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A survey experiment on climate change beliefs, opinions, and actions

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WORKING PAPER SERIES

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A Survey Experiment on Climate Change Beliefs, Opinions, and Actions

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Abstract

We examine how individuals update their views on climate change when exposed to competing advocacy or skeptical signals on social media. In a representative survey experiment of 1,633 adults in Italy, respondents were randomly assigned to one of three conditions: (1) exposure to climate-advocacy content, (2) exposure to climate-skeptical content, or (3) an active control featuring content on gender equality. We elicit beliefs about the reality of climate change and its human causes both before and after treatment, along with climate-related opinions and actions. We first focus on beliefs and interpret their dynamics by developing a structural updating model that nests Bayesian-like updating within a behavioral framework allowing for anchoring to a survey-wide reference point, underreaction to information, and treatment-specific experimenter-demand effects. We find that the advocacy treatment significantly increases beliefs about the reality of climate change but not about human causation, whereas the skeptical treatment shifts beliefs toward skepticism in both domains and with larger magnitude. Underreaction patterns imply opposite belief dynamics: with equally likely advocacy and skepticism signals, intermediate beliefs fluctuate closer to advocacy regarding climate-change reality but closer to skepticism regarding human causation. Opinions and actions are largely mediated by posterior beliefs, though we also detect belief-independent effects, including a backfire in support for a fossil-fuel tax under skepticism and an additional positive effect of advocacy on signing a climate-action petition.

JEL codes: D83, D82, D03, Q54

Keywords: Beliefs Formation, Survey Experiment, Climate Change, Social Media Campaigns.

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1 Introduction

Climate change is one of the greatest threats facing humanity.¹ Rising temperatures and sea levels, more frequent droughts and floods, and food insecurity have helped forge broad political consensus, culminating in the 2016 Paris Agreement, where 197 countries committed to policies to keep warming below 2°C and strengthen adaptation. However, the recent consensus on climate policy has faced setbacks: the EU has softened its 2040 targets² and the US has withdrawn from key climate treaties.³ These political setbacks reflect the volatility of climate change beliefs exacerbated by social media campaigns (Ratter et al., 2012; Scruggs and Benegal, 2012; Lewandowsky et al., 2019). Social networks are especially rich in climate-related content: in 2019, the term “climate change” appeared in an average of 15,914 tweets per day (Repke et al., 2024). Social media are also saturated with contents from organizations, interest groups, lobbyists, and activists promoting either climate advocacy or climate skepticism. Consequently, individuals’ climate change beliefs may be continually updated in response to cues from opposing sides.

Previous experimental studies provided key insights on how targeted information affects beliefs, opinions, and actions related to climate change (see, e.g., Lewandowsky et al., 2019; Tvinnereim et al., 2020; Stoetzer and Zimmermann, 2024; Dechezleprêtre et al., 2025). Dechezleprêtre et al. (2025), for instance, conducted a large-scale experimental survey of more than 40,000 individuals across 20 countries to assess how pedagogical messages about climate impacts and climate policy influence climate beliefs. They find that information about climate policies increases support for climate policy, whereas information about climate impacts primarily increases climate knowledge and encourages private actions such as donating, signing petitions, and adopting climate-friendly behaviors.

These studies are fundamental for designing information campaigns and tailoring policy communication effectively. Indeed, relying on average treatment effect models, they are able to estimate the expected variation in beliefs given the current prior distribution. A common limitation, however, is that they do not model the underlying belief-updating process. This matters in a context where beliefs can shift rapidly with ongoing exposure to competing messages, a non-negligible fraction of respondents is clustered on the top of the scale because they already accept climate change, and responses on contested issues may reflect perceived experimenter expectations, each of which can affect or bias estimated effects.

Because the belief distribution changes as individuals are exposed to signals (e.g., from social media) and update their beliefs, the impact of a given informative provision can also vary. This is true even in a standard model in which beliefs are updated according to Bayes’ rule: the magnitude of belief change induced by a signal depends on the prior distribution.⁴ On top of that, notice that many respondents, particularly those who are younger, more educated, or politically progressive, already express very high levels of concern about climate change, strong belief in its anthropogenic causes, and robust support for mitigation policies. As a result, their responses tend to cluster at the top of the scale, leaving little measurable room

¹<https://www.un.org/sites/un2.un.org/files/2021/08/fastfacts-health.pdf>

²<https://carbonmarketwatch.org/2025/12/10/eus-2040-climate-target-deal-papers-over-massive-emissions-loopholes/>

³<https://www.bbc.com/news/articles/cp80ln97py5o>

⁴See, e.g., eq. (11) in section 3.3 and the ensuing discussion.

for additional shifts. This phenomenon, known as ceiling effect ([Anderson-Cook, 2005](#)), can obscure meaningful treatment effects by compressing variation in the outcome variable and biasing average treatment effect estimates toward zero.

Thus addressing the limitation of this literature, our paper aims to understand how exposure to social media content supporting either climate advocacy or climate skepticism shapes beliefs, and how these belief changes translate into opinions and actions. We seek to avoid conclusions that are specific to a particular prior distribution and to shed light on how beliefs could evolve over time. However, doing so requires inferring the underlying belief-updating process. This is challenging because individuals exhibit behavioral biases that are both intrinsic to their *true* belief-updating process (i.e., the component reflecting what they actually believe about a given subject) and induced by the particular setting used to elicit beliefs (i.e., the experimental environment). In this paper, we address this issue by developing a belief-updating model and estimating its components through an information-provision survey experiment. The model allows us to disentangle true belief updating from experimenter demand effects ([Zizzo, 2010](#); [De Quidt et al., 2018](#)), which may influence recorded posteriors. We model true belief updating as a Bayesian-like process with underreaction ([Epstein et al., 2008, 2010](#); [Bottazzi et al., 2023](#); [Massari, 2025](#)), while experimenter demand effects enter through an *anchoring and adjustment* heuristic ([Tversky and Kahneman, 1974](#); [Antico et al., 2025](#)). The idea is that, while the prior belief can be considered correctly measured (for instance, because it is elicited at the beginning of the survey), the structure of the survey itself (e.g., the sequence or wording of items) may create an anchor in the updating process and thus affect posteriors. This anchor is then modified by an adjustment that combines true belief updating with a component capturing individuals' (conscious or unconscious) willingness to comply with (or counteract) the experimenter's intent. True beliefs are assumed to affect opinions (measured as support for or agreement with a proposition) and actions (choices with real consequences). A number of studies have found a strong correlation between beliefs, opinions, and actions (see, e.g., [Van Valkengoed et al., 2021](#); [Dechezleprêtre et al., 2025](#)). In our experimental and modeling framework, however, we can disentangle their relationship with true (posterior) beliefs from other information-specific effects.

To address our research questions, we use data from a survey experiment conducted between November and December 2024 on a representative sample of the Italian population. The experiment examines how exposure to social media content from climate advocacy and climate-skeptic organizations affects individuals' climate-change beliefs and related behaviors. Respondents were randomly assigned to one of three groups: (i) exposure to X posts from the Intergovernmental Panel on Climate Change (IPCC), the United Nations scientific body that assesses the evidence on climate change and concludes that it is real and primarily caused by human activities; (ii) exposure to X contents from the CO2 Coalition, an organization that promotes skepticism about the risks of carbon dioxide and questions mainstream climate science; or (iii) an active control group presented with X posts unrelated to climate change. To capture belief updating, we elicited prior beliefs about the existence of climate change and its human causes before treatment and reassessed them after treatment. In the framework of our belief updating model, the IPCC treatment is considered a signal supporting climate advocacy, the CO2 treatment is considered a signal supporting climate skepticism, and the active control is considered a non-informative signal. To study links with opinions and actions, we included items on support for climate-adaptation policies and sustainable behaviors (opinions), as well as willingness to share posts, sign petitions, and donate to them (actions). The items used

to elicit priors, posteriors, and opinions are drawn from [Van Valkengoed et al. \(2021\)](#), who validate a climate-change belief scale.

The results support our behavioral belief-updating model. First, over the whole sample, the average prior probability attached to climate change being real is 0.84 with 42% of respondents expressing the highest value on the scale. The average prior probability for climate change being human caused is 0.75 with 31% of respondents expressing the largest value on the scale. These numbers indicate that ceiling effects are possible. Second, the unconstrained estimation of parameters naturally respects the theoretical bounds we have to impose on parameter values to let the belief updating model make sense. This constitutes a consistency check for our framework. Moreover, the statistical significance of key parameters supports the idea that posteriors about reality and human causation of climate change depend nonlinearly on their heterogeneous priors. The estimated parameters indicate that the anchor probability induced by the survey structure is tilted toward climate advocacy, and that the adjustments induced by the information treatments are relatively strong. This suggests that anchoring to the survey structure plays only a limited role in shaping updates. Importantly, genuine variation in beliefs dominates the compliance effect. The average variation in true beliefs shows that the advocacy treatment significantly shifts respondents toward climate advocacy for beliefs about the reality of climate change, while the corresponding shift for beliefs about human causation is not significant. The skepticism treatment, by contrast, induces a significant shift toward climate skepticism in both domains, with largest magnitude than the opposite ones generated by advocacy. These average variations, however, are prior dependent. To understand how beliefs could move over time, we must look at underreaction parameters. Although we find substantial underreaction, the magnitude of these estimated parameters shows that individuals tend to underreact more to skepticism than to advocacy with respect to reality, while they underreact more to advocacy than to skepticism with respect to human causes. This suggests opposite evolutionary patterns for beliefs about the reality of climate change and beliefs about its human causes. This result is further supported by an analysis of the true belief-updating process in a dynamic setting, where individuals may be exposed to one of two signals with given probabilities. In this setting, assuming equal probabilities for the two signals, individuals with non-extreme priors should fluctuate around 0.75 for beliefs about reality and around 0.40 for beliefs about human causes.

Concerning opinions and action, we find that true posterior beliefs play a key role in influencing them and the effects go in the expected direction. Thus, informative treatments about climate change can have an effect on adaptation policies and sustainable behavior opinions and to climate-related actions, but it is likely to be mediated by a shift in beliefs and, since people underreact, the variation can be small and difficult to detect. Interestingly, we find two effects that are not explained by climate change beliefs. The first is a form of back firing with respect the opinion on taxing fossil fuels for the climate skepticism treatment. The second is a further positive effect of the climate advocacy treatment with respect to sign a petition about climate action.

2 Literature Review

Survey experiments have become a central tool to study climate change beliefs and policy preferences (McGrath, 2021). Information provision designs test how targeted messages affect perceptions of scientific consensus, personal beliefs about anthropogenic global warming, and support for mitigation policies. Most studies report significant effects in the expected direction but with heterogeneous magnitudes across samples and treatments (Deryugina and Shurchkov, 2016; Van Der Linden et al., 2015; Diamond et al., 2020; Douenne and Fabre, 2022). Experimental messages span three main areas: statements about scientific consensus, exposures to misinformation, and information on policy options. A large body of work focuses on scientific consensus messaging. Simple statements highlighting near-unanimous agreement among climate scientists reliably raise perceived consensus and, to a lesser extent, personal belief in human-caused climate change, consistent with the “gateway belief” model (Lewandowsky et al., 2013; Deryugina and Shurchkov, 2016; Cook et al., 2016; Van Der Linden et al., 2015; Kerr and Wilson, 2018; Diamond et al., 2020). Effects depend on message format, source credibility, and question wording (Sanz-Menéndez and Cruz-Castro, 2019; Schuldt et al., 2015; Motta et al., 2019), and are moderated by ideology, education, and prior attitudes (Bolsen and Druckman, 2018; Zhang et al., 2018). Another strand examines misinformation and corrective interventions. Exposure to misinformation typically reduces climate concern across partisan lines (Benegal and Scruggs, 2018; Hardy and Jamieson, 2017; McCright et al., 2016; Van Der Linden, 2015). “Inoculation” strategies, warning participants about misleading arguments or providing corrective statements, can counteract these effects, demonstrating the potential for carefully designed debunking messages (Cook et al., 2017; Van Der Linden et al., 2017). A third set of experiments evaluates treatments aimed at shifting policy preferences. Providing information about carbon pricing, dividend schemes, or the economic costs of inaction produces modest average increases in policy support, but effects are weaker and more heterogeneous than those observed for belief change (Douenne and Fabre, 2022; Cantner and Rolvering, 2022; Drews and Van Den Bergh, 2016). Highlighting peer climate-friendly behaviors can influence resistant subgroups, though results vary by political orientation and baseline attitudes (Falk et al., 2021). Other relevant factors associated with climate action support are its perceived effectiveness, distributional impacts, and self-interest (Dechezleprêtre et al., 2025).

Design and measurement choices strongly influence estimated effects across all these domains. Studies differ in whether and how they elicit prior beliefs (Van Der Linden, 2015; Diamond et al., 2020), construct control and treatment conditions (Bolsen and Druckman, 2018; Hardy and Jamieson, 2017), and format interventions from plain text statements to emotionally charged narratives (Gustafson et al., 2020). These methodological differences complicate cross-study comparisons, but also illustrate the range of tools available to study belief formation. Overall, the literature shows that carefully designed survey experiments can shift climate beliefs. Our paper contributes to this literature by implementing a survey experiment that embeds real-world social media content as the information treatment. This design brings the intervention closer to the communication environment in which climate beliefs are actually formed. In addition, and in contrast to most existing studies, which estimate treatment effects through mean differences across groups, we develop a structural model that explicitly captures the process of belief updating by linking priors to posteriors. This approach addresses common limitations of traditional survey experiment designs, including prior-dependent heterogeneous treatment effects and survey-induced experimenter demand effects.

3 Modeling Beliefs, Opinions, and Actions

The theoretical framework guiding our analysis is based on the idea that information provision affects climate change beliefs, opinions, and actions in different ways. We define beliefs as the probabilistic assessment that a given statement is true, opinions as quantitative measures of an individual’s level of support for or agreement with a proposition, and actions as choices an individual makes that can produce real consequences.

Beliefs strongly shape both opinions and actions. Accordingly, our analysis focuses on modeling how climate change beliefs are updated, accounting for biases that are both intrinsic and induced by the experimental setting. In particular, we consider two dimensions of climate change beliefs, following [Van Valkengoed et al. \(2021\)](#): (i) reality (e.g., “climate change is real” or, equivalently, “climate change is occurring”) and (ii) human causes (e.g., “human activities are a major cause of climate change” or “the main causes of climate change are human activities”). For each of these two dimensions, we apply and estimate the belief-updating model introduced below and recover the *true* update, i.e., the component that does not depend on the setting. The posteriors implied by this true update, together with information provision, then shape opinions and actions.

3.1 Belief Updating Model

Consider a situation in which individual of a group of N agents has to evaluate the likelihood of a given statement to be true before and after the provision of some piece of information. As noted above, we consider two statements: one regarding the reality of climate change and one regarding its human causes. To keep the notation as light as possible, we do not use subscripts or superscripts to indicate which statement a variable or parameter refers to; nonetheless, it should be understood that each probability and parameter introduced below pertains to a specific statement.

Each individual builds its beliefs about each statement combining two probabilistic models, i.e. probability distributions $(\pi, 1 - \pi)$ on the state space {statement true, statement false}. The first model supports the truthfulness of the statement and is referred to as the *advocacy model*: $(\pi_a, 1 - \pi_a)$ with $\pi_a \in (0.5, 1)$. The second model, instead, supports the falseness of the statement and is referred to as the *skepticism model*: $(\pi_s, 1 - \pi_s)$ with $\pi_s \in (0, 0.5)$. The individual prior probability agent i attaches to the statement to be true is

$$p_{0,i} = w_{0,i}\pi_a + (1 - w_{0,i})\pi_s, \quad (1)$$

with $w_{0,i} \in (0, 1)$ the probability i assigns to the advocacy model to be the correct one and $1 - w_{0,i}$ the probability assigned to the skepticism model to be the correct one. Information provision changes the probabilities respondents assign to each model to be the true one. In particular, we assume that each individual $i \in \{1, \dots, N\}$ is randomly assigned to one among three groups: A , S , and C . The individuals in group A receive a cue about the truthfulness of the statement (an advocacy treatment), those in S receive a cue about the statement to be false (a skepticism treatment), and the ones in C receive a cue uninformative about the nature of the statement (an active control). The posterior probability of individual i is

$$p_{1,i} = w_{1,i}\pi_a + (1 - w_{1,i})\pi_s, \quad (2)$$

and we assume that the posterior probability assigned to the advocacy model to be the correct one ($w_{1,i}$) follows a Bayesian-like updating rule composed by two parts, one pertaining the way in which agents process information and one driven by the experimental setting. The first part is considered the *true* update in beliefs, that is the actual variation in the likelihood agents assigns to the advocacy model to be the true one. The second one, instead, captures the variation in the likelihood induced by the particular experimental context used to elicit it. On top of that, we assume that both components are influenced by behavioral effects.

More specifically, define the true update in beliefs as

$$w_{1,i}^* = \begin{cases} w_{0,i} & \text{if } i \in C, \\ \phi_1 \frac{\pi_a w_{0,i}}{p_{0,i}} + (1 - \phi_1) w_{0,i} & \text{if } i \in A, \\ \phi_2 \frac{(1 - \pi_a) w_{0,i}}{1 - p_{0,i}} + (1 - \phi_2) w_{0,i} & \text{if } i \in S, \end{cases} \quad (3)$$

with $\phi_1, \phi_2 \in [0, 1]$. As one can see, when exposed to the uninformative cue, the agent does not update its true beliefs, whereas when exposed to one of the two informative cues, the agent updates its true beliefs by combining a Bayesian update with the prior. That is, individuals underreact to information (see, e.g., [Epstein et al., 2008, 2010](#); [Bottazzi et al., 2023](#); [Bohren and Hauser, 2023](#); [Massari, 2025](#)): they update true beliefs in the correct direction, but by an insufficient amount relative to Bayes' rule. This matches the evidence reported by [Edwards \(1982\)](#) on the behavioral bias known as conservatism. We further assume that underreaction may depend on the type of information provided. In particular, the parameters ϕ_1 and ϕ_2 differentiate and modulate the degree of underreaction across the two information treatments: the larger ϕ_1 (ϕ_2), the stronger the effect of the advocacy (skepticism) cue on the true-belief update.

As mentioned above, we obtain $w_{1,i}$ by combining $w_{1,i}^*$ with variation induced by the experimental setting. In particular, survey features that are common across treatments⁵ may generate a shared anchor in the belief-updating process. Thus, belief updating takes the form of an anchor combined with an adjustment characterized by two components: (i) changes in true beliefs, as discussed above, and (ii) an experimenter-demand component, capturing the possibility that individuals respond to being in an experiment by attempting to please (or oppose) the experimenter. Accordingly, we model $w_{1,i}$ as an anchoring-and-adjustment heuristic ([Tversky and Kahneman, 1974](#)) that captures *experimenter demand effects* (both related to structure and to compliance with the experiment, [Zizzo, 2010](#); [De Quidt et al., 2018](#)), while embedding the true belief update in the adjustment term. Finally, both the strength of adjustment and the degree of compliance may vary with the information provided. Formally, we assume

$$w_{1,i} = \begin{cases} \mu_0 w_{1,i}^* + (1 - \mu_0) \lambda & \text{if } i \in C, \\ \mu_1 \left(\theta_1 w_{1,i}^* + 1 - \theta_1 \right) + (1 - \mu_1) \lambda & \text{if } i \in A, \\ \mu_2 \theta_2 w_{1,i}^* + (1 - \mu_2) \lambda & \text{if } i \in S, \end{cases} \quad (4)$$

where $\lambda \in [0, 1]$ is the induced anchor probability of the statement to be true, $\mu_0, \mu_1, \mu_2 \in [0, 1]$ are the parameters capturing the strength of adjustment induced by the information provision

⁵E.g., the sequence of questions following the elicitation of priors and proceeding the measurement of the posterior, the exact wording of the item used to elicit the posterior, etc.

(active control, advocacy, and skepticism, respectively), θ_1, θ_2 are the parameters regulating the compliance with the experimental setting for, respectively, advocacy and skepticism. This belief-updating model extends the anchoring-and-adjustment framework of Antico et al. (2025) by integrating the true-belief update in (3) (inspired by Epstein et al., 2008, 2010) and by introducing an explicit compliance component.⁶ In the case $\mu_0 = \mu_1 = \mu_2 = 0$, the posterior probability is fully induced by the anchor probability λ and the information provided to individuals does not have any influence. When $\mu_j \in (0, 1)$, $j \in \{0, 1, 2\}$, the individual form their posterior probability as an information-specific convex combination of the anchor and the update driven by the information provision. Such an update is built combining the true one in (3) with the one induced by a conscious or unconscious willingness of the individual to comply with the experiment. In our setting, that simply amounts to consider an update equal to 1 if $i \in A$, i.e. the largest possible change in beliefs as a consequence of a cue in favor of the truthfulness of statement, and an update equal to 0 if $i \in S$, i.e. the largest possible change in beliefs as a consequence of a cue in favor of the falseness of statement. The parameters θ_1 and θ_2 modulate the relative strength of the two components in the two cases. More specifically, θ_j , $j = 1, 2$, close to zero indicates that beliefs do not really change because of a (more or less) standard process of updating, but because of some induced and prior-independent adjustment (possibly) related to the experimental setting. Such an effect decreases as θ_j approaches 1 and is reverted as the parameter exceeds such a threshold. That is, θ_1 and θ_2 can be larger than 1 (but not too large) to accommodate a form of *backfiring*: instead of complying with the experimenter's intents, individuals may want to go against them showing an adjustment smaller in magnitude than the one actually generated. As previously mentioned, these parameters cannot be too large: to ensure $w_{1,i} \in [0, 1]$ we assume that

$$\theta_1 \in \left[0, 1 + \frac{1 - \mu_1}{\mu_1} \lambda\right] \quad \text{and} \quad \theta_2 \in \left[0, 1 + \frac{1 - \mu_2}{\mu_2} (1 - \lambda)\right].$$

Notice that the prior-independent part of the adjustment may also be driven by some emotional response, not directly linked to the experiment itself but to the characteristics of the information provisions. Indeed, it is likely that the parameters θ_1 and θ_2 capture a combination of both effects. Nonetheless, since we shall use our model to understand whether a particular form of information diffusion through social media can generate an update in the true belief updating, disentangling between the two effects is not particularly relevant for the present study. Indeed, in what follows, we shall estimate the parameters of our model for two dimension of climate change beliefs (*climate change is real* and *climate change is caused by humans*) and pay particular attention to the values of ϕ_1 and ϕ_2 . If those parameters turn out to be significantly different from zero, then our model allows us to say that, after controlling for possible experimenter demand effects and/or emotional reactions, the information diffusion operated via social media is effective in letting beliefs change. Moreover, the true update in beliefs is key for opinion and action formation.

3.2 Opinions and Actions Models

Formally define the true posterior belief of individual i as $p_{1,i}^* = \pi_a w_{1,i}^* + \pi_s (1 - w_{1,i}^*)$: that is the likelihood i assigns to the statement to be correct after the information provision and

⁶The model of Antico et al. (2025) is recovered setting $\mu_0 = \mu_1 = \mu_2$ and $\phi_1 = \phi_2 = \theta_1 = \theta_2 = 1$. Moreover, Bayes rule emerges as the special case obtained setting $\mu_0 = \mu_1 = \mu_2 = \phi_1 = \phi_2 = \theta_1 = \theta_2 = 1$.

removing all the biases related to the experimental setting. This quantity is assumed to influence opinions and actions. In particular, we assume that opinions and actions are influenced both by the information provision and by the true posterior beliefs about reality and human causes of climate change. In particular, call $p_{1,i}^{*,r}$ the true posterior belief about climate change being real of individual i and $p_{1,i}^{*,h}$ the true posterior belief about climate change being human caused of individual i . Then, define

$$T_i^A = \begin{cases} 1 & \text{if } i \in A, \\ 0 & \text{otherwise,} \end{cases} \quad \text{and} \quad T_i^S = \begin{cases} 1 & \text{if } i \in S, \\ 0 & \text{otherwise,} \end{cases}$$

the opinion of i about proposition x is assumed to be constructed linearly combining the true posterior beliefs with treatment-specific effects that do not pertain to beliefs. That is

$$o_{x,i} = \eta_0 + \eta_1 T_i^A + \eta_2 T_i^S + \eta_3 p_{1,i}^{*,r} + \eta_4 p_{1,i}^{*,h}. \quad (5)$$

For actions, we first focus on binary choices and use a linear probability model. Specifically, individual i chooses action y with a probability that linearly depends on true posterior beliefs and treatment-specific effects not related to beliefs, i.e.

$$\Pr(a_{y,i} = 1) = \delta_0 + \delta_1 T_i^A + \delta_2 T_i^S + \delta_3 p_{1,i}^{*,r} + \delta_4 p_{1,i}^{*,h}. \quad (6)$$

Finally, we consider an action involving an amount of money that the individual states it would like to donate. Even in this case, the mathematical form of the model follows the same linear structure described above: the amount chosen by individual i is

$$d_i = \psi_0 + \psi_1 T_i^A + \psi_2 T_i^S + \psi_3 p_{1,i}^{*,r} + \psi_4 p_{1,i}^{*,h}. \quad (7)$$

3.3 Econometric Estimation and Average Treatment Effects

Concerning beliefs, substituting (1) in (3), (3) in (4), and (4) in (2), one can obtain an econometric model suitable for estimation with OLS. Assume that the recorded prior $P_{0,i}$ is a precise measure of the prior ($P_{0,i} = p_{0,i}$), while the recorded posterior $P_{1,i}$ is affected by an error ($P_{1,i} = p_{1,i} + \varepsilon_i$ with ε_i strictly exogenous), one obtains

$$P_{1,i} = \beta_0 + \beta_1 P_{0,i} + \beta_2 T_i^A + \beta_3 T_i^S P_{0,i} + \beta_4 \frac{T_i^A}{P_{0,i}} + \beta_5 T_i^S + \beta_6 T_i^S P_{0,i} + \beta_7 \frac{T_i^S}{1 - P_{0,i}} + \varepsilon_i, \quad (8)$$

where $\beta_0, \dots, \beta_7$ are functions of the structural parameters $\lambda, \mu_0, \mu_1, \mu_2, \phi_1, \phi_2, \theta_1, \theta_2, \pi_a, \pi_s$.⁷

The standard econometric model commonly used to estimate Average Treatment Effects (ATEs) is a special case of (8). In our theoretical setting, the standard ATE model is correctly specified in two (rather opposite) situations. The first is the ideal experimental setting: no experimenter demand effect ($\mu_0 = \mu_1 = \mu_2 = \theta_1 = \theta_2 = 1$) and homogeneous prior ($p_{0,i} = p_0 \forall i$). In such a case, (8) reduces to

$$P_{1,i} = P_0 + \phi_1 \frac{(\pi_a - P_0)(P_0 - \pi_s)}{P_0} T_i^A - \phi_2 \frac{(\pi_a - P_0)(P_0 - \pi_s)}{1 - P_0} T_i^S + \varepsilon_i.$$

⁷See Appendix A for the underlying mathematical derivations and functional forms.

Thus, the estimated constant is directly informative of the common prior, while, assuming that π_a and π_s are known and $P_0 \in (\pi_s, \pi_a)$,⁸ the estimated coefficients on the treatment dummies are informative of ϕ_1 and ϕ_2 . In particular, the advocacy and skepticism treatments affect beliefs if and only if $\phi_1 \neq 0$ and $\phi_2 \neq 0$, respectively. This further reinforces the earlier point about the importance of these two parameters in our setting: in an ideal experiment, they determine the strength of the observed ATEs. The second case in which the standard ATE model is correctly specified is when the prior is heterogeneous and the belief update is purely driven by the experimenter demand effect. In terms of parameters that amounts to $\theta_1 = \theta_2 = \mu_0 = 0$. Under such an assumption, one has $\beta_1 = \beta_3 = \beta_4 = \beta_6 = \beta_7 = 0$ and the standard ATE model is recovered. Hence, estimating such a constrained version of (8) within our framework, under heterogeneous prior beliefs and assuming correct specification, implies that the observed effects are purely driven by the experimental setting. Along similar lines, if one estimates (8) and the five coefficients $\beta_1, \beta_3, \beta_4, \beta_6, \beta_7$ are not significantly different from zero, it is likely that the observed effects stem from experimenter demand effects.

Neglecting the ensuing model misspecification and proceeding to estimate an ATE model generates some issues in the interpretation of coefficients. Suppose, for instance, that one estimates the model

$$P_{1,i} = \gamma_0 + \gamma_1 T_i^A + \gamma_2 T_i^S + u_i, \quad (9)$$

with OLS (thus, considering u_i as strictly exogenous) when $P_{1,i}$ is as in (8). Assuming that $\forall X \in \{A, S, C\}$ it is $E[P_{0,i}|i \in X] = E[P_0]$, $E[1/P_{0,i}|i \in X] = E[1/P_0]$, $E[1/(1 - P_{0,i})|i \in X] = E[1/(1 - P_0)]$, $T_i^k \sim \text{Bernoulli}(1/3) \forall i$ with $k \in \{A, S\}$, $E[T_i^A T_i^S] = 0$, and $(T_i^A, T_i^S) \perp P_{0,i}$; from the moment conditions implied by strict exogeneity, one obtains

$$\begin{aligned} \gamma_0 &= \beta_0 + \beta_1 E[P_0], \\ \gamma_1 &= \beta_2 + \beta_3 E[P_0] + \beta_4 E\left[\frac{1}{P_0}\right], \\ \gamma_2 &= \beta_5 + \beta_6 E[P_0] + \beta_7 E\left[\frac{1}{1 - P_0}\right]. \end{aligned} \quad (10)$$

One immediately notices that the coefficient γ_1 and γ_2 cannot be directly and unambiguously linked to structural parameters. That is, those quantities are largely silent on whether an observed effect is driven by the setting or by a genuine variation in beliefs. Moreover, the magnitude of these effects depends on the prior distribution. Indeed, note that, even with a carefully designed unbiased experimental setting, looking at ATEs one may fail to detect changes in beliefs even when beliefs do respond to information. This occurs because of a prior distribution too concentrated on one side of its domain (i.e., ceiling or floor effect). To see this, assume that agents exhibit no bias and update beliefs according to Bayes' rule ($\mu_0 = \mu_1 = \mu_2 = \theta_1 = \theta_2 = \phi_1 = \phi_2 = 1$). Estimating the ATE model by OLS under these assumptions yields

$$\begin{aligned} \gamma_0 &= E[P_0], \\ \gamma_1 &= \pi_a + \pi_s - E[P_0] - \pi_a \pi_s E\left[\frac{1}{P_0}\right] \leq \frac{(\pi_a - E[P_0])(E[P_0] - \pi_s)}{E[P_0]}, \\ \gamma_2 &= \pi_a + \pi_s - 1 - E[P_0] + (1 - \pi_a)(1 - \pi_s) E\left[\frac{1}{1 - P_0}\right] \geq -\frac{(\pi_a - E[P_0])(E[P_0] - \pi_s)}{1 - E[P_0]}, \end{aligned} \quad (11)$$

⁸In our framework, this assumption excludes the possibility that individuals are ex ante convinced that either the advocacy model or the skepticism model is the correct one.

where the inequalities follow from Jensen's inequality. Therefore, (i) treatment coefficients depend on the prior distribution through its mean; and (ii) if $E[P_0]$ is close to either π_a or π_s , the coefficients become small and hard to detect. Importantly, this occurs even when individuals update beliefs in the least biased way, namely, according to Bayes' rule. Consequently, as individuals are exposed to a sequence of signals that shifts the belief distribution, previously estimated coefficients may no longer be informative about the effects of additional information provisions. For instance, in the Bayesian case, if ATEs are estimated under a prior distribution concentrated near one boundary of the domain, and subsequent signals move beliefs toward the center of the support, then the effect of a further information provision will be underestimated.

Controlling for the prior may mitigate the problems, but it does not solve them. In such a case, one estimates with OLS a model of the form

$$P_{1,i} = \gamma_0 + \gamma_1 T_i^A + \gamma_2 T_i^S + \gamma_3 P_{0,i} + u_i. \quad (12)$$

Under the same assumptions made in advance, from the moment conditions one obtains γ_1 and γ_2 as in (10), while the other coefficients are

$$\begin{aligned} \gamma_0 &= \beta_0 - \frac{E[P_0]}{3} \left(\beta_3 + \beta_4 \frac{\text{Cov}[P_0, 1/P_0]}{V[P_0]} + \beta_6 + \beta_7 \frac{\text{Cov}[P_0, 1/(1-P_0)]}{V[P_0]} \right), \\ \gamma_3 &= \beta_1 + \frac{1}{3} \left(\beta_3 + \beta_4 \frac{\text{Cov}[P_0, 1/P_0]}{V[P_0]} + \beta_6 + \beta_7 \frac{\text{Cov}[P_0, 1/(1-P_0)]}{V[P_0]} \right). \end{aligned}$$

Thus, OLS estimation of (12) yields ATE estimates that are theoretically equivalent to those obtained from (9), while offering the additional advantage that controlling for the prior may improve precision. Again, this reduced-form model is largely silent about the underlying structural parameters. Controlling for the prior can increase precision and help detect effects that are small because prior beliefs are concentrated near one side of the domain. However, the estimated effect still depends on the current distribution of priors. Thus, even in settings where individuals are completely unbiased, ATE is informative only about how an information intervention shifts beliefs given the present distribution of beliefs. As that distribution changes, the ATE estimates no longer identify what would happen under an additional information provision.

Concerning opinions, we estimate OLS linear models akin to (5). Since the true posteriors $p_{1,i}^{*,r}$ and $p_{1,i}^{*,h}$ are not observed, we proxy them with plug-in estimates $\hat{p}_{1,i}^{*,r}$ and $\hat{p}_{1,i}^{*,h}$ obtained substituting in the equations the recorded priors and the estimated values for the parameters $(\pi_a, \pi_s, \phi_1, \phi_2)$ derived from the previous exercise. We then estimate, for each proposition x , the following econometric specification:

$$O_{x,i} = \eta_0 + \eta_1 T_i^A + \eta_2 T_i^S + \eta_3 \hat{p}_{1,i}^{*,r} + \eta_4 \hat{p}_{1,i}^{*,h} + v_{x,i}, \quad (13)$$

where $O_{x,i}$ denotes individual i 's observed opinion about proposition x , and the disturbance term $v_{x,i}$ is assumed to be strictly exogenous. The ATE (treatment-only) regression is obtained by imposing the restrictions $\eta_3 = \eta_4 = 0$ in (13). If the true model is (13) with η_3 and/or η_4 nonzero, but one nonetheless estimates the restricted ATE regression, the resulting treatment coefficients recover total (reduced-form) effects, that is, direct effects plus belief-mediated components with weights determined by the belief-updating rule. Hence, the treatment-only specification cannot disentangle the contribution of beliefs from other belief-independent channels. The same procedure is followed for actions and similar econometric set-ups and considerations apply.

In what follows, after describing our experimental setting and data, we focus on beliefs about the reality of climate change and its human causes. For each dimension, we first estimate the reduced-form models in (9) and (12) by OLS with heteroskedasticity-robust standard errors, to account for the potential heteroskedasticity induced by misspecification and bounded posteriors. This allows us to evaluate average treatment effects (ATEs) and to provide results comparable with those in the literature. We then estimate the structural model in (8) by OLS for both dimensions and recover the underlying parameter values from the estimated β coefficients. We then turn to opinions and actions. Here as well, we estimate both standard ATE specifications and structural ones, leveraging the estimated true beliefs obtained from the previous exercise.

4 Experimental survey

This section outlines our experiment, including detailed information on data collection and the survey.

4.1 Survey data collection and sample

We collected our data by conducting an experimental survey between November and December 2024. The research protocol, including the hypotheses tested and the questionnaire, was submitted in August 2024 and received ethical approval from the Joint Ethical Committee for Research of the Scuola Superiore Sant’Anna and the Scuola Normale Superiore on November 15, 2024. We designed our survey in both Italian and English using the online platform Qualtrics and distributed it with the support of our data collection partner, SWG. The sample was constructed to be representative of the Italian population aged 18–64, accounting for sociodemographic characteristics, public attitudes, and geographical distribution. Our partner ensures that the sample is representative of the Italian population, not only demographically, but also in terms of public opinion.⁹ The latter is particularly relevant in our case since we examine beliefs related to climate change that are part of an individual’s public view. Respondents who completed the survey received small cash rewards as compensation, incentivizing attentive participation. We collected 2,210 responses, with a median completion time of 6.6 minutes. In our survey, we included several attention and quality checks, to ensure the quality of responses, we excluded inattentive respondents and individuals who completed the survey in less than 4 or more than 60 minutes. Following this quality control step, our final sample comprises 1,633 respondents. Our results are robust to varying thresholds for acceptable completion times. In terms of geographic location of the respondents, our respondents are fairly well distributed across Italy, as illustrated in Figure C1 in the Appendix. Figure C2 in the Appendix compares our sample with the Italian population and illustrates the representativeness of our sample in terms of key sociodemographic characteristics. While the overall sample composition aligns with the general population, it differs slightly in terms of education. Our sample presents a larger share of college-educated respondents. This discrepancy is typical of online

⁹SWG has extensive experience in monitoring Italian public opinion and launched a continuous observatory in 1997. See additional information on their website <https://www.swg.it/chisiamo>, accessed February 2026.

survey samples, which are known to over-represent relatively more educated groups (see [Alsan et al., 2023](#); [Stantcheva, 2021, 2023](#)). While online survey results warrant careful interpretation, since the “online population”, often urban and more educated, might differ somewhat from the broader public ([Dechezleprêtre et al., 2025](#)), our data collection partner employs sampling strategies designed to reflect Italian public views and electoral outcomes, thereby mitigating this concern.

4.2 Survey Experiment

Our survey experiment is designed to test how exposure to social media content from climate advocacy and climate-skeptic organizations affects individuals’ climate-change beliefs and related behaviors. The survey is structured in four blocks. Block 0 introduces the survey and collects sociodemographic information. In Block 1, we elicit respondents’ beliefs regarding the existence and significance of Anthropogenic Climate Change (ACC) and we assess individual prior beliefs. Block 2 is the randomization layer, where individuals are randomized in three blocks (2a, 2b, or 2c) containing either the control or the two information treatments. Finally, in Block 3, we ask additional questions about climate change and related policies to assess posterior beliefs and actions. Appendix B presents our survey, and Appendix Figure C3 shows the block structure.

4.2.1 Socio-demographic Background

Block 0 opens with an introduction to the survey and a consent form outlining the use of personal data, data protection measures, and privacy rights, assuring respondents of the survey’s anonymity. It also includes instructions for completing the survey and emphasizes the presence of quality checks, warning that low-quality responses will be discarded (see [Colonnelli et al., 2024](#)). Next, respondents are asked three sociodemographic questions about their year of birth, gender, and income class. To conceal the survey’s experimental purpose, encourage honest responses, and maintain a high-quality experience for the control group, we frame its primary objective as “*understanding your views on current popular topics*.” We then introduce and define “*two of the most discussed topics in the public debate*”, climate change and the gender pay gap, to establish a common understanding among all participants. To ensure consistency, we incorporate questions on both topics throughout the survey.

4.2.2 Prior Beliefs on Climate Change

In Block 1, we assess respondents’ prior beliefs regarding climate change. This block contains seven questions evaluating respondents’ opinions on specific statements: five pertain climate change, while two focus on gender roles and gender equality.

The climate change-related questions are drawn from the validated questionnaire by [Van Valkengoed et al. \(2021\)](#). The authors provide a comprehensive mapping of climate beliefs across five dimensions: reality (the extent to which people believe climate change is happening); causes (whether people attribute climate change to human activity or natural factors);

consequences (whether people perceive climate change’s effects as negative or positive); spatial distance (whether people see these effects as occurring nearby or far away); and temporal distance (whether they believe the consequences will occur soon or in the distant future). This theoretical distinction between climate change perceptions has been validated in the literature (e.g., [Bostrom et al., 2012](#); [Heath and Gifford, 2006](#); [Zawadzki et al., 2020](#)). Research indicates that beliefs about the reality of climate change, its human causation, and its negative consequences are distinct constructs that independently contribute to explaining outcomes such as mitigation behaviors and support for climate policies. [Van Valkengoed et al. \(2021\)](#) demonstrate that the selected items exhibit a high degree of internal consistency, indicating that, although distinct, they measure the same general construct ([Tavakol and Dennick, 2011](#)). This makes them particularly well-suited for eliciting the same class of beliefs pre- and post-treatment without repeating the exact phrasing of questions, which could otherwise amplify experimenter demand effects, introduce biases, or increase attrition.

Finally, the two questions on gender issues help mitigate potential experimenter demand effects, masking the aim of our experiment and creating a coherent questionnaire experience for participants in the active control group, who will later be exposed to social media content related to gender-related themes.

4.2.3 Information Provision

In Block 2, we implement our information treatments by exposing respondents to different social media content. Participants are randomly assigned to one of three groups during the information provision phase: 2a. T^C is the active control group exposed to social media content from the European Institute for Gender Equality (EIGE); 2b. T^S is the treatment group exposed to climate change skepticism content from the CO2 Coalition (CO2); 2c. T^A is the treatment group exposed to climate advocacy content from the Intergovernmental Panel on Climate Change (IPCC), the UN agency that supports climate policies.

Each block follows the same structure: an introductory page presents the organization’s name and mission, followed by three posts shared on X from their official accounts.¹⁰ Each post appears on a separate page with a few explanatory points. To ensure engagement, we implement attention checks, tracking metrics such as clicks and time spent on each page. Additionally, the “Next” button was disabled for 10 seconds, allowing respondents to have adequate time to review the material. Below, we describe the treatment content in detail.

Block 2a Control (C). The individuals assigned to the active control group C are shown content posted on the social media platform X from the European Institute for Gender Equality (EIGE) profile page, addressing the issue of the Gender Pay Gap, a topic unrelated to climate change. This assignment is expected to have no significant effect on climate-related beliefs, opinions, and actions. EIGE is a decentralized agency of the European Union (EU) that conducts independent research promoting best practices to advance gender equality and eliminate discrimination. EIGE creates tools and offers technical support for integrating gender equality into policies and collaborates with a wide range of stakeholders, including EU institutions,

¹⁰We embedded the posts using X’s official embedding tool.

Member States, NGOs, research bodies, and the media.¹¹

The first post shows information about the gender pay gap in the European Union. It states that, on average, women earn 16% less than men, and as a result, November 4 marks the symbolic day when women stop being paid for the rest of the year compared to their male counterparts. The post includes a striking visual of a train platform warning sign that typically reads “MIND THE GAP”, but has been edited to include the word “PAY” in red, reinforcing the message about wage disparity. The second post addresses the gender pay gap in relation to work-life balance, particularly among couples with children. The accompanying text explains that the most significant earnings gap is found in households where family responsibilities fall disproportionately on women. The image itself features a father and child engaged in an activity, suggesting the importance of shared caregiving responsibilities in achieving greater gender equality. The post promotes the idea that tackling the gender pay gap requires policies that support a better balance between work and family life. The third post shifts focus to education and gender segregation in the labor market. Published on the International Day of Education, the post emphasizes that gender stereotypes continue to shape and limit the choices men and women make in their careers, ultimately affecting their economic opportunities. The illustration features a stylized representation of education, with books, a graduation cap, and people engaged in learning activities. The message reinforces the need to challenge traditional gender roles in education to create a more equitable labor market.

Block 2b Skepticism Treatment (S). The *S* treatment group is exposed to content posted from the social media “X” profile page of the CO2 Coalition. The CO2 Coalition is an advocacy group challenging common scientific knowledge about climate change. It aims to actively engage in the ongoing dialogue on climate change, addressing topics such as human impact, the limitations of climate models, and the implications of regulating CO2 emissions. Chaired by Dr. William Happer, Professor Emeritus at Princeton University, and including Nobel Laureate Dr. John F. Clauser among its members, the coalition promotes the view that carbon dioxide (CO2) is essential for life and beneficial to the planet. On their website they describe themselves as a foundation with the purpose of educating “about the important contribution made by carbon dioxide to our lives and the economy”.¹²

Tax records obtained by the Climate Investigations Center show that the CO2 Coalition has received over \$1 million in funding from foundations backing conservative causes and from individuals associated with the energy industry.¹³

Representing anti-climate lobbies, their information content is directed at minimizing the impact of climate change or humans’ role in climate change, and is expected to shift subjects’ beliefs in the direction of increased skepticism toward climate change. The first item displayed is a social media post from the CO2 Coalition, questioning the correlation between CO2 levels and temperature throughout geological history. It includes a graph that displays reconstructed atmospheric CO2 concentrations and global mean surface temperatures over millions

¹¹More information on their website <https://eige.europa.eu/about>.

¹²More information about the CO2 Coalition is available on their website <https://co2coalition.org/about-us/>.

¹³See <https://www.science.org/content/article/physicist-leading-trump-s-adversarial-climate-review-also-led-group-touting-carbon> and <https://www.influencewatch.org/non-profit/the-co2-coalition/>

of years. The post implies skepticism about a direct relationship between CO₂ and temperature changes. The second post claims that increased CO₂ levels contribute to higher agricultural production. It features a graph showing the rise in grain production (including wheat, rice, and coarse grains) alongside increasing CO₂ levels and global temperatures. The message suggests that CO₂ has played a beneficial role in global food production. The third post discusses climate change consensus, stating that there is no evidence that human activity is making the climate worse. It argues that higher CO₂ levels and natural warming have benefited agriculture and ecosystems. The image includes a quote attributed to Galileo, which suggests that scientific consensus should not outweigh individual reasoning.

Block 2c Advocacy Treatment (A). Finally, the treatment group A is exposed to content posted from the social media “X” profile page of the Intergovernmental Panel on Climate Change (IPCC). IPCC is the UN agency supporting climate policies. IPCC is responsible for assessing the science related to climate change. It reviews and synthesizes the latest scientific research to provide policymakers with comprehensive, objective, and policy-relevant information on climate change, its impacts, risks, and potential adaptation and mitigation strategies. The IPCC does not conduct original research but compiles and evaluates studies from scientists around the world to inform global climate action.¹⁴ This content is directed at highlighting the impact of climate change and the role played by industrial emissions caused by humans’ activity. Their information is expected to shift subjects’ beliefs in the direction of increased advocacy for policies and behaviors contrasting climate change. The first item displayed the IPCC X post shared on World Meteorological Day. The post highlights that 2023 was confirmed as the warmest year on record by the World Meteorological Organization (WMO) and provides a link to the IPCC’s Synthesis Report. It features a graph illustrating global temperature change and its impact on different generations. The graph shows global temperature change from 1900 to 2100, with projections based on different emission scenarios. The graph is framed with statements emphasizing the intensifying adverse impacts of human-caused climate change and how the choices made now will determine the severity of those impacts for current and future generations. The second post states that human-induced climate change is already affecting many weather and climate extremes globally. It lists heatwaves and fire weather, heavy rainfall and flooding, and droughts. The image associated with the post shows a city skyline under a bright, intense sun, possibly representing a heatwave. Finally, the last post of the treatment highlights the importance of universal water and energy access in reducing poverty, improving well-being, and building resilience to adverse climate impacts. The post includes an image showing a child standing in a dry, cracked landscape.

4.2.4 Posterior Beliefs, Opinions, and Actions Related to Climate Change

After the information treatment is administered, we collect posterior beliefs in Block 3. The block begins with attitudinal questions on gender roles, asking participants to evaluate the statement that women have it harder than men in contemporary society and to indicate their agreement with the claim that men’s greater involvement in household chores has made it more difficult for families to secure sufficient income. These items are intended to function as masking instruments designed to mitigate potential experimenter demand effects and to ensure that

¹⁴More information about the IPCC are available on their website <https://www.ipcc.ch/about/>

participants in the active control group experience a coherent questionnaire structure. The block then proceeds to items on individual behavioral choices with climate and lifestyle relevance. Respondents are asked about the likelihood of purchasing insurance against natural hazards, their willingness to replace car use with cycling or public transportation, and their stance on eating red meat at dinner. These questions address practices that connect to adaptation, mitigation, and everyday lifestyle. Next, the block elicits support for policy interventions, specifically higher taxation on fossil fuels and investment of public funds to improve the resilience of critical infrastructure to climate risks. This component provides an indication of respondents' orientation toward collective solutions to climate challenges. The choice of these questions was done again drawing from the item pool collected by [Van Valkengoed et al. \(2021\)](#).

Most importantly, the final block (Block 4) contains again two questions that focus directly on respondents' beliefs about the reality and causes of climate change. The initial item presents the statement "climate change is NOT occurring" and asks participants to indicate their level of agreement on a continuous response scale. The second item complements the first by addressing causal attribution: respondents are asked to rate their agreement with the statement "the main causes of climate change are human activities." These two items are particularly important in our design as they represent rephrased versions of two questions asked before the information provision. Their function is to measure as directly as possible the shift in beliefs induced by the treatments.¹⁵

Finally, two questions that involve "real stakes" on the part of the respondent, namely about the propensity to share a social media post, and a petition to sign and to donate to, respectively. More in detail, we presented respondents with three different social media posts, each originating from a distinct treatment block: one from the Intergovernmental Panel on Climate Change (IPCC), one from the CO2 Coalition, and one from the European Institute for Gender Equality (EIGE). As specified above, these organizations represent different perspectives on climate change, with IPCC advocating more decisive action against it, the CO2 Coalition supporting a skeptic position, and the European Institute for Gender Equality acting as an active control. This item allows us to gauge respondents' inclinations toward sharing content from the different sources. Following this, we introduced respondents to two petitions, each addressing a distinct social issue. The first petition, titled "Ask COP26 Leaders to Take Urgent Action Against Climate Change", advocates for stronger global measures to combat climate change. The second petition, titled "Close the Gender Inequality Gap", focuses on addressing gender disparities. We then asked participants whether they would be willing to sign one of these petitions—or if they would prefer not to sign either. Finally, we assessed respondents' willingness to financially support their chosen cause. Given a hypothetical budget of 50 euros, we asked how much they would be willing to allocate as a donation to the petition they supported. To reinforce the credibility of this exercise, the researchers committed to making an actual donation equivalent to the average amount chosen by respondents, ensuring that participants' stated preferences could have a tangible impact.

¹⁵We selected these two items among others because they correspond most closely to the "Reality" and "Causes" dimensions identified in Block 1 of the oblique multiple group method study by [Van Valkengoed et al. \(2021\)](#). Moreover, they appear among the three items retained in their final version of the validated scale for each dimension.

	(1) All Mean [SD]	(2) Control Mean [SD]	(3) T^S Mean [SD]	(4) T^A Mean [SD]	(5) Univariate T^S	(6) Balance T^A	(7) Joint T^S	(8) Balance T^A
<i>Socio-Economic Characteristics:</i>								
Age	45.97 [12.47]	46.35 [12.33]	46.22 [11.97]	45.35 [13.07]	-0.000 (0.852)	-0.001 (0.191)	-0.000 (0.870)	-0.001 (0.287)
Male	0.47 [0.50]	0.48 [0.50]	0.46 [0.50]	0.48 [0.50]	-0.027 (0.377)	-0.003 (0.911)	-0.035 (0.262)	-0.005 (0.871)
Income	2.06 [0.99]	2.01 [0.98]	2.1 [0.99]	2.08 [0.99]	0.023 (0.138)	0.017 (0.274)	0.022 (0.161)	0.019 (0.238)
<i>Priors:</i>								
Climate Change is Real	0.84 [0.22]	0.82 [0.23]	0.84 [0.22]	0.85 [0.22]	0.001 (0.147)	0.001* (0.079)	0.001 (0.599)	0.001 (0.246)
Humans Caused Climate Change	0.75 [0.25]	0.73 [0.26]	0.75 [0.25]	0.76 [0.24]	0.001 (0.204)	0.001* (0.074)	0.000 (0.870)	0.001 (0.320)
Negative Consequences	0.81 [0.22]	0.80 [0.23]	0.81 [0.22]	0.82 [0.21]	0.000 0.546	0.001 0.426	-0.001 (0.277)	-0.001 (0.358)
Negative Local Effects	0.71 [0.22]	0.69 [0.23]	0.73 [0.22]	0.71 [0.22]	0.002** (0.011)	0.001 (0.457)	0.002** (0.037)	-0.001 0.476
Effects Close in Time	0.62 [0.28]	0.61 [0.28]	0.62 [0.28]	0.63 [0.27]	0.001 (0.33)	0.001 (0.215)	0.000 (0.857)	0.000 (0.632)
Women's Rights Progress	0.69 [0.27]	0.68 [0.27]	0.69 [0.27]	0.70 [0.27]	0.000 (0.689)	0.001 (0.283)	-0.000 (0.524)	0.000 0.674
Observations	1633	542	541	550	1083	1092	1083	1092
F-test P-value							0.2895	0.5439

Table 1: Summary statistics on socio-demographic characteristics and prior beliefs as well as the balance between treatment and control groups in our experiment. Column 1 reports mean and standard deviation of our sample of survey respondents, while column 2, 3, 4 shows the same for the control and the two treatment groups. We check for balance in two ways: (i) through univariate regressions of an indicator variable equal to 1 if the individual is subject to a given treatment on each demographic characteristic separately (columns 5-6), and (ii) through multivariate regressions of an indicator variable equal to 1 if the individual is subject to a given treatment on all demographic characteristics jointly (columns 7-8). The sample for each column consists of all individuals in the specific treatment group and all individuals in the control group.

4.3 Data Construction and Sample Balance

The questionnaire included a variety of response formats, such as sliders ranging from 1 to 100, 7-point Likert scales, and binary choices. To enhance the survey experience and maintain respondent engagement, some items were phrased so that higher values indicated stronger agreement with climate change acceptance or liberal viewpoints, while others were phrased in the opposite direction. This approach helped mitigate common response biases such as straightlining, non-differentiation, acquiescence bias, and extreme responding. To ensure consistency in the analysis, we systematically reordered and rescaled all variables. Specifically, all variables were adjusted so that higher values uniformly reflect greater agreement with climate change and more liberal beliefs. Finally, to align with the model's requirements, all Likert and 100 scale points variables were rescaled in the interval $[0.0001, 0.9999]$.¹⁶

¹⁶This is motivated by the technical need to exclude 0 and 1 from the possible values that priors can take. Indeed, including those two extrema would make the estimation of the model in (8) not possible because of infinite values appearing. Reducing or expanding the interval, for instance, considering $[0.001, 0.999]$ or $[0.00001, 0.99999]$,

Related to our experiment, a crucial assumption for the validity of our design is the absence of statistical differences between the treatment and control groups. Table 1 presents summary statistics for the treatment and control groups, along with the results of univariate and joint balance tests for the subsample of the control and a given treatment group. The univariate balance test involves running separate regressions of an indicator variable (equal to 1 if the individual receives a given treatment) on each demographic characteristic for each treatment and control group sub-sample (columns 5-6). In contrast, the joint balance test conducts multivariate regressions of the same indicator variable on all demographic characteristics simultaneously (columns 7-8). The balance tests indicate that the characteristics of respondents in the treatment groups are indistinguishable from those in the control group. Although some coefficients appear statistically significant in the table, none remains significant after applying the Benjamini–Hochberg procedure to control the false discovery rate at the 0.1 level.

4.4 Descriptive Statistics

Variable	Mean	Median	Std Dev	IQR
<i>Prior Beliefs:</i>				
Climate Change is Real	0.82	0.90	0.23	0.26
Humans Caused Climate Change	0.73	0.83	0.26	0.33
Negative Consequences	0.80	0.86	0.23	0.28
Negative Local Effects	0.70	0.67	0.23	0.29
Effects Close in Time	0.61	0.63	0.28	0.44
Mean Value of Priors	0.73	0.75	0.19	0.27
<i>Opinions on Individual Behavior:</i>				
Eat Red Meat	0.51	0.50	0.27	0.33
Use Bike or Public Transport	0.71	0.75	0.25	0.36
Purchase Insurance	0.52	0.50	0.30	0.50
<i>Opinions on Policy Support:</i>				
Tax Fossil Fuel	0.46	0.50	0.31	0.49
Built Resilient Infrastructures	0.71	0.75	0.22	0.27

Table 2: Mean, median, Standard Deviation, Interquartile Range for the main items of the survey over the control group. The variable “Mean Value of Priors” represents the arithmetic average of the five “Priors” items.

The descriptive statistics shown in Table 2 are based on the control group sample only. In terms of prior beliefs, the overwhelming majority of the sample appears to be sensitive to the issue of climate change and aware of the impact of climate change on their lives, in line

does not affect the results.

with concurrent studies (Dechezleprêtre et al., 2025). On average, respondents strongly believe that climate change is real, are convinced that climate change will bring mostly negative consequences, and that it will bring, short-term consequences. Nevertheless, while the consensus for climate change’s existence and causes is almost overwhelming, the perceived time horizon of its effects is more controversial, with a substantial minority that sees the consequences of global warming as a problem of the future rather than a present and urgent issue. In general, respondents are on average convinced that human activities are a major cause of climate change and that their local area will be influenced to some degree by climate change.

Despite the general widespread belief that anthropogenic climate change is a real, and an important, and urgent problem, support for climate policy measures such as the carbon tax is relatively mild, with a median support of 50/100. In contrast, the support for policies of less immediate costs, like improving the resilience of vital infrastructure, is higher. Also, regarding personal actions to mitigate climate change, such as reducing the use of cars for transportation, insuring one’s own home, reducing the consumption of red meat, support is fairly controversial. For instance, less than 50% of the interviewed sample considers likely to insure against natural hazards, and less than 30% of the interviewed sample supports reducing red meat consumption. Overall, these results suggest that policy support, as well as willingness to adopt climate-friendly habits, may not be strictly related to climate beliefs in itself, a result that is also found in the existing literature (Stoll-Kleemann et al., 2001; Deryugina and Shurchkov, 2016; Douenne and Fabre, 2022) and fall within the framework of impersonal impact theory.¹⁷ Further, in Figure C8, we show how prior beliefs related to climate change vary across socio-economic characteristics and progressive views.

5 Beliefs on Reality and Human Causes of Climate Change

Table 3 shows how the different treatments influence belief about the reality of climate change (column 1-2) and the anthropogenic cause of it (3-4) using a standard ATE model as in (9) and a prior-augmented ATE model as in (12). Regarding beliefs about the reality of climate change, climate-advocacy social media content (T^A) increases confidence in climate change by 2 to 4pp. In contrast, content from the climate-skeptic lobby (T^S) has a non-significant effect. Regarding beliefs about the causes of climate change, neither climate-skeptic nor climate-advocacy treatments (T^S, T^A) appear to have any effect.

As explained in advance, these results are not very informative of the underlying belief updating mechanism and may be driven by experiment-induced factors. Hence, we use our theoretical framework to recover the structural parameters driving the updating process for *Reality of Climate Change* and *Human Causes of Climate Change*. To do that, we estimate (8) by OLS for both types of beliefs. In each estimation, the values $\hat{\beta}_0, \dots, \hat{\beta}_7$ are obtained. The parameters π_a and π_s are estimated directly considering, respectively, the maximum value (0.9999) and the minimum value (0.0001) of the recorded priors. Under this assumption, the estimated structural parameters are perfectly identified and can be computed analytically from the functional forms of the coefficients. All the details concerning this procedure is reported in Appendix A. Notice that, even though we imposed theoretical bounds on the values of the

¹⁷In social psychology, the impersonal impact theory states that when media convey a threat (such as climate change) it impacts societal concerns, but it does not affect personal concerns (Tyler and Cook, 1984).

Table 3: Changes in Beliefs about Reality and Human Causes of Climate Change.

	<i>Dependent Variable:</i>			
	Posterior Reality		Posterior Human Causes	
	(1)	(2)	(3)	(4)
Climate Advocacy Treatment (T^A)	0.041*** (0.015)	0.022** (0.010)	0.023 (0.015)	0.001 (0.009)
Climate Skepticism Treatment (T^S)	-0.001 (0.015)	-0.017 (0.011)	0.002 (0.016)	-0.014 (0.009)
Prior Reality		0.804*** (0.022)		
Prior Humans Causes				0.802*** (0.022)
N	1633		1633	
Mean D.V. Control	0.818		0.726	
SD D.V. Control	0.260		0.263	

Notes: Robust standard errors in parenthesis, * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

structural parameters (which can be translated into constraints on the β coefficients), we preferred to estimate the models without imposing such constraints and subsequently verified that the resulting estimates satisfy the theoretical bounds. All the estimated structural parameters comply with these bounds and this can be considered a consistency check for our modeling approach. Figure 1 displays these estimates along with their 95% confidence intervals, obtained by bootstrapping the OLS estimation and parameter computation 100000 times. The estimates of the two key parameters regulating underreaction to advocacy and skepticism (ϕ_1 and ϕ_2) are both significantly different from zero at the 5% significance level in the case of Climate Change Reality, whereas only the estimate of ϕ_2 is significantly different from zero at the 5% level for Human Causes of Climate Change.¹⁸ Hence, the information provision promoting climate advocacy effectively shifts beliefs only with respect to Reality of Climate Change, while it appears largely ineffective regarding Human Causes of Climate Change. In contrast, the climate skepticism treatment induces a belief shift that is smaller in magnitude than that generated by climate advocacy for Reality, but its effect is significant also for Human Causes of Climate Change.

Concerning the other parameters capturing behavioral reactions related to the experimental setting, we can conclude that, on the one hand, the estimated induced anchor in beliefs (λ) tends to lean toward climate advocacy; on the other hand, our experimental framework appears to be effective in mitigating this influence, yielding estimated adjustment parameters (μ_0, μ_1, μ_2) close to one, indicating low anchoring. Regarding the parameters governing compliance with the experimental setting (θ_1 and θ_2), the point estimates are greater than one;

¹⁸We further confirmed these findings by means of bootstrap hypothesis testing (100000 replications). Specifically, we performed two-sided tests with the null hypothesis $\phi_k = 0$, $k \in 1, 2$. The obtained p-values are $1.5e-3$ and 0.0142 for ϕ_1 and ϕ_2 , respectively, in the case of Reality of Climate Change, and 0.3334 and $2.66e-3$ for ϕ_1 and ϕ_2 , respectively, in the case of Human Causes of Climate Change.

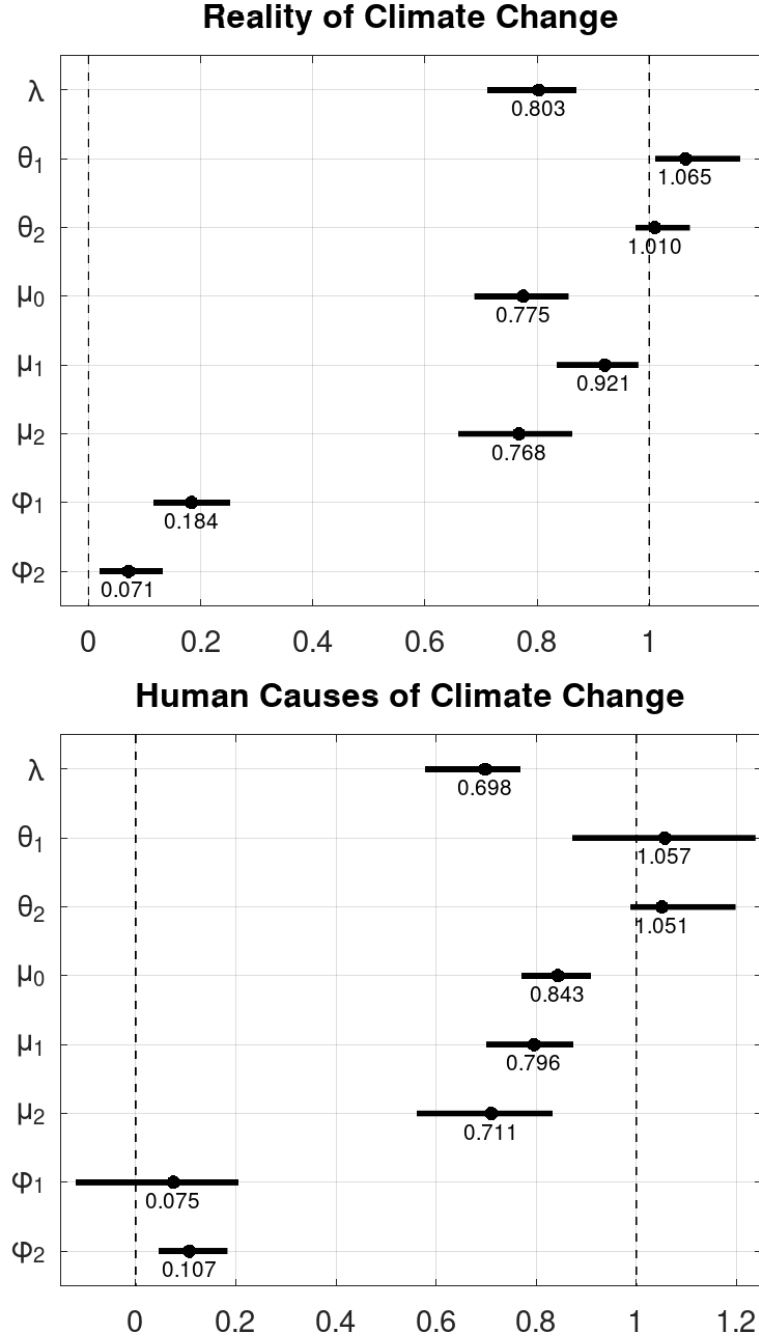


Figure 1: Point and 95%-confidence interval estimates of parameters. The numbers represent the point estimates rounded to the third decimal digit. Interval estimates have been obtained by bootstrap (100000 replicas of the OLS estimation and the computation of parameters).

however, only one estimate has a 95% confidence interval that excludes 1.

In Figure 2 we show the average difference between true posterior beliefs and priors, including 95% bootstrap confidence intervals. This gives the magnitude of the true beliefs update and provides a comparison with the ATE estimates in Table 3. The main difference lies in the climate skepticism treatment, whose effects become statistically significant, while the climate advocacy treatment remains consistent with prior findings and similar in magnitude. Specifically, contrary to the ATE predictions, once a reasonable prior-dependent belief-

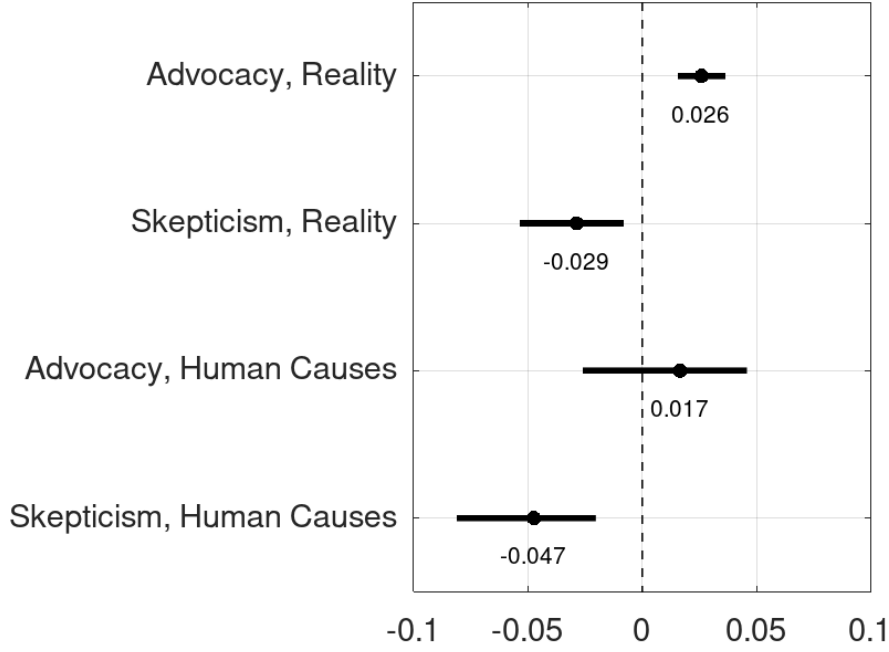


Figure 2: Point and 95%-confidence interval estimates of average difference between true posterior and prior for the two types of beliefs and the two treatments. The numbers represent the point estimates rounded to the third decimal digit. Interval estimates have been obtained by bootstrap (100000 replicas of the OLS estimation and the computation of average differences).

updating structure is considered and survey-induced biases are accounted for and removed, the climate skepticism treatment reduces beliefs that climate change is real by 2.9 percentage points and reduces beliefs in human causation by 4.7 percentage points.

5.1 Evolution of True Beliefs

Next, we investigate how true beliefs may evolve over time assuming that individuals are exposed to sequences of signals with agent-specific probabilities, the dynamics follows the model in (3), and the key parameters ϕ_1 and ϕ_2 take the values emerging from the previous estimation.

In formal terms, assume that each individual i can be exposed to an infinite sequence of signals $\sigma^i = (\sigma_1^i, \sigma_2^i, \dots, \sigma_t^i, \dots)$ in which each signal σ_t can be one among advocacy (a), skepticism (s), and neutral (c) with given probabilities. In particular, we assume $\sigma_t \in \{a, s, c\}$ with $\text{Prob}(\sigma_t^i = a) = \rho_a^i \geq 0$, $\text{Prob}(\sigma_t^i = s) = \rho_s^i \geq 0$, and $\text{Prob}(\sigma_t^i = c) = 1 - \rho_a^i - \rho_s^i$. Hence, probabilities of observing different signals may be different across agents but, for simplicity, are assumed to do not change over time. The dynamics follows the true belief updating model

in subsection 3.1, in particular, we have, $\forall i, p_{t,i}^* = w_{t,i}^* \pi_a + (1 - w_{t,i}^*) \pi_s$ with

$$w_{t,i}^* = \begin{cases} w_{t-1,i}^* & \text{if } \sigma_t^i = c, \\ \phi_1 \frac{\pi_a w_{t-1,i}^*}{p_{t-1,i}^*} + (1 - \phi_1) w_{t-1,i}^* & \text{if } \sigma_t^i = a, \\ \phi_2 \frac{(1 - \pi_a) w_{t-1,i}^*}{1 - p_{t-1,i}^*} + (1 - \phi_2) w_{t-1,i}^* & \text{if } \sigma_t^i = s, \end{cases} \quad (14)$$

and initial conditions $w_{0,i}^* = w_{0,i}$. That is, the ones derived from the recorded priors of our experimental survey.

Following the approach of Bottazzi and Dindo (2022) and the applications to models that have similar mathematical structure of Bottazzi et al. (2018); Bottazzi and Giachini (2019); Dindo (2019); Dindo and Massari (2020); Giachini (2021), define the variable

$$z_{t,i} = \log \frac{w_{t,i}^*}{1 - w_{t,i}^*}, \quad (15)$$

mapping each possible value of $w_{t,i}$ to the real line,¹⁹ and its drift

$$D_i(w) = \mathbb{E} \left[z_{t,i} - z_{t-1,i} \mid z_{t-1,i} = \log \frac{w}{1 - w} \right] = \rho_a^i \log \frac{\phi_1 \pi_a + (1 - \phi_1)(w \pi_a + (1 - w) \pi_s)}{\phi_1 \pi_s + (1 - \phi_1)(w \pi_a + (1 - w) \pi_s)} + \rho_s^i \log \frac{1 - \phi_2 \pi_a - (1 - \phi_2)(w \pi_a + (1 - w) \pi_s)}{1 - \phi_2 \pi_s - (1 - \phi_2)(w \pi_a + (1 - w) \pi_s)}.$$

Note that $z_{t,i} - z_{t-1,i} = (\log w_{t,i}^* - \log w_{t-1,i}^*) - (\log(1 - w_{t,i}^*) - \log(1 - w_{t-1,i}^*))$, so $D_i(w)$ can be interpreted as the difference between the conditional expected log-growth rate of the likelihood that individual i assigns to the advocacy model being correct and the conditional expected log-growth rate of the likelihood assigned to the skepticism model being correct. Hence, if $D_i(w) > 0$ then, conditional on assigning probability w to the advocacy model after a sequence of signals, individual i expects that probability to increase; if $D_i(w) < 0$, it is expected to decrease.

To keep the exposition simple, assume that individual i has the same probability to be observe an advocacy signal or a skepticism signal, i.e. $\rho_a^i = \rho_s^i = \rho^i \in [0, 0.5]$. In the top panels of Figure 3 we compute $D_i(w)$ for reality and human cause of climate change and considering different values of ρ^i . As expected, the sign of $D_i(w)$ does not depend on ρ^i , whereas the estimated values of ϕ_1 and ϕ_2 are crucial. In both cases, the drift is positive for low values of w and negative for high values of w , but the threshold at which the sign changes differs markedly: for reality it is closer to 1 (around 0.75), whereas for human causes it is closer to 0 (around 0.4). Since the only deterministic fixed points of the dynamics are 0 and 1, over sequences of equally likely signals the beliefs of an agent who is not initially convinced that either the advocacy or the skepticism model is correct keep fluctuating.²⁰ However, in the reality case, beliefs tend to fluctuate closer to climate advocacy, while in the human causes case the fluctuations

¹⁹The resulting stochastic process $\{z_{t,i}\}$ presents bounded increments, finite positive increments as long as $\phi_1 \in (0, 1)$, and finite negative increments as long as $\phi_2 \in (0, 1)$.

²⁰This is a direct consequence of Theorem 3.1 and Corollary 3.2 of Bottazzi and Dindo (2022) applied to $\{z_{t,i}\}$.

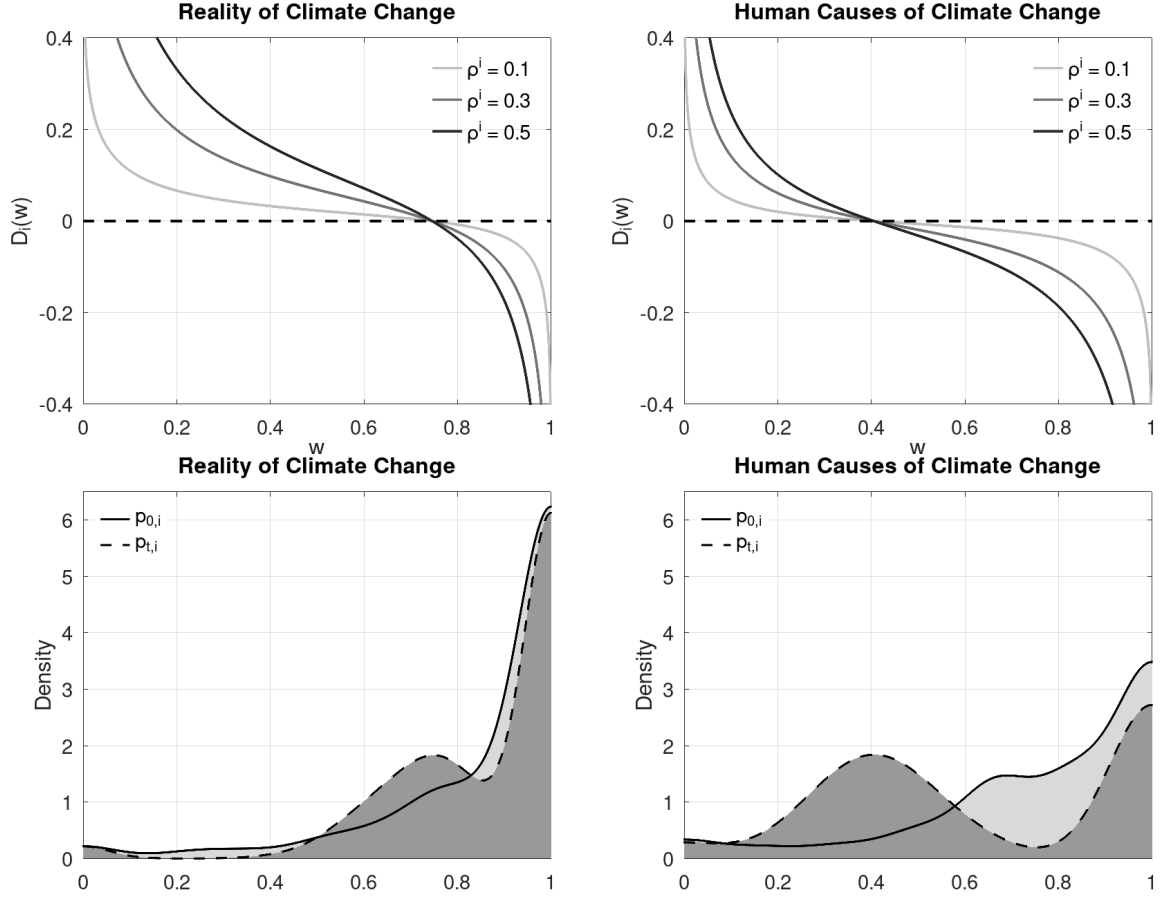


Figure 3: **Top panels:** drift of the variable $z_{t,i}$ computed for $w \in [0, 1]$ and for different values of ρ^i . Reality and Human Causes differ because of the values of ϕ_1 and ϕ_2 resulting from the estimations performed in advance. **Bottom panels:** Comparison of smoothed belief densities (gaussian kernel smoothing, reflected at the boundaries), initial ($p_{0,i}$, computed from recorded priors) and after 10000 steps ($p_{t,i}$) considering individual-specific sequences of signals with $\rho^i = 0.5 \forall i$. Even if we used one particular sequence of events for each individual, considering different sequences drawn from the same underlying Bernoulli process does not change the results.

are concentrated around a position slightly closer to skepticism. This is further confirmed by comparing the recorded density of (prior) beliefs with the one obtained after sufficiently long sequences of signals. In particular, we assume that $\rho^i = 0.5 \forall i$ and iterate the map in (14) for 10000 steps considering a randomly selected sequence of signals for each individual and initial conditions computed from recorded priors. The results of this exercise are shown in the bottom panels of Figure 3. It is immediately apparent that individuals strongly committed to either model do not change, whereas those with intermediate beliefs tend to cluster around 0.75 for reality and around 0.4 for human causes. The fact that the empirical exercise cannot exclude that ϕ_1 for human causes is different from zero makes the situation even starker: with $\phi_1 = 0$ the drift becomes negative and one should expect the beliefs of each agent to gradually move toward skepticism over time.²¹

²¹This is a direct consequence of Corollary 4.1 of Bottazzi and Dindo (2022) applied to $\{z_{i,t}\}$ under the assumption $\phi_1 = 0$.

Even though the previous analyses rely on simplifying assumptions about the stochastic process governing the sequence of observed signals,²² they still provide a useful baseline for how beliefs may evolve in a controlled environment. For instance, the asymmetry between beliefs about the reality of climate change and about its human causes suggests that greater effort in disseminating information on the human causes of climate change is needed to shift beliefs toward advocacy. Indeed, this would increase the individual probability of observing an advocacy signal and, thus, counteract the baseline tendency of moving toward skepticism.

6 Opinions and Actions

Table 4: Opinions about Behaviors and Policies.

	<i>Dependent Variable:</i>									
	Purchase Insurance		Use Bike or Public Transport		Eat Red Meat		Tax Fossil Fuel		Build Resilient Infrastructures	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Climate Advocacy Treatment (T^A)	0.025 (0.018)	0.009 (0.018)	0.003 (0.015)	-0.018 (0.014)	-0.006 (0.016)	-0.016 (0.016)	0.027 (0.018)	0.001 (0.017)	0.032** (0.013)	0.011 (0.012)
Climate Skepticism Treatment (T^S)	0.028 (0.018)	0.033* (0.018)	0.014 (0.015)	0.022 (0.014)	0.020 (0.016)	0.024 (0.016)	0.058*** (0.018)	0.068*** (0.017)	0.005 (0.013)	0.010 (0.012)
True posterior Reality		0.206*** (0.042)		0.251*** (0.043)		0.094** (0.046)		0.303*** (0.041)		0.356*** (0.037)
True posterior Human Causes		0.115*** (0.036)		0.193*** (0.035)		0.112*** (0.037)		0.255*** (0.038)		0.074** (0.028)
N	1633		1633		1633		1633		1633	
Mean D.V. Control	0.519		0.706		0.514		0.459		0.711	
SD D.V. Control	0.299		0.247		0.267		0.307		0.221	

Notes: Robust standard errors in parenthesis, * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

In Table 4 we report the results of the econometric estimation of the ATE and structural models for opinions about behaviors and policies. Across the five dimensions, the ATEs (columns 1, 3, 5, 7, 9) are generally small and rarely statistically significant. Interestingly, the climate skepticism treatment significantly increases support for a tax on fossil fuels by about 5.8 percentage points (suggesting a form of backfiring), while the climate advocacy treatment significantly increases support for building resilient infrastructures by about 3.2 percentage points. For the remaining behaviors (i.e., purchasing insurance, using bike or public transport, and eating red meat) neither treatment produces robust changes relative to the control group.

Once we consider the structural model by conditioning on the true belief posteriors on reality and human causes (columns 2, 4, 6, 8, 10), it turns out that true beliefs are strongly and consistently associated with outcomes in the expected direction.²³ Higher posterior beliefs about climate change reality and human causes are positively related to pro-mitigation or

²²See [Giachini et al. \(2025\)](#) for a model in which these probabilities depend on the population's beliefs and on the actions of external agents (lobbyists).

²³This is consistent with the findings of [Van Valkengoed et al. \(2021\)](#) about the positive association between climate change beliefs and opinions across those dimensions.

Table 5: Actions related to post sharing.

	<i>Dependent Variable:</i>							
	Share IPCC		Share CO2		Share EIGE		Share None	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Climate Advocacy Treatment (T^A)	0.101*** (0.029)	0.069** (0.028)	-0.011 (0.022)	0.001 (0.022)	-0.084*** (0.026)	-0.091*** (0.026)	-0.006 (0.027)	0.021 (0.026)
Climate Skepticism Treatment (T^S)	0.032 (0.028)	0.044* (0.027)	0.011 (0.022)	0.006 (0.022)	-0.072*** (0.026)	-0.070*** (0.026)	0.028 (0.027)	0.019 (0.027)
True posterior Reality		0.337*** (0.054)		-0.111* (0.058)		0.107* (0.058)		-0.333*** (0.069)
True posterior Human Causes		0.343*** (0.050)		-0.152*** (0.051)		0.031 (0.053)		-0.221*** (0.058)
N	1633		1633		1633		1633	
Mean D.V. Control	0.345		0.157		0.225		0.273	
SD D.V. Control	0.476		0.364		0.418		0.446	

Notes: Robust standard errors in parenthesis, * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

pro-adaptation behaviors and policy support: they significantly predict purchasing insurance, using bike or public transport, supporting a fossil-fuel tax, and supporting resilient infrastructures. The magnitude of these effects is substantial. For instance, the coefficients on true posterior beliefs about reality range from 0.094 (eating red meat) to 0.356 (building resilient infrastructures), and those on human causes range from 0.074 to 0.255, all statistically significant at conventional levels. Including posterior beliefs also attenuates most direct treatment coefficients. In particular, the skepticism effect on fossil-fuel tax support remains positive and significant (rising to 0.068 and significant at 99% confidence level), while most other treatment coefficients become small and statistically indistinguishable from zero. This pattern is consistent with treatments operating mostly through belief updating, while also leaving room for belief-independent channels in specific cases (notably skepticism on fossil-fuel tax support).

Overall, the table suggests limited average treatment effects on reported behaviors and policy attitudes, but a strong relationship between true posterior beliefs and opinions. Taken together with the previous results on the effects of treatments on beliefs, this indicates that, even when not evident in reduced-form ATEs, opinions can respond to climate advocacy or skepticism cues shared via social networks, with any shifts operating primarily through belief updating.

Table 5 reports ATE and structural models for actions regarding sharing choices, with ATE specifications appearing in odd columns and structural specifications in even columns. Concerning the results of ATEs estimations, the only noteworthy effect concerns the positive one exerted by the climate advocacy treatment on sharing the IPCC post. Indeed, the negative ones observed with respect to sharing the EIGE post are mostly related to the nature of the active control we have chosen.²⁴ In the structural specifications, true posterior beliefs are strongly predictive of both inaction and sharing decisions regarding climate-related contents. Higher

²⁴Nonetheless, one can interpret the result as indicating that showing social media contents on the gender pay gap increases the willingness to share posts on such a topic.

Table 6: Actions related to petition signing and donation.

	<i>Dependent Variable:</i>							
	Sign Petition Climate Advocacy		Sign Petition Gender Gap		Sign None		Donation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Climate Advocacy Treatment (T^A)	0.102*** (0.030)	0.062** (0.028)	-0.068** (0.027)	-0.068** (0.028)	-0.034 (0.024)	0.006 (0.021)	0.001 (1.009)	-0.747 (0.997)
Climate Skepticism Treatment (T^S)	0.010 (0.030)	0.025 (0.029)	-0.012 (0.028)	-0.014 (0.028)	0.002 (0.025)	-0.011 (0.023)	-1.883* (1.039)	-1.731* (1.017)
True posterior Reality		0.464*** (0.061)		0.075 (0.071)		-0.539*** (0.062)		15.562*** (2.693)
True posterior Human Causes		0.388*** (0.057)		-0.094 (0.060)		-0.295*** (0.052)		1.439 (2.312)
N	1633		1633		1633		1281	
Mean D.V. Control	0.503		0.298		0.200		29.254	
SD D.V. Control	0.500		0.457		0.400		14.927	

Notes: Robust standard errors in parenthesis, * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

true posterior beliefs about the reality of climate change and its human causes are associated with a substantially higher probability of sharing the IPCC post (coefficients around 0.34 for both belief dimensions, highly significant), and with a lower probability of sharing the CO2 Coalition post (negative and significant, especially for human causes) as well as of choosing not to share any post (large and highly significant negative coefficients).

Including true posteriors also affects the treatment coefficients. The advocacy effect on sharing the IPCC post declines from 0.101 to 0.069 but remains statistically significant, consistent with advocacy operating partly through belief updating while still leaving some belief-independent influence on sharing. By contrast, the negative treatment effects on sharing the EIGE post remain large and highly significant for both advocacy and skepticism even after conditioning on beliefs. This suggests that posterior beliefs about climate change have little explanatory power for this specific sharing decision, which provides a useful consistency check for our setting.

Table 6 reports the results concerning petition signing and donation. As in the previous tables, odd columns report ATEs, while even columns show the estimates for the structural specifications. In the ATE models, the climate advocacy treatment strongly increases climate-related activism: it significantly raises the probability of signing the climate advocacy petition by about 10.2 points. At the same time, advocacy reduces signing the gender gap petition by about 6.8 points, suggesting substitution toward the climate-related petition rather than a general increase in petition signing. Consistent with this, the effect on to do not sign is small and not statistically significant. The climate skepticism treatment does not materially affect petition signing choices, with coefficients close to zero and statistically insignificant across petition outcomes. Turning to donations, the skepticism treatment seems to reduce donation amounts by roughly 1.9 euros in the reduced-form model, while advocacy has no detectable effect on

donations.²⁵

Once beliefs are included (columns 2, 4, 6, 8), true posterior beliefs about climate change are strongly associated with climate-directed actions. Higher posteriors on climate-change reality and human causes are linked to a substantially higher probability of signing the climate-advocacy petition (coefficients 0.464 and 0.388, both significant at the 99% confidence level) and a significantly lower probability of signing no petition (large negative coefficients, 99% confidence level). By contrast, neither posterior is statistically related to signing the unrelated gender-gap petition, which is consistent with the belief measures capturing climate-specific channels rather than generic prosocial engagement. For donations, the posterior on climate-change reality is strongly and positively associated with the amount indicated (about +15.6 euros, 99% confidence level), whereas the human causes posterior is not statistically significant. Notably, controlling for beliefs does not eliminate the negative skepticism coefficient on donations, which remains marginally significant. This suggests that the skepticism treatment may affect donations through channels not captured by the belief measures, whereas the association between beliefs and donations appears primarily driven by beliefs about climate reality.

Overall, the table indicates that the advocacy treatment shift action toward climate-specific engagement, while beliefs are a strong predictor of climate-relevant actions and inaction. Willingness to donate appears more sensitive to the skepticism treatment and to beliefs about climate reality than to beliefs about human causation.

7 Conclusions

This paper studies how exposure to social media content supporting opposite views on climate change induces updates in beliefs, and how, in turn, these beliefs influence opinions and actions. Using a nationally representative survey experiment in Italy, we randomly exposed respondents to X social media content from either a climate advocacy source (the IPCC), a climate skepticism source (the CO2 Coalition), or an active control. We measured beliefs about the reality and human causes of climate change before and after treatment, as well as opinions and actions after treatments. To interpret the resulting belief dynamics, opinions, and actions, we develop and estimate structural behavioral models. In particular, our structural belief-updating model separates true updating from survey-induced distortions, combining Bayesian-like learning with underreaction and possible experimenter demand effects entering through anchoring and adjustment.

We show that without explicitly modeling how beliefs update, characteristics of climate change beliefs (such as prior belief asymmetries and the resulting ceiling effect) and the potential existence of experimenter demand effects, might lead to misleading conclusions when using commonly employed ATE estimations. Our estimates reveal that substantial underreaction is observed, while anchoring to the survey structure plays only a limited role in shaping updates. Importantly, the genuine variation in beliefs dominates the compliance-related experimenter demand effect. Looking at belief update and comparing the result emerging from true

²⁵Notice that the donation sample is smaller ($N = 1281$) which also limits precision. This is due to the fact that the sample is constituted only by those that have chosen to sign a petition and to elicit a donation amount.

beliefs with those obtained from a standard ATE approach, we find that the latter provides reasonable estimates for the climate advocacy treatment, while it systematically underestimates the impact of the climate skepticism treatment, both in terms of magnitude and of statistical significance. Indeed, in the true belief updating, the skepticism exerts a statistically significant effect, decreasing beliefs about the reality of climate change by 2.9 pp and of human caused by 4.7 pp. This is particularly relevant for policies addressing fake news and misleading information about climate change, as it implies that relying on reduced-form ATE estimates, can materially understate the persuasive power of skeptical content, and therefore lead policymakers to under-invest in interventions, such as platform design, fact-checking, and targeted information campaigns, aimed at limiting exposure to misinformation and strengthening accurate beliefs, especially on the human causes of climate change.

An additional contribution of our paper is that it can provide some indications on how beliefs may evolve in the future. We do so by studying the properties of the belief-updating process and iterating it under random sequences of advocacy and skepticism signals. Our exercise shows that, when advocacy and skepticism signals are equally likely, individuals who are strongly committed to either model do not change their beliefs, whereas those with intermediate beliefs fluctuate. These fluctuations are asymmetric and cluster around different levels: closer to advocacy for beliefs about the reality of climate change, and closer to skepticism for beliefs about human causes. This asymmetry suggests that shifting beliefs about human causation likely requires greater dissemination of advocacy-consistent information, that is, increasing exposure to advocacy signals to counter the pull toward skepticism.

Regarding opinions and actions, we find that individuals' true posterior beliefs play a central role in shaping both, and the effects are in the expected direction. Thus, the climate advocacy and skepticism treatments can influence climate-related actions and opinions on adaptation policies and sustainable behavior, but these impacts are mediated by belief updating. Since underreaction to information is observed, the resulting changes may be small and hard to detect. Interestingly, we also identify two effects that cannot be accounted for by climate-change beliefs. First, the climate skepticism treatment appears to trigger a backfire effect on support for taxing fossil fuels. Second, the climate advocacy treatment has an additional positive impact on willingness to sign a petition for climate action.

Our results also speak to the broader literature on belief formation and experimental surveys. By embedding underreaction, anchoring and adjustment, and compliance to the experimental setting in a tractable structural framework, we show how survey experiments can be used to recover “deep” parameters of belief updating, rather than only reduced-form effects. The model is sufficiently flexible to reproduce canonical Bayesian learning, pure anchoring-and-adjustment, and standard ATE designs as special cases, while remaining estimable by OLS once the functional mapping between structural parameters and regression coefficients is derived. This approach can be readily extended to other domains (such as vaccine attitudes or political misinformation) where belief asymmetries, ceiling effects, and experimental demand effects may be consequential and where the policy relevance of information treatments depends on their operation across the entire prior distribution.

The analysis has limitations that point to avenues for future research. Our evidence is drawn from a single country and a specific period, in which climate change was already highly salient and public discourse polarized; the extent of anchoring, underreaction, and asymmetry may differ in contexts with lower baseline concern or different media environments. Our struc-

tural estimates rely on functional form assumptions, which, while theoretically consistent, may not capture the full richness of individuals' mental models. Notwithstanding these caveats, the evidence presented in this paper offers a nuanced picture of how individuals process climate information and the difficulties of measuring it. More generally, our framework illustrates the value of moving beyond average treatment effects to structurally grounded models of belief updating, opinion formation, and action choice when evaluating information-based climate policies and communication strategies.

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A Mathematical derivations

Following the sequence of substitutions and considering the assumptions made on prior and posterior measurements, one obtains

$$\begin{aligned}
P_{1,i} = & (1 - \mu_0)(\lambda \pi_c + (1 - \lambda) \pi_n) + \mu_0 P_{0,i} \\
& + (\lambda(\mu_0 - \mu_1)(\pi_a - \pi_s) + \mu_1(1 - \theta_1)(\pi_a - \pi_s) + \pi_a \phi_1 \mu_1 \theta_1 - \pi_s \mu_1 \theta_1 (1 - \phi_1) + \pi_s \mu_0) T_i^A \\
& + (\mu_1 \theta_1 (1 - \phi_1) - \mu_0) T_i^A P_{0,i} - \mu_1 \phi_1 \theta_1 \pi_a \pi_s \frac{T_i^A}{P_{0,i}} \\
& + (\lambda(\mu_0 - \mu_2)(\pi_a - \pi_s) - \pi_s \mu_2 \theta_2 (1 - \phi_2) + \pi_s \mu_0 - (1 - \pi_a) \mu_2 \theta_2 \phi_2) T_i^S \\
& + (\mu_2 \theta_2 (1 - \phi_2) - \mu_0) T_i^S P_{0,i} + \mu_2 \phi_2 \theta_2 (1 - \pi_a) (1 - \pi_s) \frac{T_i^S}{1 - P_{0,i}} + \varepsilon_i.
\end{aligned}$$

Hence, it is

$$\left\{ \begin{aligned}
\beta_0 &= (1 - \mu_0)(\lambda \pi_a + (1 - \lambda) \pi_s), \\
\beta_1 &= \mu_0, \\
\beta_2 &= \lambda(\mu_0 - \mu_1)(\pi_a - \pi_s) + \mu_1(1 - \theta_1)(\pi_a - \pi_s) + \pi_a \phi_1 \mu_1 \theta_1 - \pi_s \mu_1 \theta_1 (1 - \phi_1) + \pi_s \mu_0, \\
\beta_3 &= \mu_1 \theta_1 (1 - \phi_1) - \mu_0, \\
\beta_4 &= -\mu_1 \phi_1 \theta_1 \pi_a \pi_s, \\
\beta_5 &= \lambda(\mu_0 - \mu_2)(\pi_a - \pi_s) - \pi_s \mu_2 \theta_2 (1 - \phi_2) + \pi_s \mu_0 - (1 - \pi_a) \mu_2 \theta_2 \phi_2, \\
\beta_6 &= \mu_2 \theta_2 (1 - \phi_2) - \mu_0, \\
\beta_7 &= \mu_2 \phi_2 \theta_2 (1 - \pi_a) (1 - \pi_s),
\end{aligned} \right.$$

and the econometric model in (8) follows. In Table A1, we report the OLS-estimated coefficients of the of such an econometric model for both Climate Change Reality and Human Causes of Climate Change. As can be observed, the proposed econometric models explain more than half of the variance in the posterior beliefs, and the estimates of the coefficients $\beta_1, \beta_4, \beta_7$ are significantly different from zero. This suggests that the results are unlikely to be driven purely by the setting. Using the formulas presented above, we recover the estimated values of the

structural parameters. In particular, we obtain

$$\left\{ \begin{array}{l} \hat{\lambda} = \frac{\hat{\beta}_0 - \pi_s(1 - \hat{\beta}_1)}{(1 - \hat{\beta}_1)(\pi_a - \pi_s)}, \\ \hat{\mu}_0 = \hat{\beta}_1, \\ \hat{\mu}_1 = \hat{\beta}_1 + \frac{\pi_s(\hat{\beta}_2 + \pi_a \hat{\beta}_3) + \hat{\beta}_4(1 - \pi_a + \pi_s)}{\pi_s(\pi_a - \pi_s)(1 - \hat{\lambda})}, \\ \hat{\theta}_1 = \frac{\pi_a \pi_s(\hat{\beta}_1 + \hat{\beta}_3) - \hat{\beta}_4}{\pi_a \pi_s \hat{\mu}_1}, \\ \hat{\phi}_1 = -\frac{\hat{\beta}_4}{\pi_a \pi_s \hat{\mu}_1 \hat{\theta}_1}, \\ \hat{\mu}_2 = \hat{\beta}_1 - \frac{(1 - \pi_s)(\hat{\beta}_5 + \pi_s \hat{\beta}_6) + \hat{\beta}_7}{(1 - \pi_s)(\pi_a - \pi_s) \hat{\lambda}}, \\ \hat{\theta}_2 = \frac{(1 - \pi_a)(1 - \pi_s)(\hat{\beta}_1 + \hat{\beta}_6) + \hat{\beta}_7}{(1 - \pi_a)(1 - \pi_s) \hat{\mu}_2}, \\ \hat{\phi}_2 = \frac{\hat{\beta}_7}{(1 - \pi_a)(1 - \pi_s) \hat{\mu}_2 \hat{\theta}_2}. \end{array} \right.$$

Table A1: OLS estimates of the coefficients of the econometric model in (8) applied to beliefs on Reality of Climate Change and Human Causes of Climate Change.

	<i>Dependent Variable:</i>	
	Posterior Reality	Posterior Human Causes
$\hat{\beta}_0$	0.1805 (0.0379)	0.1093 (0.0291)
$\hat{\beta}_1$	0.7752 (0.0423)	0.8434 (0.0349)
$\hat{\beta}_2$	0.0037 (0.0505)	0.0514 (0.0462)
$\hat{\beta}_3$	0.0250 (0.0551)	−0.0658 (0.0553)
$\hat{\beta}_4$	−1.8e-05 (3.36e-06)	−6.35e-06 (6.75e-06)
$\hat{\beta}_5$	0.0061 (0.0548)	0.0927 (0.0532)
$\hat{\beta}_6$	−0.0553 (0.0674)	−0.1764 (0.0716)
$\hat{\beta}_7$	5.53e-06 (2.03e-06)	8.00e-06 (2.19e-06)
N	1633	1633
R^2	0.5294	0.6556
Adjusted R^2	0.5273	0.6541
F(5, 1627)	4072.89	255.42
P-value(F)	0.0000	0.0000

Notes: Robust standard errors in parenthesis.

B Survey

Qualtrics Survey Software

<https://labmessantannapisa.eu.qualtrics.com/Q/EditSection/Blocks/Aj...>

English ▾

Block 0

Survey Introduction

Your participation in this survey and your input is very valuable for our project and it is a fundamental part of the project's successful development. If you agree to take part in the study, please complete the CONSENT FORM IN THE NEXT PAGE

Who are we?

Researchers from

- Sant'Anna School of Advanced Studies,
- University of Pisa,
- University of Naples Parthenope,
- University of Camerino,
- Queen Mary University of London.

We work on the project ALMONDO, funded by the Italian research funding PRIN PNRR 2022.

Main objective: understanding your views on current popular topics.

Data protection and privacy details (version 1.0, 12-08-24):

- You are free to withdraw from the study at any time without giving a reason.
- All information that is collected is anonymous.
- No personal information will be distributed to any other unauthorized individual or third party.
- Answers will be elaborated as aggregate for research purposes related to the project.
- If you want to know more about data treatment and GDPR please look at this link: [Data processing and GDPR](#)
- Our research received the ethical approval from Scuola Superiore Sant'Anna Research Ethics committee (<https://www.santannapisa.it/it/ateneo/comitato-etico-congiunto>), you can contact them via email at comitatoetico@santannapisa.it.
- For any further information or to withdraw your consent you can contact us at

daniele.giachini@santannapisa.it.

CONSENT FORM FOR RESEARCH PARTICIPANTS

Below there is a list of conditions that we kindly ask you to read through.

If you AGREE with all of these conditions, please SELECT YES. By selecting YES in this informed consent form YOU DO understand that you give your CONSENT to participate in the questionnaire, and in particular you know that:

- Your participation in this survey is voluntary.
- You can decide to withdraw your participation at any time.
- You are encouraged to ask questions about the project and your participation at any time.
- Your personal data will be processed as stated in the privacy information

CONSENT:

- ☐ YES, I would like to take part in this study
- ☐ NO, I would not like to participate

Before we start

- Please answer honestly and read the questions carefully before answering.
- Anytime you don't know an answer, give your best guess.
- Please be sure to spend enough time reading and understanding the question.
- To ensure the quality of our survey data, we will perform various statistical checks.
- Thus, responding without adequate effort may result in your responses being flagged for low quality.
- It is crucial for our research's success that you complete the entire survey once you have started.
- You will need about 10 minutes to complete our survey.
- The survey has different types of questions indicated in the following list.
 - Single Choices -- it asks you to select one choice
 - Text -- it asks you to write your answer
 - Slider Choices -- it asks you to move the slide cursor to express a quantity
 - Drop-down Menu -- it asks you to select one choice from the list of the

dropdown menu

What is your year of birth? Please select the year from the drop-down menu.

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Non-binary/Third gender
- ☐ Prefer not to say

What is your total annual household income in euro?

- ☐ Less than 25 000
- ☐ 25 000 - 49 999
- ☐ 50 000 - 74 999
- ☐ 75 000 - 99 999
- ☐ 100 000 - 149 999
- ☐ 150 000 or more

Two of the most discussed topics in the public debate are **climate change** and the **gender pay gap**. Here you find their definitions.

Climate change refers to long-term **shifts in temperatures** and **weather patterns**. Such shifts can be **natural** (due to changes in the sun's activity or large volcanic eruptions) or driven by **human activities** (due to emissions of carbon dioxide and other greenhouse gasses from the combustion of fossil fuels).

The **gender pay gap** refers to the **difference** between the average yearly **wage earned by women** and the average yearly **wage earned by men**.

Block 1

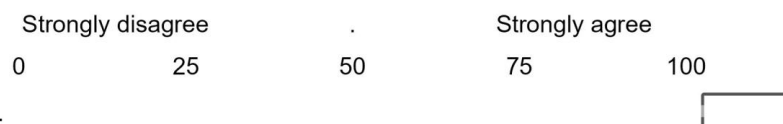
Move the cursor to indicate how much you agree with the sentence **"I believe that climate change is real"**.



How much do you agree with the sentence **"human activities are a major cause of climate change"**?

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

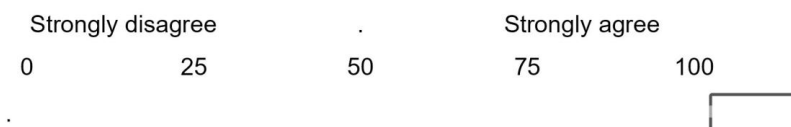
Move the cursor to indicate how much you agree with the following sentence **"overall, climate change will bring more negative than positive consequences to the world"**.



How much do you agree with the sentence **"my local area will be influenced by climate change"**?

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

Move the cursor to indicate how much you agree with the sentence "**the consequences of climate change will only be experienced in the far future**".



How much do you agree with the sentence "**when it comes to giving women equal rights with men, I think the country has not gone far enough**"?

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

Move the cursor to indicate how much you agree with the sentence "**society these days is too accepting when it comes to women taking on roles that are typically associated with men**".



Control

Please read the following text:

The European Institute for Gender Equality (EIGE)

- is the EU's independent knowledge center advancing gender equality,
- it provides research, data, tools, and policy support on the topic of gender equality,
- it cooperates with EU institutions, Member States, international organizations, NGOs, equal opportunities organizations, universities and media.

Here you find some of the contents the EIGE shares on social media. Please

read carefully the text that appears below it.

Women earn on average 16 % less than men.

With just 16% of the year left to go, 4 November marks the day when women in the EU 'symbolically' stop getting paid.

Here are the reasons behind the [#genderpaygap](#) - <https://t.co/VkFxIXbuTn>
[#EqualPayDay2019](#) pic.twitter.com/2LMGIS9IRa

— EIGE (@eige_eu) [November 4, 2019](#)

- The post explains the gender pay gap, that is the average difference between the remuneration for men and women who are working.
- The EIGE claims that women earn on average 16 % less than men.
- The EIGE claims that the gender pay gap is as if European women were not paid between the 4th of November and the end of the year.

The next button is disabled for a few seconds to give you the time to read

Here you find some of the contents the EIGE shares on social media. Please read carefully the text below it.

'The biggest gap in earnings is among couples with children. This shows that the financial cost of having a family falls heavily on women's shoulders', says EIGE's Director at the launch of our [#GenderPayGap](https://t.co/GzvOOs2LSn) Report <https://t.co/GzvOOs2LSn>
[@EU_Justice](#) [@EuropeanWomen](#) pic.twitter.com/vJfczK59fI

— EIGE (@eige_eu) [May 29, 2019](#)

- The post reports a statement by EIGE's Director and shows a picture of a father and his son.
- EIGE's Director claims that the largest difference in earning between men and women is among couples with children and that the financial cost of having a family falls heavily on women.
- EIGE claims that a better work-life balance is needed to tackle the gender pay gap.

The next button is disabled for a few seconds to give you the time to read.

Here you find some of the contents the EIGE shares on social media. Please read carefully the text below it.

 The International Day of Education brings much needed focus on persisting segregation in the field.

 Gender stereotypes still influence and limit the choices women and men make in their life, leading to negative impacts on the labour market. pic.twitter.com/KyAn2nktJk

— EIGE (@eige_eu) [January 24, 2024](#)

- The post is related to the international day of education and addresses gender stereotypes in the field.
- EIGE claims that segregation is persistent in education and gender stereotypes influence and limit the choice women and men make in their life, leading to negative impacts on the labor market.

The next button is disabled for a few seconds to give you the time to read.

CO2

Please read the following text

The CO2 Coalition

- is a non profit organization,
- it provides facts, resources and information about the role carbon dioxide (CO2) plays in our environment,
- it is chaired by Dr. William Happer, Professor Emeritus in the Department of Physics at Princeton University,
- Dr. John F. Clauser, recipient of the 2022 Nobel Prize in Physics, is among its members.

Here you find some of the contents the CO2 Coalition shares on social media.

Please read carefully the text below it.

Do you see the correlation between CO2 and Temperature throughout geological history? Yeah, neither do we. pic.twitter.com/9DpOJmI0XL

— CO2 Coalition (@CO2Coalition) [May 18, 2023](#)

- The post shows the evolution of average global temperature (red) and carbon dioxide concentration in the atmosphere (blue) over the last 600 million years.
- The CO2 Coalition claims that there is no correlation between average temperatures and carbon dioxide concentration throughout geological history.

The next button is disabled for a few seconds to give you the time to read.

Here you find some of the contents the CO2 Coalition shares on social media.

Please read carefully the text below it.

pic.twitter.com/AmQUg0CBza

— CO2 Coalition (@CO2Coalition) [September 29, 2023](#)

- The post shows the trends in global carbon dioxide emissions, temperature increases, and agricultural production of wheat, rice, and coarse grains over the past 60 years.
- The CO2 Coalition claims that grain production breaks records while temperatures and carbon dioxide increase.
- The CO2 Coalition claims that more carbon dioxide helps to feed more people worldwide.

The next button is disabled for a few seconds to give you the time to read.

Here you find some of the contents the CO2 Coalition shares on social media.

Please read carefully the text below it.

Climate change? Everchanging. However, it's important to know that there is no evidence that humans are making the climate “worse.” In fact, data suggests that the higher concentrations of CO2 and natural warming have benefited agricultural production and ecosystems.... pic.twitter.com/5Bz7m6w54B

— CO2 Coalition (@CO2Coalition) [August 30, 2023](#)

- The post shows a picture with a quote of Galileo, saying: “In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual”.
- The CO2 Coalition claims that the climate is everchanging.
- The CO2 Coalition claims that there is no evidence that humans are making the climate “worse” and data suggests that higher concentration of CO2 and natural warming have benefited agricultural production and ecosystems.

The next button is disabled for a few seconds to give you the time to read.

IPCC

Please read the following text

The Intergovernmental Panel on Climate Change (IPCC)

- is the United Nations body for assessing the science related to climate change,
- it has thousands of contributors from all over the world: experts who volunteer their time to assess the thousands of scientific papers published each year,
- it publishes assessment reports to provide a comprehensive summary of:
 - what is known about the drivers of climate change,
 - the impacts on climate change and future risks,
 - how adaptation and mitigation can reduce those risks.

Here you find some of the contents the IPCC shares on social media. Please read carefully the text below it.

[#WorldMetDay](#)

This week [@WMO](#) confirmed that 2023 was the warmest year on record. [#IPCC](#)'s Synthesis Report shows the extent to which current & future generations will experience a hotter & different world depends on choices now & in the near term.

<https://t.co/zAMzd12TGF> [pic.twitter.com/TfQEDDcBGc](https://t.co/zAMzd12TGF)

— IPCC (@IPCC_CH) [March 23, 2024](#)

- The post is related to the World Meteorological Day and the picture shows the global temperature change above 1850-1900 levels.
- 2023 was the warmest year on record and the picture highlights that 2011-2020 was around 1.1 celsius degrees warmer than 1850-1900.
- The IPCC claims that, depending on future emission scenarios and how we address climate change, the increase in temperature in the next 70 years will be between 1.5 and 4 degrees celsius.
- The IPCC claims that the extent to which future generations will experience a hotter and different world depends on the choices now and in the near term.

The next button is disabled for a few seconds to give you the time to read.

Here you find some of the contents the IPCC shares on social media. Please read carefully the text below it.

Human-induced [#climatechange](#) is already affecting many weather and climate extremes in every region across the globe.

 Heatwaves & fire weather

 Heavy rainfall & flooding

 Droughts [#IPCC #ClimateReport](#)  <https://t.co/7l6ZV7Wllq> [pic.twitter.com/hi4L9oaKxQ](https://t.co/7l6ZV7Wllq)

— IPCC (@IPCC_CH) [July 18, 2022](#)

- The post shows a picture of an extremely warm town.
- The IPCC claims that human-induced climate change is already affecting many weather and climate extremes (such as heatwaves and fire weather, heavy rainfall and flooding, droughts) in every region across the globe.

The next button is disabled for a few seconds to give you the time to read.

Here you find some of the contents IPCC shares on social media. Please read carefully the text below it.

Universal water  and energy  access can help to reduce poverty and improve well-being while making populations less vulnerable and more resilient to adverse climate impacts.

Learn more about developing climate resilience  <https://t.co/31XeCHUuGI#WorldFoodDay.pic.twitter.com/P6KUD1IUCR>

— IPCC (@IPCC_CH) [October 16, 2023](#)

- The post shows a picture of a child walking on dry land and carrying water.
- The IPCC claims that universal water and energy access can help to reduce poverty and improve well-being while making populations less vulnerable and resilient to adverse climate effects

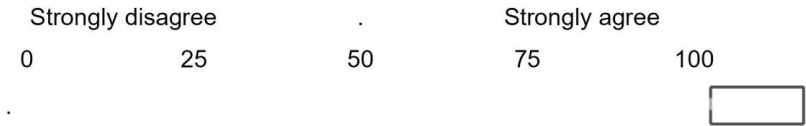
The next button is disabled for a few seconds to give you the time to read.

Block 3

How much do you agree with the sentence "**all things considered, I think women have it harder than men in our country nowadays**"?

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

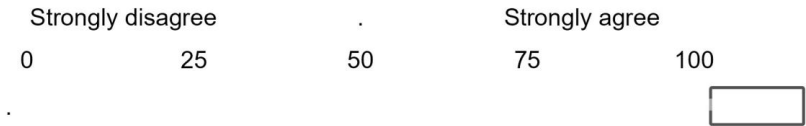
Move the cursor to indicate how much you agree with the sentence **"in general, I think that men being more involved in household chores have made it harder for families to earn enough money to live comfortably"**.



How likely would it be for you to perform the following action in the near future?
"Purchasing insurance against losses from natural hazards".

- ☐ Extremely unlikely
- ☐ Unlikely
- ☐ Slightly unlikely
- ☐ Neither likely nor unlikely
- ☐ Slightly likely
- ☐ Likely
- ☐ Extremely likely

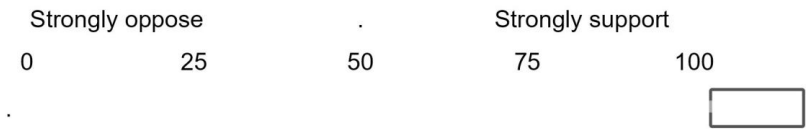
Move the cursor to indicate how much you agree with the action **"Riding a bicycle or taking public transportation rather than taking the car"**.



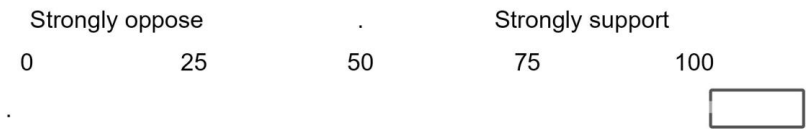
How much do you agree with the following action?
"Eating red meat with my dinner".

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

Move the cursor to indicate how much you support the policy **"Increasing taxes on fossil fuels, such as oil, gas, and coal"**.

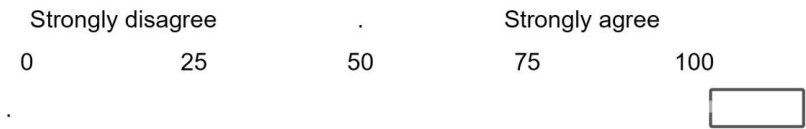


Move the cursor to indicate how much you support the policy **"investing public money to make vital infrastructure (for example, energy utilities, power lines, cell towers) more resistant to climate change risks"**.



Block 4

Move the cursor to indicate how much you agree with the sentence **"climate change is NOT occurring"**.



How much do you agree with the sentence **"the main causes of climate change are human activities"**?

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Agree
- ☐ Strongly agree

Which of the following posts would you share on your social media? The project will share on its web page the most chosen one, at the end of the data collection period.

IPCC: Human-induced climate change is already affecting many weather and climate extremes (such as heatwaves and fire weather, heavy rainfall and flooding, droughts) in every region across the globe.

CO2 Coalition: Climate change? Everchanging. However, it's important to know that there is no evidence that humans are making the climate "worse." In fact, data suggests that the higher concentrations of CO2 and natural warming have benefited agricultural production and ecosystems.

EIGE: 'The biggest gap in earnings is among couples with children. This shows that the financial cost of having a family falls heavily on women's shoulders', says EIGE's Director at the launch of our GenderPayGap Report. 'The biggest gap in earnings is among couples with children. This shows that the financial cost of having a family falls heavily on women's shoulders', says EIGE's Director at the launch of our

- ☐ I would share the post of IPCC
- ☐ I would share the post of the CO2 Coalition
- ☐ I would share the post of EIGE
- ☐ I would not share anything

Consider these two petitions on change.org:

- **Ask COP26 leaders to take urgent action against climate change,**
- **Close the Gender Inequality Gap.**

Which of them would you like to sign?

- ☐ I would like to sign the "**Ask COP26 leaders to take urgent action against climate change**" petition.
- ☐ I would like to sign the "**Close the Gender Inequality Gap**" petition.
- ☐ None of them.

Suppose you have a budget of 50 euros for donations, how much would you donate to the petition you have chosen? We will donate to the petition the average of the amounts chosen by respondents.

0 13 25 38 50

Please leave any comment to our survey

was the survey easy to understand?

- ☐ No
- ☐ Maybe
- ☐ Yes

was the survey visually ok?

- ☐ No
- ☐ Maybe
- ☐ Yes

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C Descriptive Analysis

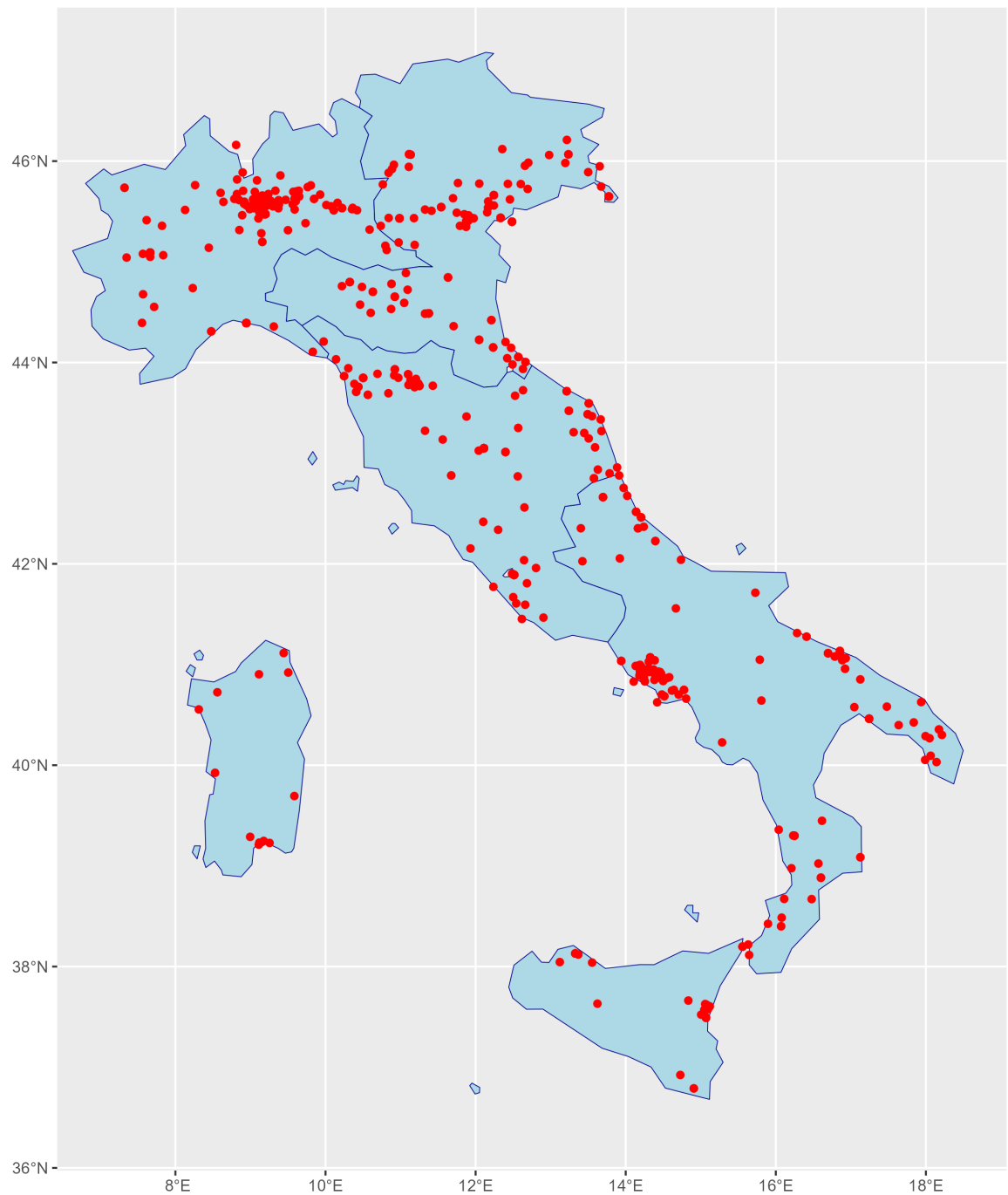


Figure C1: Geographical Location of Respondents

Notes: The Figure shows the approximate location of respondents across Italy, reconstructed by analyzing geolocation information from IP addresses provided by the survey platform.

	<i>Dependent variable (Priors):</i>									
	Climate Change is Real	Humans Caused Climate Change	Negative Consequences	Negative Local Effects	Effects Close in Time					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Age 25-34	-0.011 (0.026)	-0.022 (0.024)	0.040 (0.030)	0.027 (0.028)	0.016 (0.026)	0.006 (0.024)	0.039 (0.027)	0.028 (0.025)	-0.004 (0.033)	-0.012 (0.032)
Age 35-50	-0.066*** (0.024)	-0.071*** (0.022)	-0.008 (0.027)	-0.014 (0.025)	-0.040* (0.024)	-0.044** (0.022)	0.007 (0.024)	0.003 (0.022)	-0.096*** (0.030)	-0.100*** (0.029)
Age Over 50	-0.089*** (0.023)	-0.088*** (0.022)	-0.056** (0.026)	-0.055** (0.024)	-0.063*** (0.023)	-0.062*** (0.022)	-0.014 (0.023)	-0.012 (0.022)	-0.110*** (0.029)	-0.109*** (0.028)
Male	-0.018 (0.011)	0.021* (0.010)	-0.012 (0.013)	0.032*** (0.012)	-0.025** (0.011)	0.008 (0.010)	-0.026** (0.011)	0.011 (0.011)	-0.015 (0.014)	0.014 (0.014)
Income 50 000 - 74 999	0.034*** (0.012)	0.030*** (0.012)	0.042*** (0.014)	0.037*** (0.013)	0.042*** (0.012)	0.038*** (0.012)	0.026** (0.013)	0.023* (0.012)	0.014 (0.015)	0.011 (0.015)
Income 75 000 or more	0.028 (0.022)	0.022 (0.021)	0.049* (0.025)	0.042* (0.023)	0.023 (0.022)	0.018 (0.021)	0.071*** (0.022)	0.065*** (0.021)	0.039 (0.028)	0.035 (0.027)
North East	-0.020 (0.018)	-0.015 (0.016)	-0.017 (0.020)	-0.011 (0.018)	-0.009 (0.017)	-0.004 (0.016)	-0.022 (0.018)	-0.017 (0.016)	0.001 (0.022)	0.005 (0.021)
Center	0.007 (0.014)	0.008 (0.013)	0.031** (0.016)	0.033** (0.015)	0.021 (0.014)	0.022* (0.013)	0.019 (0.014)	0.020 (0.013)	-0.022 (0.017)	-0.021 (0.017)
South	-0.013 (0.017)	-0.013 (0.016)	0.008 (0.019)	0.008 (0.018)	0.016 (0.017)	0.016 (0.016)	-0.011 (0.017)	-0.011 (0.016)	-0.092*** (0.021)	-0.092*** (0.020)
Islands	-0.049* (0.025)	-0.037 (0.023)	-0.006 (0.028)	0.007 (0.026)	-0.037 (0.025)	-0.027 (0.023)	-0.021 (0.025)	-0.010 (0.023)	-0.076** (0.031)	-0.067** (0.030)
OTHER	-0.033 (0.038)	-0.001 (0.035)	-0.039 (0.043)	-0.002 (0.039)	-0.030 (0.037)	-0.002 (0.035)	-0.047 (0.038)	-0.016 (0.035)	-0.010 (0.046)	0.014 (0.045)
Gender Opinion Control		0.321*** (0.019)		0.369*** (0.022)		0.278*** (0.019)		0.316*** (0.020)		0.242*** (0.025)
Constant	0.894*** (0.025)	0.655*** (0.027)	0.740*** (0.029)	0.465*** (0.031)	0.831*** (0.025)	0.625*** (0.028)	0.704*** (0.025)	0.469*** (0.028)	0.725*** (0.031)	0.546*** (0.036)
Observations	1,633	1,633	1,633	1,633	1,633	1,633	1,633	1,633	1,633	1,633

Note:

*p<0.1; **p<0.05; ***p<0.01

Table C1: Correlation between priors and individual characteristics. "Gender Opinion Control" represents the answer to the question "When it comes to giving women equal rights with men, I think the country has not gone far enough". The outcome "OTHER" was introduced for 37 respondents who appeared to be outside Italy at the time of the survey. Since the panel provider guarantees that all respondents are Italian residents, this small fraction of observations was most likely traveling at that moment or using VPN tools.

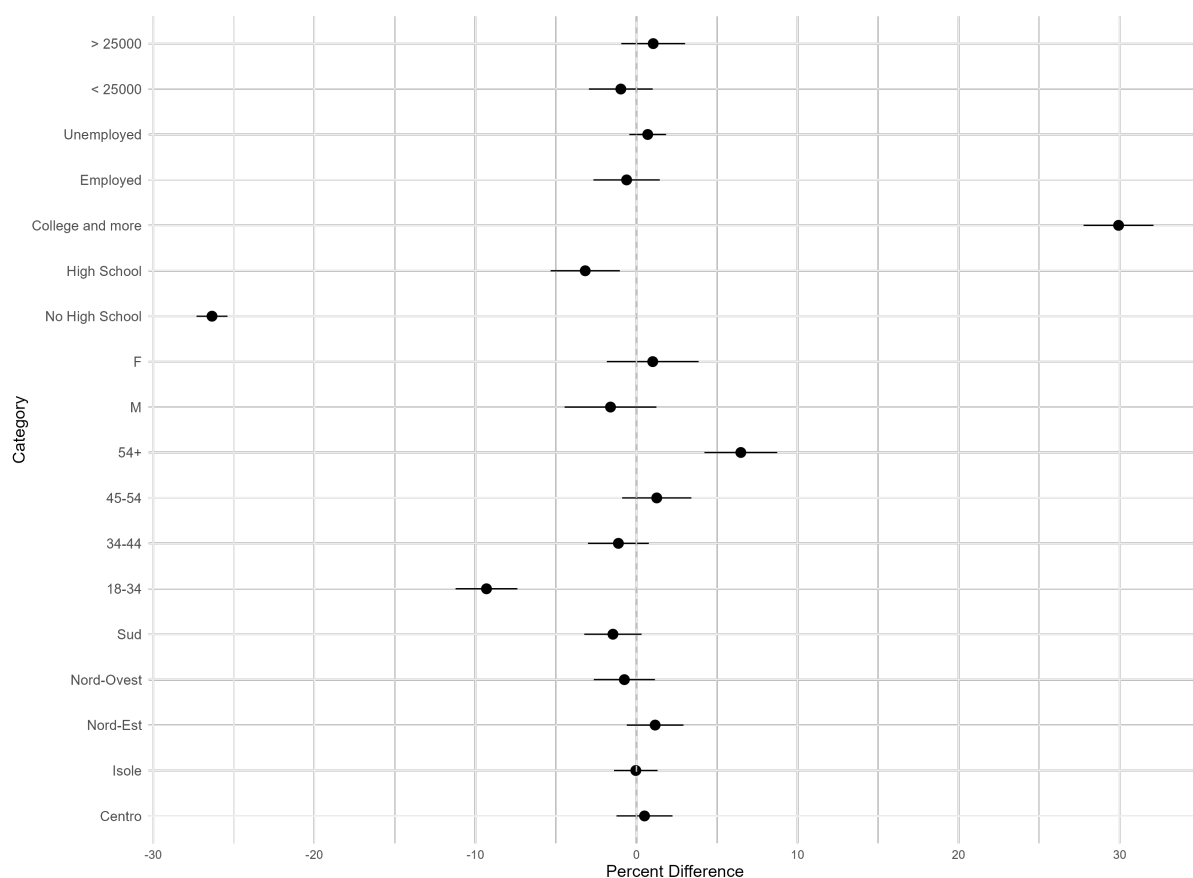


Figure C2: Sample representativeness

Notes: This figure displays the difference between our sample and the Italian population characteristics. Bars represent 95% confidence intervals. Statistics on the Italian population are sourced from ISTAT. Specifically, data on education levels and employment status are derived from the 2024 *Rilevazione Forze di Lavoro* (RFL), income data comes from the 2024 EU-SILC survey, and information on age, gender, and residency is obtained from the 2024 *Censimento Permanente*.

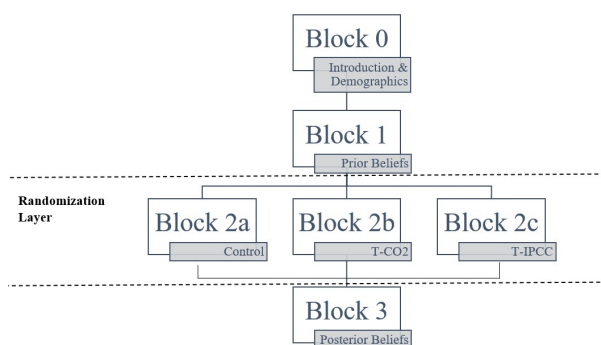


Figure C3: Survey Blocks

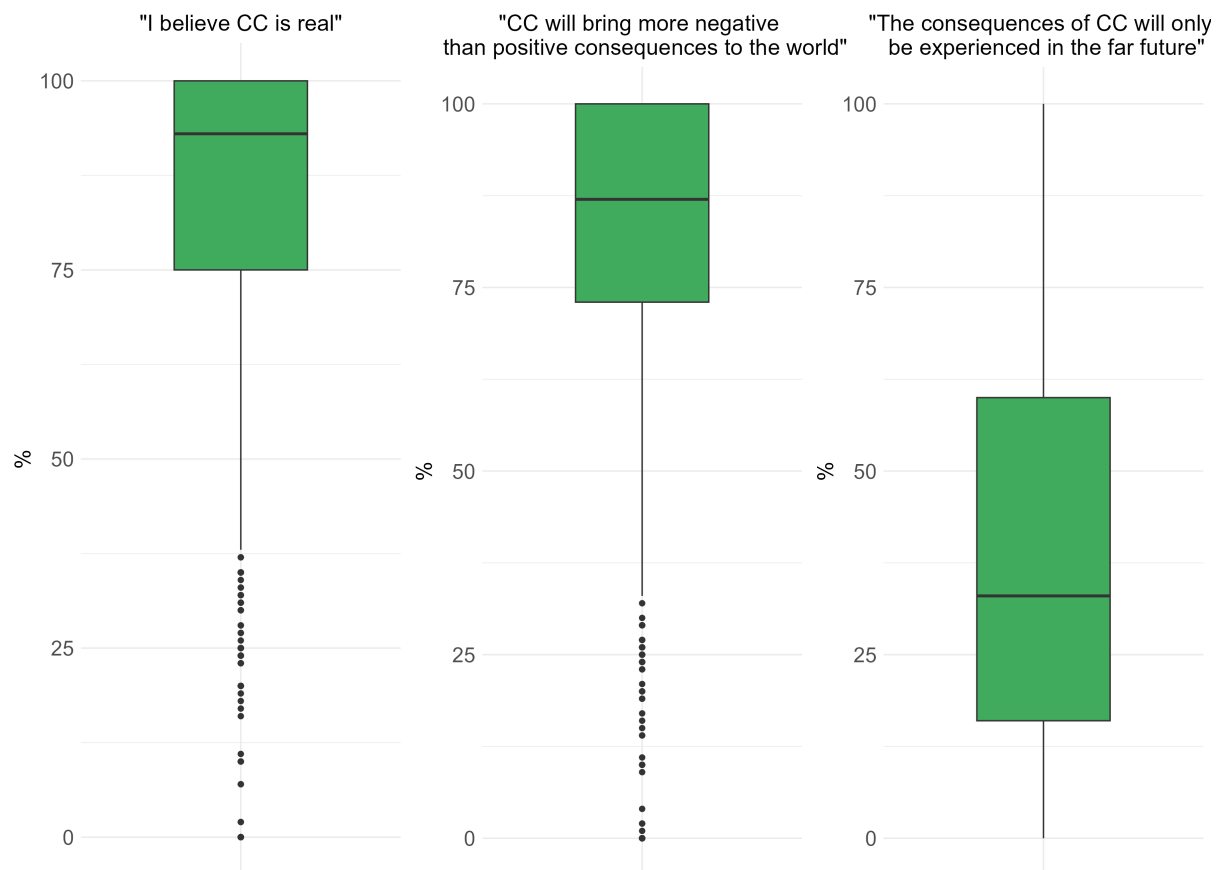


Figure C4: Beliefs on a 0-100 scale for the statements: “I believe that climate change is real” (left), “Overall, climate change will bring more negative than positive consequences to the world” (center), and “The consequences of climate change will only be experienced in the far future” (right). The box covers the middle 50% (IQR) with the median as a horizontal line, whiskers span typical values (within 1.5 times the IQR), and dots represent outliers.

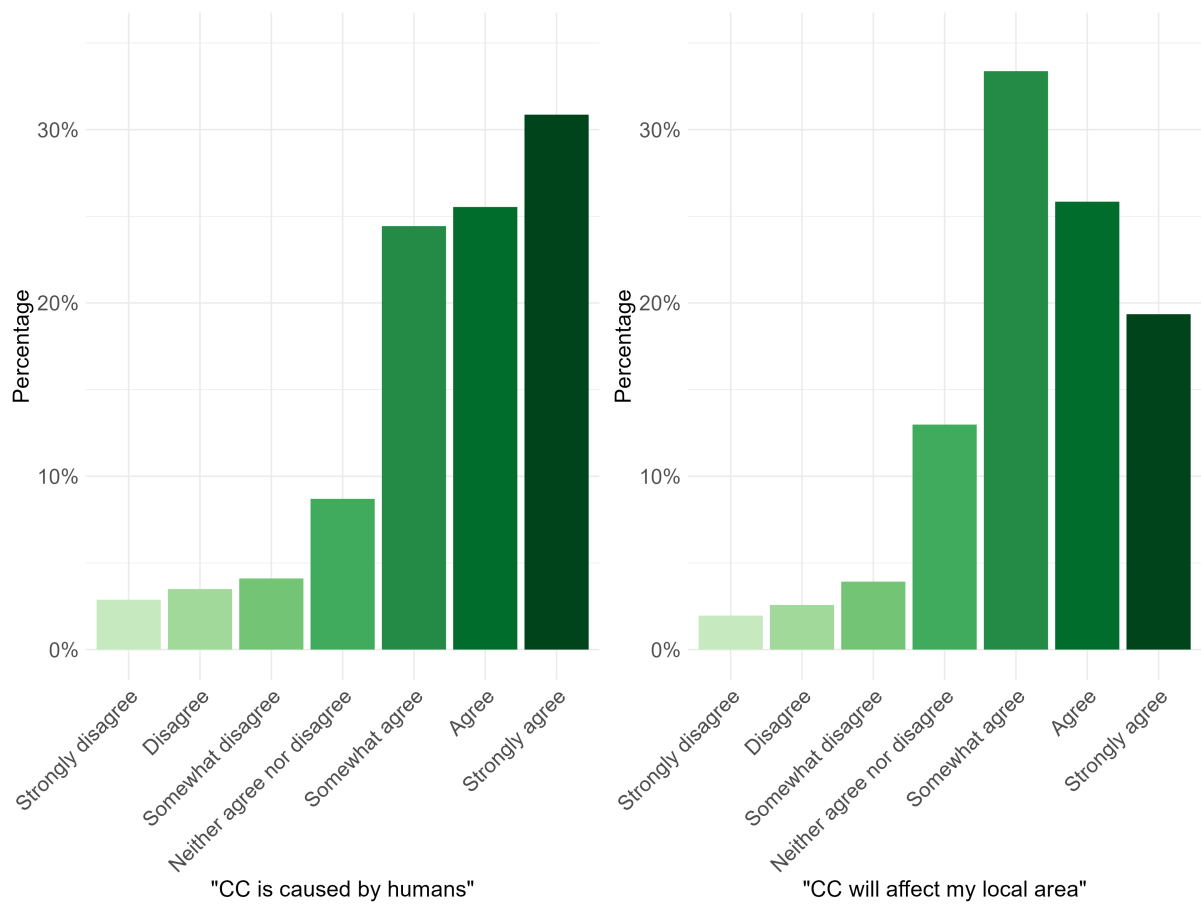


Figure C5: Beliefs on a 7-item likert scale on the statements: “Human activities are a major cause of climate change” (left) and “My local area will be influenced by climate change” (right)

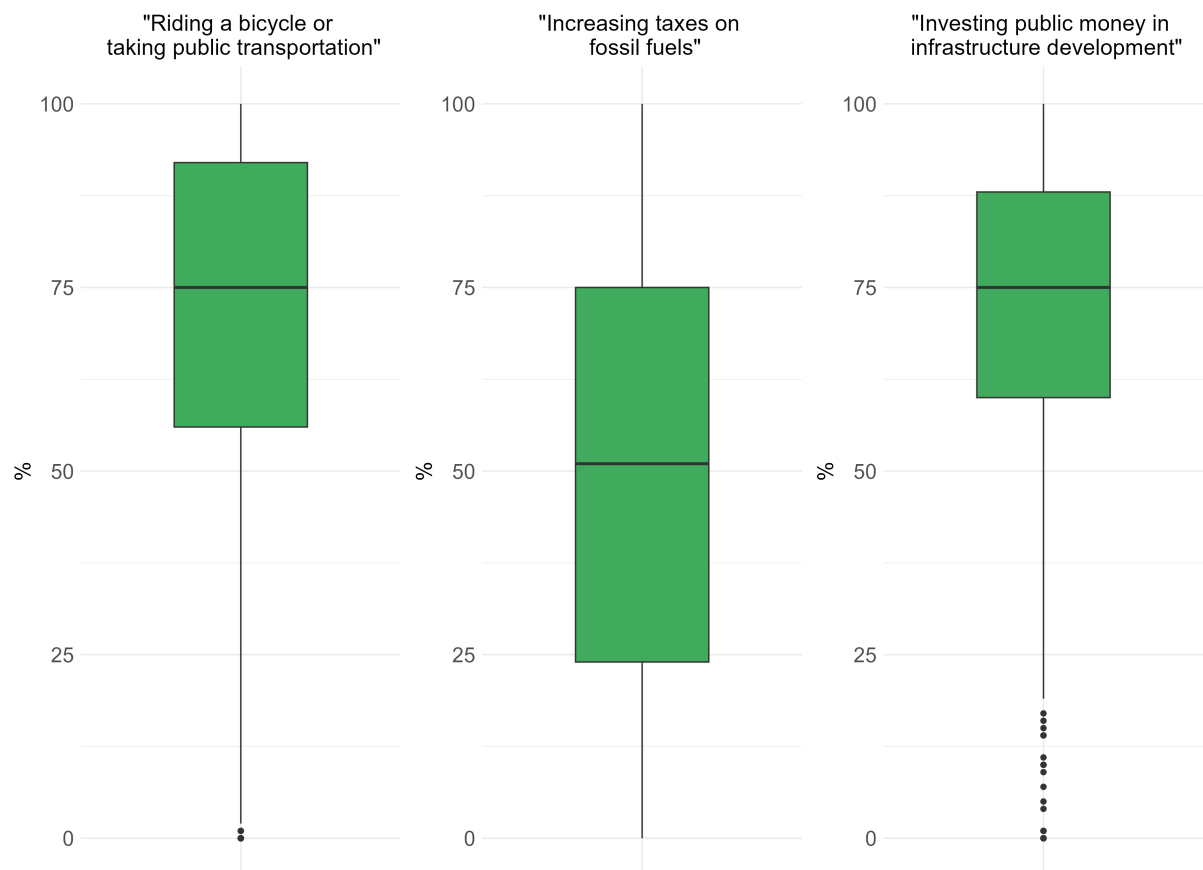


Figure C6: Opinion on a 0-100 scale to: “Riding a bicycle or taking public transportation rather than taking the car” (left), “Increasing taxes on fossil fuels, such as oil, gas, and coal” (center), and “Investing public money to make vital infrastructure (for example, energy utilities, power lines, cell towers) more resistant to climate change risks” (right). This figure only includes respondents in the control group only. The box covers the middle 50% (IQR) with the median as a horizontal line, whiskers span typical values (within 1.5 times the IQR), and dots represent outliers.

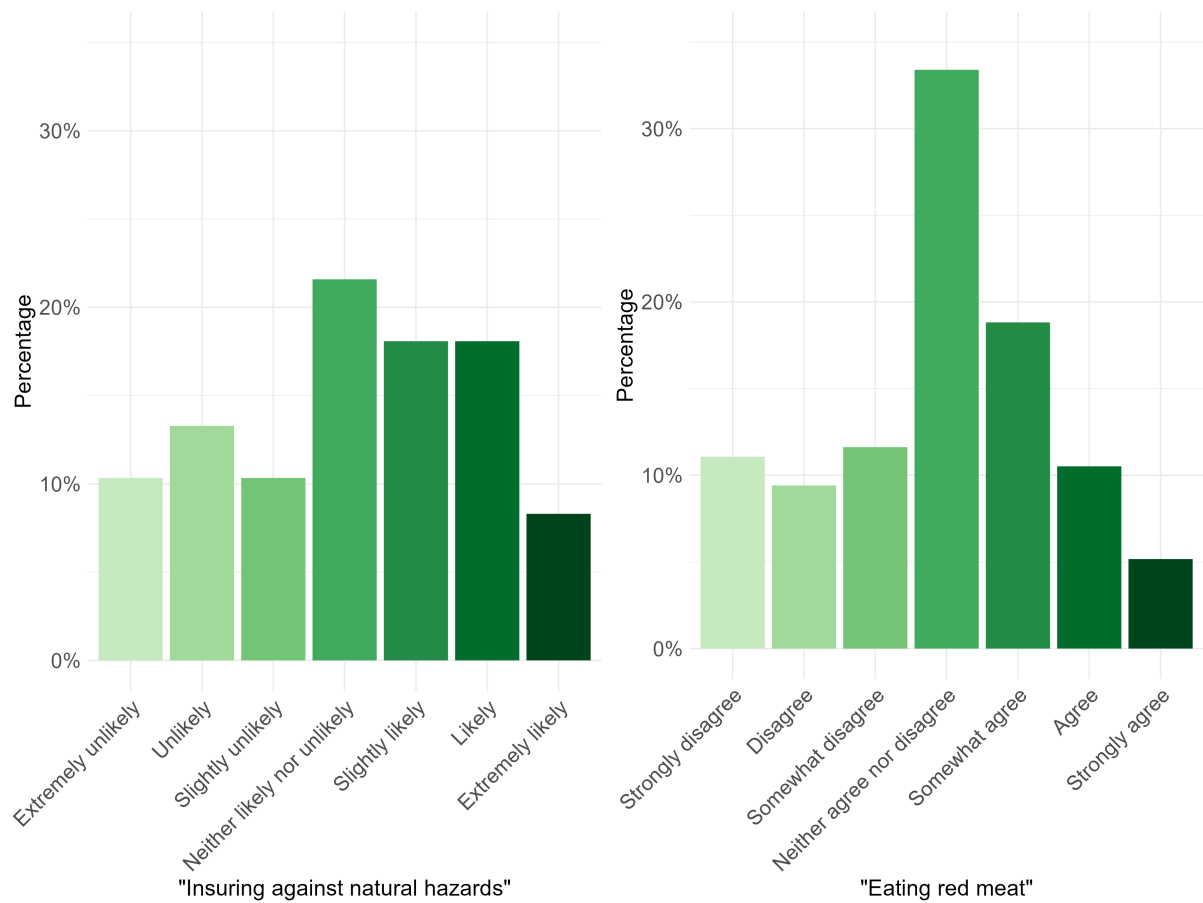


Figure C7: Opinions on a 7-item Likert scale on the statements: “Purchasing insurance against losses from natural hazards” (left) and “Eating red meat with my dinner” (right). This figure only includes respondents in the control group only.

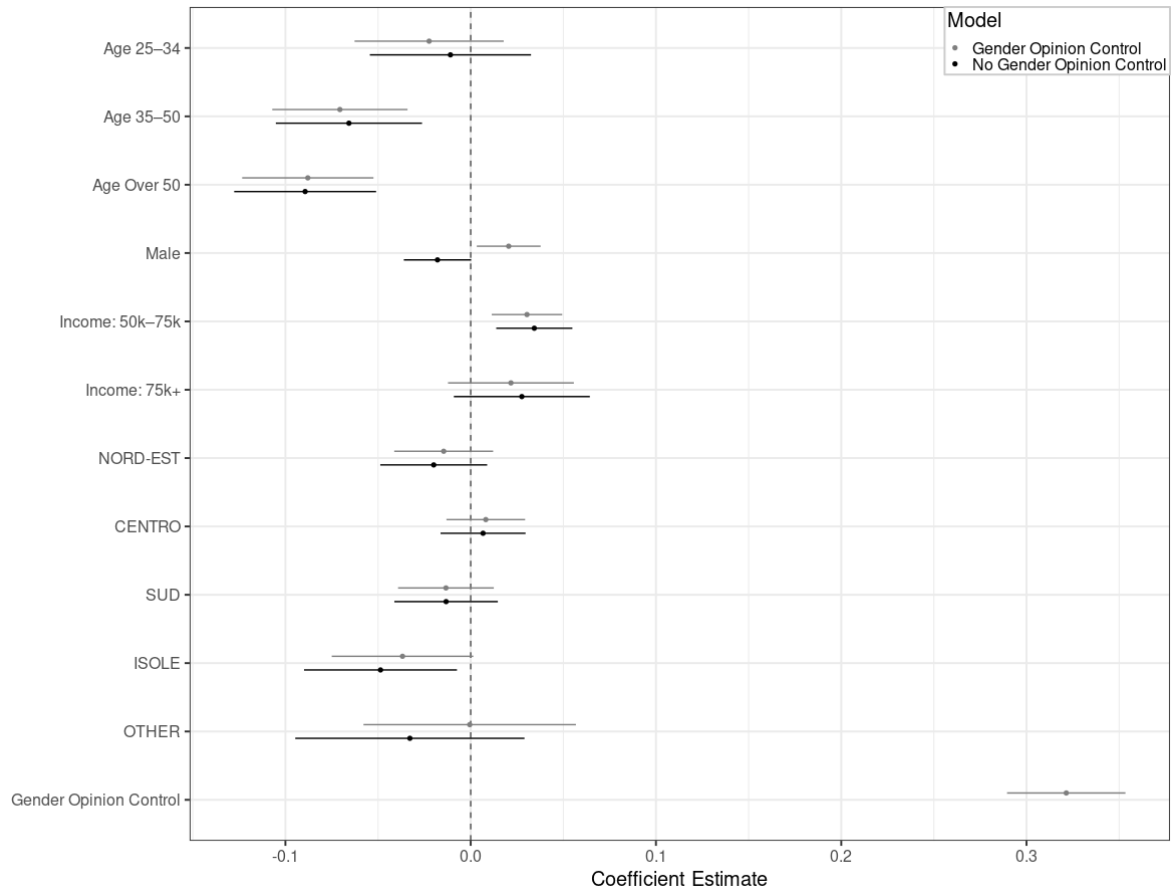


Figure C8: The coefficients from an OLS regression of priors on climate change reality on indicators for individual socioeconomic characteristics. Gray dots indicate coefficients when controlling also for gender role opinions. Bars represent 95% confidence intervals. "Gender Opinion Control" represents the answer to the question "When it comes to giving women equal rights with men, I think the country has not gone far enough". The outcome "OTHER" was introduced for 37 respondents who appeared to be outside Italy at the time of the survey. Since the panel provider guarantees that all respondents are Italian residents, this small fraction of observations was most likely traveling at that moment or using VPN tools.