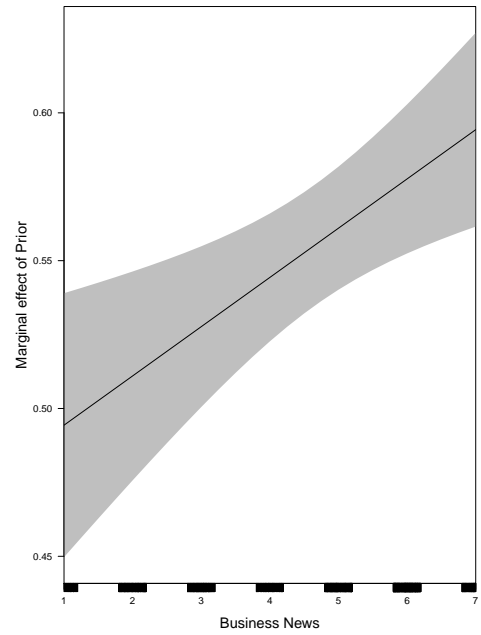

Figure 9: Marginal Effect of Priors on Posterior Inflation Expectation by Business News Consumption

Our third hypothesis considers the role of economic and political sophistication. We proxy for sophistication by asking respondents to self-report their media consumption, asking for both general as well as business news consumption. As shown in Table 2 (Model 3), the general consumption of news media does not matter for respondents' posterior inflation expectations and does not interact with prior inflation expectation in determining the posterior. Respondents who self-report consuming more business news, however, hold lower posterior inflation expectations than those who do not consume business news as much. Business news consumption also interacts significantly with prior inflation expectation. In particular, as shown in Figure 9, the weight on prior inflation expectation increases with business news consumption. Further, respondents who report to consume more business news are also more likely to have inflation priors closer to the ECB target . Interestingly, unlike in models where political sophisticated are more likely to take up elite information, in this case we see that people more exposed to business news have stickier priors than those that report less exposure to business news.
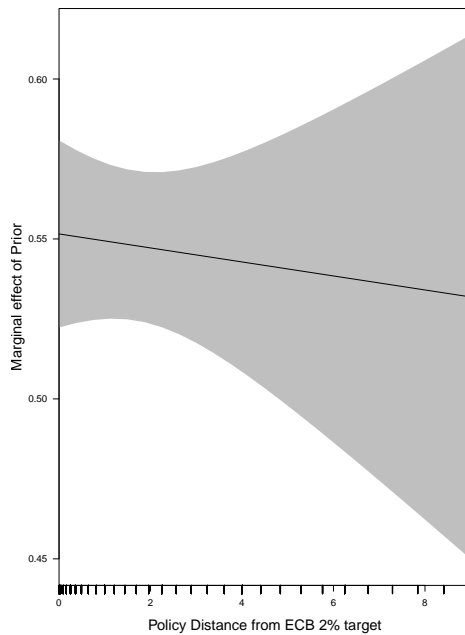
Figure 10

Our final consideration is whether deviations in individual's preferences from the ECB's monetary target may also condition the influence of monetary information. As mentioned above, we try to elicit respondents priors in a number of ways. We first ask them directly, both for their own personal inflation preferences, their preferences for the Eurozone as a whole, and their preferences for Germany. On average, respondents do not vary much in their answers despite these different hypothetical scenarios, with a median response that is very stable across the three types of questions (2.8, 2.8, 2.7). For inducing respondents to consider monetary policy as if it involves trade-offs, we show sliders on respondents' screen and ask them to select their preferred inflation rate, while they can see the effect of their preferred rate on other variables of interest (interest rate, unemployment rate, and growth rate). Respondents' preferred inflation rate emerges at a very similar 2.5.

4   Conclusion

In this paper, we provide some evidence that German households are sensitive to (short) textual information communicated by the monetary authority and that they especially update to the inflation target rather than to the "correct" inflation rate. This is suprising as, during the time period that we investigate, current inflation is very low ($< 2\%$) and the ECB's quantitative definition of price stability (2%) emerges as a stronger anchor than actual inflation data (1%).

We motivated our experiment as a tool to test predictions from different theories. We find evidence for both Bayeisan learning and political predispositions. Our findings are also important for understanding how central banks can help in improving the public's financial literacy. In Bayesian learning, political institutions transfer knowledge to citizens and this knowledge is expected to improve citizens' financial literacy. In contrast, if political predispositions shape citizens information processing, central bank communication may only be as effective as the average level of support for the central bank. Whether members of the public learn or recite economic knowledge, therefore, has important micro-level consequences for determining individuals' economic outlook as well as important consequences for the smooth functioning of monetary policy.

In addition to these theoretical contributions for the study of central banking, our findings provide a number of new findings for the literature on public opinion. While previous studies suggest that political sophisticates may be more likely to adopt political information by their favored elites, in our experiment, we find little evidence that public information crowds out private sector information for those well informed. We also find surprising stability in households' personal preferences over inflation and we find that households are likely to report consistent preferences and make little distinction between personal inflation preferences, Eurozone inflation, and German inflation. Furthermore, while many studies have examined how non-elected political elites change citizens' opinion (Iyengar and Kinder, 1987; Broockman and Butler, 2017), new to this study is testing whether or not non-majoritarian institutions change citizens' understanding of the economy, which also has important knock-on effects of models of politics, for example, models of economic voting. This paper therefore also contributes to that literature.

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Supporting information

A Statistical appendix

A.1 Wave and treatment statistics

		Frequency	Proportion
Wave 1			
Precise information		1729	.499
Vague information		1735	.501
		3464	
Wave 2			
Precise information	short	769	.25
	long	767	.25
Vague information	short	768	.25
	long	768	.25

Table A.1: Wave and treatment statistics

B Experimental design

B.1 Questionnaire items

B.1.1 Wave 1 (November 2014)

1. Assessing inflation

   (a) German original:

   Bei den folgenden Fragen besteht Ihre Aufgabe darin, Preisentwicklungen einzuschätzen. Eine Person gibt aktuell 1500 Euro für Lebensmittel und Kleidung sowie für Friseurbesuche pro Monat aus. Wie werden sich diese Ausgaben in 12 Monaten verändern? Geben Sie bitte an, wie viel diese Person für Lebensmittel und Kleidung sowie für Friseurbesuche in 12 Monaten ausgeben wird. Gehen Sie bitte davon aus, dass sich weder die Lebensumstände noch das Konsumverhalten der Person verändern wird, d.h. sie wird in 12 Monaten ähnliche Produkte und Dienstleistungen im gleichen Umfang wie derzeit nutzen. Bei dieser Frage können Sie nur eine Antwort geben.

   Ausgaben in 12 Monaten [Answer key:] *weniger als 1500 EUR, 1500 EUR, 1515 EUR, 1530 EUR, 1545 EUR, 1560 EUR, 1575 EUR, 1590 EUR, 1605 EUR, 1620 EUR, 1635 EUR, 1650 EUR oder mehr.*

2. Inflation expectation, vague/ precise treatment condition

   (a) German original:

   Bei den folgenden Fragen besteht Ihre Aufgabe darin, Preisentwicklungen einzuschätzen. Eine Person gibt aktuell 1500 Euro für Lebensmittel und Kleidung sowie für Friseurbesuche pro Monat aus. Wie werden sich diese Ausgaben in 12 Monaten verändern? Geben Sie bitte an, wie viel diese Person für Lebensmittel und Kleidung sowie für Friseurbesuche in 12 Monaten ausgeben wird. [Anchoring treatment 1 (AT1):]

   AT1.1 Vague information:

   Die europäische Zentralbank erwartet, dass die wichtigen Zinssätze für eine längere Zeit auf dem gegenwärtigen Level oder darunter liegen werden. Diese Einschätzung beruht auf den insgesamt gedämpften Inflationsaussichten. Die Inflationserwartung für die Eurozone deckt sich mit dem Ziel der Zentralbank die Preissteigerung auf angemessenem Niveau zu halten.

   AT1.2 Precise information:

   Die europäische Zentralbank erwartet, dass die wichtigen Zinsssätze in den nächsten 6 bis 12 Monaten auf dem gegenwärtigen Level oder darunter liegen werden. Diese Einschätzung beruht auf den insgesamt gedämpften Inflationsaussichten von derzeit 1 Prozent pro Jahr. Die Inflationserwartung für die Eurozone deckt sich mit dem Ziel der Zentralbank die Preissteigerung nahe 2 Prozent zu halten.

   Bei der vorherigen Frage haben Sie angegeben, dass eine Person im [Date, year from now][Answer from question 1] *für Lebensmittel und Kleidung ausgeben wird. Dieser Betrag entspricht einer jährlichen Inflationsrate von* [Answer from question 1 expressed as inflation rate]. *Wenn Sie nun die Erwartungen der EZB berücksichtigen, was schätzen Sie: Wie viel Euro wird diese Person für die gleichen Lebensmittel und die gleiche Kleidung im* [Date, year from now] *bezahlen? Gehen Sie bitte davon aus, dass sich weder die Lebensumstände noch das Konsumverhalten der Person verändern wird, d.h. sie wird in 12 Monaten ähnliche Produkte und Dienstleistungen im gleichen Umfang wie derzeit nutzen. Bei dieser Frage können Sie nur eine Antwort geben.*

Ausgaben in 12 Monaten [Answer key:] *weniger als 1500 EUR, 1500 EUR, 1515 EUR, 1530 EUR, 1545 EUR, 1560 EUR, 1575 EUR, 1590 EUR, 1605 EUR, 1620 EUR, 1635 EUR, 1650 EUR oder mehr.*

3. Medium-term inflation expectation

   (a) German original:

   Mit welcher jährlichen Inflationsrate rechnen Sie in 5 Jahren? Bei dieser Frage können Sie nur eine Antwort geben. [Answer key:] *-1,0,1,2,3,4,5,6,7,8,9,10 %*

4. Long-term inflation expectation

   (a) German original:

   Mit welcher jährlichen Inflationsrate rechnen Sie in 10 Jahren? Bei dieser Frage können Sie nur eine Antwort geben. [Answer key:] *-1,0,1,2,3,4,5,6,7,8,9,10 %*

5. Manipulation check

   (a) German original:

   Vague information treatment condition:
   In einer der vorherigen Fragen haben Sie folgende Informationen gelesen: Die Inflationserwartung für die Eurozone deckt sich mit dem Ziel der Europmäischen Zentralbank, die Preissteigerung auf angemessenem Niveau zu halten.

   Precise information treatment:
   In einer der vorherigen Fragen haben Sie folgende Informationen gelesen: Die Inflationserwartung für die Eurozone deckt sich mit dem Ziel der Europäischen Zentralbank, die Preissteigerung nahe 2% zu halten.

   Für wie detailliert halten Sie diese Information?
   Answer key: *überhaupt nicht detailliert, wenig detailliert, mäßig detaillier, ziemlich detaillier, sehr detailliert*

B.1.2 Wave 2 (November 2015)

1. Preference inflation vs unemployment Germany (*CD20100 pref_inflation_unemployment_de*)

   (a) German original:
   Bei den folgenden Fragen geht es um Inflation. Wenn alles teurer wird spricht man von Inflation und meint damit, dass Sie sich für denselben Geldbetrag weniger kaufen können. Die Stärke der Inflation wird als Inflationsrate bezeichnet. Die Inflation wirkt sich auf die Arbeitslosenrate aus. Üblicherweise sind entweder die Inflationsrate oder die Arbeitslosenrate niedrig, nicht aber beide zum selben Zeitpunkt. Stellen Sie sich vor, dass Sie für Deutschland zwischen zwei extremen Szenarien wählen müssten. Für welches dieser beiden Szenarien würden Sie sich entscheiden? [Answer key:] *Deutschland hätte in den nächsten 2 Jahren eine Inflationsrate von nur 2% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von 15%. Deutschland hätte in den nächsten 2 Jahren eine Inflationsrate von 15% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von nur 2%.*

2. Comprehension inflation vs unemployment trade-off Germany (*CD20101 pref_inflation_unemployment_de_* or *CD20102 pref_inflation_unemployment_de_s3*

   (a) German original:
   Sie haben sich bei der vorherigen Frage für das [erste/zweite] Szenario entschieden:

Deutschland hätte in den nächsten 2 Jahren eine Inflationsrate von nur [2/15]% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von [15/2]%. Das [zweite/erste] Szenario lautete: Deutschland hätte in den nächsten 2 Jahren eine Inflationsrate von [15/2]% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von nur [2/15]%. Wie hoch müsste die prozentuale Arbeitslosenrate im ersten Szenario mindestens sein, damit Sie sich für das zweite Szenario entscheiden würden? Bitte tragen Sie eine Zahl [zwischen 16 und 100/größer als 15] ein. [Answer key:] Integer [16-100/>15]

3. Preference inflation vs unemployment Eurozone (*CD20103 pref_inflation_unemployment_eu*)

   (a) German original:

   Stellen Sie sich vor, dass Sie für den Euroraum zwischen zwei extremen Szenarien wählen mässten. Für welches dieser beiden Szenarien würden Sie sich entscheiden ? [Answer key:] *Der Euroraum hätte in den nächsten 2 Jahren eine Inflationsrate von nur 2% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von 15%. Der Euroraum hätte in den nächsten 2 Jahren eine Inflationsrate von 15% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von nur 2%.*

4. Comprehension inflation vs unemployment trade-off Eurozone (*CD20104 pref_inflation_unemployment_de_* or *CD20105 pref_inflation_unemployment_de_s1*

   (a) German original:

   Sie haben sich bei der vorherigen Frage für das [erste/zweite] Szenario entschieden: Der Euroraum hätte in den nächsten 2 Jahren eine Inflationsrate von nur [2/15]% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von [15/2]%. Das [zweite/erste] Szenario lautete: Der Euroraum hätte in den nächsten 2 Jahren eine Inflationsrate von [15/2]% pro Jahr, bei einer gleichzeitigen Arbeitslosenrate von nur [2/15]%. Wie hoch müsste die prozentuale Arbeitslosenrate im ersten Szenario mindestens sein, damit Sie sich für das zweite Szenario entscheiden würden? Bitte tragen Sie eine Zahl [zwischen 16 und 100/größer als 15] ein. [Answer key:] Integer [16-100/>15]

5. Inflation/interest rate/unemployement rate/growth rate preference Eurozone/Germany (*CD20106 pref_inflation_eu* or *CD20107 pref_inflation_de*)

   (a) German original:

   Die Europäische Zentralbank (EZB) und die Euroländer, wie beispielsweise die Deutsche Bundesbank, legen die wichtigsten Zinssätze für den Euroraum fest. Dieser Zins wird als Leitzins bezeichnet, da er die gesamte Volkswirtschaft beeinflusst. Durch die Erhöhung des Leitzinses macht die Zentralbank das Geld "teurer," das heißt Bürger und Unternehmen nehmen weniger Kredite auf. Damit ist das Geld der Banken weniger gefragt und die Inflation sinkt. In den folgenden zwei Fragen werden Sie gebeten, einmal die Rolle der EZB einzunehmen und den Leitzins für den Euroraum festzulegen und einmal die Rolle der deutschen Bundesbank einzunehmen und entsprechend den Leitzins für Deutschland festzulegen. In der dritten Frage bittet man Sie, einen Leitzins festzulegen, der für Ihre eigene finanzielle Situation am besten ist. Der Leitzins hat einen Einfluss auf die Höhe der Inflation, der Arbeitslosigkeit und des Wirtschaftswachstums im Euroraum und auch in Deutschland.
   Stellen Sie sich vor, dass Sie die Rolle der [EZB/Bundesbank] übernehmen und den Leitzins für [den Euroraum/Deutschland] festlegen. Der Leitzins hat einen Einfluss auf die Höhe der Inflation, der Arbeitslosigkeit und des Wirtschaftswachstums im Euroraum.
   Die vier unten stehenden Linien sind so miteinander verbunden, dass ein höherer Zinssatz zu einer niedrigeren Inflation, einer höheren Arbeitslosenrate und einem niedrigeren Wirtschaftswachstum führt. Ein niedrigerer Zinssatz hat die gegenteiligen

Auswirkungen. Bitte klicken Sie auf die [erste/zweite/dritte/vierte] Linie, um Ihren bevorzugten Zinssatz auszuwählen. Anschließend können Sie die Werte verändern, indem Sie eines der Vierecke verschieben [order of sliders is randomized]. [Answer key:]

Zinssatz:

-0,5%   4,5%

Inflation:

0,0%   5,0%

Arbeitslosenrate:

4,5%   9,5%

Wirtschaftswachstum:

-1,0%   4,0%

Figure B.1: Example of screen as displayed to respondents to answer question item *CD20106* and *CD20107*

6. Preferences personal inflation (*CD20108 pref_inflation_personal*)

   (a) German original:
       Stellen Sie sich vor, dass man Sie persönlich beauftragt hat, einen Leitzins festzulegen, der für ihre eigene finanzielle Situation am besten ist. Der Leitzins hat einen Einfluss auf die Höhe der Inflation, der Arbeitslosigkeit und des Wirtschaftswachstums in Deutschland. Die vier unten stehenden Linien sind so miteinander verbunden, dass ein höherer Zinssatz zu einer niedrigeren Inflation, einer höheren Arbeitslosenrate und einem niedrigeren Wirtschaftswachstum führt. Ein niedrigerer Zinssatz hat die gegenteiligen Auswirkungen. Bitte klicken Sie auf die [erste/zweite/dritte/vierte] Linie, um Ihren bevorzugten Zinssatz auszuwählen. Anschließend können Sie die Werte verändern, indem Sie eines der Vierecke verschieben [order of sliders is randomized]. [Answer key:] See previous question item.

7. Weighting inflation/unemployment rate (*CD20109 weight_unemployment_EZB*, *CD20110 weight_inflation_EZB*, *CD201011 weight_unemployment_EZB*, and *CD201102 weight_inflation_EZB*)

   (a) German original:
       Die Politik der [EZB/deutschen Bundesregierung] beeinflusst die Inflation und die Arbeitslosenrate. Auf einer Skala von 0 bis 10: Wie stark sollte Ihrer Meinung nach die Verringerung der Inflation und wie stark die Reduzierung der Arbeitslosenrate gewichtet werden?
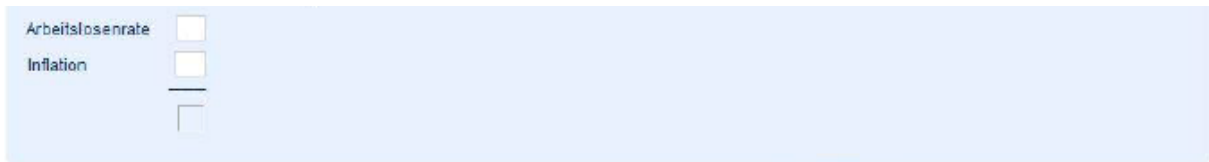   *Die Summe der Antworten muss 10 ergeben.* [Answer key:]

Figure B.2: Example of screen as displayed to respondents to answer question item *CD20106* and *CD20107*

8. Inflation expectation (next 12 month, (*CD20113 change_inflation_ecb*)

   (a) German original:
       Der folgende Bericht beschreibt und erklärt die Handlungen der EZB für die Öffentlichkeit. Bitte beachten Sie diese Informationen bei der Beantwortung der anschließenden Frage. [Anchoring treatment 2 (AT2):]

   AT2.1 Precise information, long:
       Die EZB dehnt ihre Ankäufe auf Anleihen aus, die von im Euroraum ansässigen Zentralstaaten, Emittenten mit Förderauftrag und europäischen Institutionen begeben werden. Insgesamt sind monatliche Ankäufe von Vermögenswerten in Höhe von 60 Milliarden Euro geplant. Die Ankäufe sollen mindestens bis September 2016 erfolgen. Das Programm dient der Erfüllung des Mandats der EZB, die Preisstabilität zu gewährleisten und mittelfristige Inflationsraten nahe 2% zu erreichen.

   AT2.2 Vague information, long:
       Die EZB dehnt ihre Ankäufe auf Anleihen aus, die von im Euroraum ansässigen Zentralstaaten und anderen Emittenten und Institutionen begeben werden. Insgesamt sind monatliche Ankäufe von Vermögenswerten in großer Höhe geplant. Die Ankäufe sollen mindestens bis Mitte nächsten Jahres erfolgen. Das Programm dient der Erfüllung des Mandats der EZB, die Preisstabiliät zu geährleisten und mittelfristige Inflationsraten nahe einem angemessenen Level zu erreichen.

   AT2.3 Precise information, short:
       Die EZB dehnt ihre Ankäufe auf Anleihen aus. Die Ankäufe in Höhe von 60 Milliarden Euro sollen bis September 2016 erfolgen und dienen der Erfüllung des Mandats der EZB zur Gewährleistung von Preisstabilität und einer Inflationsrate nahe 2%.

   AT2.4 Vague information, short:
       Die EZB dehnt ihre Ankäufe auf Anleihen aus. Die Ankäufe in großer Höhe sollen bis Mitte nächsten Jahres erfolgen und dienen der Erfüllung des Mandats der EZB zur Gewährleistung von Preisstabilität und einer angemessenen Inflationsrate.

       Wie sehr wird Ihrer Meinung nach die Inflationsrate in den nächsten 12 Monaten steigen oder sinken (in Prozent)? [Answer key]: *-1 oder mehr sinken, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10% oder mehr steigen.*