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Biased perceptions of other people's attitudes to carbon taxation

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ABSTRACT

Beliefs about other people's opinions on climate change influence one's own opinion. Such beliefs can, however, suffer from biases in perception. Using two nationally representative surveys, we examine this issue in a new context, namely of carbon-tax acceptance in Spain. We find that the more one expects the tax to be accepted by others, the more one accepts it personally. But opponents of a carbon tax tend to strongly overestimate the prevalence of their opinion, i.e. they exhibit a so-called false consensus effect. In contrast, despite holding the majority view, tax supporters somewhat underestimate the prevalence of their own view, which is known as pluralistic ignorance. We further test the role of information provision by providing participants with different percentages of people accepting the tax. Overall, we find little evidence that such information provision significantly increases tax acceptance. The impact of information provision on tax acceptance tends to be moderated by the degree of false consensus.

1. Introduction

Carbon pricing, in the form of taxation or cap-and-trade, is widely viewed as a cornerstone of an effective climate policy package to reach the Paris Climate Agreement (Edenhofer et al., 2015; Baranzini et al., 2017; Best et al., 2020). Most countries around the world do, however, not have a carbon tax, while the stringency of the over 20 existing (sub) national carbon taxes tends to be rather low (World Bank, 2019; OECD, 2018). A major factor explaining both facts is public opposition, translating in insufficient political support (Jenkins, 2014; Klenert et al., 2018; Rabe, 2018). For example, the emergence of the "Yellow Vest" movement led to a halt in the planned regular raise of the French carbon tax, partly due to concerns about regressive tax effects (Douenne and Fabre, 2020).

A growing body of interdisciplinary research has emerged to understand public attitudes[1] to carbon pricing and underlying factors (Carattini et al., 2018). These include, among others, personal and distributional policy costs (Hammar and Jagers, 2007), other policy design issues like how to spend tax revenues (Maestre-Andrés et al., 2019), the framing and communication of the policy (Rhodes et al., 2014; Hardisty et al., 2019), education and perceived knowledge about the carbon tax (Savin et al., 2020), and political identity (Van Boven et al., 2018). Here we examine an issue which has only recently gained attention in the research on climate perceptions in general and to a lesser extent on policy acceptance, namely the role of social perceptions or so-called social second-order beliefs.

A first-order belief is what an individual herself believes about an issue, whereas a second-order belief is what a person believes what others might think about it.[2] In general, second-order beliefs can be considered a special type of a social norm. There is a considerable amount of research regarding social norms and more general environmental behaviors (Kinzig et al., 2013; Nyborg et al., 2016; Farrow et al., 2017; Bergquist et al., 2019), but this tends to focus on people's thoughts about what others *do*, not so much what others *think*. Arguably, it is easier to observe whether other people litter (a well-known case in the research on social norms, see Cialdini, 2003) than to know what other

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[1] Here we mainly employ the term "public acceptance", but for stylistic reasons also use synonyms and antonyms such as "public support" and "public opposition". However, it is worth noting that some authors see conceptual differences between these and other terms to describe public attitudes to climate policy (Kyselá et al., 2019).

[2] Second-order beliefs can also be about one's own beliefs (Baron, 1987). However, here we are concerned with beliefs about others' beliefs. For reasons of brevity, we henceforth omit the term "social" and simply speak of "second-order beliefs".

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people think about a climate change and particularly specific climate policies.

Relatively few studies are available on social perceptions related to climate policy. For example, Schuldt et al. (2019) examine second-order beliefs and public support for coal-to-gas policy in China and find that beliefs about socially proximal reference groups in China (e.g., “My friends and family” or “Chinese people in general”) together accounted for 18% of the variance in individual-level policy support. A study for the US shows that perceived social consensus can bridge the notorious political divide between liberals and conservatives regarding climate change beliefs and policy attitudes (Goldberg et al., 2019). A study for the US and China finds that both American and Chinese respondents – including the general public as well as political actors – underestimate the prevalence of pro-climate views (Mildenberger and Tingley, 2019).

An important question is how people respond when being confronted with external information about other people’s beliefs. As mentioned before, social norm provision has generally been shown to have effects on environmental behaviors, but little is known about this in the context of climate policy perceptions and attitudes. A US study involving university students examines norm interventions related to a “carbon emissions cap” (Bolsen et al., 2014). In one experimental condition, participants were informed that 85% of Americans believe in climate change, are willing to engage in behavioral changes, and support a tax to reduce greenhouse gas (GHG) emissions. This norm intervention, which mixes tax-related with other second-order climate beliefs, did not influence policy acceptance. However, an additional experimental condition which conveyed that only a 15% minority has pro-climate views led to lower policy acceptance. A study for the UK, involving 123 participants, tested the effect of a strong (80% majority acceptance of policies) and a weak (20% acceptance) norm (de Groot and Schuitema, 2012). It found that people informed about the strong norm were more supportive of two incentive-based policies, namely a car tax and a littering fine. Furthermore, a study by Mildenberger and Tingley (2019) exposed US respondents to information about the true proportion of Chinese people’s pro-climate beliefs (98%), which on average slightly increased support by US respondents for a global climate treaty.

The effect of information provision about second-order beliefs might be moderated by biases in social perceptions, in particular a so-called false consensus effect (FCE, Ross et al., 1977). This refers to an individual overestimating how common their own opinion is in the wider population. Several mechanisms can explain this effect. For example, people may lack exposure to dissimilar views; or people are motivated to appear normal. In general, understanding biases in social beliefs, such as FCE, and their implications for environmental policy, has been identified as an important research gap in environmental economics (Millner and Ollivier, 2016).

Probably the first study examining second-order beliefs in the context of climate change (not climate policy) was Leviston et al. (2013). It found that on average respondents overestimated the proportion of people who are skeptical about the existence of climate change, with the strongest overestimations voiced by skeptics themselves. No attempt to manipulate second-order beliefs was undertaken. The latter was done in a study by Geiger and Swim (2016) who led American university students experimentally to believe that most other people are either concerned or unconcerned about climate change (see “Study 2” in their paper). They found that those very concerned were more willing to talk about climate change if they were led to believe that most others are also concerned.

A related, sometimes contrasting phenomenon is so-called pluralistic ignorance. This denotes people’s tendency to incorrectly believe that an opinion they reject is held by an absolute or relative majority of others (Leviston et al., 2013; Sokoloski et al., 2018). Such effects have been observed for certain pro-climate views, e.g. people who believe in the existence of climate change believe that climate change skepticism is much more common than it actually is (Leviston et al., 2013).

The contribution of the present article is twofold. First, it aims to corroborate some of the earlier findings related to second-order beliefs in a new context, namely of public acceptance of carbon taxation. Specifically, we examine in two nationally representative surveys for Spain whether perceived public attitudes to carbon taxes are associated with personal acceptance of the tax. At present, there is no economy-wide carbon tax in Spain. In addition, we investigate to what extent our respondents exhibit FCE regarding carbon taxation. Empirical findings reviewed above indicated that minorities have skeptical views about climate change. If the same holds for views on climate policy, then we expect that particularly carbon tax opponents show stronger FCE than tax supporters. This expectation is also justified by more general research on consensus estimates (Krueger and Clement, 1997; Dvir-Gvirsman, 2015). One explanation why minorities overestimate the prevalence of their own view is that this tendency helps to counteract the psychological threats of holding minority views.

A second contribution of this study is that we test the effects of influencing second-order beliefs, and how they are moderated by FCE. There is a lack of experimental research on whether social perceptions related to climate change can be revised (Abeles et al., 2019). Some related studies have experimentally manipulated perceptions of others’ policy attitudes (de Groot and Schuitema, 2012; Bolsen et al., 2014), but they do not examine how experimental information provision interacts with FCE. We fill this research gap by providing respondents with information about acceptance of a carbon tax among the Spanish population to test the claim that people with high initial false consensus are more resistant to change their own tax acceptance. This is based on general psychology research showing stability of FCE despite contrary information (Krueger and Clement, 1994), as well as longitudinal evidence suggesting such a tendency for more general climate beliefs (Leviston et al., 2013). Finally, given that all of the prior research comes from Australia, China, the UK and the US, and at least in some cases draws on non-representative samples, our study for Spain is a useful addition for generalizing results across countries and entire populations.

This paper reports results from two surveys conducted in Spain. Methods and results of the first and second survey are reported as two separate studies in Section 2 and 3, respectively. The first study can be viewed as rather exploratory, while the second study tried to improve upon some limitations of the first survey as well as confirm the initial findings. Section 4 provides a general discussion of the results. Section 5 concludes.

2. Study 1

2.1. Data and method

We draw on a survey conducted in August 2019 in Spain. The survey, including its experimental part, was approved by the University’s Human Ethics Committee. It was conducted by the survey company ‘Netquest’. Sampling was done by using quotas on age, gender and geographical distribution, making the survey sample representative of the general population on these and other characteristics (see Table A1 in Appendix A for further information). The response rate was 59%, with the final sample consisting of 2004 complete responses. Respondents took on average about 15 min to finish. This is because the survey included various additional questions on carbon taxation apart from the ones described below (see Appendix B for full questionnaires). Participation and completion of the survey was encouraged through a non-monetary gift voucher.

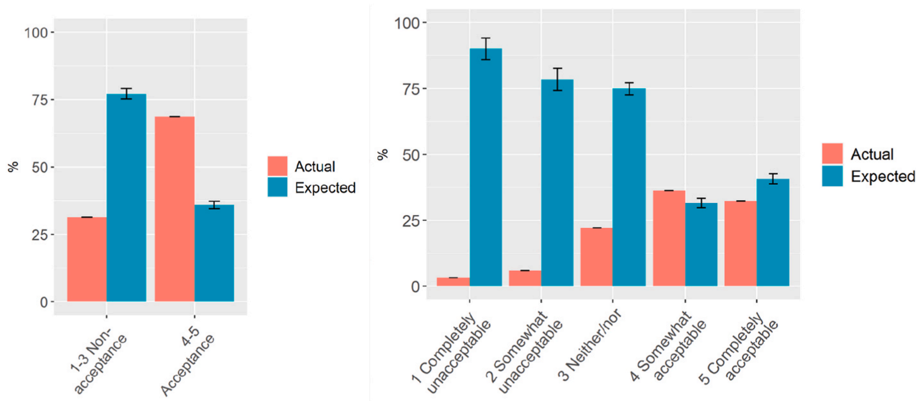

Fig. 1. Actual and expected (non-)acceptance level of a carbon tax, depending on respondents' own (non-) acceptance. The Y-axis shows how prevalent a certain level of (non-)acceptance actually is (in red) versus how people holding this opinion expect the prevalence of their opinion to be in the overall population (in green). Right panel is a disaggregation of left panel. Error bars indicate ± 2 standard errors. The green bars add up to more than 100% because they represent expected averages for each response option, whereas red bars denote actual shares of each acceptance level. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Our measure of carbon tax acceptance prior to any experimental intervention is based on the following survey question: "How acceptable do you find the carbon tax if its revenues are used to support the development of climate projects?" (Q1). Participants could respond by using a 5-point Likert scale with 1 (completely unacceptable), 2 (somewhat unacceptable), 3 (neither unacceptable nor acceptable), 4 (somewhat acceptable) and 5 (completely acceptable). The frequencies of responses to Q1 are depicted in Fig. 1 by the actual level of acceptance. After answering various other questions about carbon taxation (used for other research projects), respondents were confronted with the following question aimed at capturing second-order beliefs: "To the best of your knowledge, what percentage of the Spanish population would somewhat or completely accept a carbon tax? Type a number from 0 (no one) to 100 (everyone)." (Q2). The frequencies of responses to Q2 are presented in the Appendix in Figure A1 (left plot). Right afterwards, they read: "A recent public opinion survey in Spain demonstrated that 19% [alternative: 67%] of people would accept a carbon tax if the revenues are used for climate projects. Given this information, how acceptable do you find such a carbon tax?" (Q3). Approximately half of the sample received at random the 19% and the other half the 67% version. Responses could again be given on a 5-point scale. Frequencies of responses to Q3 are again depicted in Figure A1 in Appendix. These fictitious numbers were chosen to reflect two conditions of either minority or a majority acceptance. We decided to use fictitious numbers as there was no recent real survey data available that we could draw on for our purposes. The European Social Survey for 2016 found that 27% of the Spanish population was in favor of "increasing taxes on fossil fuels" (Pohjolainen et al., 2018), which is somewhat similar to our wording ("carbon tax"). This value is fairly close to the value for our minority group (19%). Study participants were debriefed at the end of the survey about the nature and purpose of the provided information. Regarding the use of fictitious information and potential ethical concerns, consider that disciplinary norms exist: It is typically permitted in social psychology and sociology (Barrera and Simpson, 2012). In contrast, experimental economics tends to proscribe it, but surveys of economists show that even within this discipline there is disagreement on what is permissible or not (Colson et al., 2016; Krawczyk, 2019).

To understand whether respondents change their tax acceptance, we measure the impact of information provision on their tax acceptance level and assess if this is significantly associated with the level of false consensus they exhibit. We operationalize FCE by estimating for each respondent the deviation of own expected (non-)acceptance from the actual public (non-)acceptance level:

$$false\,consensus\,bias_i = expected\,(non)acceptance_i - public\,(non)acceptance \tag{1}$$

While the former element on the right-hand side of Eq. (1) varies across the respondents collected by Q2, the latter is the same for all subjects (and equals 69%) and is calculated as an average tax acceptance, based on Q1. To distinguish between FCE for the two types of opinions, we separately estimate Eq. (1) for those accepting and not accepting a carbon tax.[3] For example, for a person who accepts a carbon tax and expects a level of acceptance of 79%, while the actual level is 69%, FCE will be equal to 10%, i.e. she overestimates the prevalence of her own view. Alternatively, for a person who does not accept a carbon tax and expects a non-acceptance rate of 60% while the actual public non-acceptance rate is of 31% (100%–69%), FCE will be equal to 29%, i. e. she overestimates the prevalence of non-acceptance of a carbon tax. Further note that a negative value of FCE may indicate pluralistic ignorance. For example, a person who accepts the tax and expects prevalence of this view to be 51%, has negative FCE (51%–69% = −18%), but does not show pluralistic ignorance. This is only the case if expected prevalence of own opinion is below 50%. We will highlight cases of pluralistic ignorance at relevant places. Our analytical focus is, however, on FCE, given that this phenomenon is much more common, particularly among the politically more relevant case of carbon tax opponents.

The change in acceptance rate, in turn, is operationalized as a difference between acceptance rates collected after (Q3) and before (Q1) the fictitious information has been provided:

$$change\ in\ acceptance = acceptance\ after - \ acceptance\ before \tag{2}$$

The constructed variable "change in acceptance" has a limited value range: those who originally accept a carbon tax based on Q1 can at most

[3] Non-acceptance includes response options 1, 2 ("completely"/"somewhat unacceptable") and 3 ("neither … nor …"). This is because when measuring second-order beliefs through Q2 we distinguish only between two possibilities: either somewhat/completely accept a carbon tax (response options 4 and 5) or all the remaining options (1, 2 and 3). Excluding respondents who choose option 3 from non-acceptance would bias our results, as we cannot distinguish them from non-acceptance in Q2. In the next Section (Study 2) we use a revised format of Q2 to make such a distinction possible.

increase their acceptance by one unit (i.e. from 4 to 5) and decrease most by four units (i.e. from 5 to 1), whereas those who do not accept can increase most by four (from 1 to 5) and decrease most by two (from 3 to 1) units.

2.2. Results

First, we examine how perceptions of public opinion relate to individuals' own carbon tax (CT) acceptance. Conducting an OLS regression of tax acceptance on perceived population-wide tax acceptance:

$$CT\ acceptance\ level = \alpha + \beta * expected\ acceptance\ level\ +\ \varepsilon \tag{3}$$

we find that the higher the perceived acceptance, the higher is the respondent's own acceptance (β = 0.012, SE = 0.001, $p < 0.01$, R^2 = 0.09).[4] These results remain robust when controlling for socio-demographic characteristics like age, gender, education, household income and political orientation (see Table A2 in Appendix A).

Next, we look at how perceptions of public attitudes depend on one's own tax acceptance. The left plot in Fig. 1 shows that people who accept a carbon tax, on average, estimate the proportion of the population holding a similar attitude to be lower than what it actually is (36% vs. 69%), whereas those not accepting a carbon tax tend to overestimate the prevalence of their own attitude (77% vs. 31%). In other words, those critical of the tax on average exhibit FCE, whereas most tax supporters display pluralistic ignorance. Note also that both groups underestimate the 'true' prevalence of carbon tax support (23% expected by those who do not accept and 36% expected from those who accept compared to the actual 69%). The right plot in Fig. 1 gives a more detailed depiction of actual and expected acceptance depending on all levels of personal acceptance. In other words, for each group (separated on the X-axis) the percentage of people who are in this group are depicted, versus the percentage of the population this specific subgroup believes to be in this group. The figure shows that the expectation mismatch is largest for the extreme case that people find a carbon tax completely unacceptable.

In the following we compare own tax acceptance before and after information provision. This is done for the overall sample of observations and by splitting it based on the information being provided and the initial level of acceptance (Table 1). We use a pairwise Mann-Whitney test that explicitly compares responses from the same individuals. P-values below conventional significance levels indicate that acceptance has changed after information provision. We find that on average acceptance went down for both communicated levels acceptance (19% and 67%). This drop is a bit steeper if they are given the 19% compared to the 67% treatment. There is a drop among people who accept and are told 19%. There is a small (non-significant) drop among people who reject and are told 19%. There is a drop among people who accept and are told 67%. And there is a slight (non-significant) increase among those who reject and are told 67%. In sum, if we distinguish between those who initially accepted the tax from those who did not, we find that the effect is mostly explained by the drop in acceptance among the tax supporters (row 4 and 6 versus 5 and 7 in Table 1). These results are further discussed in Section 4.

As a next step, we test how FCE of the respondents is related to their change in tax acceptance. We do this in four subsamples, namely respondents who personally accept the tax or not, combined with the message received, i.e. either the information of 19% or 67% population-wide tax acceptance. Testing results for separate samples is motivated by the following consideration. FCE has been measured in different ways for those accepting and those not accepting the carbon tax (see Eq. (1)). Thus, negative FCE among supporters indicates they underestimate public acceptance, while they most likely react to external information by revising their acceptance downwards (rows 4 and 6 in Table 1). In contrast, negative FCE among tax opponents means they overestimate acceptance of the tax, while they likely react to external information by revising their acceptance upwards (rows 5 and 7 in Table 1). Therefore, by estimating Eq. (4) on the full sample, such nuances would be lost, as opposed to estimating it for separate subsamples. Our regression equation for the four subsamples then has the following form:

$$false\ consensus\ effect = \alpha + \beta * change\ in\ acceptance\ +\ \varepsilon \tag{4}$$

and tests if people with different FCE have a different propensity to change their acceptance level.[5] We first estimate Eq. (4) using OLS.[6] Figure A3 in Appendix A depicts related scatter plots combined with 2D density plots to illustrate where most observations are concentrated. The reported results are robust to alternative functional forms, namely ordered logit regression. Furthermore, to ensure robustness of our results to outliers and allow for the possibility that people with different FCE may have changed their acceptance differently, we additionally conducted a quantile regression (QR, Koenker and Bassett, 1978) of Eq. (4) as it allows to differentiate the role of the explanatory variable throughout the distribution of the dependent variable. The latter motivated us to put FCE on the left-hand side of Eq.(4), thus distinguishing

Table 1
Average tax acceptance before and after information provision.

	Type of sample, with sample size	Acceptance before information manipulation	Acceptance after information manipulation	Pairwise Mann-Whitney test's p value
1	All respondents, n = 2004	3.886 (3.840–3.932)	3.455 (3.399–3.511)	<0.0001
2	Informed with 19% acceptance, n = 1005	3.884 (3.817–3.950)	3.332 (3.253–3.411)	<0.0001
3	Informed with 67% acceptance, n = 999	3.888 (3.824–3.952)	3.579 (3.500–3.657)	<0.0001
4	Informed with 19% acceptance and initially accepting the tax, n = 689	4.480 (4.442–4.519)	3.721 (3.636–3.807)	<0.0001
5	Informed with 19% acceptance and initially not accepting the tax, n = 316	2.582 (2.504–2.660)	2.484 (2.361–2.607)	0.0827
6	Informed with 67% acceptance and initially accepting the tax, n = 687	4.461 (4.423–4.499)	3.977 (3.897–4.057)	<0.0001
7	Informed with 67% acceptance and initially non-accepting the tax, n = 312	2.625 (2.552–2.698)	2.702 (2.571–2.833)	0.3528

Note: Results are reported with±two standard errors in parentheses.

[4] As a robustness check, we estimated an ordered logit model, since the dependent variable can be considered categorical, confirming that coefficient β from Eq. (3) is positive and significant (with a pseudo R^2 of 9%).

[5] Note that on advice of one of the anonymous reviewers we also tested an equation regressing change in carbon tax acceptance on prior acceptance level, expected level of acceptance and their interaction effect. Results for Study 1 and Study 2 are reported in the Appendix in Table A10 and do not show any systematic pattern.

[6] One might argue that our estimates are biased because both FCE and change in acceptability are constructed using own CT acceptance level. To test this, we estimate Eq. (4) by adding own CT acceptance level as a control and examining multicollinearity using Variance Inflation Factor (VIF). As one can see in Table A9 in Appendix A, our estimations remain robust, while VIF values vary between 1.02 and 1.06, which is far below the conservative benchmark of 5, suggesting absence of multicollinearity.

how the relationship between FCE and the change in acceptance level varies depending on the extent of FCE. In other words, in contrast to OLS, QR does not impose β to be constant but allows it to vary with the degree of FCE shown by the respondents. The results of QR for different percentiles in FCE distribution are reported in Figure A4 and indicate a nonlinear relationship between the degree of FCE and change in acceptance level.

Overall, the results show that people exhibiting a relatively high degree of FCE are less inclined to revise their own carbon-tax acceptance in response to information about others' opinions (Figure A3-A4). This effect is stronger among what is arguably the politically most relevant group, namely tax opponents. This type of analysis is repeated in a very similar way in Study 2 below. This is why we report detailed results only of Study 2 in the main text, while detailed results from Study 1 can be found in Appendix A.

Study 1 has several limitations. One is the measure of the respondents' estimate of population-wide acceptance of a carbon tax, which is not perfectly comparable to the measure of respondents' own acceptance of carbon taxes. This is because we asked them to estimate other people's acceptance of a carbon tax in general, whereas we elicited personal acceptance of a carbon tax before and after information provision under the condition that the revenues will be spent on climate projects. The reason for this is that the latter survey question was part of another research objective of the survey described in Maestre-Andrés et al. (2021). This wording might have affected our results, as public perceptions of carbon taxes can differ depending on the use of tax revenues. To improve upon this issue and to test the robustness of our insights was one of our motivations to conduct Study 2.

In addition, the conceptualization and measurement of "non-acceptance" in Study 1 is somewhat limited. Remember that tax opponents were not asked to directly estimate the prevalence of their own attitude, but rather what percentage of the population they think accepts the tax. Thus, we assumed that tax opponents' beliefs of the prevalence of their own attitude can be measured by subtracting beliefs of tax acceptance from the total population (100%). However, previous research shows that people on average believe that about 20% of the population does not hold any substantive opinions (Leviston et al., 2013), i.e. they think others do not know, are indifferent or undecided about climate change. This means that when tax opponents are asked directly about the expected prevalence of their own attitude, one might arrive at a lower number than in Study 1. In contrast, we added a third category of second-order beliefs to Study 2, namely of other people who are undecided about the tax. In this way, we can more precisely measure aggregate second-order beliefs and individual-level FCE. This also responds to calls in the literature to avoid binary conceptualizations and measurements of second-order beliefs (Mildenberger and Tingley, 2019).

3. Study 2

3.1. Data and method

To apply lessons from the previous study and overcome some of its limitations we undertook a second study. The survey was conducted between June–July 2020 in Spain. It was approved by the University's Human Ethics Committee. The same survey company and techniques as in Study 1 were used. Sampling was again done by using quotas on age, gender and geographical distribution, making the survey sample representative of the general population on these characteristics (see Table A3 in Appendix A). The sample included 2200 respondents who took on average 19 min to finish. The response rate was 68%.

About half of the respondents participated also in the survey of Study 1. These participants had a response rate of 82%, compared to 57% among the remaining ones. The reason for partially inviting the same respondents is a related research project on temporal changes of attitudes and behaviors, which however is not part of the present analysis. The sampling entailed first inviting respondents from Study 1. After reaching a certain threshold, the sample was extended by inviting new participants. This mixed sampling strategy is the reason for differences in response rates between the two subsamples. Anyway, given that participation in Study 1 might somehow affect results of Study 2, we test potential differences in key variables. Using the Kruskal-Wallis rank sum test with Bonferroni correction we tested if the level of acceptance (asked initially and in a follow-up question after information manipulation) differed between people who participated in Study 1 ($n = 1172$) or not ($n = 1028$). The results indicate that the two samples are not significantly different in: any of the key variables (Table A4), the relationship between own tax acceptance and expected acceptance of others (Table A2), the extent of FCE (Figure A5), the effects of the experimental treatment (Table A5), and the role of FCE moderating the effect of information on changes in CT acceptability (Figure A6). Moreover, it is worth considering that the respondents are members of a survey panel, hence they participate in surveys of different types at a regular basis. We therefore deem it unlikely that they have a strong memory of the first survey taken almost one year before. In sum, we consider the two groups of respondents as comparable and suitable for an integrated analysis. An additional analysis shows that there are no significant differences in climate concern and tax acceptance between the participants who participated in both surveys and the full samples of respondents in Studies 1 and 2 (Table A6). Together with a low survey dropout rate (6.6%), this indicates that there is little reason to be concerned about self-selection bias.

Attitudes to carbon taxation in this survey were measured by the question "How acceptable do you find a carbon tax?" (Q1), to which participants could respond by using the same Likert scale from 1 (completely unacceptable) to 5 (completely acceptable) as in Study 1. The tax with unspecified revenues was considered somewhat or completely acceptable by 51% of respondents. Second-order beliefs were measured similarly as in Study 1: "In your opinion, what percentage of the Spanish population would accept or not accept a carbon tax? Type a number from 0 (no one) to 100 (everyone). The total amount should be equal to 100%.". However, this time participants could enter three numbers for the "% of people who accept the tax", "% of people who do not accept the tax", and the "% of people who are undecided or indifferent" (Q2). Afterwards participants answered a set of other questions which are not used for this article, such as on acceptance of other carbon tax schemes and other climate policies, as well as on several experiences and perceptions related to the COVID-19 crisis (see full questionnaire in Appendix B). Subsequently, a randomly drawn half of the sample received the following information: "A recent public opinion survey in Spain demonstrated that 43% of them would accept a carbon tax, 38% would not accept it, and 19% is undecided." A control group received no such information. In contrast to Study 1, the provided information is not fictitious but derived from the results of Study 1. Note that these numbers are calculated from a question on carbon taxes without any specified use of the tax revenues. Respondents in both the treatment and control group were then asked again the question from before, that is, "How acceptable do you find a carbon tax?" (Q3).[7] The logic of the control group was to capture potential attitude changes due to other random noise in the survey.

Here we operationalize FCE by estimating for each respondent the deviation of own expected attitude from the actual level (Eq. (1)), i.e. the same as in Study 1 with the only difference that here we also measured FCE separately for those who were undecided (response option "3") on Q1.

[7] Frequencies of responses to Q2 and Q3 are reported in the Appendix in Figure A2.

4. Results

We start again by examining how perceptions of public opinion relate to individuals' tax acceptance. Conducting an OLS regression of tax acceptance on estimated acceptance (Eq. (3)), we find that the higher is the perceived population-wide tax acceptance, the higher is the respondent's own acceptance ($\beta = 0.021$, $SE = 0.001$, $p < 0.01$, $R^2 = 0.13$).[8] As in the first study, these results here are robust when controlling for socio-demographic characteristics (see Table A2). As one can see, the explanatory power of expected acceptance of carbon taxation in Study 2 is higher than in Study 1.

Next, we investigate how perceptions of public attitudes depend on one's own tax acceptance. First of all, the upper panel in Fig. 2 shows that everyone overestimates tax rejection, but the opponents themselves have a stronger overestimation. Everyone underestimates acceptance, but opponents and those who are undecided, again, exhibit stronger underestimation. Undecided people are accurate about the prevalence of those with undecided views, while both rejectors and supporters underestimate the prevalence of undecided views. People who accept a carbon tax estimate the proportion of the population holding a similar attitude to be lower than what it actually is (36% vs. 51%), while at the same time overestimating the prevalence of tax opponents (48%). This is again a form of pluralistic ignorance, although this time only to the extent of incorrectly assuming a relative, but not absolute, majority. Those rejecting a carbon tax strongly overestimate the prevalence of their own attitude (67% vs. 26%) and underestimate prevalence of other opinions (19% and 14% for acceptance and indecisiveness). In other words, the tax opponents on average again exhibit FCE. Finally, the undecided respondents tend to overestimate only the prevalence of tax opponents (54%). The right panel in Fig. 2 gives a more detailed depiction of actual and expected acceptance depending on all levels of personal acceptance. It shows that the expectation mismatch is largest at the extreme where people completely reject a carbon tax. In addition, there is generally more overestimation of minority opinions than underestimations of majority opinions (further see Table A7). Taken together, despite somewhat different question wordings, these results are largely consistent with Study 1.

Now we compare acceptance before and after information manipulation for the overall sample of observations and by splitting it depending on the information being provided and the initial level of acceptance (Table 2). This is done with a pairwise Mann-Whitney test that explicitly compares responses from the same individuals. We find that acceptance is reduced irrespective of whether any information on the level of acceptance in Spain is provided. If we distinguish between

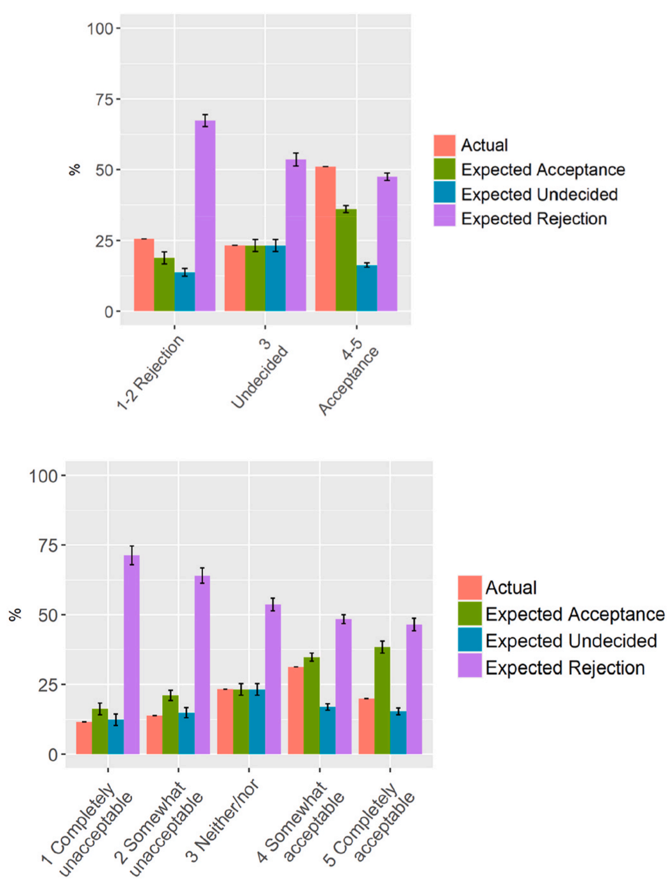

Fig. 2. Actual and expected (non-)acceptance of a carbon tax, depending on respondents' own (non-)acceptance. The Y-axis shows how prevalent a certain level of (non-)acceptance actually is (in red) versus how people holding this opinion expect prevalence of other opinions to be in the overall population (other colors). The lower panel is a disaggregation of the upper panel. Actual acceptance in the lower panel is given for each specific response unit, while expected acceptance is an average of (non-)acceptance (i.e. 1-2 and 4–5). Error bars indicate ± 2 standard errors. The red bars denote actual shares of each acceptance level and add up to 100%, while other bars add up to more than 100% because they represent expected averages for each response option. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 2
Average tax acceptance before and after information provision.

	Sample, with sample size	Acceptance rate before information manipulation	Acceptance rate after information manipulation	Pairwise Mann-Whitney test's p value
1	All respondents, n = 2200	3.338 (3.284–3.392)	3.243 (3.189–3.297)	<0.0001
2	Informed with 43/38/19% acceptance rates, n = 1110	3.335 (3.256–3.412)	3.247 (3.170–3.324)	0.0007
3	No additional information, n = 1100	3.342 (3.266–3.417)	3.239 (3.163–3.315)	<0.0001
4	Informed with 43/38/19% acceptance rate and initially accepting the tax, n = 570	4.382 (4.342–4.423)	4.058 (3.987–4.129)	<0.0001
5	Informed with 43/38/19% acceptance rate and initially undecided, n = 245	3.000 (3.000–3.000)	2.914 (2.812–3.016)	0.0899
6	Informed with 43/38/19% acceptance rate and initially rejecting the tax, n = 285	1.526 (1.467–1.586)	1.912 (1.788–2.036)	<0.0001
7	No additional information and initially accepting the tax, n = 555	4.396 (4.355–4.438)	4.081 (4.014–4.148)	<0.0001
8	No additional information and initially undecided, n = 268	3.000 (3.000–3.000)	2.907 (2.803–3.010)	0.0625
9	No additional information and initially rejecting the tax, n = 277	1.560 (1.500–1.619)	1.874 (1.755–1.992)	<0.0001

Note: Results are reported with±two standard errors in parentheses.

[8] Again, as a robustness check, we estimated an ordered logit model, confirming that β is positive and significant (with a pseudo R^2 of 14%).

those who initially accepted the tax from those who did not, we find that those who accepted the tax reduced their acceptance on average, while those who originally rejected the tax revised their acceptance upwards. People who were initially undecided in their tax attitudes are the only group for who we do not observe a significant revision in tax acceptance. Surprisingly, the same effects are identified among the cohort of people who received no additional information about population-wide acceptance. These results remain robust if we exclude respondents who originally reported very high support or opposition to the tax (values 1 and 5 on the Likert scale) on Q1 (see Table A5). Therefore, we can conclude that our findings cannot be explained by the regression to the mean effect (Yu and Chen, 2015). Although our analytical focus here is on within-subject comparison, an additional between-subject analysis of levels of acceptance after the information provision confirms no significant treatment effects (see Table A8). We discuss these findings further in Section 4.

We proceed by testing how FCE of the respondents is related to their change in tax acceptance. We do this for six subsamples, namely respondents who personally accept the tax, are undecided or reject it, combined with information manipulation received, i.e. either the information on 43/38/19% acceptance levels or no additional information. As in Study 1, we measured FCE separately for those accepting or not the carbon tax (see Eq. (1)), with the difference that here we additionally measured FCE for those who are undecided as a difference between expected fraction of undecided respondents and actual fraction of such survey participants. The results are plotted in Fig. 3. The reported results are robust to alternative functional forms, namely ordered logit regression. In addition, just like in Study 1, results of QR for different percentiles in FCE distribution are reported in Fig. 4.

Starting with the case of respondents who initially rejected the proposal of a carbon tax and who received information ($n = 285$), we find the association to be negative and significant ($\beta = -6.684$, $p < 0.01$, $R^2 = 0.07$, upper right panel in Fig. 3). According to QR analysis in the upper right panel of Fig. 4, this negative association is more pronounced in the lower percentiles of the FCE, i.e. those who overestimated the prevalence of carbon tax opposition by no more than 50%. Results are similar for the control group of tax opponents that did not receive information ($\beta = -4.989$, $p < 0.01$, $R^2 = 0.04$, $n = 277$). However, at lower levels of FCE the β coefficients of the QR estimation are considerably higher in the treatment group, suggesting that FCE moderated the effect of information. Overall, the negative association implies that people who had lower FCE revised their acceptance more strongly upwards, while those who had a very high FCE revised them less, which is in line with our expectations and findings in Study 1.

If we now look at the people who initially accepted the carbon tax and received additional information ($n = 570$, upper-left panel in Fig. 3), we find a positive relationship between FCE and change in acceptance ($\beta = 3.3047$, $p < 0.01$, $R^2 = 0.02$). This suggests that those with lower FCE are more likely to revise their acceptance downwards than those with high FCE. This intuition is supported by the results of the QR in upper left panel of Fig. 4, where we see a significant association between the two variables only for upper percentiles of FCE corresponding to absolute values of FCE in the interval (−11, −1), i.e. those with relatively accurate expectations of carbon tax acceptance. Thus, people who accepted the tax but slightly underestimated the prevalence of their own opinion revised their acceptance downwards, while those who underestimated public acceptance a lot did not change their acceptance significantly. The percentage of acceptance we have communicated was relatively low (43%, which is lower than the acceptance observed in Study 2, namely 51%), which might explain that people with low FCE who were originally more positive about the carbon tax reduced their acceptance. In addition, it should be noted that results look fairly similar in the control group of tax supporters without information ($\beta = 3.665$, $p < 0.01$, $R^2 = 0.02$, $n = 555$).

If we look on people who were undecided and received additional information ($n = 245$, top central chart in Fig. 3), we find no statistically significant relationship between FCE and change in acceptance ($\beta = -0.11$, $p = 0.95$, $R^2 = <0.001$). A similar result is obtained for

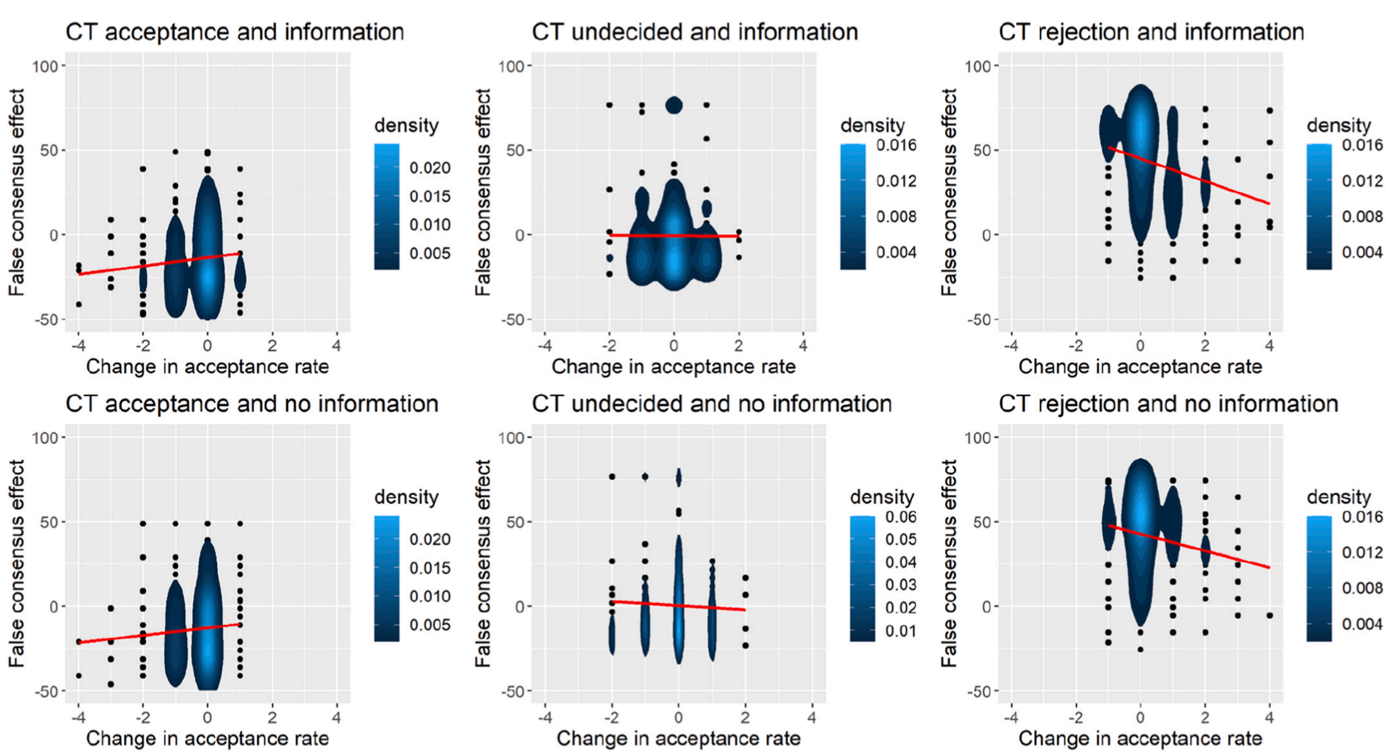

Fig. 3. The relationships between FCE and change of carbon tax acceptance after receiving or not information about population-wide tax acceptance, based on OLS estimation of Eq. (4). The six sub-samples are defined by combinations of information messages and personal carbon tax acceptance, indifference or non-acceptance. Higher density indicates where observations are concentrated.

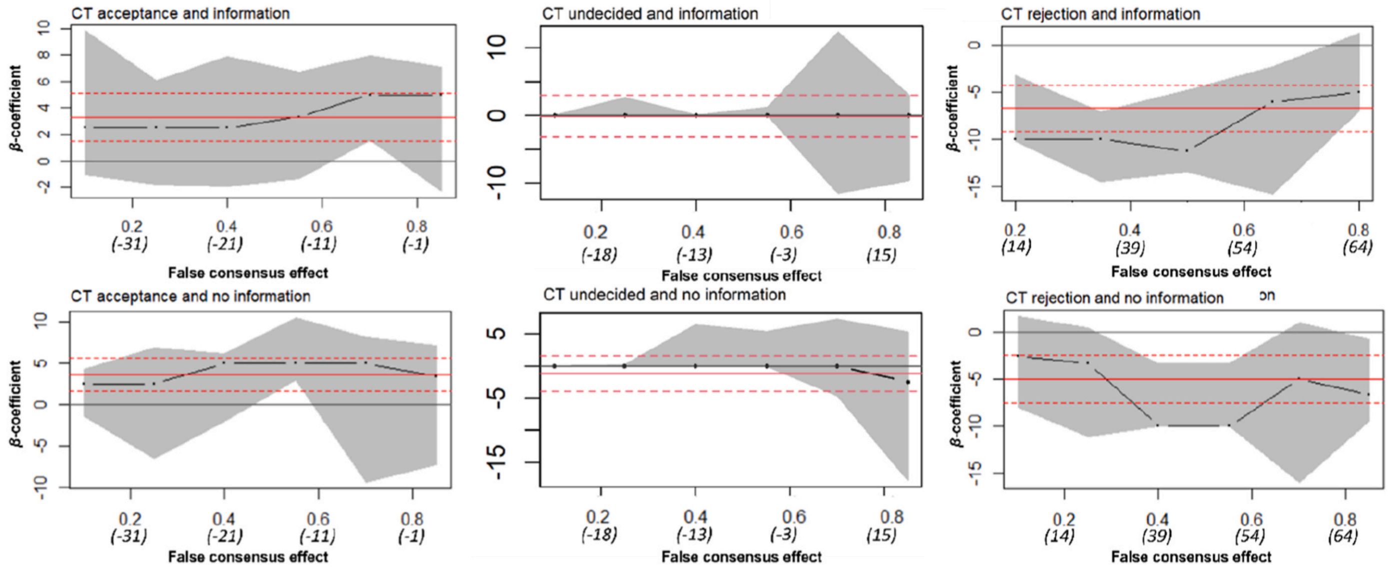

Fig. 4. Quantile regression of Eq. (4). On the X-axis the percentile in the distribution of FCE is given, while the Y-axis shows the value of the β-coefficient from Eq. (4) with 95% confidence interval. Since observations on FCE are distributed unevenly, next to the percentile we report in parentheses the actual FCE value corresponding to it. With red color the estimation provided by OLS is given for comparison. The six sub-samples are defined by combinations of information messages and personal carbon tax acceptance, indifference or rejection. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

undecided individuals who received no additional information (n = 268, bottom central chart in Fig. 3; $\beta = -1.18$, $p = 0.49$, $R^2 = <0.002$). This is not surprising given high accuracy of respondents in these groups in predicting popularity of their own opinion (Fig. 1) and low propensity of changing their carbon tax acceptance level (see Table 2).

5. Discussion

Using two nationally representative surveys from Spain, we derived several insights about perceptions regarding other people's acceptance of a carbon tax, a topic that has so far received little attention in the literature on public opinion about carbon pricing (Carattini et al., 2018; Maestre-Andrés et al., 2019; Levi, 2021). In both studies we found that a person's own acceptance of a carbon tax is positively associated with their beliefs about others' acceptance. This result replicates previous findings on related climate perceptions from the US and China (Schuldt et al., 2019; Goldberg et al., 2019) for the context of carbon tax acceptance in Spain. It is worth noting at this point that the causality of this relationship is unclear. People's social beliefs can shape their own beliefs, but also vice versa, which can result from processes of social contagion or homophily (Shalizi and Thomas, 2011).

We further found that everyone underestimates public acceptance of a carbon tax. This general tendency may be explained by considerable publicity given to climate contrarian views in traditional mass media (Kjeldahl and Hendricks, 2018), which could be the result of journalistic norms, or even of organized political campaigns (Boykoff, 2013). More specifically, however, we found that carbon tax opponents strongly overestimate the prevalence of their own attitude in the population. On average, opponents believe that there are more than twice as many people thinking like them than what the numbers actually show. In both studies, overestimations of tax opposition were higher than 40%. This can be considered as relatively high when compared with the few existing other, related estimates. For example, people who believed that climate change is not happening overestimated their opinion by 25% in the US study by Mildenberger and Tingley (2019). However, such climate denialism represents arguably a more marginal opinion than opposition to a carbon tax, which makes our FCE estimates appear as fairly sizeable. In contrast, carbon tax supporters tend to underestimate the prevalence of their own attitude, although to a somewhat lesser extent than tax opponents overestimate (particularly in Study 2). Based on insights from related research (Geiger and Swim, 2016), these findings suggest that tax supporters may self-silence their (majority) view, while opponents may be more inclined to voice their (minority) position. These findings are in line with non-climate research showing that majorities and minorities tend to under- and overestimate, respectively, their own views (Krueger and Clement, 1997).

Our research further contributes to the literature by experimentally examining whether influencing social (mis)perceptions triggers a change in people' own carbon tax acceptance, depending on FCE. In general, our findings suggest that a relatively high FCE leads people to be fairly unresponsive to information provision about others' tax acceptance. The politically perhaps most relevant case of respondents who initially reject the carbon tax shows that those with low FCE can become slightly more supportive of a carbon tax when they are informed about others' attitudes. These findings are largely consistent with Leviston et al. (2013) who found that people with high FCE showed more stability of climate perceptions over time. Our experimentally derived insights on change of policy attitudes complement their longitudinal research design examining opinion stability.

The results also indicate that low FCE can work in the other, undesired direction: Those initially accepting the carbon tax reduced their acceptance after receiving information that either a minority or a majority of Spanish citizens support a carbon tax. Overall, such 'downward' attitude change is more prevalent in our data than 'upward' revision. These diverging effects, which depend on FCE, might explain why some prior research for the US has found zero overall effects on support for climate policy after communicating a strong social norm of 80% pro-climate sentiment (Bolsen et al., 2014; but see de Groot and Schuitema, 2012 for an effective norm intervention). In other words, some people might become more favorable about climate policy, while information may reduce acceptance for others. The latter effect possibly occurs because some types of messages trigger the well-known psychological phenomenon of reactance (Rains, 2013). In any case, the experimental results need to be interpreted with caution, as will be discussed in the following.

This research has some limitations. First, Study 1 lacks a control group, so one cannot compare with the case of no information provision. This was improved upon in Study 2. Second, the experimental findings of Study 2 are, surprisingly, very similar to the control group. This could mean that attitude changes happened for other reasons than information. After responding to the first question on personal acceptance of carbon tax, and to the question eliciting beliefs about others' tax acceptance, participants were asked questions about other climate mitigation policies, carbon tax schemes under distinct revenue uses (e.g. with progressive redistribution), as well as various questions about health and economic effects of COVID-19. Such questions might have reduced acceptance of a carbon tax, for example, because preferences for other policies, or other carbon tax designs, became more salient. This may explain the overall decrease of tax acceptance with and without information provision. Yet, some questions may also have increased acceptance of those who initially opposed the tax. For example, several questions referred to the use of the revenues of carbon taxes. People who have been made aware that carbon taxes create revenues which can be used for various purposes (e.g. environmental, social) may have become more favorable of the policy in general. One detail of our survey design may have contributed to the generally more moderate responses when questioned the second time, namely the communicated percentages others' tax (non-)acceptance. The numbers (43/38/19%) can be interpreted as if there are still many varying opinions on the topic, which may have increased participants' reflection on the policy. Future studies could thus test attitude change using other research designs. Moreover, although our single item measure of carbon tax acceptance is fairly common in the literature (Maestre-Andrés et al., 2019), future studies might use multi-item indexes of carbon tax acceptance to measure attitude change more reliably (Kyselá et al., 2019). Finally, another possibility is that attitude changes at least to some extent resulted from respondents paying insufficient attention to questions, but a statistical test did not provide any evidence for this proposition.[9]

Future research also needs to dive deeper into the processes underlying the observed patterns. For example, in line with the idea of (dis) confirmation bias one could examine whether respondents with high FCE are more likely to discard information contradicting their prior beliefs, so as to protect their opinion. On the other hand, it is also possible that people do not update their beliefs because they consider the provided message as unreliable or untrustworthy (Druckman and McGrath, 2019). Here one could test whether other forms of information provision, such as higher consensus messages or more trusted message sources, can lower resistance to climate policy. Such information provision may also depend on people's (un)certainty about opinion prevalences, exemplified by simple mental shortcuts such as "fifty-fifty" rules (de Bruin et al., 2000). In addition, one could extend our work by testing other than population-level beliefs, such as about friends, family or other social reference groups, including populations from other countries. This can build on earlier work (Schuldt et al., 2019; Goldberg et al., 2019; Rohring and Akerlof, 2020). Furthermore, it might be worth investigating how social media use and social networks (Konc and Savin, 2019) shape a person's social perceptions. Many people nowadays get their news and information in general and specifically on climate change from like-minded peers in online environments (Williams et al., 2015), which may further amplify the identified biased perceptions. The latter does not have to be the case, though, as proposals are emerging to establish behavioral online interventions aimed at counteracting false consensus and other biased perceptions (Lorenz-Spreen et al., 2020).

[9] Specifically, in Survey 2 we find no statistically significant correlation between change in acceptance and survey completion time (which we consider a proxy of paying attention). The Pearson correlation coefficient was 0.004 ($p = 0.85$) for the whole sample and -0.018 ($p = 0.55$) for those who received no additional information.

6. Conclusion and policy implications

This study has examined several aspects of social perceptions related to the acceptance of a carbon tax. It finds a positive association between people's own tax acceptance and their beliefs about others' acceptance. This is in line with prior research on more general climate change perceptions in other contexts, which finds that opinions are consistent with perceived consensus. We not only identify a general tendency of underestimating others' tax acceptance, but demonstrate that opponents of a carbon tax underestimate public acceptance of the policy, thus overestimating the prevalence of their own view. That is, they show a false consensus effect. To a lesser extent, carbon tax supporters underestimate the prevalence of their own majority position, i.e. many of them show pluralistic ignorance. Such effects may lead to a vocal minority of tax opponents, and a silent majority of tax supporters. We tried to influence these social perceptions by communicating hypothetical and actual information about what percentage of the population accepts or not a carbon tax. We obtain tentative evidence that people who initially reject the tax slightly increase their acceptance when they are informed that a majority is in favor of the tax. Such an attitude change tends to take place when the false consensus effect is relatively small. There is some indication that communicating others' tax acceptance can also reduce tax acceptance. Overall, our study suggests that perceptions of others' tax opinions can be very inaccurate and that influencing these perceptions with the goal of improving tax acceptance will not be easy. Further research using other methods and types of communication is needed to get a better understanding of this challenge.

Final note

Data and code for this study are available at https://github.com/IvanVSavin/FalseConsensusProject.

CRediT authorship contribution statement

Stefan Drews: Conceptualization, Investigation, Writing – original draft, Writing – review & editing. **Ivan Savin:** Data curation, Formal analysis, Writing – review & editing, Visualization. **Jeroen van den Bergh:** Writing – review & editing, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A and B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2022.113051.

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