# Targeted Information Provision and the Public Acceptance of Carbon Pricing

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August 27, 2023

**Abstract**

Public support for carbon pricing is crucial to mitigate greenhouse gas emissions and combat climate change. However, the public's lack of understanding of carbon pricing and its impacts has led to low acceptance of this policy instrument. Communication has been suggested as a remedy, with tailored and targeted communication being more effective than general information. Using novel survey data from Germany, this study investigates the effectiveness of tailored communication in form of video-based information provision in increasing public support for carbon pricing. Specifically, the study aims to answer the research question of whether targeting audiences with tailored messages on the most salient concern (high personal cost burden, low effectiveness, or lack of fairness) increases support for carbon pricing. The results show that targeting audiences with tailored messages performs better in increasing support for carbon pricing. The effect is mainly driven by the cost video, while the fairness and effectiveness treatments individually did not significantly change acceptance beyond the effect observed for the control video. The study provides practical implications for policymakers on the importance of tailoring communication to address the most salient concerns of the public. It also highlights the need for further research on the reasons for the heterogeneity observed in the treatment effects.

**JEL Codes**: Q58, H23, D83

**Keywords**: Carbon Price, Policy Acceptance, Policy Communication, Experiment

**Acknowledgements**: We gratefully acknowledge financial support by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) under grant 03EI5213D. Further, we would like to thank the participants of the the EAERE Annual Conference 2022, the Workshop in Environmental Policy Evaluation at the University of St. Gallen 2023 and the Scientific Conference of the Carbon Price Project 2021, for the fruitful discussion and suggestions. Also, we would like to thank the research team of the CO2-Preis project and the project's stakeholders for their comments and advice. Any remaining errors are our own.

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# 1 Introduction

Carbon pricing schemes are widely recommended by economists as the most efficient policy instrument to mitigate climate change (Akerlof et al., 2019). However, despite many countries adopting carbon pricing (IMF, 2021), the public acceptance of this policy remains a challenge, hindering the adoption of more ambitious price trajectories (Douenne and Fabre, 2019; Drews and Bergh, 2016; Sommer et al., 2022). Despite widespread consensus among economist about the benefits of carbon pricing, such as its high efficiency in reducing emissions and the potential to offset any regressive distributional impact through revenue redistribution (Goulder et al., 2019; Klenert et al., 2018), concerns regarding the high cost (e.g. Jagers and Hammar, 2009), unfair distribution of the cost (e.g. Rivers and Schaufele, 2015), and inefficiency of the policy (e.g. Saelen and Kallbekken, 2011) are important drivers of low public support. Addressing these concerns could potentially increase public acceptance, paving the way for the implementation of more ambitious pricing schemes.

To tackle this challenge, this paper presents the results of a survey experiment conducted among 4,000 respondents in Germany in 2021. Our aim is to test the effectiveness of tailored and targeted video-based information on the acceptance of carbon pricing by addressing the major concerns identified by the literature. The experiment involved eliciting respondents' primary concerns and then presenting them with an information video tailored to their specific concern, while a randomly selected control group watches a more general video. By comparing the two groups, we can identify the effect of tailoring information to a targeted audience on public support of carbon pricing. Additionally, we employ machine learning techniques to identify groups of individuals that respond particularly well to the videos, allowing for more effective targeting of information campaigns. To our knowledge, we are the first to test the impact of tailored video treatments targeted to specific audience segments on the acceptance of carbon pricing.

Germany is an interesting case study for our experiment due to its status as the world's fourth-largest economy and its responsibility for almost 2% of global greenhouse gas (GHG) emissions. In line with its emission reduction targets, Germany introduced a carbon price of €25 per tonne of $CO_2$ on fossil fuels in the heating and transport sector in 2021. The policy provides for an explicit path that increases the carbon price to €55 by 2025, followed by the implementation of a national emissions trading scheme. Prior to the implementation of the carbon price, there

was an intensive public debate about the necessity, design, and distributional impacts of the policy. To raise awareness and bolster public support, the government launched and advertising campaign, including animated information videos. Given this context, our research is highly relevant form a policy perspective.

A substantial body of research has examined the determinants of public acceptance of carbon pricing. According to a recent meta analysis of more than 50 studies by Bergquist et al. (2022), while both the concern about and the belief in climate change are important factors, perceived fairness and environmental effectiveness are even more significant in shaping public support carbon pricing. However, other studies have also highlighted that the cost burden is a major obstacle to gaining public support for carbon prices (e.g. Saelen and Kallbekken, 2011; Sommer et al., 2022; Douenne and Fabre, forthcoming). Therefore, addressing these concerns may increase acceptance, allowing for more stringent pricing schemes to be implemented, which is necessary for achieving climate targets in Germany.

Effective communication can be a potential means of reducing concerns around carbon prices by targeting individuals' prime concerns with tailored messages. Since climate change and respective climate policies emerged on the public agenda, policymakers and scientist have increasingly recognized the importance of communication. To be effective, policy communication should target specific audiences and be credible (Hine et al., 2014; Marshall et al., 2018), as mismatches between messages, messengers, and audiences can undermine the credibility and persuasiveness of climate change communications (Moser, 2010). Additionally, studies have identified that distinct groups of the population react differently to climate change issues and may be more or less receptive to certain types of communication (see e.g. Leiserowitz et al., 2021). For instance, Bain et al. (2012) found that climate change deniers respond more positively to pro-environmental messages framed in terms of social welfare and economic development compared to messages that emphasize avoiding the risks of climate change.

Moreover, some scholars advocate the adoption of tailored messages that include different information, framing, and behavioral options depending on the characteristics and expectations of specific audience segments (e.g. Horton and Doran, 2011). For instance, Goldberg et al. (2021) found that a tailored campaign which included messages specifically designed for targeted congressional districts increased Republicans' understanding of the existence, causes, and harms of climate change by several percentage points. Furthermore, some laboratory experiments have

shown that informing people about revenue recycling of carbon pricing schemes can significantly increase the acceptance of the policy (Saelen and Kallbekken, 2011; Baranzini and Carattini, 2017; Kallbekken et al., 2011; Kotchen et al., 2017).

While initial evidence reveals the potential of tailoring and targeting information campaigns, most of the research is focused on the US and based on laboratory experiments, not directly addressing carbon pricing. Our experiment contributes to this literature by testing the potential of tailored and targeted information campaigns to alleviate concerns and increase support for carbon pricing policies. Our results suggest that, overall, tailored information has a greater impact on stated acceptance of carbon pricing than generic information. However, this effect is primarily driven by the impact of information about cost, while communication on fairness and effectiveness does not outperform the general information video. We observe very heterogeneous treatment effects across all three videos. For instance, the video on fairness is particularly effective in increasing acceptance among respondents with particular strong fairness preferences. Additionally, the effect of the video on effectiveness increases the acceptance of respondents who already have a good knowledge of carbon pricing.

The rest of the paper is organised as follows: Section 2 provides a description of the experiment, Section 3 presents the data, and Section 4 the empirical methods employed in the analysis. We present and discuss the results in Section 5. The paper closes with a short discussion of the implications of our findings for carbon price policy communication as well as further research.

## 2 Experimental design

Our experiment is embedded in a larger survey that assessed participants' attitudes towards the current German carbon price. Prior to the experiment, we asked participants to rate their acceptance of the carbon price on a Likert scale of 1 to 5, where 1 represented "totally disagree" and 5 "totally agree", while a rating of 3 implied "neither agree nor disagree". Subsequently, we assessed respondents' level of concern about (1) the cost burden, (2) the fairness, and (3) the effectiveness of the carbon price, respectively. Answers to this question could vary from 1 ("not concerned at all") to 5 ("very concerned"), with an additional option for "don't know".

Based on their responses to the concern questions, we performed a two-step random sorting process to assign participants to treatment and control groups. Figure I.1 in the appendix

**Table 1:** Group structure

| audience | **(1)** costs | | **(2)** fairness | | **(3)** effectiveness | | **(4)** control | **Total** |
|---|---|---|---|---|---|---|---|---|
| # | (1.T) | (1.C) | (2.T) | (2.C) | (3.T) | (3.C) | | |
| info. video | cost | general | fairness | general | effect. | general | general | – |
| N | 530 | 269 | 559 | 297 | 589 | 297 | 852 | 3,386 |

provides an illustration of the experimental setup, and Table 1 summarizes the treatment and control structure and sample size. We first assigned 75% of respondents to one of the three concern audiences (cost, fairness, and effectiveness), based on the highest concern expressed by each participant in response to the survey question.[1] The remaining 25% of respondents were assigned to a general control group (group (4) in Figure I.1 and Table 1). Respondents who indicated "not concerned" or "don't know" for all three concern questions could not be assignment to a concern audience and were therefore dropped from the experiment. If multiple concerns ranked equally high, stratified sorting was used to assign respondents more frequently to smaller audiences.

Two-thirds of the final concern audiences were shown a video tailored to their prime concern (treatment groups 1.T, 2.T & 3.T in Figure I.1 and Table 1), while the remaining third was randomly selected as a control group within each concern audience (yielding control groups 1.C, 2.C & 3.C). By employing this random sorting process, we ensured that the treatment and control groups were comparable and that any observed differences in the outcomes could be attributed to the treatment. The experiment ended, with a final question on respondents' acceptance of the current carbon price, which is the main outcome variable in our empirical assessment.

Our experimental design allows us to estimate the conjoint effect of tailoring and targeting information to a unique audience. We explicitly compare the effectiveness of tailored and targeted information versus non-tailored and non-targeted communication. It is important to note, that our focus is not on whether any information better than no information, as this has been tested by various scholars (Saelen and Kallbekken, 2011; Baranzini and Carattini, 2017; Kallbekken et al., 2011; Kotchen et al., 2017). Rather, our goal is to contribute to the sparse literature on what constitutes effective communication.

Our experimental setup involved several explicit design choices. Firstly, we designed four in-

[1] We will use the term "concern audience" to refer to individuals assigned to the cost, fairness or effectiveness audience. The three groups include treated as well as controls.

formative and aesthetically pleasing videos, of which three were tailored to the prime concerns of respondents, a novelty in our research.[2] The fourth video serving as control covered more general content, with a narrative resembling an information video of the German government.[3] Each of the three treatment videos was approximately three minutes long, while the control video was one minute shorter. All four videos were animated using professional animation software, with the treatment videos featuring a diverse set of avatars covering different ethnicities, genders, and ages. We intentionally kept the animation of the control video simple to resemble closely the reference government video. The scripts for all four videos are available in Appendix G.

Secondly, we implemented three key elements identified by the literature as critical for successful communication of carbon pricing: relatable characters, a trustworthy speaker, and easily understandable language (Marshall et al., 2018; Hine et al., 2014). The narratives in our treatment videos were built around characters commonly discussed in the German context, such as an elderly couple in the sub-burbs and a family, marking the videos more relatable to our sample. We recruited a German female environmental scientist with ample experience in science communication as the speaker for the videos, resulting in more than 60% of our treated sample finding her to be highly trustworthy, competent and sympathetic (see Appendix H). To ensure that the used in the videos was easily understandable, we consulted professionals working with different groups in the population. To ensure treatment compliance, respondents underwent an audio test and were unable to fast forward or to skip the video altogether.

Thirdly, we intentionally adapted a simple targeting strategy based on participants' responses the the three concern questions. While a more complex audience segmentation approach may have been more effective, it would have required more data collection efforts to identify distinct audiences, rendering such campaigns financially unfeasible in practice. However, the trade-off between a more complex segmentation strategy and the more simple approach employed in this study may be larger heterogeneity in the treatment response, which could diminish the overall effectiveness of our treatment.

Lastly, our experiment was specifically designed to eliminate the risk of a positive treatment effect simply due to experimenter demand effect (e.g. that respondents indicate higher accep-

[2]The three treatment videos are accessible on https://www.youtube.com/channel/UC03PlzQSvG4p0cT-bzOIeeA.

[3]This video is available at https://www.bundesregierung.de/breg-de/themen/klimaschutz/video-co2-bepreisung-1832200.

tance simply because they think this is the goal of the survey) (Rosenthal, 1966; Zizzo, 2010). Since all respondents watched a related video, and hence the difference in the post-video acceptance between the treatment and control groups reflects the additional gains from targeting and tailoring information campaigns, any response bias is cancelled.

Figure 1 plots the acceptance of the carbon price of €25 – which was effective in Germany at the time of survey – prior to the experiment. Roughly 41% of respondents reject it, while only 37% accept it. At the same time 18% neither accept nor reject it, while another 4% are unsure. Consequently, although more than 50% do not outright reject the policy, a priori the carbon price lacks a majority support. Nevertheless, the baseline acceptance figure suggests that a narrow majority acceptance could be reached by gaining the support of undecided respondents (accept 36.6% + neither agree/disagree 54.5%, + don't know 58.6%).

Examining in more detail the reason for rejection, we find that 23% of those not accepting the price (including those neither agreeing nor disagreeing) believe that the price is currently too low.[4] Though the price level may not be the only reason for rejection, the result nevertheless suggests that a non-negligible share of respondents rejects the policy partially due to its non-ambitious price level.

As depicted in Figure 2, the responses from participants reveal a significant level of concern across all three dimensions, with a strong correlation between the three concerns ($\rho \in [0.35, 0.56]$). More than half of the sample expresses concern regarding the cost burden, fairness and effectiveness of a carbon price. Interestingly, there are slightly higher shares of "strongly concerned" and fewer who are "unconcerned" about fairness and effectiveness, compared to the cost burden. Moreover, the fact that fewer respondents indicate to be uncertain or having no opinion ("don't know") when asked about the cost burden suggests that opinions may be more firmly established on this dimension.

[4] Among those accepting the carbon price, more than 50% feel that the price is set too low, while only 5% accept it despite finding it (rather) too high.

**Figure 1:** Acceptance Prior to the Experiment

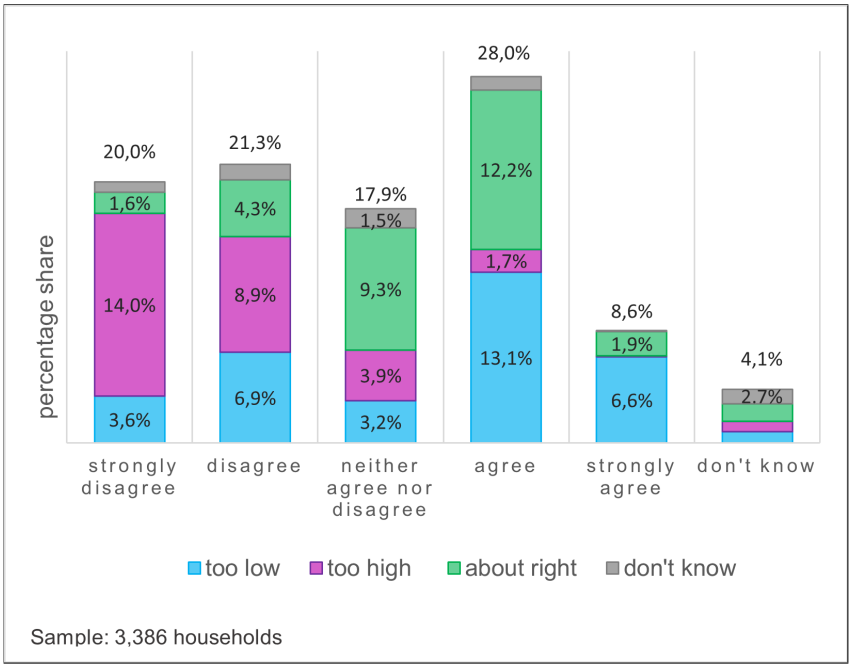
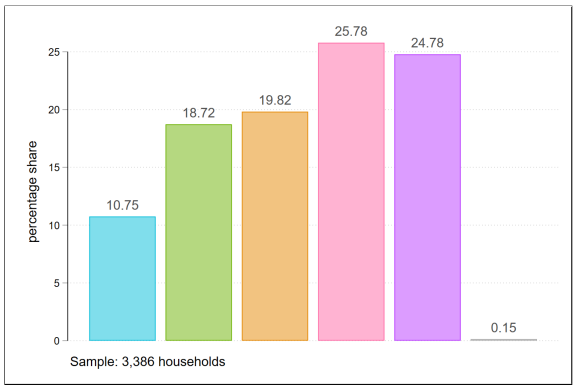
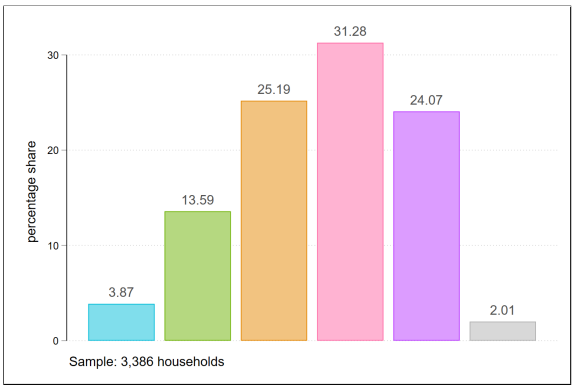



**Figure 2:** Level of Concern before Treatment

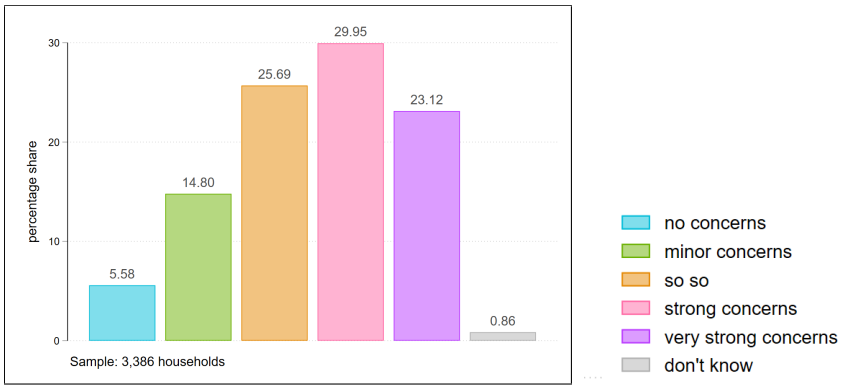
**(a)** Personal Costs




**(b)** Fairness




**(c)** Effectiveness



# 3 Data

Our experiment was part of a large survey of about 7,000 German individuals conducted during the summer 2021. The participants were drawn from the forsa.omninent panel run by forsa, a highly recognised German survey institute. The panel consists of approximately 100,000 individuals and is representative for the German online population above the age of 14. Recruitment of participants is carried out via telephone and cellphone. Participation in forsa.omninet surveys is remunerated with bonus points, which can be exchanged for vouchers or a lottery ticket, or be donated to organizations such as UNICEF.

To ensure both suitability and comprehensibility, the questionnaire was pretested with approximately 300 individuals. The main data collection took place between August 18, 2021 and September 9, 2021, eight months after the introduction of the carbon price. Out of the 18,405 randomly invited panelists, 38% completed the survey, resulting in our targeted net sample of roughly 7,000 respondents (N=7,058). Invitations to the survey were sent via a short email that included the link to the survey and a brief introduction to the general topic.

The survey entailed in total three experiments (A, B & C), where participants were assigned to either experiment A or B, followed in both instances by experiment C. The focus of this paper is solely on experiment A, which explores the impact of targeted information provision on individual acceptance of the German carbon price. Experiments B and C, which focus on individual preferences regarding revenue usage, are discussed in a separate study by Kaestner et al. (upubl.). Respondents were randomly assigned to either experiments A or B based on a 60/40 quota, with the exception of those who did indicate "no concern" regrading the carbon price. Given the quota of 60%, our final sample consists of 3,248 respondents.

The survey participation was limited to individuals aged 18 and above for two reasons: First, the legal voting age in Germany is 18. Thus, excluding younger individuals ensures that the sample is representative for the current voting population. Second, individuals under 18 rarely act as household heads and may not be aware of household bills, such as utility costs. Therefore, concerns regarding carbon prices among this group may differ substantially from the rest of the population. As a result, any information campaigns aimed at them may need to convey different messages.

Summary statistics of the sample are provided in Table 2. On average, the respondents are

54 years old and roughly 59% of the sample are male. Hence, female respondents are under-represented in the sample as according to the micro census 49.5% of the population are male. Compared to the population of the German population, our sample is somewhat older and better educated (see Table F.1 in the appendix).

**Table 2:** Summary Statistics

| | full sample | | costs | | effectiveness | | fariness | |
|---|---|---|---|---|---|---|---|---|
| | mean | sd | mean | sd | mean | sd | mean | sd |
| *socioeconomic factors:* | | | | | | | | |
| respondent age | 53.80 | 16.09 | 54.15 | 16.09 | 52.43 | 16.79 | 54.90 | 15.59 |
| male | 0.586 | 0.493 | 0.584 | 0.493 | 0.597 | 0.491 | 0.585 | 0.493 |
| high school grad. (Abitur) | 0.428 | 0.495 | 0.349 | 0.477 | 0.497 | 0.500 | 0.444 | 0.497 |
| hh member < 18 | 0.214 | 0.410 | 0.234 | 0.424 | 0.223 | 0.417 | 0.201 | 0.401 |
| hh income (mean cat value) | 3459.5 | 1468.5 | 3352.4 | 1410.6 | 3591.6 | 1491.4 | 3447.6 | 1493.9 |
| urban | 0.404 | 0.491 | 0.375 | 0.484 | 0.428 | 0.495 | 0.409 | 0.492 |
| rural | 0.400 | 0.490 | 0.207 | 0.405 | 0.193 | 0.395 | 0.191 | 0.393 |
| medium density | 0.196 | 0.397 | 0.419 | 0.494 | 0.379 | 0.485 | 0.400 | 0.490 |
| formerly GDR | 0.148 | 0.355 | 0.154 | 0.361 | 0.146 | 0.353 | 0.141 | 0.349 |
| *cost factors:* | | | | | | | | |
| fossil heating | 0.710 | 0.454 | 0.736 | 0.441 | 0.704 | 0.457 | 0.708 | 0.455 |
| car owner | 0.920 | 0.271 | 0.944 | 0.231 | 0.897 | 0.304 | 0.910 | 0.286 |
| frequent driver | 0.871 | 0.335 | 0.907 | 0.290 | 0.827 | 0.378 | 0.861 | 0.346 |
| *political factors:* | | | | | | | | |
| politically interested | 0.706 | 0.456 | 0.677 | 0.468 | 0.702 | 0.458 | 0.741 | 0.438 |
| pol. orient. left-right (1-10) | 4.773 | 1.771 | 5.099 | 1.694 | 4.597 | 1.768 | 4.644 | 1.814 |
| trust government (0/1) | 0.429 | 0.495 | 0.433 | 0.496 | 0.454 | 0.498 | 0.428 | 0.495 |
| trust gov. climate (0/1) | 0.278 | 0.448 | 0.320 | 0.467 | 0.249 | 0.433 | 0.285 | 0.452 |
| trust media climate (0/1) | 0.518 | 0.500 | 0.466 | 0.499 | 0.560 | 0.497 | 0.538 | 0.499 |
| *general concerns:* | | | | | | | | |
| worried climate (0/1) | 0.684 | 0.465 | 0.606 | 0.489 | 0.712 | 0.453 | 0.723 | 0.448 |
| worried health (0/1) | 0.426 | 0.495 | 0.441 | 0.497 | 0.394 | 0.489 | 0.433 | 0.496 |
| worried youth education (0/1) | 0.627 | 0.484 | 0.645 | 0.479 | 0.605 | 0.489 | 0.641 | 0.480 |
| *CO2 knowledge and environmental behaviour:* | | | | | | | | |
| env. friendly behav. (0-1) | 0.576 | 0.148 | 0.540 | 0.146 | 0.592 | 0.152 | 0.593 | 0.143 |
| NEP scale continuous (0-1) | 0.808 | 0.165 | 0.792 | 0.170 | 0.815 | 0.165 | 0.808 | 0.164 |
| knowledge CO2 & price (0-1) | 0.567 | 0.246 | 0.565 | 0.243 | 0.568 | 0.249 | 0.568 | 0.242 |
| *fairness preferences:* | | | | | | | | |
| equity fairness princ. (0-1) | 0.506 | 0.198 | 0.514 | 0.203 | 0.501 | 0.199 | 0.496 | 0.194 |
| equality fairness princ. (0-1) | 0.638 | 0.185 | 0.659 | 0.180 | 0.624 | 0.176 | 0.629 | 0.188 |
| merit fairness princ. (0-1) | 0.697 | 0.173 | 0.681 | 0.174 | 0.698 | 0.174 | 0.706 | 0.169 |
| *local Covid cases:* | | | | | | | | |
| total cases (per 100k) | 2764.2 | 4243.3 | 2951.6 | 4485.8 | 2705.7 | 4141.0 | 2793.7 | 4269.0 |
| current cases (per 100k) | 124.9 | 187.0 | 131.4 | 197.2 | 120.7 | 175.6 | 128.0 | 195.0 |
| Observations | 3386 | | 718 | | 824 | | 812 | |

To assess treatment effect heterogeneity, we elicit a large suite of variables that have been found to influence public support for carbon pricing. For instance, the acceptance of a carbon price is affected by individual costs associated with carbon pricing, which in turn, depends on the type of heating system used in households. With more than 70% of households in our sample heating with gas or oil, and over 90% of our owning at least one car, which the majority uses at least

once per week, the additional cost of carbon pricing is likely to be an important consideration for most respondents. Political attitudes also play a crucial role in determining acceptance. Our sample is highly politically interested, with around 70% of respondents seeking political information on a daily basis. When asked to rate their political stance on a scale between 1 (left) and 10 (right), the mean score was 4.8, indicating that respondents see themselves as fairly centrists. Interestingly, the majority of respondents "do not" or "rather do not trust" the current government (57%), but about half of the sample indicate that they "(rather) trust" reports on climate change from public service broadcasting or national daily newspapers.

Aside from the concerns related to our treatment, we also collected data on a range of other topics that respondents found concerning. Climate was identified as the most pressing concern, followed closely by concerns about youth education. Given that the survey took place during the SARS COV-19 pandemic, with a then high incidence rate of around 100 cases per 100k residents, it is not surprising that approximately 40% of respondents expressed concerns about their personal health.

Moreover, we gathered information on respondents' prior knowledge of the carbon price using a set of questions related to the carbon price. For instance, we asked about the effective carbon price level at the time of the survey (€25), with only 13% of the respondents answering this question correctly (Table 2). We also asked respondents about the current revenue use and the sectors to which it is applied (true/false questions). In addition, we elicited the respondents' general knowledge about energy consumption and emissions by asking about the most carbon-intensive areas of consumption in an average German household and the most carbon-intensive heating fuel. We computed a composite measure based on these knowledge question, with a score of 1 indicating a high level knowledge about the carbon price. The average score among our respondents was approximately 0.57, indicating a moderate level of knowledge.

Finally, we collected a suite of attitudinal variables that are relevant to our analysis of acceptance, such as environmental and fairness attitudes. For instance, we used a shortened version of the New Ecological Paradigm (Dunlap et al., 2000), which showed that our respondents had an average score of 0.576 on a scale ranging from 0 to 1. We also elicited fairness attitudes using the established scale from Schmitt et al. (1995), which consists of three fairness principles: equality, equity, and merit. Our respondents tended to favor the merit principle over the equality and equity principles.

# 4 Empirical Approach

To test our main hypothesis that targeted and tailored information is more effective in increasing acceptance, we exploit a randomized treatment and control design. In the experiment, the treatment group was exposed to a targeted and tailored information treatment, while the control group watched a general video. Notably, due to our experimental design, the estimated treatment effects always reflect the conjoint effect of targeted and tailored information relative to the effect of general information. The assignment into the treatment and control groups followed a two-stage random sorting strategy. To derive the average treatment effects (ATE), we employ two approaches: a simple difference-in-means (SDM) and a regression-adjusted (RA) estimator.

Under random assignment, the ATE can be derived using a SDM estimator. Let $W_i$ be the treatment indicator for individual $i$. With $N_1$ treated and $N_0$ control individuals the sample averages are defined as:

$$\bar{Y_0} = N_0^{-1} \sum_{i=1}^{N} (1 - W_i) Y_i \tag{1}$$
$$\bar{Y_1} = N_1^{-1} \sum_{i=1}^{N} (W_i) Y_i,$$

where $Y_i$ is the observed outcome for individual $i$. Following from the sample averages, the SDM is then defined as:

$$\hat{\tau}_{SDM} = \hat{Y}_1 - \hat{Y}_0. \tag{2}$$

We can retrieve the SDM estimator from the simple regression (see for example Imbens and Rubin, 2015a, for a detailed discussion):

$$Y_i = \alpha + \tau W_i + \epsilon_i, \tag{3}$$

where $\alpha$ is a constant, $\tau$ is the parameter to be estimated and $\epsilon$ is a random error term.

If there is imperfect random assignment or a large treatment heterogeneity, the SDM approach can yield a biased ATE. To address this issue, one can employ RA estimators that control for pre-treatment heterogeneity in the treatment and control groups by including relevant covariates in the regression model. The RA estimator approach involves a two-step process. First, separate

regression models of the outcome variable on a set of covariates are fitted for the treatment and control groups. In the second step, the predicted outcomes are averaged for each individual and experimental condition to obtain the potential-outcome means (POM). The difference in these POMs provides an estimate of the ATE. By exploiting the differences of averages of treatment-specific predicted outcomes, the RA estimator approach effectively reduces the bias that can arise from pre-treatment differences in the covariates between the treatment and control groups.

To derive the RA estimator, we define the linear projections ($L$) of the potential outcomes on the vector of covariates $\boldsymbol{X}_i$ as

$$\begin{aligned} L[Y_i(0)|1, \mathbf{X_i}] &= \alpha_0 + \mathbf{X_i}'\beta_0 \\ L[Y_i(1)|1, \mathbf{X_i}] &= \alpha_1 + \mathbf{X_i}'\beta_1, \end{aligned} \tag{4}$$

where the sample average is defined as $\bar{\mathbf{X}} = N^{-1}\Sigma_{i=1}^{N}\mathbf{X}_i$. Hence, the RA estimator is given by:

$$\hat{\tau}_{RA} = (\hat{\alpha}_1 - \hat{\alpha}_0) + \bar{\mathbf{X}}'(\hat{\beta}_1 - \hat{\beta}_0). \tag{5}$$

We can obtain this estimator from the regression

$$Y_i = \alpha + \tau W_i + \mathbf{X_i}'\beta + W_i\dot{\mathbf{X}}_i'\delta + \epsilon_i, \tag{6}$$

where $\dot{\mathbf{X}}_i$ are the demeaned covariates given the sample averages $\bar{\mathbf{X}}$.

As demonstrated by Negi and Wooldridge (2021), with treatment heterogeneity, the RA estimator with pre-treatment covariates asymptotically yields an ATE that is no less precise than the SDM estimator. Given the complexity or our random sampling strategy, we will assess the robustness of our ATE estimates by testing the sensitivity of the results to the inclusion of pre-treatment covariates.

## 5 Results

Our results are organized three main sections. First, we examine the level of acceptance of the German carbon price before any treatment was administered. Next, we delve into the experimental results, with a particular focus on the differences observed across the three treatment

videos. Finally, we explore the heterogeneity of the treatment effects across the three concern audiences.

### 5.1 A priori acceptance of the German carbon price

To assess the efficacy of our treatment, it is helpful to first gain a basic understanding of the distribution of acceptance across our sample. To this end, we run two regression models with pre-treatment acceptance as the dependent variable. We define acceptance as a binary variable with a value of one for participants who "(strongly) agree" (4 & 5) and zero for those who "(strongly) disagree" or are "uncertain"/"don't know" about their acceptance of the carbon price. The results are presented in Table A.1 in the Appendix. The models in column 1 and 2 assume a simple linear relationship between acceptance and the explanatory variables, evaluated using Ordinary Least Squares (OLS). The models in column 3 and 4 are estimated using a logistic regression model. The models in column 2 and 4 additionally include our three measures of concerns regarding personal cost, effectiveness, and fairness of the carbon price.

Despite depicting a non-causal relationship, the estimates provide valuable insights into the general determinants of carbon price acceptance. Firstly, our estimates on various explanatory variables largely confirm previous findings in the literature. For instance, acceptance is positively associated with left-wing political orientation (as in Thalmann, 2014), trust in the government (see also Harring and Jagers, 2013; Baranzini and Carattini, 2017), and particularly trust in climate policies. Additionally, individuals who trust media reports regarding climate change less are generally more opposed to the carbon price. Similar to Sommer et al. (2022), policy support in our sample is higher among individuals who favour fairness according to the equality principle. In contrast to Jagers and Hammar (2009), we observe no clear relationship between factors related to higher individual costs from the carbon price (heating with oil or gas, frequently driving a car) and acceptance.

Regarding our main variables of interest – the three main concerns about carbon pricing targeted by our treatments – columns (2) and (4) show that all three measures are strongly associated with pre-treatment acceptance, with cost concerns having the largest negative association. The clear connection between concerns about cost, effectiveness and fairness gives us confidence in our audience-segmentation approach, the efficacy of which we analyze subsequently.

### 5.2 Targeted and tailored versus general information

Comparing responses before and after the videos for the full sample, we observe an average increase in the probability of acceptance by approximately 4 percentage points (ppt) among the respondents. However, we must be cautious when interpreting the absolute effect size due to a potential experimenter demand effect (Rosenthal, 1966; Zizzo, 2010). Instead, we are interested in the relative difference in the effect between individuals who watched the treatment video and those who watched the general information video.

To evaluate the effectiveness of our treatment videos, we first examine the joint effect of the treatment videos compared to the control video. Under perfect random assignment, the ATE can be retrieved using a simple logistic regression with post-treatment acceptance as the dependent variable (defined as a binary variable) and our treatment indicator as the independent variable. To ensure the validity of our randomisation strategy, we employed a balancing test suggested by Imbens and Rubin (2015b), which involved calculating the normalised difference in covariate values and their composite measure as a natural measure of the distance between the locations of the distributions and the overlap across the entire set of covariates. We also provide the difference in the logarithms of the two sample standard deviations as a measure of the dispersion in the two distributions. The results indicate a strong balance of covariates across treated and controls in the full sample and within each respective concern audience (see Table C.1 in the Appendix).

Row one in Table 3 provides the corresponding estimates. We observe a small but significant ATE of 0.036 at the 5% significance level, with the POM for the control group being 0.441. This implies that our treatment video led to an average increase in the acceptance by 3.6 ppt compared to the control video. Therefore, participants were slightly more supportive of the policy after watching a tailored video regarding their prime concern.

In row 2, we assess the robustness of our ATE estimates by testing the sensitivity of the results to the inclusion of covariates in the model employing an RA estimator. The results from both the SDM and the RA results are highly similar in terms of effect size and precision, suggesting that the randomisation strategy worked well at the sample level.

**Table 3:** Treatment Effect on Acceptance Tailored/Targeted versus General Information

| | POM | ATE | | N |
|---|---|---|---|---|
| *Model* | control | effect | p-value | |
| logistic regression | 0.441 | 0.036 | 0.033 | 3,386 |
| regression adj.[a] logit outcome model | 0.444 | 0.030 | 0.032 | 3,386 |

Note: For all models we apply robust standard errors.
[a] Regression adjustment methods applied exploiting differences in the averages of treatment-specific predicted outcomes. Covariates included in the two outcome models are: COV-19 cases per 100k, individual characteristics, cost burden indicators, political variables, other concerns, environmental knowledge and attitude measures as well as fairness preferences.

### 5.3 Differences in the treatment response across concern audiences

Next, we are interested in identifying differences in the treatment effect across the three concern audiences. Previous literature has suggested that all three concerns are important drivers of acceptance. However, our results from Section 5.1 suggest that the relations relationship between pre-treatment acceptance and our three concern measures varies in strength. Therefore, the extent to which changes in these concerns affect acceptance may differ. Additionally, our videos may not only differ in quality, but the ability to be convinced though any information might also vary across the three concern dimension. While conveying facts regarding the cost incidence of a carbon price is relatively easy, messages framed around fairness and effectiveness may have a stronger potential to conflict with individuals' core moral beliefs and convictions.

To identify differences across the three treatments, we first restrict the respective control group for each treatment video to respondents selected for one of the three audiences, but sorted into the audience control (1.C, 2.C & 3.C). We further include individuals drawn for the general control group 4, who given their concern levels would have been eligible for the treatment. For instance, anyone in group 4, whose prime concern is the fairness of the carbon price and thus is eligible for treatment with the fairness video, is assigned to the fairness control group.

**Table 4:** Summary Treatment Effects on Acceptance (0/1)

| | SDM methods | | | RA methods | | | N | |
|---|---|---|---|---|---|---|---|---|
| | POM | ATE | | POM | ATE | | | |
| *concern* | control | effect | p-value | control | effect | p-value | T | C |
| personal costs | 0.380 | 0.090 | 0.002 | 0.380 | 0.085 | 0.001 | 522 | 715 |
| fairness | 0.452 | 0.040 | 0.149 | 0.472 | -0.003 | 0.887 | 557 | 749 |
| effectiveness | 0.429 | 0.056 | 0.039 | 0.438 | 0.034 | 0.157 | 583 | 794 |

Note: For all models we apply robust standard errors. We employ regression adjustment methods, which exploit the differences in the averages of treatment-specific predicted outcomes. Covariates included in the two outcome models include COV-19 cases per 100k, individual characteristics, cost burden indicators, political variables, other concerns, environmental knowledge and attitude measures as well as fairness preferences.

Table Table 4 reports the respective ATEs for each video applying both SDM and RA methods.

We find the ATEs to vary across the three videos, ranging from 0.090 for the cost video to 0.040 for the fairness video, with the latter effect being insignificant. Notably, applying RA methods results in a decline in effect size for all ATEs, with the ATE of the fairness video even turning negative. Once we control for heterogeneity across treatment and control groups, only the ATE of the cost video remains significant at the 1% significance level. Specifically, for individuals concerned with increasing costs, watching our tailored video increases acceptance on average by 8.5 ppt compared to the control group. Therefore, further investigation reveals that the positive effect of our treatment videos is primarily driven by the cost video, while we cannot identify any individual effects for the fairness and effectiveness videos.

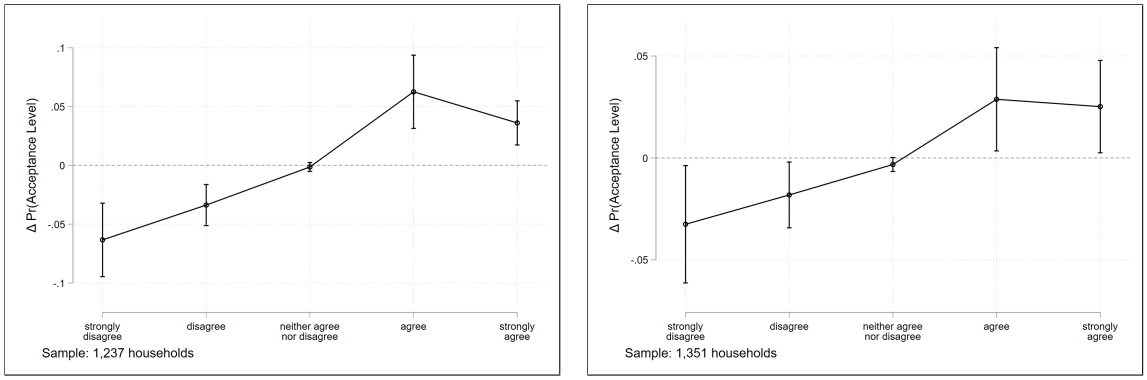
Although the treatment effects for the fairness and effectiveness video are insignificant, we may observe changes in the strength of objection between treated and controls, such as switches from 1 to 3 across the Likert Scale. Though these switches may not affect acceptance directly, they could suggest an increase in the proportion of individuals tolerating the policy. From a policy perspective, this increase in tolerance could reduce the risk of social unrest in response to more stringent carbon policies.

Therefore, we employ a generalized ordered logistic regression model using information on the Likert scale to estimate the treatment effect of each video on the post-treatment acceptance level, defined as an ordinal variable ranging from one "strongly disagree" to five "strongly agree".[5] The model also includes a set of control variables to minimize any heterogeneity in the treatment effect resulting from pre-treatment differences between treated and controls. Figure 3 plots the ATEs of each video on the probability of respondents choosing the respective level of post-treatment acceptance. Our results show a statistically significant decline in the probability of respondents "strongly disagreeing" with the carbon price for all three treatment videos. Moreover, across all three treatments, the ATE on the probability of individuals "agreeing" is positive and significant, although with considerable uncertainty around the effect for the fairness and effectiveness video. From the figure, we infer that our treatment videos were particularly convincing for those with a strong opposition towards the policy. Yet, while opposition to the carbon price weakened in response to all three tailored videos (relative to the control group), only the cost video is effective in increasing overall acceptance.

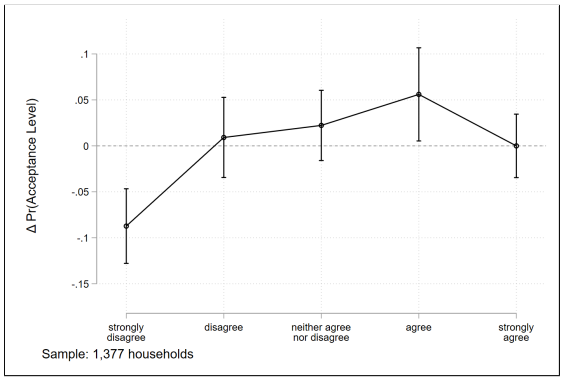
[5]Note that individuals, who choose "don't know" for post-treatment acceptance are dropped from the sample for this analysis.

**Figure 3:** Average Treatment Effect on the Level of Acceptance

**(a)** Personal Costs **(b)** Fairness




**(c)** Effectiveness




Note: The respective control groups consist of respondents assigned to the control group within each respective audience (1.C|2.C|3.C + 4). Estimates are retrieved from three separate generalized ordered logistic regressions with the post-treatment acceptance level (1-5) as the ordinal outcome variable and the binary treatment variable as explanatory variable. The model further includes the following controls: Covariates included in the two outcome models include COV-19 cases per 100k, individual characteristics, cost burden indicators, political variables, other concerns, environmental knowledge and attitude measures as well as fairness preferences. For all models we apply robust standard errors.

## 6 (Un)successful targeting or tailoring?

Our study suggests that providing tailored information can be an effective way to increase stated acceptance of a carbon price. However, we found that this effect was driven by the strong effect of tailored information among the cost audience. It remains unclear whether the lack of an effect for the fairness and effectiveness video is due to ineffective targeting (we identify the wrong audience) or tailoring (our message was unconvincing).

To evaluate the quality of our tailoring approach, we conducted a short post-video evaluation and asked participants several follow-up questions about the videos' content and quality. The results, which are presented in the Appendix, indicate that compared to the control group, participants in all treatment groups found the video easier to understand and more informative. Although the tailored videos were one minute longer than the control video, participants did not perceive a significant difference in the video length. We also found that both the treatment videos and the control video performed equally well in terms of relatedness of the content.

The success of our selection strategy hinges on how well we can identify distinct concern audiences. Comparing summary statistics for each concern audience (Table 2) reveals some differences in the covariates among the three groups. For instance, rural households and those heating with gas or oil are more likely to be assigned to the cost audience, while individuals with a more left-wing political orientation and those with higher environmental concerns and awareness are more frequently among the fairness and effectiveness audience. Also, acceptance prior to the experiment is considerably higher among the effectiveness and fairness group. Thus, separating respondents by their primary concern did result in three somewhat distinct groups. However, we are unsure whether these groups are homogeneous enough in terms of their their perception of our tailored messages.

To shed some light on this issue, we employ machine learning techniques to study the heterogeneity of the treatment effects for each video. This enables us to understand whether and if so how individuals within the three audiences may respond differently to our videos. We use a random forest approach to estimate conditional treatment effects (CATEs) based on the covariates identified as potentially important in Section 5.1. To better understand the significance of these moderating effects we rank the predicted conditional average treatment effects (CATE) on the y-axis, and order them according to their size on the x-axis. The results, presented in

the Appendix B, reveal significant heterogeneity in the effect size for all three videos. Notably, about 25% of the predicted CATEs for both the effectiveness and the fairness video are negative, with the reduction in acceptance reaching up to 5ppt. In contrast, all CATEs for the cost video are clearly positive. Therefore, it is reasonable to conclude that our targeting strategy for the effectiveness and fairness video failed. Moreover, the existence of negative CATEs underscores the potential risk of targeting the wrong individual with a tailored message. When targeting or tailoring fails, it could lead to less positive public reactions as the scope for disagreement may be larger with tailored campaigns.

Lastly, we examine how the treatment affect is moderated by each covariate. Figure B.1 in the Appendix shows that individuals' level of environmental behaviour, their concerns about climate change, their fairness preferences, and to some lesser extent their personal costs have a moderating effect on the treatment effect. For instance, the cost video had a lower treatment effect on individuals with strong fairness preferences according to the equity and merit principle, while indicators of high tax incidence have a relatively small moderating effect. The fairness video, on the other hand, resonates particularly well among those with strong fairness preferences. For the effectiveness audience, the CATE is significantly smaller for those already behaving environmentally friendly, those concerned about the climate, and those with strong fairness preferences according to the equity and merit principle. Instead, the video is more effective among those with a better understanding of carbon emissions and the carbon price. Overall, the observed heterogeneity in the CATEs suggest that a more restrictive targeting strategy could have resulted in even greater treatment effectiveness. Therefore, conducting a thorough evaluation of alternative segmentation approaches prior to implementing targeted information campaigns to crucial for their success.

## 7 Conclusion

The ongoing discussion about the most effective and widely accepted instruments to reduce GHG emissions will prevail. To meet its climate targets, the German government will need to either increase the price path of the carbon price or identify alternative measures. Planning sufficient resources for explaining the mechanisms of these measures will be crucial to ensure public support for more stringent climate policies.

As noted by Hornsey and Lewandowsky (2022), conventional science communication strategies

like myth-busting and evidence building have proven ineffective in persuading many climate skeptics. A recent report by the Wold Bank recommends targeted messaging delivered by trusted sources for effective policy communication (Hine et al., 2014; Marshall et al., 2018). In line with these recommendations, we conducted a survey experiment to assess the impact of delivering tailored information videos, aimed at addressing common concerns about carbon pricing, on a targeted audience's acceptance of the policy. Our findings indicate that our tailored videos regarding the cost, fairness and effectiveness of the carbon price were jointly more effective than the general information video in increasing overall acceptance. Yet, this effect is primarily driven by the strong impact of the cost video. While we did not find an individual effect of the fairness and effectiveness treatments, estimates based on the full Likert Scale indicate that the two videos reduced the proportion of those strongly opposed to the policy within their respective audience group. From a policy perspective, this can be a valuable outcome of targeted communication campaigns, as an increase in public tolerance of a carbon price may minimize the risk of social unrest due to more stringent carbon policies. Furthermore, our heterogeneity analysis suggests that more stringent targeting could have increased the treatment impact of the tailored videos.

In conclusion, our findings indeed suggest targeted information to be more effective in strengthening acceptance. However, the results highlight the scope for further research regarding appropriate audience segmentation approaches, as well as the generalizability and persistence of the effects beyond survey responses. Besides, the additional societal gains from providing targeted information may be negligible compared to the high costs associated with producing targeted and tailored content. Therefore, the effectiveness of targeted communication should not be measured solely in terms of its impact on acceptance but also in terms of opportunity costs of the information provision. Accordingly, future research should aim to measure the cost-effectiveness of such campaigns. Given the urgency of climate change, it is imperative to identify and implement effective communication strategies to promote sustainable behaviors and policies.

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# A Determinants of Acceptance

**Table A.1:** Acceptance (0/1) pre Treatment *(non causal)*

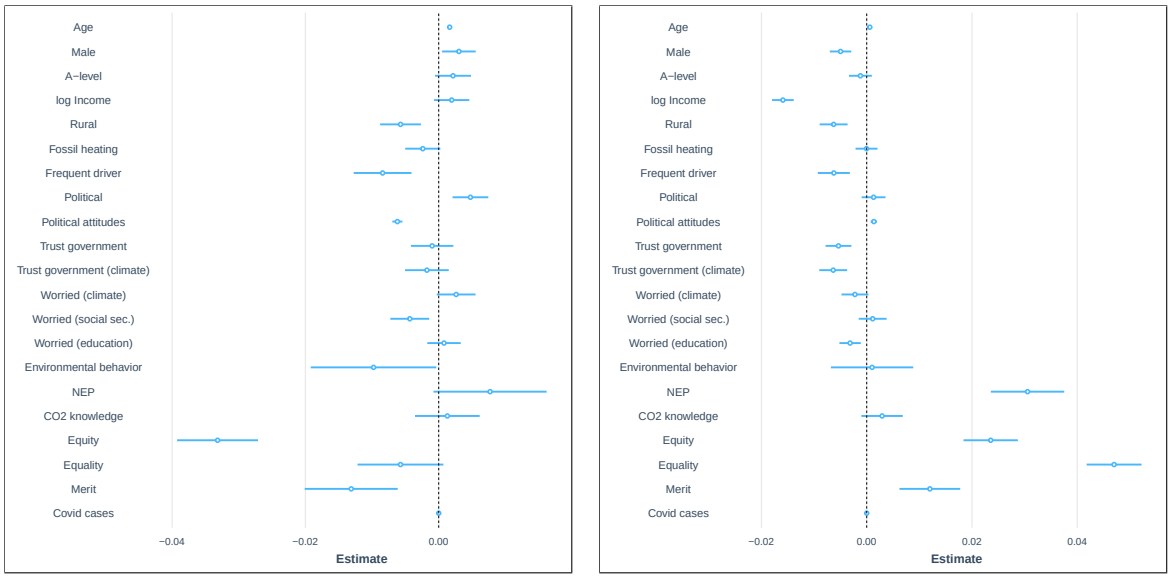
| | OLS | | | | Ordered Logit | | | |
|---|---|---|---|---|---|---|---|---|
| | env. know | | fairness & trust | | env. know | | fairness & trust | |
| concerned efficiency pre treat (0/1) | | | -0.139*** | *(0.017)* | | | -0.745*** | *(0.087)* |
| concerned fairness pre treat (0/1) | | | -0.079*** | *(0.019)* | | | -0.403*** | *(0.093)* |
| concerned costs pre treat (0/1) | | | -0.199*** | *(0.019)* | | | -0.989*** | *(0.099)* |
| respondent age | -0.003 | *(0.003)* | 0.000 | *(0.003)* | -0.017 | *(0.017)* | 0.003 | *(0.018)* |
| resp. age$^2$ | 0.000* | *(0.000)* | 0.000 | *(0.000)* | 0.000* | *(0.000)* | 0.000 | *(0.000)* |
| male | 0.001 | *(0.017)* | 0.003 | *(0.016)* | 0.010 | *(0.085)* | 0.016 | *(0.090)* |
| college graduate (Abitur) | 0.052*** | *(0.018)* | 0.027$^+$ | *(0.017)* | 0.286*** | *(0.091)* | 0.169* | *(0.097)* |
| hh member $< 18$ | -0.017 | *(0.021)* | -0.028$^+$ | *(0.020)* | -0.097 | *(0.113)* | -0.176$^+$ | *(0.118)* |
| log. hh income | 0.047*** | *(0.017)* | 0.026$^+$ | *(0.016)* | 0.261*** | *(0.089)* | 0.156* | *(0.093)* |
| rural | -0.006 | *(0.020)* | -0.003 | *(0.019)* | -0.026 | *(0.108)* | -0.026 | *(0.113)* |
| heating gas/oil | -0.015 | *(0.017)* | 0.002 | *(0.016)* | -0.076 | *(0.090)* | 0.008 | *(0.094)* |
| frequent driver | -0.002 | *(0.026)* | 0.035$^+$ | *(0.026)* | -0.017 | *(0.127)* | 0.159 | *(0.135)* |
| politically interested | 0.021 | *(0.017)* | 0.035** | *(0.017)* | 0.109 | *(0.096)* | 0.190* | *(0.100)* |
| political affil. left-right (1-10) | -0.007$^+$ | *(0.005)* | 0.002 | *(0.005)* | -0.044* | *(0.026)* | 0.003 | *(0.028)* |
| trust government (0/1) | 0.101*** | *(0.021)* | 0.058*** | *(0.020)* | 0.501*** | *(0.098)* | 0.322*** | *(0.106)* |
| trust gov. climate (0/1) | 0.057** | *(0.023)* | 0.040* | *(0.022)* | 0.327*** | *(0.106)* | 0.265** | *(0.115)* |
| trust media climate (0/1) | 0.117*** | *(0.019)* | 0.075*** | *(0.018)* | 0.575*** | *(0.090)* | 0.419*** | *(0.095)* |
| worried climate (0/1) | 0.125*** | *(0.020)* | 0.062*** | *(0.019)* | 0.723*** | *(0.109)* | 0.451*** | *(0.115)* |
| worried health (0/1) | -0.036** | *(0.016)* | -0.021$^+$ | *(0.015)* | -0.173** | *(0.081)* | -0.118$^+$ | *(0.086)* |
| worried youth education (0/1) | -0.022$^+$ | *(0.016)* | 0.004 | *(0.016)* | -0.109$^+$ | *(0.084)* | 0.027 | *(0.089)* |
| adj. scale env. friendly behav. (0-1) | 0.318*** | *(0.060)* | 0.169*** | *(0.058)* | 1.807*** | *(0.335)* | 1.126*** | *(0.358)* |
| NEP scale continuous (0-1) | 0.117** | *(0.052)* | 0.122** | *(0.050)* | 0.816*** | *(0.313)* | 0.910*** | *(0.329)* |
| knowledge CO2 & price (0-1) | 0.170*** | *(0.032)* | 0.133*** | *(0.030)* | 0.914*** | *(0.171)* | 0.763*** | *(0.178)* |
| equity fairness princ. (0-1) | 0.008 | *(0.041)* | 0.013 | *(0.039)* | 0.095 | *(0.213)* | 0.137 | *(0.224)* |
| equality fairness princ. (0-1) | 0.039 | *(0.042)* | 0.085** | *(0.040)* | 0.227 | *(0.223)* | 0.480** | *(0.234)* |
| merit fairness princ. (0-1) | 0.036 | *(0.045)* | 0.051 | *(0.043)* | 0.158 | *(0.249)* | 0.279 | *(0.265)* |
| Covid current cases (per 100k) | 0.000 | *(0.000)* | 0.000 | *(0.000)* | 0.000 | *(0.000)* | 0.000 | *(0.000)* |
| Constant | -0.607*** | *(0.155)* | -0.236$^+$ | *(0.151)* | -6.164*** | *(0.857)* | -4.714*** | *(0.897)* |
| Observations | 3383 | | 3383 | | 3383 | | 3383 | |
| F | 41.4 | | 59.7 | | | | | |
| $\chi^2$ | | | | | 536.6 | | 746.5 | |
| Log-Likelihood | -2017.6 | | -1856.9 | | -1902.4 | | -1755.9 | |

*Robust standard errors in parentheses*

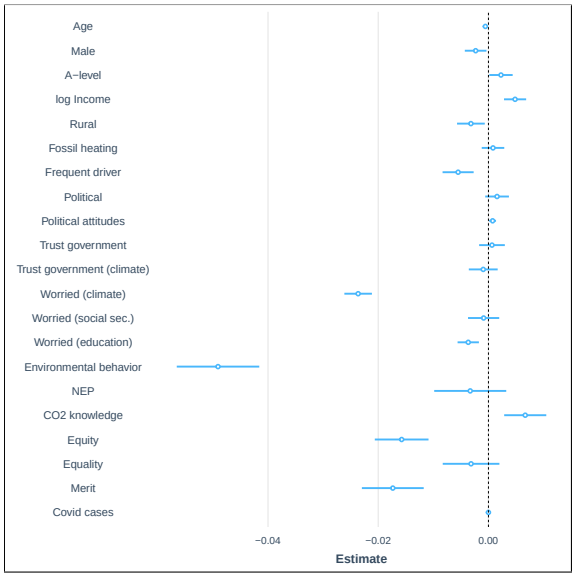
# B Machine Learning

**Figure B.1:** Conditional Average Treatment Effect of Videos

**(a)** Personal Costs **(b)** Fairness



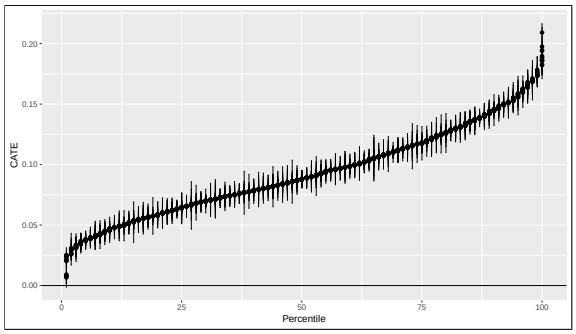

**(c)** Effectiveness



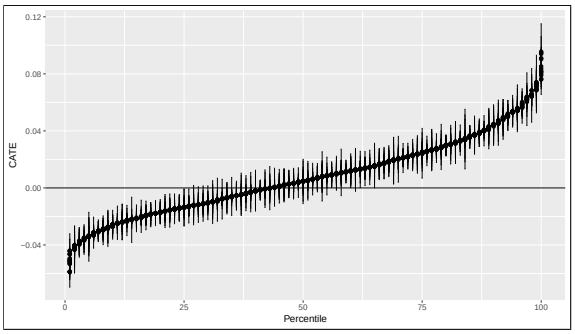

Note: The control groups consist of respondents assigned to the control group within each respective audience and those eligible to the respective treatment in the general control group (1.C|2.C|3.C + 4).

**Figure B.2:** Ranked Predicted Conditional Treatment Effects

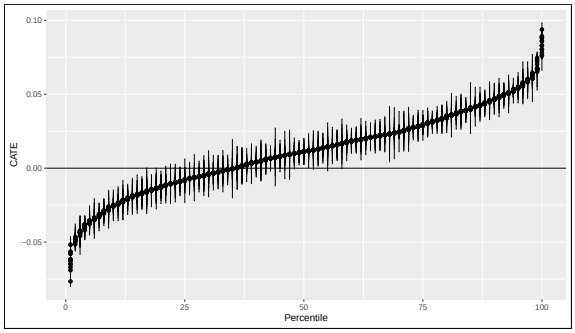
**(a)** Personal Costs




**(b)** Fairness




**(c)** Effectiveness




Note: The control groups consist of respondents assigned to the control group within each respective audience and those eligible to the respective treatment in the general control group (1.C|2.C|3.C + 4).

# C Balancing Test

**Table C.1:** Balance between Treated and Control

| | Controls | | Treated | | Overlap Measures | |
|---|---|---|---|---|---|---|
| covariate | mean | (S.D.) | mean | (S.D.) | Nor Dif | Log Ratio of STD |
| *individual characteristics:* | | | | | | |
| married | 0.578 | 0.494 | 0.577 | 0.494 | -0.003 | 0.000 |
| respondent age | 53.667 | 16.291 | 54.307 | 16.058 | 0.056 | -0.014 |
| male | 0.559 | 0.497 | 0.548 | 0.498 | -0.031 | 0.002 |
| education level | 2.226 | 0.762 | 2.231 | 0.743 | 0.010 | -0.026 |
| recipient social security | 0.029 | 0.169 | 0.020 | 0.139 | -0.088 | -0.193 |
| *household characteristics:* | | | | | | |
| hh income categories | 6.910 | 2.943 | 6.949 | 2.957 | 0.018 | 0.005 |
| # household members | 2.262 | 1.148 | 2.253 | 1.085 | -0.011 | -0.056 |
| age youngest hh member | 42.462 | 24.677 | 42.400 | 24.992 | -0.003 | 0.013 |
| hh member $< 18$ | 0.215 | 0.411 | 0.221 | 0.415 | 0.023 | 0.011 |
| hh size in $m^2$ | 110.740 | 53.501 | 110.361 | 48.373 | -0.011 | -0.101 |
| type of housing | 2.039 | 1.031 | 2.064 | 1.045 | 0.034 | 0.014 |
| *vulnerability to costs:* | | | | | | |
| tenant | 0.391 | 0.488 | 0.379 | 0.485 | -0.035 | -0.006 |
| heating gas/oil | 0.697 | 0.460 | 0.713 | 0.452 | 0.049 | -0.016 |
| car owner | 0.922 | 0.269 | 0.916 | 0.278 | -0.031 | 0.033 |
| frequent driver | 0.873 | 0.333 | 0.863 | 0.344 | -0.042 | 0.032 |
| commuting distance | 1.892 | 1.870 | 1.858 | 1.871 | -0.026 | 0.000 |
| *political characteristics:* | | | | | | |
| politically interested | 0.686 | 0.464 | 0.691 | 0.462 | 0.015 | -0.004 |
| political affil. left-right (1-10) | 4.763 | 1.761 | 4.853 | 1.777 | 0.072 | 0.009 |
| party affiliation | 3.595 | 2.380 | 3.633 | 2.456 | 0.022 | 0.032 |
| *general concerns:* | | | | | | |
| worried climate | 3.803 | 1.110 | 3.820 | 1.082 | 0.022 | -0.026 |
| worried unemp. | 1.977 | 1.112 | 1.982 | 1.110 | 0.007 | -0.001 |
| worried health | 3.270 | 1.020 | 3.269 | 1.017 | -0.001 | -0.003 |
| worried youth education | 3.637 | 1.114 | 3.667 | 1.107 | 0.038 | -0.007 |
| *trust government, media & science:* | | | | | | |
| trust gov. corona (1-4) | 2.508 | 0.891 | 2.534 | 0.867 | 0.043 | -0.028 |
| trust media corona (1-5) | 3.389 | 1.096 | 3.373 | 1.070 | -0.021 | -0.023 |
| trust media climate (1-5) | 3.313 | 1.025 | 3.326 | 1.020 | 0.018 | -0.005 |
| involvement science | 4.118 | 0.923 | 4.053 | 0.960 | -0.099 | 0.040 |
| *climate (policy) knowledge & interest, environmental awareness:* | | | | | | |
| info options saving CO2 | 0.867 | 1.031 | 0.877 | 1.050 | 0.014 | 0.019 |
| abs. z-score stated/true CO2 price | 0.181 | 1.198 | 0.141 | 0.720 | -0.057 | -0.509 |
| CO2 & price knowledge | 2.189 | 1.018 | 2.230 | 0.976 | 0.058 | -0.042 |
| NEP scale (0-6) | 5.000 | 1.395 | 5.003 | 1.369 | 0.003 | -0.019 |
| adj. scale env. friendly bahav. (0-1) | 0.460 | 0.188 | 0.472 | 0.191 | 0.087 | 0.018 |
| member env. organisation | 0.130 | 0.336 | 0.129 | 0.336 | -0.003 | -0.002 |
| flood 2021 related climate change | 3.907 | 1.236 | 3.974 | 1.169 | 0.079 | -0.056 |
| flood raised clim. change awareness | 3.138 | 1.291 | 3.230 | 1.280 | 0.101 | -0.009 |
| *preferences fairness principle:* | | | | | | |
| equality fairness princ. (0-12) | 7.478 | 2.406 | 7.548 | 2.364 | 0.041 | -0.018 |
| equity fairness princ. (0-12) | 5.865 | 2.479 | 5.911 | 2.475 | 0.026 | -0.002 |
| needs fairness princ. (0-12) | 8.107 | 2.306 | 8.209 | 2.254 | 0.064 | -0.023 |
| *survey administration:* | | | | | | |
| id interview | 4,982.719 | 2,857.029 | 4,979.849 | 2,894.827 | -0.001 | 0.013 |
| multivariate measure[a] | | | | | 0.012 | |

[a] An estimated measure of the multivariate difference in covariate distributions. See Imbens and Rubin (2015b) for a detailed discussion of the statistic.

# D Additional concern figures

**Figure D.1:** Where are higher costs experienced?

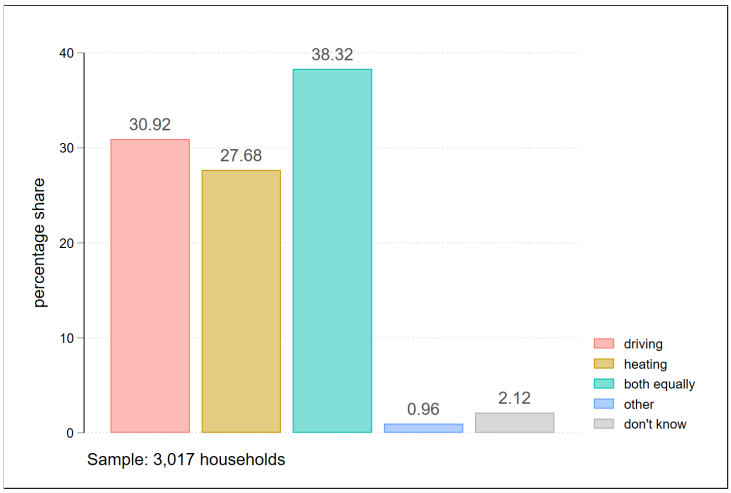
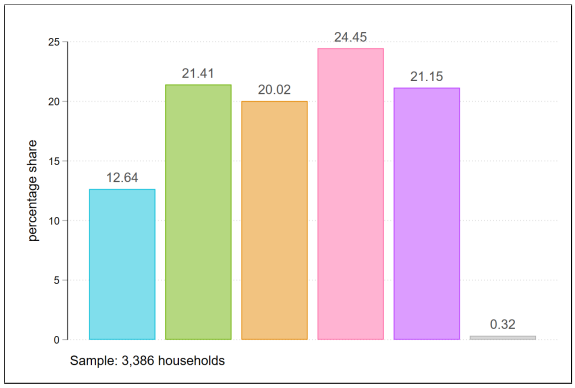
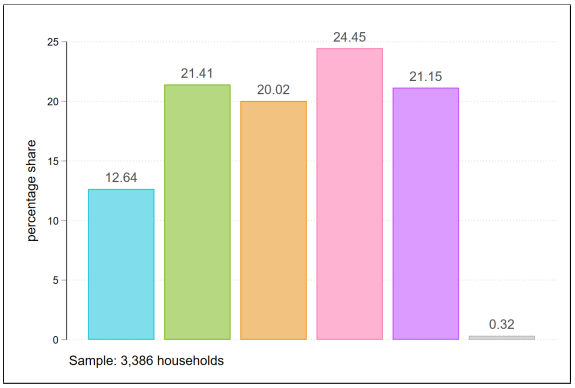



**Figure D.2:** Concern Rating Post Treatment

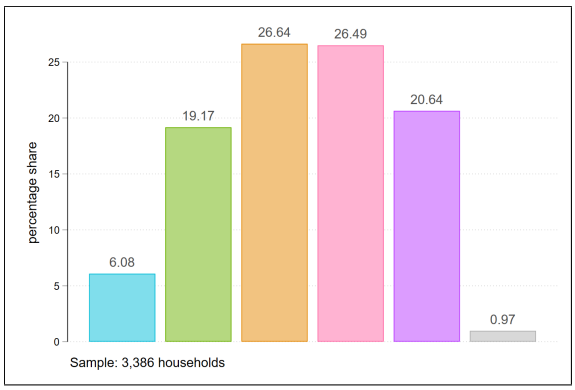
**(a)** Effectiveness




**(b)** Personal Costs




**(c)** Fairness



# E Sample Balance for Control and Treatment

**Table E.1:** Balancing Test

| | total | | costs | | fairness | | effectiveness | |
|---|---|---|---|---|---|---|---|---|
| | Nor Dif | Log R of STD | Nor Dif | Log R of STD | Nor Dif | Log R of STD | Nor Dif | Log R of STD |
| married | -0.003 | 0.000 | -0.139 | 0.024 | 0.038 | -0.008 | 0.032 | -0.004 |
| respondent age | 0.056 | -0.014 | 0.052 | 0.018 | 0.038 | -0.051 | 0.070 | -0.067 |
| male | -0.031 | 0.002 | -0.082 | 0.011 | -0.006 | 0.001 | -0.060 | 0.009 |
| education level | 0.010 | -0.026 | 0.023 | -0.055 | -0.071 | 0.032 | -0.024 | -0.052 |
| recipient social security | -0.088 | -0.193 | 0.028 | 0.093 | -0.071 | -0.215 | -0.035 | -0.130 |
| # household members | -0.011 | -0.056 | -0.104 | -0.096 | 0.068 | 0.042 | -0.017 | -0.102 |
| age youngest hh member | -0.003 | 0.013 | -0.015 | 0.029 | 0.032 | -0.001 | 0.058 | -0.011 |
| household member < 18 | 0.023 | 0.011 | -0.014 | -0.010 | 0.013 | 0.008 | -0.029 | -0.019 |
| hh size in $m^2$ | -0.011 | -0.101 | -0.074 | -0.089 | -0.018 | -0.215 | 0.001 | -0.046 |
| type of housing | 0.034 | 0.014 | 0.140 | 0.057 | -0.070 | 0.004 | 0.113 | 0.090 |
| tenant | -0.035 | -0.006 | 0.010 | 0.003 | 0.056 | 0.014 | 0.019 | 0.005 |
| heating gas/oil | 0.049 | -0.016 | -0.002 | 0.001 | 0.010 | -0.005 | 0.018 | -0.008 |
| car owner | -0.031 | 0.033 | -0.085 | 0.125 | 0.046 | -0.084 | 0.021 | -0.028 |
| frequent driver | -0.042 | 0.032 | -0.038 | 0.040 | 0.035 | -0.047 | 0.005 | -0.004 |
| commuting distance | -0.026 | 0.000 | -0.048 | 0.001 | -0.048 | -0.028 | 0.060 | 0.066 |
| politically interested | 0.015 | -0.004 | -0.034 | 0.018 | -0.003 | 0.001 | 0.008 | -0.003 |
| political affil. left-right (1-10) | 0.072 | 0.009 | 0.082 | 0.048 | 0.047 | -0.022 | 0.093 | 0.036 |
| party affiliation | 0.022 | 0.032 | -0.038 | 0.012 | 0.041 | 0.021 | 0.115 | 0.063 |
| worried climate | 0.022 | -0.026 | 0.000 | -0.024 | -0.044 | 0.029 | 0.039 | -0.069 |
| worried unemployment | 0.007 | -0.001 | -0.042 | 0.028 | 0.112 | 0.030 | -0.017 | -0.008 |
| worried health | -0.001 | -0.003 | 0.008 | 0.008 | 0.001 | 0.009 | 0.034 | 0.007 |
| worried youth education | 0.038 | -0.007 | 0.136 | -0.030 | 0.035 | 0.047 | -0.029 | -0.012 |
| hh income categories | 0.018 | 0.005 | -0.057 | -0.019 | 0.053 | 0.031 | 0.004 | -0.005 |
| trust gov. corona (1-4) | 0.043 | -0.028 | 0.046 | 0.025 | -0.113 | -0.068 | 0.055 | -0.013 |
| trust media corona (1-5) | -0.021 | -0.023 | 0.003 | 0.003 | -0.108 | -0.022 | -0.088 | 0.002 |
| trust media climate (1-5) | 0.018 | -0.005 | 0.047 | 0.017 | -0.041 | -0.001 | 0.002 | -0.018 |
| involvement science | -0.099 | 0.040 | 0.103 | -0.029 | -0.195 | 0.179 | -0.093 | -0.024 |
| info options saving CO2 | 0.014 | 0.019 | -0.092 | -0.020 | -0.027 | -0.002 | 0.130 | 0.095 |
| abs. z-score CO2 price | -0.057 | -0.509 | 0.051 | 0.323 | -0.011 | 0.324 | -0.026 | -0.231 |
| CO2 & price know. | 0.058 | -0.042 | 0.122 | 0.000 | 0.059 | -0.050 | 0.002 | -0.092 |
| NEP scale (0-6) | 0.003 | -0.019 | 0.076 | -0.085 | 0.013 | -0.021 | -0.004 | -0.044 |
| env. friendly bahav. (0-1) | 0.087 | 0.018 | 0.086 | -0.047 | 0.068 | -0.032 | 0.103 | 0.067 |
| member env. org. | -0.003 | -0.002 | -0.010 | -0.010 | -0.043 | -0.060 | 0.034 | 0.033 |
| flood 2021 rel. climate change | 0.079 | -0.056 | 0.057 | -0.037 | 0.059 | -0.005 | 0.028 | -0.107 |
| flood raised awareness | 0.101 | -0.009 | 0.129 | -0.011 | 0.011 | 0.024 | 0.088 | -0.022 |
| equality fairness princ. (0-12) | 0.041 | -0.018 | -0.001 | 0.033 | 0.046 | 0.013 | 0.082 | -0.032 |
| equity fairness princ. (0-12) | 0.026 | -0.002 | 0.042 | 0.055 | 0.106 | 0.017 | 0.021 | -0.070 |
| needs fairness princ. (0-12) | 0.064 | -0.023 | 0.103 | -0.061 | 0.063 | 0.072 | 0.041 | -0.061 |
| id interview | -0.001 | 0.013 | 0.019 | 0.021 | 0.022 | 0.005 | -0.022 | 0.010 |
| multivariate measure | 0.012 | | 0.052 | | 0.047 | | 0.039 | |

# F Comparison Sample with German Population

**Table F.1:** Comparison with German population

| | Survey | Population |
|---|---|---|
| Age | 53.8 | 44.5 |
| Male | 0.586 | 0.493 |
| high school grad. (Abitur) | 0.428 | 0.468 |
| Household net income | 3,459 | 3,612 |
| East Germany | 0.148 | 0.194 |
| Rural | 0.400 | 0.203 |
| Fossil heating | 0.710 | 0.856 |

Notes: Socio-economic population data is taken from Destatis (2021a) and Destatis (2021b), heating information from Destatis (2019) and information about urbanization rate for the population from Bundesinstitut für Bevölkerungsforschung (2022). @miscdestatis2021bev, author=Destatis, year=2021, title=Bevölkerungsstand: Amtliche Einwohnerzahl Deutschlands 2020, note=Statistisches Bundesamt (Destatis). Federal Statistical Office. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsstand/_inhalt.html

# G Video Scripts

## G.1 Video 1: Personal Costs

Introduction section

Hello, my name is [redacted], I am a climate scientist and I am conducting research on the effect of the carbon price in Germany. The carbon price is supposed to motivate us all to save carbon emissions.

Earlier you expressed your concern about the high additional costs caused by the carbon price. This concern is often raised. Let's take a closer look at it together using concrete examples.

Information section

Let's first take a look at the retired couple Fritz and Rosa, who live in a single-family house on the outskirts of a town. Due to the carbon price, they pay about 65 Euros more a year for heating with gas. Their weekly visits to their grandchildren by car cost about 45 Euros more per year. Fritz and Rosa, however, save on their electricity bill. The government uses part of the revenue from the carbon price to reduce electricity costs. As a result, they save around 107 Euros a year on their electricity bills. The money from the CO2 price is also used to invest in the expansion of public transportation, so that it will be easier to visit the grandchildren by bus, streetcar and train in the future.

The Müller family lives in the country. Although they pay around 150 Euros more per year to heat their terraced house, they save the equivalent of around 150 Euros on electricity costs. As a nurse, Samira Müller is dependent on the car and has to drive 30 kilometers to work every day. Her additional costs for gasoline for driving 30,000km a year are estimated at 165 Euros. However, Samira receives a total tax refund of around 2,000 euros a year through the increased commuter allowance. Samira is also considering starting a carpool with colleagues to share travel costs.

As a final example, let's look at Björn, a graphic designer who lives in an rented apartment[6] in the city center. With the CO2 price, he pays about 38 Euros more a year for heating, but saves about 62 Euros on electricity. For the 10 km commute to work by car, Björn pays just under 77 Euro more. He could take the bike every now and then and save money that way.

[6] The original script refers to an "Altbauwohnung", which directly translated means "old building apartment". In Germany the "Altbau" period typically refers to buildings erected before 1950.

Björn is also considering buying an electric car. The purchase is supported with a bonus from the government and by the expansion of charging stations.

Closing section

As you have seen from the examples, the costs of Fritz and Rosa, the Müller family and Björn differ greatly. They alone know what their personal costs are. It is important to note that the German government has been reducing costs elsewhere since the beginning of this year to compensate for this. After all, everyone should be able to participate in climate protection, since every contribution counts.

*Video length: 2:57 min*

## G.2 Video 2: Fairness

Introduction section

Hello, my name is [redacted], I am a climate scientist and I am conducting research on the effect of the carbon price in Germany. The carbon price is supposed to motivate us all to save carbon emissions.

Earlier you expressed your concerns about the fairness of a carbon price. This concern is often raised. Let's take a closer look at it together using concrete examples.

Information section

The carbon price is based on a recognized fairness principle called the polluter pays principle. Anyone who emits CO2 harms the climate and must pay for it. Those who reduce their pollution can save money. This is fair because it applies to everyone without exception.

For example, Björn, a graphic designer, lives only 15 minutes by bike from his workplace. But he takes the car almost every day. For the CO2 he emits with it, he now has additional expenses. If he would take the bike every now and then, he could protect the climate and save money. The carbon price works in exactly the same way: those who cause CO2 pay for it. Those who save CO2 do not pay.

But not everyone can reduce their carbon emissions so easily. The retired couple Fritz and Rosa, for example, have a small pension and support their daughter Lena with childcare. The couple relies on their car to do so, as their bus service runs infrequently.

To ensure that individual population groups are not overly burdened, the state uses part of the revenue to cushion unavoidable costs. For example, all citizens are relieved by the reduction in electricity costs. In the case of Fritz and Rosa, the additional costs for heating and gasoline roughly balance out their lower expenses for electricity. Low-income earners in particular are relieved by the reduction in electricity costs.

Housing subsidies have also been increased to provide even more targeted support for low-income households. Those who commute are supported by the increased commuter allowance or the new mobility premium. In addition, the government is using the revenue from the carbon price to expand local public transport and thus make it easier to switch to environmentally friendly modes of transport.

Closing section

As you have seen from the examples, all citizens have to bear costs in the amount by which they pollute the climate. If they cause less carbon emissions, they have to pay less. At the same time, since the beginning of the year new relief measures were introduced specifically designed for low-income households, which are financed by the revenue from the carbon price. After all, everyone should be able to participate in climate protection, as every contribution counts.

*Video length: 2:54 min*

### G.3 Video 3: Effectiveness

Introduction section

Hello, my name is [redacted], I am a climate scientist and I am conducting research on the effect of the carbon price in Germany. The carbon price is supposed to motivate us all to save carbon emissions.

You indicated earlier that you are not fully convinced of the effectiveness of the carbon price. This concern is often raised. Let's take a closer look together using concrete examples.

Information section

Everyone knows it: you're standing in the supermarket, thinking about what to buy. Often there are similar products that differ only in price - usually we then decide on the cheaper one. From economics we know that shopping is strongly influenced by the price. If a product

becomes more expensive, it is bought less.

The carbon price is also based on this logic: products and behavior that cause a lot of CO2 become more expensive. This makes more climate-friendly products and behavior more attractive. Björn, for example, lives only 15 minutes by bike from his work. Since he always leaves the house at the last minute, he takes the car almost every day. For the carbon emissions he emits as a result, the additional cost amounts to roughly 77 Euros a year. If he were to take the bicycle every now and then, he could save this money and protect the climate at the same time.

However, not everyone can react to a price change and behave differently. To look after the grandchildren once a week, the retired couple Fritz and Rosa depend on the car because they live on the outskirts of the city, where the bus rarely runs. That's why the government is also using the revenue from the carbon price to expand public transportation and create more environmentally friendly alternatives.

The carbon price therefore also protects the climate indirectly by using the revenue for climate-friendly investments. In Germany, in addition to reducing electricity costs, the money is spent in particular on promoting energy-efficient building renovations and climate-friendly mobility. This makes climate-friendly behavior cheaper and easier. This is especially true for those segments of the population that cannot easily afford more efficient appliances or renovation. The money therefore does not stay with the federal government, but flows back to the citizens via various channels.

Closing section

As they have seen from the examples, the carbon price motivates a change in behavior. To save money, people heat less and drive less often, buy more efficient appliances, or switch to a more climate-friendly technology. All this is additionally promoted by the state through the revenue from the carbon price.

*Video length: 2:55 min*

### G.4 Video 4: Control Video

Like all countries in the world, Germany shares responsibility for the ongoing climate change. That's why Germany has committed to cutting 55% of its greenhouse gases by 2030 compared

to 1990 levels. Germany is the first country in the world to commit to this by law.

Since 2005, carbon emissions from energy companies, industry and air traffic have been regulated by the European emissions trading system. But carbon is also produced in transport and heating, which drives climate change. In Germany, the two sectors together account for around one-third of carbon emissions. That's why the German government introduced a carbon price on fossil fuels such as oil and gasoline in 2021. This creates incentives to save energy and make greater use of renewable energies.

The goal is to cover 65% of electricity consumption in Germany with energy from wind, sun, water or biomass by 2030. At the same time, the climate protection program will support climate-friendly housing and electromobility.

The program also aims to promote innovation. For instance, pioneering energy storage and world-leading hydrogen technologies could replace fossil fuels in industry.

The climate protection program thus reduces Germany's carbon emissions. It makes climate-damaging behavior more expensive, promotes climate-friendly action, and offsets higher financial burdens with relief elsewhere. Everyone should be able to participate, because every contribution counts.

*Video length: 1:55 min*

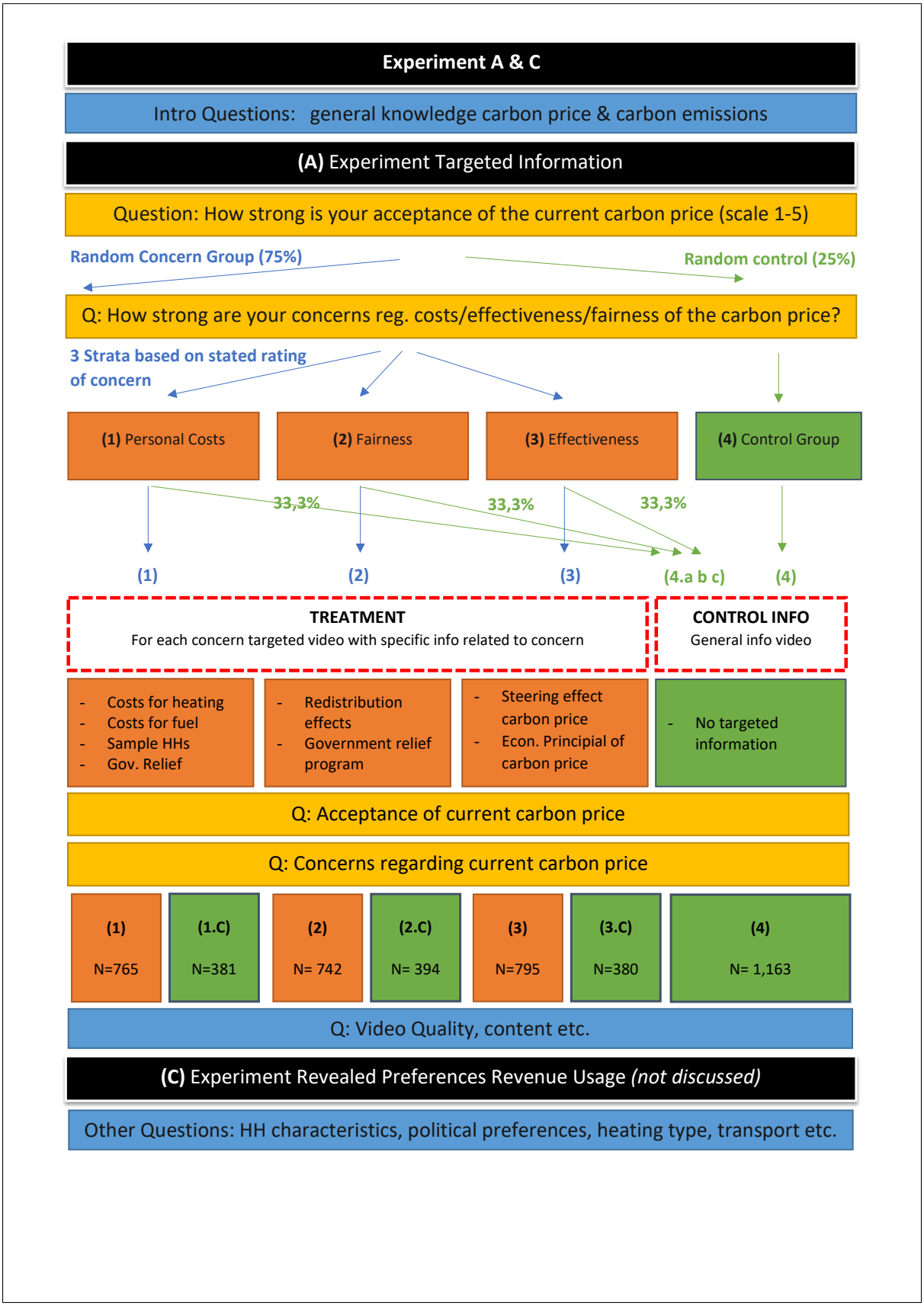
# H Post-Video Evaluation

**Table H.1:** Cross Audience Comparison of Post-Video Evaluation Questions

| | Full Sample | | Cost | | Effectiveness | | Fairness | |
|---|---|---|---|---|---|---|---|---|
| *mean agreement with statement* | T | C | T | C | T | C | T | C |
| I learned something new from the video. | 0.668 | 0.600 | 0.709 | 0.591 | 0.636 | 0.586 | 0.664 | 0.579 |
| The video was too long. | 0.405 | 0.389 | 0.413 | 0.405 | 0.397 | 0.387 | 0.407 | 0.395 |
| The exampkes in the video were relatable. | 0.703 | 0.718 | 0.667 | 0.694 | 0.747 | 0.716 | 0.689 | 0.692 |
| The speaker seems trustworthy. | 0.731 | | 0.713 | | 0.754 | | 0.724 | |
| The speaker seems sympathic. | 0.772 | | 0.759 | | 0.779 | | 0.776 | |
| The speaker seems competent. | 0.763 | | 0.742 | | 0.786 | | 0.760 | |

# I Experimental Setup

**Figure I.1:** Experimental Setup



# J Questionnaire

**Question B1:** On January 1, 2021, a $CO_2$ price was introduced in Germany for the building heat and transport sectors to reduce $CO_2$ emissions. $CO_2$ emissions in these sectors currently account for approximately one third of total $CO_2$ emissions in Germany. The price is €25 per ton of $CO_2$ on all $CO_2$ emissions generated by burning fuels such as gasoline, diesel or heating oil and gas. Please indicate to what extent you agree with the current $CO_2$ price.

- Strongly disagree
- Somewhat disagree
- Neutral
- Somewhat agree
- Strongly agree
- Do not know / not specified

**Question B2:** To what extent do you personally have concerns when it comes to the current $CO_2$ price? In your opinion, how does this relate to ... (*The order of the items is randomized.The respondents indicated their level of concern on a five-point Likert scale.*)

- ...the effectiveness of the $CO_2$ price with regard to climate protection
- ...the resulting increase in heating and driving costs for me
- ...an unfair design of the $CO_2$ price

**Question B2_1:** Where does the $CO_2$ price have the greatest financial impact for you? (*The order of the items is randomized.*)

- When driving
- When heating
- Both equally
- Other
- Do not know / not specified

**Question B3:** In your opinion, to what extent do citizens in Germany have concerns when it comes to the current $CO_2$ price? In their opinion, what are their concerns with regard to ... (*The order of the items is randomized.The respondents indicated the level of Concern on a five-point Likert scale.*)

- ...the effectiveness of the $CO_2$ price with regard to climate protection
- ...the resulting increase in heating and driving costs for me

- ...an unfair design of the $CO_2$ price

**Question B4:** What do you think: What is the approximate percentage of citizens in Germany who agree with the current $CO_2$ price of 25€ per ton of $CO_2$?

- ----------
- Do not know / not specified