Brave green world: Simulating preferences and trade-offs for carbon footprint reducing behaviors using a priority evaluator?

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**Motivation and research question (200)**

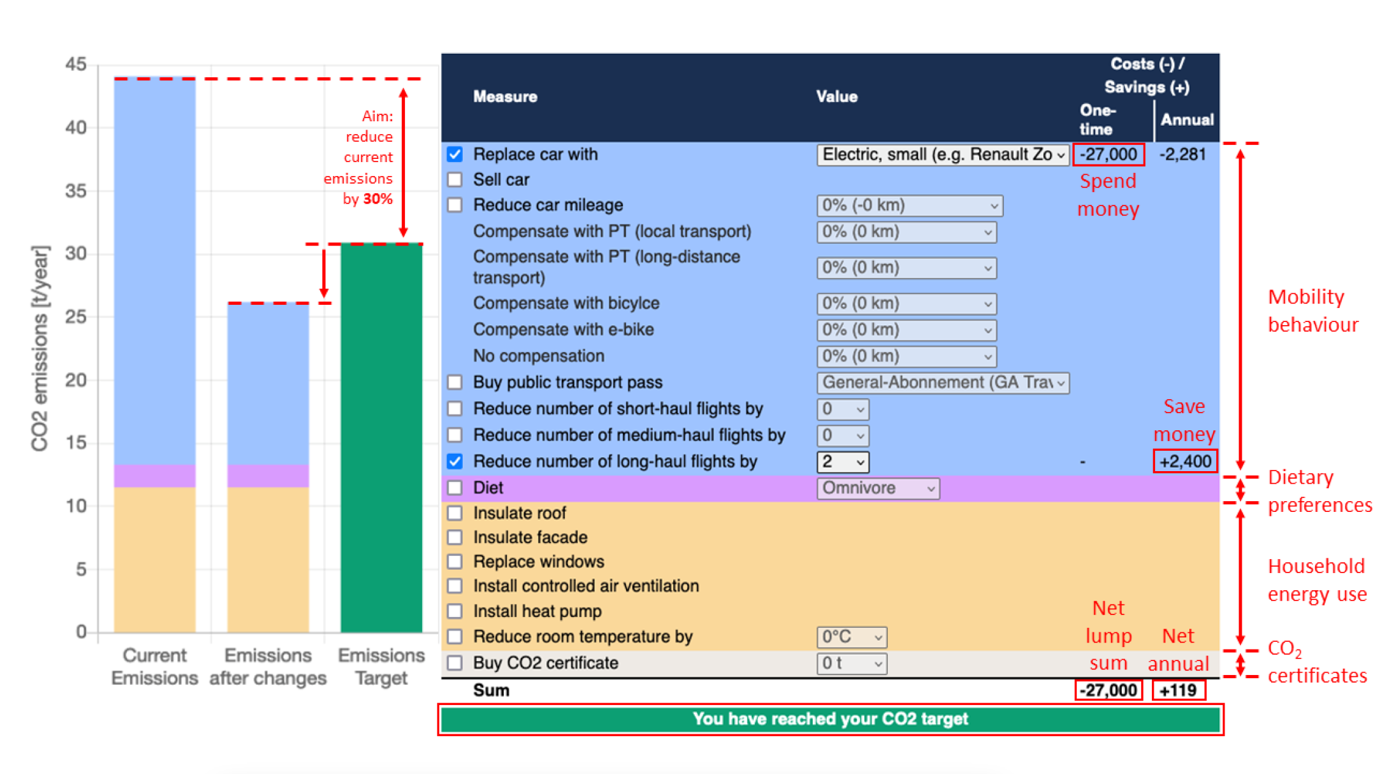
Urgent action is needed in order to limit climate change (IPCC, 2022). Recent focus has increasingly shifted to the domestic political sphere to tackle climate change (Aklin and Mildenberger, 2020), where particularly the distributional dimension of climate policy has been picked up by both the electorate and politicians, and become highly salient for both elections and referenda on climate policy (COLANTONE et al., 2023; Schaffer, 2023; Stokes, 2016).

While cost of climate policies and their distributional consequences have become increasingly relevant, very little is currently known about how people across societal sub-groups evaluate and trade-off necessary behavioural changes and financial costs when faced with decisions about how to reduce individual carbon emissions. As individual emission reductions will become inevitable, it is imperative for policymakers to better understand the feasibility of individual adaptation options in order to develop policy instruments that will effectively foster changes, as well as provide support where such changes pose unfavorable distributional outcomes. Accordingly, this paper investigates the following: when tasked with reducing their personal carbon emissions to a level that is compatible with net-zero goals, how do people trade off behavioural adaptations and lifestyle changes with their related cost implications? How are these trade-offs conditioned by individual capacities to change and attitudinal priors?

**Method (250)**

We study this question by developing a priority evaluator-based methodology: a highly individualized and interactive choice task that allows each respondent to develop a set of behavioural adaptations and mitigation pathways to reach a personalized carbon emission reduction target (Jäggi, 2015). The priority evaluator was fielded in an online survey amongst a population-representative sample in Switzerland (N = 5941) in 2022. First, respondents are asked about their CO2-relevant behaviours and living conditions (carbon calculator). These responses are utilized to calculate each respondent’s CO2 emission and populate a list of realistic adaptation options. The dynamic nature of the digital application then allows citizens to compare the effectiveness of these different behavioural adaptations, while at the same time, weigh their choices against behavioural and financial cost implications. The respondents are tasked with developing a 30% reduction in their carbon emissions, and are presented with the annual (over time) and one-time purchase costs or benefits of their behavioural changes (see Figure 1). Respondents can either reach their 30% reduction target or not. Lastly, respondents are asked to evaluate their cost and benefits perceptions of these changes. Here we are able to identify the preferred pathways for behavioural changes, which sub-groups of respondents are more or less likely to meet their emissions reduction targets (and how), and perceptions about how difficult and costly these behavioural changes are.

**Fig. 1. The Priority Evaluator (screenshot, annotations in red)**



**Expectations (300)**

Citizens usually lack information on the availability of different behavioural adaptations and lifestyle changes to reduce their emissions, and how they compare with regards to financial and behavioural costs and effectiveness (Attari et al., 2010). The priority evaluator serves here as an individualized tool that makes these trade-offs transparent.

However, the availability of choices for behavioural adaptations and lifestyle changes are dependent on individual financial capabilities and constraints. While wealthier individuals are high emitters (Gössling and Humpe, 2023; Wiedmann et al., 2020) because they consume more as well as more energy intensive goods (Oswald et al., 2020), they also have a wider array of different options that are available to them in order to reduce emissions compared to less wealthy individuals. Additionally, wealthier individuals possess more financial capabilities to reduce their emissions.

* **Exp 1:** We expect high-income earners to have a higher likelihood to reach their emission reduction targets and be more willing to accept financially costly adaptations. ~~Amongst those that do, higher incomes lead to a smaller amount of adaptation measures chosen, as well as to a higher share of financially instead of behaviourally costly measures chosen.~~

Further, behavioural choices can be expected to depend heavily on belief systems, norms, and attitudes of individuals (Ajzen, 1991; Stern et al., 1999). Respondents that that are environmentally concerned and have strong pro-environmental norms can be expected to show ex ante a higher willingness to engage in behaviours to reduce their carbon emissions. Further, they are also more willing to bear higher behavioural costs than others (Kaiser et al., 1999).

* Exp 2: We expect people with higher environmental concern and pro-environmental norms to have a higher likelihood to meet the emission reduction target and be more willing to accept the associated financial and behavioural changes.
* **~~Exp 2:~~** ~~We expect that the effect of income on target reaching formulated above is stronger for people with higher levels of environmental concern and pro-environmental norms than for others.~~
* **~~Exp 3:~~** ~~Amongst those that reach the target, we would expect that the positive effect of income on the share of financially costly measures is weaker for people with higher levels of environmental concern and pro-environmental norms, as they’re more willing to bear behavioural costs.~~

**Contribution (why is it important and what does it mean, especially for climate change politics, 150 words)**

Our study exceeds existing studies of behavioural adaptations towards reducing individual carbon emissions (which commonly rely upon simple survey questions (Lange et al., 2023)), providing an interactive tool that simulates the ‘real-world’ trade-offs in behavioural and financial costs. These findings contribute to the questions of how individual climate action is shaped by attitudinal and material factors (Steg, 2023). Additionally, studying the willingness to adapt behaviours and lifestyles allows to identify perceived losers of such a transition which would need to be targeted most by compensatory measures (such as redistributive payments or support for low-cost alternatives to high-carbon lifestyles) in order to counteract unfavorable distributional outcomes of climate policy (GAIKWAD et al., 2022). These insights are imperative to achieve winning coalitions that are necessary to successfully implement climate policy (Meckling et al., 2015).

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***Set of Expectations I***

Following this we can expect the following patterns regarding who reaches the emission reduction target:

* **Exp 1:** We would expect that respondents with higher income levels to be better able to reach the target because they have more financial opportunities and have a wider range of adaptation pathways available to them (*DV: Target reached/not reached*).
* **Exp 2:** However, this relationship is stronger for people with higher levels of environmental concern, pro-environmental norms and a leftist ideology than for others, as their willingness to engage in adaptive behaviours is higher in the first place. (*DV: target reached/not reached, interaction with ideology, environmental concern, pro-environmental norms*)

With regards to how such a target is reached, we would expect the following patterns:

* **Exp 3:** We would expect respondents to choose strategies that yield the highest effect with regards to emission reductions, while at the same time keep behavioural and financial costs as low as possible *(DV: mitigation measures)*
* **Exp 4:** However, we would expect respondents with increasing income levels to increasingly use strategies that are rather financially than behaviourally costly (e.g. renovate a house / buy an electric car instead of taking PT) (*DV: mitigation measures*).
* **Exp 5:** Also, we would expect that the willingness to engage in behaviourally costly adaptations is stronger for people with higher levels of environmental concern, pro-environmental norms and a leftist ideology than others (*DV: mitigation measures, interaction with ideology, environmental concern, pro-environmental norms*).
* **Exp 6:** We would expect respondents with increasing income levels to need a smaller amount of adaptation measures, and therefore also find it easier to be able to reach their target (*DV: number of measures to reach target/ difficulty perception*)

***>>>>>>>>>>>>>>> TO BE CONTINUED <<<<<<<<<<<<***

***THEORY II***

**Is there an alternative/complementary framework that provides us with contrasting hypotheses and explanations to deal with other outcomes than the ones already hypothesized above?**

The framework above largely follows a classic behavioural framework as well as the somewhat underlying assumption that people don’t refuse to lower their emissions in our non-forced setting, but rather ‘try their best’ according to their capabilities, and differ in how they do it according to their ideological dispositions. Our PE was a bit weird, as we strongly pushed them to do it, but did not force them.

On the contrary, one could think that respondents ‘refuse’ to engage in certain actions based on a combination of material capabilities & due to fairness concerns/concerns about distributional implications/ideology, as our experiment does not force them to reach the target.

|  |  |  |  |
| --- | --- | --- | --- |
| **Group** | **Original expectation** | **Additional theoretical framework / reasoning** | **Updated expectation (in yellow)** |
| **Left-enviro**  **low income**  **high emissions** | unlikely combo | unlikely combo | unlikely combo |
| **Left-enviro**  **low income**  **low emissions** | Target: not reached  Measures:  Perceptions: hard & costly | unfair | Target: not reached  Measures:  Perceptions: hard & costly, unfair |
| **Left-enviro**  **high income**  **high emissions** | Target: reached  Measures: financial & behavioural  Perceptions: easy & cheap | fair | Target: reached  Measures: financial & behavioural  Perceptions: easy & cheap, fair |
| **Left-enviro**  **high income**  **low emissions** | unlikely combo | unlikely combo | unlikely combo |
| **Right-brown**  **low income**  **high emissions** | unlikely combo | unlikely combo | unlikely combo |
| **Right-brown**  **low income**  **low emissions** | Target: not reached  Measures:  Perceptions: hard & costly | don’t care | Target: not reached  Measures:  Perceptions: hard & costly, don’t care |
| **Right-bown**  **high income**  **high emissions** | Target: reached  Measures: financial  Perceptions: easy & not costly | don’t care | Target: not reached  Measures:  Perceptions: easy & not costly, don’t care |
| **Right-brown**  **high income**  **low emissions** | unlikely combo | unlikely combo | unlikely combo |

Here, the difficulty is that unfortunately we don’t really have any kind of items that tap into these mechanisms (distributive preferences, fairness perceptions, etc.). We’d need to largely derive these interpretations from their behaviours and interactions with general ideological dispositions, but the expectations regarding the PE are for a lot of subgroups the same for the different theoretical explanations put forward above.

**Relevance / Implications of findings (150)**

**And what can this tell us about theory / the real world / what is the contribution (at least 3 points)?**

* Exploratory
  + Allows for ‘surprising’ findings outside of general behavioral framework
  + “First of all, this study can serve as an exploratory tool to identify how people would behave in a world where personal emission reductions become a necessity (reiterate argument about changes that will come).”
* Theory (interpreting results with regards to the distributional implications of having to reduce carbon emissions)
  + rational/behavioral framework VS. distributive concern/fairness framework
  + Are respondents taking into account distributive consideratioins when trying to adapt?
    - State here why it is important, and give examples of what different outcomes would mean…
* Policy design / implications
  + What can we learn with regards to policy design
    - Exploratory findings: Which measure has the biggest potential to save carbon emissions for different groups (e.g. middle-aged males mostly invest in housing infrastructure), here we should help them more via policy X, Y, Z.
    - Theoretical findings: depending on how people perceive distributive effects of different behavioral adaptations and lifestyle changes, politics/policy needs to react via X, Y, Z.

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**APPENDIX (DELETE BEFORE SUBMITTING)**

A1: Overview of carbon mitigation measures and effects on carbon dioxide, costs and savings as well as behavioral costs

|  |  |  |  |
| --- | --- | --- | --- |
| Attribute | Impact on CO2 | Impact on costs (-) and saving (+) | Behavioral cost |
| Mobility behavior |  |  |  |
| Auto ersetzen durch |  | High (-) | Low |
| Auto verkaufen | negative | High (+) | High |
| Fahrleistung Auto reduzieren | negative |  | Low |
| Kompensation mit ÖV / Fahrrad / E-Bike | low (positive) | Low (-) | High |
| Kaufe Abo für den öffentlichen Verkehr |  |  |  |
| Anzahl Kurzstreckenflüge reduzieren | high | Low (+) | High |
| Anzahl Mittelstreckenflüge reduzieren | high | High (+) | High |
| Anzahl Langstreckenflüge reduzieren | high | High (+) | High |
| Diet |  |  |  |
| Ernährung ändern | low | No impact | High |
| Housing |  |  |  |
| Dach dämmen | Negative | High (-) | Low |
| Fassade dämmen | Negative | High (-) | Low |
| Fenster austauschen | Negative | High (-) | Low |
| Solaranlage installieren | Negative | High (-) | Low |
| Kontrollierte Lüftung installieren | Negative | High (-) | Low |
| Wärmepumpe installieren | Negative | High (-) | Low |
| Raumtemperatur reduzieren um | Negative | Low (+) | Low |
| Carbon offsetting |  |  |  |
| CO2-Zertifikat kaufen | negative | Depends on price level | Low |

A2: Typology of respondents and overview of hypotheses (2\*2\*2=8 combinations)

|  |  |  |
| --- | --- | --- |
| **Group** | **Pr(Target reached)** | **Mitigation strategy** |
| Left low income high emissions | Unlikely combo | Unlikely combo |
| Left low car owner |  |  |
| Left low meat |  |  |
| Left low house owner |  |  |
| Left low frequent flyer |  |  |
|  |  |  |
| Left low income low emissions | Low | - |
| Left low no car |  |  |
| Left low vegetarian |  |  |
| Left low apartment |  |  |
| Left low no flyer |  |  |
|  |  |  |
|  |  |  |
| Left high income high emissions | High | Behavioral & financial |
| Left high car owner |  |  |
| Left high meat |  |  |
| Left high house owner |  |  |
| Left high frequent flyer |  |  |
|  |  |  |
|  |  |  |
| Left high income low emissions | Unlikely combo | Unlikely combo |
| Left high no car |  |  |
| Left high vegetarian |  |  |
| Left high apartment |  |  |
| Left high no flyer |  |  |
|  |  |  |
|  |  |  |
| Right low income high emissions | Unlikely combo | Unlikely combo |
| Right low car owner |  |  |
| Right low meat |  |  |
| Right low house owner |  |  |
| Right low frequent flyer |  |  |
|  |  |  |
| Right low income low emissions | Low | - |
| Right low no car |  |  |
| Right low vegetarian |  |  |
| Right low apartment |  |  |
| Right low no flyer |  |  |
|  |  |  |
| Right high income high emissions | high | financial |
| Right high car owner |  |  |
| Right high meat |  |  |
| Right high house owner |  |  |
| Right high frequent flyer |  |  |
|  |  |  |
| Right high income low emissions | Unlikely combo | Unlikely combo |
| Right high no car |  |  |
| Right high vegetarian |  |  |
| Right high apartment |  |  |
| Right high no flyer |  |  |

A3: Priority evaluator survey items

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Scale** | **Concept** | **Source** |
| ***Before PE*** |  |  |  |
| *B1\_text: Now, we would like to ask you some questions about climate change (global warming).*  **B1 Do you think that climate change is caused by natural processes, human activity, or both?** | From 1 entirely by natural processes to 5 entirely by human activity, incl. DK | Climate change beliefs – climate change cause | *ESS 2016* |
| **B2 How worried are you about climate change?** | From 1 not at all worried to 5 extremely worried, incl. DK | Climate concern | *ESS 2016* |
| **B3 To what extent do you feel you have a personal responsibility to try to reduce carbon dioxide (CO2) emissions that are contributing to climate change, where 0 is not at all and 10 is a great deal?** | From 0 not at all to 10 a great deal, incl. DK | Pro-environmental personal norm | *Own wording (based on ESS 2016)* |
| **B4 How much do you think the local area where you live will be affected by climate change in the next 100 years, where 0 is not at all and 10 is a great deal?** | From 0 not at all to 10 a great deal, incl. DK | Climate change impact – future impact | *?* |
| **B5 How much do you think the local area where you live is currently being affected by climate change, where 0 is not at all and 10 is a great deal?** | From 0 not at all to 10 a great deal, incl. DK | Climate change impact – current impact | *?* |
| **B10 How much do you agree or disagree with the following statement? Climate change is an unstoppable process, we cannot do anything about it.** | From 1 strongly agree to 5 strongly agree, incl. DK | ? | *Eurobarometer, LITSII* |
| ***Before & After PE*** |  |  |  |
| *B6\_txt: The following two statements are about changes you could make to your current behaviours and living conditions that would reduce your carbon dioxide (CO2) emissions. Examples are driving/flying less, reducing personal energy usage, switching to an electric vehicle, or installing solar panels on your home.*  *Please state how confident you are in each of these statements, where 0 means not at all confident and 10 is completely confident.*  **B6 I could reduce my own carbon dioxide (CO2) emissions.** | From 0 not at all confident to 10 completely confident, incl. DK | Efficacy beliefs – self efficacy | *Own wording (based on ESS 2016)* |
| **B7 Reducing my own carbon dioxide (CO2) emissions will help limit climate change.** | From 0 not at all confident to 10 completely confident, incl. DK | Efficacy beliefs – personal outcome expectancy | *Own wording (based on ESS 2016)* |
| *B8\_txt: Now, the following two statements are about new policies and regulations that the Swiss Government could institute with the aim of reducing carbon dioxide (CO2) emissions. Please state how confident you are in each of these statements, where 0 is not at all confident and 10 is completely confident.*  **B8 The Swiss Government will institute new policies and regulations aimed at reducing carbon dioxide (CO2) emissions.** | From 0 not at all confident to 10 completely confident, incl. DK | Efficacy beliefs – institutional efficacy | *Own wording (loosely based on ESS 2016)* |
| *Please state how confident you are in each of these statements, where 0 is not at all confident and 10 is completely confident.*  **B9 Now imagine that the Swiss Government does institute new policies and regulations aimed at reducing carbon dioxide (CO2) emissions: How confident are you that these policies and regulations will help limit climate change?** | From 0 not at all confident to 10 completely confident, incl. DK | Efficacy beliefs – institutional outcome expectancy | *Own wording (loosely based on ESS 2016)* |
| ***After PE*** |  |  |  |
| *D1\_text: For the following questions, please think about the changes you made to your behaviours and living conditions in order to meet your carbon dioxide (CO2) emission reduction target in the previous exercise.*  **D1 How costly do you think these changes to your behaviours and living conditions would be for you to make, where 0 is not at all expensive and 10 is extremely expensive?** | From 0 not at all expensive to 10 extremely expensive | PE financial cost perception | *Own wording* |
| **D2 How difficult do you think these changes to your behaviours and living conditions would be for you to make, where 0 is not at all difficult and 10 is extremely difficult?** | From 0 not at all difficult to 10 extremely difficult | PE behavioral adaptation difficulty  perception | *Own wording* |
| **D7 In general, how would you rate the CO2 emission reduction target exercise, where 0 is lowest and 10 is highest?** | From 0 to 10 | PE rating | *Own wording* |
| **D8 Do you have any additional feedback that you would like to share with us about the CO2 emission reduction target exercise?** | - | PE additional feedback | *Own wording* |

**What can the methods tell us / tell us substantively:**

**Logit models:**

* Effect of individual characteristics on probability to reach emission reduction target
* Interaction of different individual characteristics on probability to reach emission reduction target

**MDCEVM:**

Key parameters / model output

* Alternative specific constants ASC (i.e., effects of adaptation measure on utility
* T-stats (i.e. effects of individual characteristics on different adaptation measure
* Satiation parameters/curves (i.e., effect on continuous part of adaptation measure, i.e. how much has it been used)

Postestimation (?)

* Elasticities
* Marginal probabilities
* Cluster analysis

*Description MDCEVM in Meister et al. (2022)*

MDCEV models were first proposed in 2005 by Bhat (*[4](https://journals.sagepub.com/doi/full/10.1177/03611981221089545" \l "bibr4-03611981221089545)*) and extended by numerous works to introduce or relax certain key model assumptions. As opposed to traditional discrete choice models, they allow the modeling the simultaneous choice of multiple goods (discrete dimension) and the corresponding continuous quantities of consumption (continuous dimension). While conventional multiple discrete models only allow modeling of the selection of one alternative from a set of mutually exclusive alternatives, MDCEV models consider goods as imperfect substitutes and enable modeling of the choice of multiple alternatives simultaneously using additive utility functions. These functions are of a non-linear nature and introduce diminishing marginal returns for each alternative’s consumption (satiation). This problem framing is by design well suited to represent real-world and relevant choices in many fields including time use, marketing and transport research. Furthermore, the derived satiation parameters generate more behavioral insights into the modeled decision process. In the transport sector, MDCEV models have been applied to a wide range of use cases, including the choice of household vehicle holdings and usage (*[20](https://journals.sagepub.com/doi/full/10.1177/03611981221089545" \l "bibr20-03611981221089545)*), Mobility-as-a-Service services and usage (*[21](https://journals.sagepub.com/doi/full/10.1177/03611981221089545" \l "bibr21-03611981221089545)*), general time use (*[22](https://journals.sagepub.com/doi/full/10.1177/03611981221089545" \l "bibr22-03611981221089545)*), travel-based time use (*[23](https://journals.sagepub.com/doi/full/10.1177/03611981221089545" \l "bibr23-03611981221089545)*), as well as modeling of social networks (*[24](https://journals.sagepub.com/doi/full/10.1177/03611981221089545" \l "bibr24-03611981221089545)*). The framework assumes the existence of a budget constraint that has to be allocated among different alternatives. The budget itself may take the form of total hours in a day, VMT or a monetary budget. The framework can further assume the existence of an outside good, defined as a good that has a positive consumption by all respondents. The specification of such a constraint affects whether corner solutions in the utility space are considered. Similar to conventional discrete choice models, the various error terms can be subjected to different assumptions. Relaxing the assumption of independent and identically distributed error across alternatives using a mixing error structure results in the mixed MDCEV (MMDCEV).

*Source:*

*Meister, A., Mondal, A., Asmussen, K. E., Bhat, C., & Axhausen, K. W. (2022). Modeling Urban Mode Choice Behavior During the COVID-19 Pandemic in Switzerland Using Mixed Multiple Discrete-Continuous Extreme Value Models. Transportation Research Record, 0(0). <https://doi.org/10.1177/03611981221089545>*

**Theory dump (DELETE BEFORE SUBMITTING)**

* Makes the cost aspect particularly salient
  + Are financial costs most important, or behavior?
    - Different types of behavioral costs, effectiveness and financial costs
* Full information environment, how will this affect distributional implications? By making costs transparent, we’d expect to

Ideological factors (left/right, environmental concern)

Material factors (income)

Behavioral factors (car ownership, flying, meat, house ownership)

Adhoc-hypotheses:

* + Behaviors determine choices
    - Car ownership: change
    - Flying: change:
    - Meat: change
    - House ownership: change
  + Income: more likely use money instead of behavioral change (incl. certificates)
  + Left/right (more likely to bear behavioral costs)

, making them susceptible to misinformation by political actors about costs and distributional effects of policies that aim at changing behaviors, as they process new information about policy implications in a way to align them with their with pre-existing ideological predispositions (i.e., motivated reasoning, cf. Douenne and Fabre, 2022; Druckman and McGrath, 2019) .

Relevance / Implications of findings (100)

Our analysis aims to add the following to our understanding of climate change politics / this is our contribution:

1. First of all, this study can serve as an exploratory tool to identify how people would behave in a world where personal emission reductions become a necessity. This is important, because asking about voluntary action can serve as a hard test compared to policy preferences (less social desirability bias) -> methodological argument
2. Further, this paper sheds light on the question whether distributional concerns impacts are focusing on different income brackets allows us to shed light on whether distributional conflicts are rooted in actual financial possibilities of individuals to reduce their carbon footprint, or whether distributional concerns mainly get raised as a political strategy to leverage votes.

* Policy implications?

1. Last, it can at least indirectly tell us something about the political feasibility of policies targeting individual behaviors.

* Higher income bracket: important for two reasons, high emitters (Nielsen et al., 2021), but also policy preferences are more likely to be translated into policy output (Gilens 2012)
* Medium income bracket: mass preferences translate into policy (Schakel)
* Low-income bracket: fairness considerations