How to Increase Public Support for Carbon Pricing *

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Abstract

The public acceptability of a carbon price depends on how the revenues from carbon pricing are used. In a fully incentivised experiment with a large representative sample of the German population, we compare five different revenue recycling schemes and show that support for a carbon price is maximised by a "Climate Premium" that pays a fixed, uniform, upfront payment to each person. This recycling scheme receives more support than tax and dividend schemes, than using revenues for the general budget of the government, and than earmarking revenues for environmental projects. Furthermore, we show that participants and experts underestimate the public support for carbon pricing.

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1 Introduction

Many policymakers have tried and failed to implement carbon pricing. In Switzerland, a proposal to increase an existing carbon price was rejected in a 2021 referendum; in France, the yellow vest movement forced President Macron to withdraw a carbon tax on fossil fuels; in the US, carbon pricing is so unpopular that none of the major political parties embraces it. Overall, only 23% of global greenhouse gas emissions are subject to carbon pricing[1].

There are several reasons for popular resistance. Some voters do not trust the government and believe that a carbon price is just tax increase in disguise[2,3]. Others feel that carbon pricing is unjust because it disproportionately harms the poor[4,5]. Many people see that they have to pay more, but they do not see the benefits in terms of reduced emissions and tax revenues that can be used for other beneficial purposes[6,7]. Can smart carbon pricing address these concerns and gain more public support?

Previous research has shown that specific uses of the revenue can increase public support for carbon pricing[8,9], in particular earmarking revenues for green investment or energy efficiency programmes[10] and returning revenues to citizens ("tax and dividend")[8,11–13]. However, this literature is inconclusive regarding which revenue recycling scheme receives the most public support[4,14].

This paper makes three main contributions. First, our paper shows experimentally that public support for a carbon price is maximised by a "Climate Premium" that compensates citizens at the time when the carbon price is introduced with a fixed payment equal to the expected revenues from carbon pricing[15]. This scheme not only makes it salient that carbon pricing is not a disguised tax increase, but it also eliminates any uncertainty about the amount people will receive. The Climate Premium receives more support than tax and dividend schemes, than using revenues for the general budget of the government, and than earmarking revenues for environmental projects.

Second, the paper uncovers several misperceptions. It shows that people underestimate the effect of carbon pricing on consumption and, hence, on emission reduction. Beliefs about the policies' effectiveness in curbing climate change have been shown to have a strong impact on voters' support[16], but so far, there is only indirect and mixed evidence on how people expect others to adjust consumption following the implementation of a carbon price[17,18]. Furthermore, the paper shows that both laypeople and experts strongly underestimate the public support for smart carbon pricing schemes.

Our third contribution is methodological. In contrast to previous analyses, our study is based on a fully incentivised experiment with a large, representative sample of the German population. In the experiment, subjects make purchase decisions that result in real carbon emissions, and they have to pay a real carbon price of €50 per ton of CO_2. We consider five conditions that differ in the way the revenues from carbon pricing are used. We measure public support by letting people vote on the introduction of carbon pricing. Our design

combines the best aspects of and improves upon both surveys and laboratory experiments, the two methods commonly used to study support for climate policy[8,16,18–28]. Surveys often use representative samples, but they are not incentivised and have been shown to overestimate public support for pro-environmental policies[29]. In contrast, our design uses monetary incentives to elicit participants' true preferences. Laboratory studies, instead, are usually incentivised, but they rely on small and non-representative samples (often undergraduates) and use experimental designs in which externalities are imposed on other participants but not on the environment. In contrast, our experiment uses a representative sample of the population and real CO_2 emissions as externalities.

2 Results

We conducted an experiment with 1,100 participants who are representative of the German population. Participants were asked to make two purchase decisions about valuable but CO_2-generating virtual products. In each decision, the participants decide whether to buy 0, 1, or 2 products. The first decision involved a low price per product, while the second decision had an additional carbon price of €3 (€50 per ton of CO_2). Following these decisions, the participants voted on whether to implement the purchase decision *with* or *without* the carbon price.

All decisions in the experiment have real consequences. The participants' purchase decisions resulted in monetary payoffs and real CO_2 emissions. Participants could earn €0, €4, or €6 by buying 0, 1, or 2 products in the decision without the carbon price, and €0, €1, or €0 for the same choices in the decision with the carbon price. They generated 60 kg of CO_2 for each product they bought. Furthermore, every participant had an equal chance (2%) of determining whether the purchase decisions with or without the carbon price were payoff-relevant for the group of 50 individuals that they were part of.

In five randomly ordered within-subject conditions, the participants voted on whether or not to implement carbon pricing schemes that differed in how revenues from carbon pricing were used. In the "State Budget" condition, the money went to the general budget of the German federal government. In the "Climate Projects" condition, the revenues were spent on government-approved environmental projects. The "Redistribute All" and "Redistribute Poor" conditions mimicked "tax and dividend" schemes: the revenues were divided equally either among all participants or among those participants who had reported an income below €2,100 (median income). In the "Climate Premium" condition, participants were promised a fixed and immediate payment in case the carbon price was implemented. In two between-subjects treatments, we used a €1.70 premium (roughly the estimated per capita revenue) and a €1.40 premium (a likely underestimate that avoids a possible deficit) respectively.

Finally, we conducted an expert survey ($N = 369$) with environmental, behavioural, and public economists working in Germany, Austria, and Switzerland (response rate 28.0%). We

asked these experts to estimate the purchase decisions and the vote shares for carbon pricing in the different conditions.

2.1 Buying behaviour

Fig. 1a illustrates the distribution of purchase decisions without the carbon price. Although it is profitable to buy both products, only 34.3% of our sample do so, suggesting that many participants are foregoing private gains for the sake of the environment. This result suggests that the participants expect their decisions to affect real CO_2 emissions. Indeed, 77.9% explicitly confirm that they believe that their purchases had the environmental consequences described in the instructions. Fig. 1b shows a sharp and significant drop in the number of units bought (and thus of CO_2 emissions) when the carbon price is introduced (average units purchased per person: 1.06 without vs. 0.59 with the carbon price; $t(1099) = 24.10$; $p < 0.001$). The figure illustrates that only a small percentage of subjects (2.9%) purchase two products when a carbon price is in effect. This choice is, in fact, dominated because it does not yield any benefits to the individual, but it results in the emissions of 120kg of CO_2. Fig. 1c shows in detail how participants adapted their consumption with the introduction of a carbon price. Only a small percentage of subjects purchased more products with the carbon price than without it (4.3% of those who could). These results suggest that the vast majority of participants understood the experiment.[a]

2.2 Voting behaviour

Fig. 2 displays the voting decisions.[b] There is substantial heterogeneity in support depending on the revenue recycling scheme. When revenues go to the general budget of the federal government, a minority of participants votes for carbon pricing (47.3%). This is reflected in reported low trust in the government: 52.5% (21.5%) disagreed (agreed) with the statement "I have confidence in the German government to use taxpayers' money wisely."

However, the majority approves the carbon price under the other revenue recycling schemes. In conditions Climate Projects and Redistribute Poor, 62.6% and 62.7% of the votes are in favour of the carbon price. This percentage grows to 68.8% in the Redistribute All condition and further jumps to 73.1% in the Climate Premium condition. All of these schemes receive significantly more than 50% of the votes ($p < 0.001$). Interestingly, Redistribute All fares better than Redistribute Poor, because richer participants are significantly less likely to vote in favour of the latter (54.5% vs. 68.8%; $z = 6.63$; $p < 0.001$) while poorer participants support both schemes similarly (70.6% vs. 68.8%; $z = 1.09$; $p = 0.275$). The share of votes in favour of the Climate Premium is significantly higher than for any other scheme (vs. State Budget

[a] See Supplementary Methods for additional information regarding the measures taken to ensure data quality. We also show that the results remain unaffected by variations in task comprehension or attentiveness levels.

[b] Supplementary Table 4 shows which demographic characteristics are predictive of overall voting behaviour.

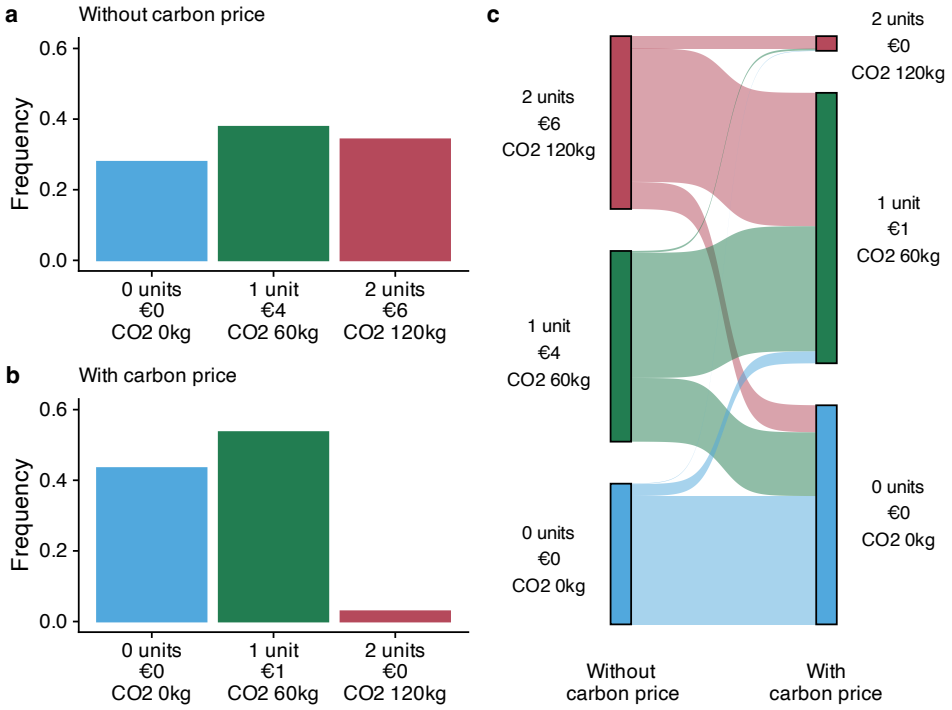

Fig. 1: Purchase decisions with corresponding payoffs and CO_2 emissions without (a) and with (b) the carbon price. (c) A Sankey diagram representing participants' responses to a price increase.

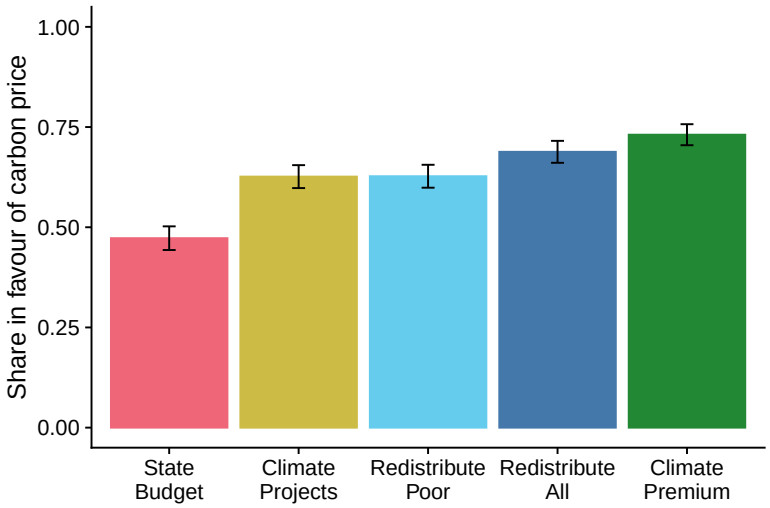

Fig. 2: Share of participants voting in favour of the carbon price under the five revenue recycling schemes. The bars indicate 95% CI.

$z = 14.84$, vs. Climate Projects $z = 7.35$, vs. Redistribute Poor $z = 7.55$, vs. Redistribute All $z = 3.49$; all $p < 0.01$ with Bonferroni correction). These results are not affected by the order of presentation of the five schemes (Supplementary Figure 7).

Overall, these results show that the Climate Premium is the most popular scheme, and they confirm that revenue recycling is an effective lever to increase support for carbon pricing. The Climate Premium receives 25 percentage points more support than giving money to the state and between 4 and 10 percentage points more than the other revenue recycling schemes.

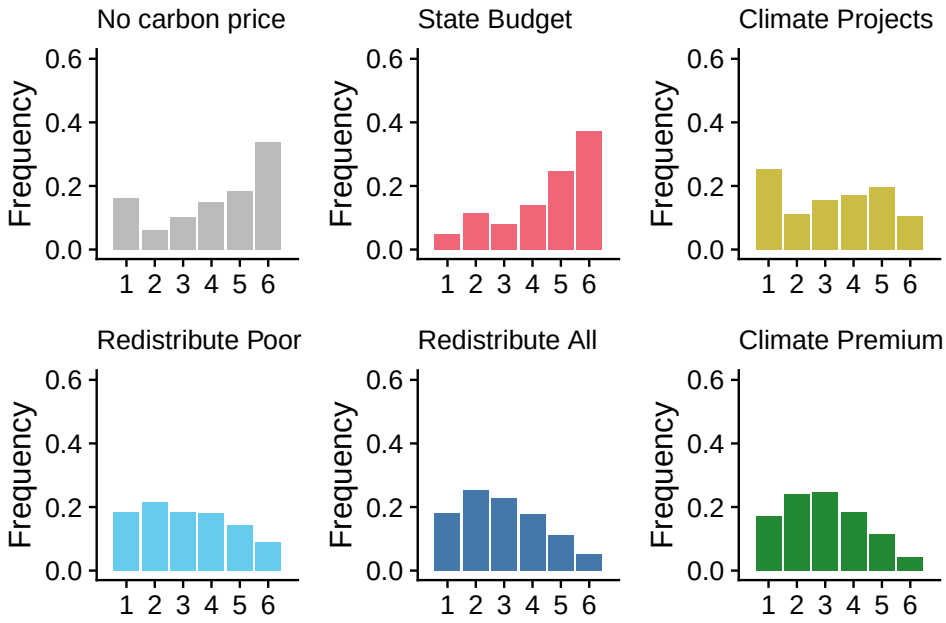

Fig. 3: Ranking of the five revenue recycling schemes and "No carbon price". Each panel shows the distribution of ranks the subjects give to each policy from 1 (the most preferred) to 6 (the least preferred). See Supplementary Methods A.1.2 for the construction of the variable.

2.3 Other desirable properties of a Climate Premium

In this section, we show that the Climate Premium is budget-friendly, it receives majority support among all demographic groups, and it is the proposal that the fewest number of participants consider to be the worst policy.

First, the Climate Premium is budget-friendly. In the €1.70 treatment, the premium was calibrated such that the total transfer was expected to be similar to the carbon pricing revenues. The calibration was successful: revenues turned out to be €1.78 per person ($SD = 1.64$, 95% CI $[1.687, 1.881]$). However, we also conducted a much more conservative €1.40 treatment to test whether the support is sensitive to the amount of the premium. This is not the case: even with the reduced premium, the Climate Premium scheme receives more votes than any other revenue recycling mechanism (vs. State Budget $z = 9.87$, vs. Climate project $z = 5.08$, vs. Redistribute Poor $z = 5.72$, vs. Redistribute All $z = 3.03$; all $p < 0.05$ with Bonferroni correction; Supplementary Figure 5). Furthermore, there is no significant difference between support for the Climate Premium with a €1.40 and €1.70 payment (74.0% vs. 72.2%; $z = 0.68$; 95% CI $[-0.034, 0.071]$; $p = 0.497$). Hence, the Climate Premium can be budget-friendly without compromising support.

Second, the popularity of the Climate Premium is not specific to one particular group of voters. Supplementary Figure 6 and Supplementary Table 3 show that the Climate Premium receives majority support in all demographic groups, including among conservatives (58.8%) and people who self-report that they are not much concerned about climate change (51.3%). Hence, the Climate Premium seems acceptable to a wide range of demographic groups and

political parties, a property that it shares only with the Redistribute All condition.

Finally, it is more difficult to implement a policy that is strongly opposed by some minority groups. In fact, there is recent evidence that politicians prefer policies that few people see as the worst possible option[30]. Fig. 3 shows that only 4.2% of the subjects consider the Climate Premium the worst policy. This number is significantly lower than the corresponding shares for State Budget (37.2%), Climate Projects (10.6%), and Redistribute Poor (9.1%), and insignificantly so for Redistribute All (5.2%). The number is also significantly lower than the share of subjects who consider no carbon price as the worst option (33.7%). According to this metric, the Climate Premium outperforms all other policies (except Redistribute All) (see Supplementary Information A.1 for the details on the statistical test[31]).

While very few subjects consider the Climate Premium to be the worst option, there are also only a few subjects (17.2%) for whom it is their most preferred. There are more subjects who rank Climate Projects and Redistribute Poor first, but also more who rank them last. Thus, the Climate Premium, which gets a medium rank from most participants, is less polarising. This result suggests that the Climate Premium is most successful because it is a good compromise.

2.4 Misperceptions

Voting decisions are affected by expectations about the behaviour of others[6]. In our experiment, the decision to vote for the carbon price depends on the belief on how this price will affect the purchasing behaviour of all other subjects: the change in behaviour will affect the amount of carbon emissions and revenues. Therefore, at the end of the experiment, we elicited the participants' beliefs about how many units are bought with and without the carbon price. We also elicited subjects' beliefs about the voting results in different conditions.

Beliefs about buying behaviour. The participants significantly underestimated the effect of the carbon price on buying behaviour. Fig. 4 shows that, on average, participants believe that the carbon price reduces purchases by 0.17 units ($SD = 0.41$), significantly less than the actual drop of 0.47 units ($t(1099) = -13.56$; 95% CI $[-0.338, -0.252]$; $p < 0.001$), which is more than 2.5 times as large. This misperception is important because beliefs about the effectiveness of climate policy are a key driver of public support[16].

Furthermore, the same Fig. 4 shows that the participants overestimate the number of units bought when the carbon price is in place. Participants buy only 0.59 units on average, but they believe that the number is 1.07, almost twice as high. This misperception makes it unlikely that the participants voted in favour of the Climate Premium because they mistakenly believed they would receive a higher payment in the Climate Premium than in the Redistribute All condition. Such a belief would have arisen if the participants had underestimated the consumption with the carbon price.

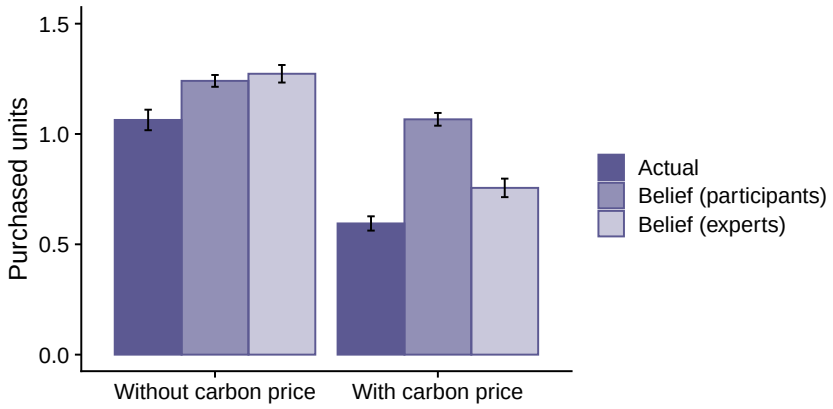

Fig. 4: Actual and guessed number of products purchased. The bars indicate 95% CI.

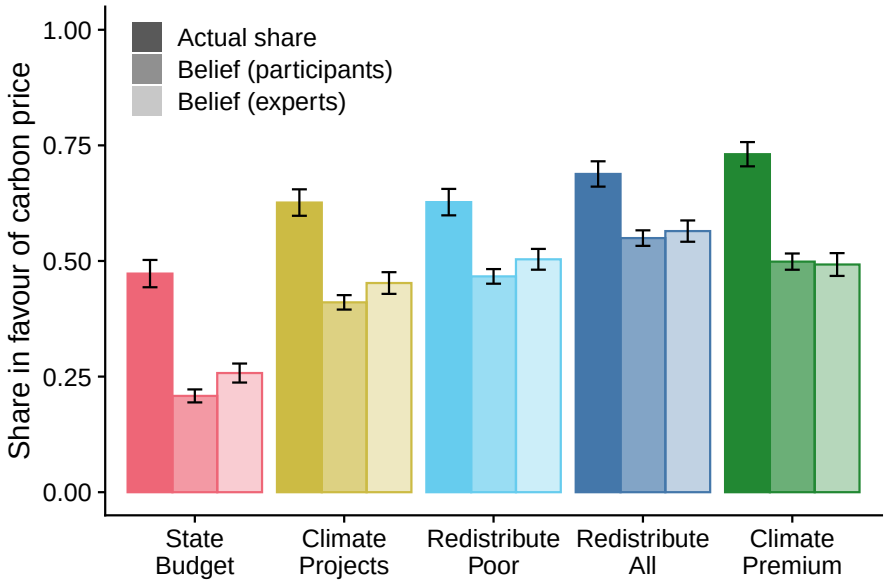

Fig. 5: Actual and guessed shares of participants voting in favour of the carbon price. The bars indicate 95% CI.

These misperceptions are consistent with previous evidence that individuals ignore the effect of taxes on prices[32] and underestimate other people's behavioural responses to policy changes[6].

Beliefs about voting behaviour. Fig. 5 shows that participants strongly and significantly underestimate the support for carbon pricing, regardless of the revenue recycling scheme. Averaged over all conditions, they predict 42.7% instead of 62.9% of votes in favour of the carbon price. The underestimation is especially large in the State Budget (26.5 percentage points) and Climate Premium (23.2 percentage points) conditions. Other studies have shown that correcting similar misperceptions raises individual willingness to act against climate change as well as support for climate policies[33,34].

2.5 Expert predictions

In contrast to the participants, the experts did not underestimate the effect of the carbon price on consumption (Fig. 4). On average, they predict that the carbon price results in a drop of 0.52 units, which is not significantly different from the actual drop of 0.47 ($t(1032) = 1.691$; 95% CI $[-0.008, 0.104]$; $p = 0.091$). However, experts significantly underestimate the support for carbon pricing for all schemes. Averaged over all conditions, experts expect that 45.4% of votes are in favour, while the actual number is 62.9%. Importantly, while experts correctly predict the three revenue redistribution schemes to be the most popular, they mistakenly believe Redistribute All and Redistribute Poor to get more support than the Climate Premium. Hence, the economics profession is too pessimistic about public support for a smart carbon pricing scheme and holds mistaken beliefs about which scheme is the most popular.

3 Discussion

This paper shows that support for carbon pricing is maximised if revenues are redistributed as a Climate Premium: a salient, upfront, fixed, and equal payment. The Climate Premium outperforms the revenue recycling schemes that have been more commonly studied, such as tax and dividend schemes and schemes that use tax revenues to finance environmental projects or go to the general budget. In addition, the Climate Premium has several properties that make it appealing to policymakers: it is budget-friendly, achieves majority support in all demographic groups, and is the policy that is rated the least preferred by the fewest people. The second best scheme is a tax and dividend scheme with equal transfers: this scheme receives slightly less support than the Climate Premium but shares many of its attractive properties. Overall, our results contrast with expert predictions: experts expected the tax and dividend schemes to fare better than the Climate Premium. Moreover, experts generally underestimate the support for carbon pricing.

The experiment provides additional support for important earlier findings. First, it confirms that revenue recycling is a strong driver of support for carbon pricing. Second, it confirms that people underestimate others' support for costly climate policies. Third, it shows that people underestimate the effectiveness of carbon taxes in reducing emissions.

Furthermore, the paper provides a methodological innovation. The literature on public support for carbon pricing has so far relied either on unincentivised surveys or on experiments with non-representative subjects. This paper, instead, combines these two approaches in a fully incentivised representative survey experiment, which has several advantages. First, it provides financial incentives for the participants to truthfully report their preferences for carbon taxes. This feature mitigates concerns that participants' responses are influenced by image concerns and desirability bias, which might artificially inflate the stated support for carbon pricing. The presence of incentives is particularly important since we compare different

revenue recycling schemes. In fact, previous evidence indicates that the magnitude of the bias in survey responses varies with the type of policy the participants have to opine upon[29]. The presence of incentives may explain why we find that redistributive schemes perform better than earmarking revenues from environmental projects, a finding that contrasts with some previous results[4,35].

Second, in the experiment, consumption and voting decisions result in real CO_2 emissions, while most other experiments on climate policies rely on monetary externalities on fellow subjects. In our setting, less consumption results in lower CO_2 emissions, which has a negligible effect on the climate. This is also true if a small country (such as Germany) reduces its carbon emissions. While the experimental task is abstract, the participants' voting decisions correlate with their political preferences (Supplementary Information A.1.4 and Supplementary Table 5). This finding suggests that our framework produces externally valid results and can be adapted to study further questions on the acceptability of climate policies.

Third, our experiment uses a representative sample of the population. Thus, the results are not biased by a selective subject pool, such as the young, well-educated, and mostly liberal undergraduate students that are typically used in economic experiments.

4 Methods

Main experiment. The experiment was carried out in June 2023 in collaboration with Bilendi, a market research company specialising in online surveys with proprietary panels in several European countries. There were 1,100 participants representative of the German population with respect to age (above 18), gender, income, education and region of residence (see Supplementary Table 1 for a summary of demographic characteristics). The instructions, available in Supplementary Information C, utilised straightforward language, visual aids, comprehension questions, and attention checks to ensure that participants understood the procedures.

Participants could buy zero, one, or two virtual products. The first product had a value of €7, the second a value of €5. Participants could buy the second product only if they bought the first. The purchase of each product resulted in the emissions of 60 kg of CO_2 (see below). In the first decision, each product had a price of €3. Thus, participants earned €4 if they bought one product ($7-3$) and €6 if they bought two ($7+5-3-3$). In the second decision, the price of each product increased to €6. Consequently, participants earned €1 for purchasing one product ($7-6$) but nothing for buying both ($7+5-6-6$). This price increase mirrors the effect of a carbon price of €50 per ton of CO_2. At this stage, participants did not know that the price increase was due to a carbon price. Participants always first made the purchase decision without the carbon tax and then the one with it. We chose this order because we want to study support for the introduction (or increase) of a carbon price. Therefore, we wanted the first decision, which could act as a baseline in the minds of participants, to have no carbon

price.

Decisions had real-world consequences. The payment received by each participant at the end of the experiment and the amount of CO_2 emissions depended on the number of products they bought and on which of the two decisions was implemented at the voting stage. We committed to buy offsets from Carbonfund.org for 60 kg of CO_2 for each product *not* purchased. Hence, the number of offsets was reduced by 60 kg of CO_2 each time a participant decided to buy a product, effectively increasing total CO_2 emissions by this amount[36]. Participants were sent proof of purchase for the offsets after all data had been collected (Supplementary Methods).

Participants had been informed that they were part of a group of 50 individuals drawn from a representative sample of the German population and that the vote of one randomly selected group member determined which of the two purchase decisions would be implemented for the entire group. This procedure, called "random dictator" in the experimental economics literature, ensured that each participant had an equal probability of deciding the outcome of the vote for the whole group (including themselves). With this procedure, participants have an incentive to vote according to their true preferences (truth-telling is a dominant strategy).

At the voting stage, participants voted in five distinct conditions that differed in how the revenues from carbon pricing were used. Every participant encountered all conditions in random order, knowing that one of them would be randomly chosen to determine their payoffs (Supplementary Table 2). In the "State Budget" condition, the revenues went to the German federal government.[c] In the "Climate Projects" condition, the revenues were given to a German organisation supported by the German National Climate Protection Initiative (Nationale Klimaschutzinitiative; `https://www.klimaschutz.de`). In the "Redistribute All" condition, each group member received an equal share of the carbon price revenues. In the "Redistribute Poor" condition, revenues were evenly divided among group members with a monthly income below €2,100, the median income in our sample (the participants reported their income at the very beginning of the experiment).[d] In both the Redistribute All and the Redistribute Poor conditions, the money was transferred to the participants two weeks after the completion of the experiment. In the "Climate Premium" condition, participants were given a fixed payment if the carbon price was implemented. These payments were made within two days of participation in the experiment. The payment was either €1.40 or €1.70 with 550 participants in each treatment.[e]

Finally, participants were asked to answer survey questions. First, they ranked the five dif-

[c]The money was transferred to the German government via a payment to a bank account dedicated to reducing the federal debt.

[d]The €2,100 threshold was established by asking 250 participants of a pilot study recruited from the same subject pool about their monthly income.

[e]In the Climate Premium condition, the revenue from the carbon price that were not needed to pay the Climate Premium simply reduced the experiment cost. On the other hand, if the carbon tax revenues had not been enough to pay for the Climate Premium, the cost of the experiment would have increased. The instructions didn't inform the participants about these details.

ferent revenue recycling schemes. Then, they reported their beliefs about the purchasing and voting behaviour of the other group members. These belief elicitations were incentivised with €10 for the correct prediction of one randomly selected question, an incentive-compatible beliefs elicitation procedure[37]. Finally, participants answered questions about their time and risk preferences as well as their political preferences.

Expert survey. For the expert survey, we contacted 1,318 academic economists. Of those contacted, 481 began the survey, and 369 completed it and are included in our data. Experts were shown a simplified version of the instructions and asked to predict the purchase and voting decisions. They could earn €40 if their estimate in a randomly chosen prediction question was at most two percentage points below or above the actual percentage. The instructions are available in Supplementary Information C.

Further method details. Further details on methods can be found in the Supplementary Methods.

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