Additional data collection to: Quantifying the role of greenhouse gas emissions in consumption choice

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October 24th, 2021

1 Additional data collection

This document describes additional data collection to Schulze Tilling, Anna. 2021. "Quantifying the role of greenhouse gas emissions in consumption choice." AEA RCT Registry. June 22. https://doi.org/10.1257/rct.7858-1.0

The original pre-registration focused on the first wave of data collection, which took place between the 22nd of June and the 8th of July 2021. I will perform a second wave of data collection in October and November 2021, which will be further described in this document. The goal of this second wave of data collection will be to add to the data collected in the first wave with additional treatment conditions and additional observations (the sample size aimed for in the first data collection wave was not quite reached due to some potential participants not physically being in Bonn during the Covid-19 pandemic).

2 Sample

Experiment participants are again recruited via hroot from the participant pool of the BonnEconLab. The requirement for participation in the experiment is that the participant does not follow a very restrictive diet (e. g. vegan, lactose-free, gluten-free or halal). Vegetarians are permitted to participate. The reason for this restriction is that people following these restrictive diets only make up a sub-part of the population and I consider them negligible in determining the effect a CO_2 label has on the population. Vegetarians, in contrast, make up a larger part of the population. In the pre-survey, 20% of participants were vegetarian. Two of the meals shown to participants in the main decision scenarios are the same across all participants (vegetarian meals), while the other two differ. This way, half of the meals shown to non-vegetarians contain meat, while vegetarians are only shown vegetarian meals.

Due to the fact that the experiment procedure differs from usual procedures at the BonnEconLab and that some potential participants may not physically be in Bonn due to the Covid-19 pandemic, it is again difficult to predict how successful recruitment will be. I plan for 200-300 participants.

The sample will be restricted as previously for the main analysis:

- The fastest 3% of participants are excluded from the main analysis.
- There are four comprehension questions to check the participants' understanding on the incentivization of WTP. If participants' response to at least one of these questions is incorrect, participants receive an error message and this counts as one error. I expect the average participant to make one to two mistakes as the questions are designed to make the participants further think about the mechanism. Participants who make more than five mistakes are excluded from the main analysis.

3 Experimental Design

3.1 General set-up

Experimental sessions are planned for the end of October and beginning of November 2021. In each session, participants first fill out a survey online (45 minutes duration) and then pick up their payment in person on the same day and no later than 2 pm. In addition to their payment, participants receive a meal for immediate consumption when picking up their payment. Participants can only sign up for one of the sessions.

The timing of the survey and pick-up of payment was chosen so as to mimic the usual process of choosing a lunch meal as far as possible. Due to COVID-19 regulations, the survey is conducted online instead of in-person. In some parts of the survey, participants make incentivized guesses: of the greenhouse gas emissions and calories attributable to each meal and of entirely unrelated issues (as a time-filling task to proxy for the greenhouse gas emissions guessing task). These guessing tasks are restricted to 60 seconds so that participants are not able to search for solutions online.

3.2 Procedure

Participants are randomly sorted into either group 4 (total of 75 participants), group 5 (total of 75 participants) or group 6 (total of 150 participants). These treatment conditions add to those observed in the first data collection wave (groups T1, T2 and C). Depending on the treatment group participants are assigned to, the information conditions under which they make consumption decisions in the core part of the survey differ.

In the course of the survey, participants' willingness to pay (WTP) for various restaurant meals is elicited under different information conditions. In one information condition, participants are shown the greenhouse gas emissions caused by each meal. These emission values are calculated using the Eaternity Institute (2020) database. I purchased an Eaternity personal license, and Eaternity has confirmed that I may use this license to calculate values for the experiment.

The experiment procedure is:

1. Questions on demographic information, allergies, eating preferences, current hunger level.
2. WTP elicitation for meals A,B, C and D.
3. A time filling task in which participants make incentivized guesses on completely unrelated issues. This task is to proxy for the greenhouse gas emissions guessing task experienced by groups T1, T2 and C in the first data collection wave, without drawing any attention to the issue of greenhouse gas emissions. For example, participants are asked to estimate how much world population increased over the past 20 years, how long a certain running route in Bonn is and how many yellow cards were shown in the last global football tournaments. For incentivization and to keep the same protocol as in the emissions guessing task, additional €0,10 are added to participant's payment for every guess within 30% of the true value. Each guess is restricted to 60 seconds.
4. Repeated WTP elicitation for meals A, B, C and D.
    - Groups 4 and 5 repeat the previous baseline WTP elicitation.

- Group 6 is now shown emission labels for each meal.

5. Repeated WTP elicitation for A, B, C and D.
   - Group 4 repeats the previous baseline WTP elicitation.
   - Group 5 is now shown emission labels for each meal.
   - Group 6 is told that the emissions attributable to the meal chosen will be offset.
6. Group 4 (who has not yet seen any emission labels) guesses the greenhouse gas emissions caused by eleven different meals, analogous to the emissions guessing task performed by groups T1, T2 and C in the first data collection wave. However, one additional meal was added to the guessing task to provide further insights. For incentivization, additional €0,10 are added to participants' payment for every guess within 30% of the true value. Each guess is restricted to 60 seconds.
7. Incentivized guess of the calories attributable to meals A, B, C, D and the cheese sandwich. Groups 4 and 6 are shown emission labels in this procedure, while group 4 is not.
8. WTP elicitation for receiving emissions information for meals E, F and G.
9. WTP elicitation for meals E, F and G, with information conditions depending on the previous decision.
10. Participants answer questions on attitudes towards the environment and psychological traits such as self control in eating. Further, they are asked how much they would support the introduction of (1) carbon labels or (2) a carbon tax in the student restaurant.

3.3 Details on the elicitation of WTP for meals (identical to first data collection wave)

In steps 2, 4, 5 and 9 of the survey, participants make a total of 15 consumption decisions. Each decision is a choice between receiving a cheese sandwich or a warm meal. This warm meal is a typical student restaurant meal, and the meals which are handed out to experiment participants after completing the experiment are in fact prepared by Bonn's student restaurant. The cheese sandwich is also prepared by the student restaurant and is a typical cheese sandwich (bread roll, slices of cheese and some lettuce garnish).

Regardless of the decisions participants make in the survey, they always receive one meal at pay-out (i.e. cheese sandwich or warm meal). This mimics usual meal choice: the alternative to not eating a certain meal is not "not eating", but eating something else. The WTP captured for a certain meal is thus relative to the participants' WTP for a cheese sandwich, as it is the participant's WTP to receive the meal instead of the cheese sandwich. If a participant prefers the cheese sandwich, this is interpreted as negative relative WTP for receiving the meal. As the main object of interest in this study is the **change** in WTP for meals which is induced by the treatments, it is secondary whether absolute or relative WTP values are captured and analyzed.

In each of the 15 decisions, participants first state whether they prefer receiving the cheese sandwich or the warm meal at payout, and then state the maximum amount they are willing to pay to exchange the two options if they are handed their less-preferred option. Participants are incentivized to respond truthfully, since one of these decisions is in fact implemented. For this decision, with 50% probability, a participant is handed their preferred option for free. With 50% probability, she is first allocated the less-preferred option, and receives her preferred option

only if her WTP lies above a price which is randomly drawn from the interval (0,3), where each value in 5-cent steps is equally likely. If her WTP lies above the price drawn, the drawn price is automatically deducted from the participant payment. If her WTP lies below the price drawn, she receives her less-preferred meal and no amount is deducted.

For each step, the order in which meals are shown to participants is randomized, i.e. there is randomization across meals A, B, C and D, there is randomization across the incentivized emission guesses and there is randomization across meals E, F and G. Further, one aspect of the layout of the design decision - whether the warm meal or the sandwich is shown on the left or right part of the screen - will differ across experimental sessions to ensure that results are not driven by this feature.

Which decision is relevant for pay-out is partly pre-determined for logistic reasons, but not known to the participants. Great care was taken to ensure that participants are not able to guess which of the decisions is relevant for pay-out. For each participant, there are a total of seven meals playing a role in her 15 payout decisions. These seven meals differ depending on whether the participant is vegetarian or not. On each day, the meal which is relevant for payout is the same across non-vegetarian participants and the same across vegetarian participants. However, the relevant meal differs across days. It is thus not possible for participants to potentially learn from experiment participants from previous days which of the meals is relevant. Further, all meals asked for in the experiment are typical student restaurant meals and are regularly offered by the student restaurant in Bonn, so that participants should not be inferring that one of the meals is unlikely to be relevant.

The meals for which WTP is elicited in the second data collection wave are identical to those of the first data collection wave. Correspondingly, the same meals will be relevant for pay-out as in the first data collection wave, of course again split across days in such a way that it is not possible to predict which meal will be relevant for payout on a given day.

3.4 Incentivization of the elicitation of WTP for emissions information (identical to first data collection wave)

For the WTP elicitation for meals E, F and G in step 8 of the survey, participants have the opportunity to purchase emissions information for these meals. Participants decide whether they prefer the information to be shown, and indicate a WTP for their preferred display option. With 50% probability, a participant's preferred display option is implemented for free. With 50% probability, she is first allocated the less-preferred display option, and receives her preferred option only if her WTP lies above a price which is randomly drawn. The price drawn for this information is only deducted from participants' payment if one of the final three decisions is the decision relevant for payout. Under these information conditions, the WTP for meals E, F and G is elicited.

4 Main Outcomes

The data collected in the second data collection wave can be pooled with data from the first data collection wave. Differences in meal tastes between July and November are controlled for due to individual by meal fixed effects included in each analysis. A total of eight observations are made for each individual, as for each of the four meals, the change in WTP taking place

both from (1) the first to the second WTP inquiry and (2) the first to the third WTP inquiry is observed. This approach maximizes power, leading to the following number of observations for each treatment effect (provided 300 participants can be recruited in the second data collection wave):

1. Change in demand occurring in reaction to being made aware of emissions (by being asked to guess emissions caused), without being shown emission labels: 1240 observations (155 participants in Group C observed twice in the first data collection wave)

2. Change in demand occurring in reaction to being made aware of emissions and then shown emission labels: 1240 observations (155 participants in group T1 and 155 participants in group T2 in the first data collection wave)

3. Change in demand occurring in reaction to being made aware of emissions and then being told that emissions will be offset: 1240 observations (155 participants in group T1 and 155 participants in group T2 in the first data collection wave)

4. Change in demand occurring in reaction to being asked for WTP a repeated time, without being made aware of emissions: 900 observations (75 participants in Group 4 observed twice and 75 participants in group 5 in the second data collection wave)

5. Change in demand occurring in reaction to being shown emission labels, without previously being made aware of emissions: 900 observations (150 participants in group 6 and 75 participants in group 5 in the second data collection wave)

6. Change in demand occurring in reaction to being told that emissions will be offset: 600 observations (150 participants in group 6 in the second data collection wave)

In the main analysis, I am interested in whether these treatment effects significantly differ and in how this interacts with the greenhouse gas emissions caused by the meal in question. Treatment effects (3) and (6) can be pooled to provide insights to the structural model for decision making under reduced environmental concerns, while treatment effects (1),(2),(4) and (5) together form a two by two design varying across the dimensions of awareness (by guessing emissions) and information (through emission labels).

As an additional analysis, the effects of providing emission labels on WTP can also be analyzed using only data collected in the second data collection wave, comparing only treatment effects (4) and (5) in the list above.

4.1 Further outcomes

WTP, guess and survey data can be pooled with data from the first data collection wave to add to the following secondary analyses (already described in the original PAP):

- WTP for carbon labels without and with having experienced carbon labels previously (as elicited in step 8) suggests the (expected) effect on welfare of being provided with these labels. The carbon labels tested in the experiment were designed together with Bonn's student restaurant and the student restaurant is considering implementing these labels on a large scale in the future.

- Participant's guesses for the emissions attributable to meals can be tested for their accuracy. Camilleri et al. (2019) found that people are insufficiently sensitive to the magnitude of differences in emissions between food items. I expect consumers to overestimate the emissions of low- and underestimate the emissions of high-carbon meals.

- The data gathered in step 2 can be used to construct a demand curve for each meal, allowing to evaluate the effect a carbon tax would have. Thus, one can compare the effectiveness of carbon labels versus carbon tax as policy instruments.

- In step 10 of the experiment, participants are asked for their approval of (1) the introduction of carbon labels and (2) the introduction of a carbon tax in the student restaurant. I will examine whether approval differs between treatment groups. Further, these answers can be used as a check on the WTP which participants indicate for being shown emissions information.

- Suggestive within-subject estimates of treatment effects can be constructed by comparing step 4 and step 5 WTP for a given meal of a given subject with her baseline WTP for the meal. This allows for some heterogeneity analysis. The effectiveness of the label might differ depending on (1) subjects' education, (2) subjects' income, (3) subjects' environmental attitude, (4) subjects' degree of self control in eating. The same factors might influence subjects' WTP for being shown the label.

- One might argue that participants shown emissions labels use these labels to infer nutritional characteristics of the meal. To check whether this is the case, I have participants guess the calories attributable to meals in step 6 of the first data collection wave/ step 7 of the second data collection wave. One group of participants is not shown emission labels for this guess, while other participants are shown the emission labels. If it is the case that participants infer nutritional information from emissions labels, the guesses made by the two groups should systematically differ.

Similarly, data from the second data collection wave can also be included in the estimation of the structural model.

5 Power analysis

In the main outcomes section above, I described how data collected in this second data collection wave will be pooled with data from the first wave and analyzed jointly. The size of the treatment groups in this second wave was those chosen such as to broadly mirror the size of treatment groups in the first data collection wave.

Further, the size of treatment groups are chosen such as to provide sufficient power for the stand-alone analysis with only second wave data described above. In this section, I provide estimates of the minimum detectable effect (MDE) sizes of the treatments on willingness to pay by kg of emissions caused by the meal.

For this purpose, I did a proxy regression analysis using some of the data from the first data collection wave as proxy control and treatment groups. As a proxy "repeated ask" (control) group, I use the third WTP of group C in the first data collection wave, with the second WTP functioning as the baseline WTP. For group C, nothing changed between the second and third WTP inquiry. I thus expect treatment effect (4) described above to be similar to this effect. As a proxy "label" (treatment) group, I use treatment effect (2), because I expect inidividuals' reactions to being made aware of emissions and then shown emissions labels to the effect of simply being shown emission labels. Here, I use the first WTP as the baseline WTP. For all individuals in the proxy sample, I thus observe two WTP values for each of the four meals, one "baseline" WTP and one later WTP. For the control group, there is no difference between the baseline and later WTP, while the treatment group was made aware of emissions and is

shown emission labels in the later WTP. In the proxy analysis, I include individual by meal fixed effects, an indicator variable for whether it being the later WTP, an indicator variable for whether emission labels were provided, emission values interacted with the indicator for whether it is the later WTP and emission values interacted with an indicator for emission labels being provided. This last coefficient is the coefficient of interest and thus the corresponding standard error observed is relevant for these power calculations.

The standard error e of the treatment effect on WTP observed is rescaled to treatment group sizes in the second wave of data collection, using the scaling factor $\delta = \sqrt{\frac{1}{n_{Treatment}} + \frac{1}{n_{Control}}} / \sqrt{\frac{1}{n_{Treatment,proxy}} + \frac{1}{n_{Control,proxy}}}$, with $n_{Treatment}$ referring to the number of observations of later WTP who are treated in data collection wave 2, and $n_{Control}$ referring to the number of observations of later WTP who are in the control condition in data collection wave 2. $n_{Treatment,proxy}$ and $n_{Control,proxy}$ refer to the corresponding sample sizes in the proxy analysis. I include only observations from the later WTP in these sample size numbers, for both wave 2 and proxy analysis sample sizes.

In the proxy analysis, the number of observations experiencing treatment is 1240 ($310 * 4$). The number of observations functioning as a control group is 620 ($155 * 4$). I set the significance level (α) for a two-sided test to 0.05 and the power level (β) to 0.8. The resulting MDE, i.e. the minimum detectable difference between treatment groups, is $MDE = (t_{1-\frac{\alpha}{2}} + t_{1-\beta}) * e * \delta = 2.802 * e * \delta$. Average WTP in the later WTP of the proxy analysis was €0.61, which is used to calculate MDE as percentages.

With 300 participants in the experiment:

	Treatment	Outcome	Standard error proxy	Treatment group	Control group	Scaling factor (δ)	MDE	as %
I	Label*GHG	WTP(meal)	0.0217	900	900	0.0958	0.0583	9.5%

With 200 participants in the experiment:

	Treatment	Outcome	Standard error proxy	Treatment group	Control group	Scaling factor (δ)	MDE	as %
I	Label*GHG	WTP(meal)	0.0217	600	600	1.1738	0.0714	11.6%

The outcome variable is the WTP which participants state for a meal. "Label*GHG" refers to the interaction of being shown the label with the true greenhouse gas emissions of the meal in question. I expect this effect to be negative, as WTP should decrease more the higher the greenhouse gas emissions of the meal.

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