

Higher-order risk preferences and climate action

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- 1 Motivation & Research Question
- 2 Design & Measurement
- 3 Results
- 4 Interpretation & Implications

Climate Change Attitudes and Climate Action



- Climate action (mitigation/adaptation) depends not only on economic incentives and technological options, but also on how individuals perceive and evaluate climate change.
 - Economic instruments (e.g. carbon pricing, subsidies) change relative prices, but behavioral responses depend on how individuals interpret the purpose, fairness, and effectiveness of these policies.
 - Technological availability reduces mitigation costs, yet adoption requires that individuals believe climate change is sufficiently likely, severe, and personally relevant.
- Climate Change involves *uncertain*, *delayed*, and *heterogeneous* risks, making individual risk perceptions a key determinant of climate-related behavior.
- As a result, differences in perceived climate risk and in how individuals assess the costs and fairness of mitigation policies can generate heterogeneous responses to identical climate interventions.

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Why Risk Perceptions Are Central

- Climate change involves both **outcome** and **timing** uncertainty.
- Consequences may be certain, timing (*when*) may not e.g., 'it is only a matter of time'
- Understanding risk preferences may help explain gaps between beliefs and actual climate actions.

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What Are Higher-Order Risk Preferences?

- **Risk Aversion (2nd order):** Aversion to mean-preserving spreads (i.e., characterized by concavity of the utility, $u''(x) < 0$)
- **Prudence (3rd order):** Precautionary motive (characterized by $u'''(x) > 0$)
 - Linked to precautionary savings (Kimbal 1990)
 - Preference to shift risk to better states (shielding low-wealth states from additional risk)
- **Temperance (4th order):** characterized by $u''''(x) < 0$
 - Risk apportionment
 - Avoid combining multiple risks
- Can be measured in both **outcome** and **timing** domains (Ebert 2021).

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Prior literature

- Risk aversion (2nd order) dominates the literature: foresters' adaptation to climate change or adoption to climate change mitigation practices or risk perceptions of climate change (e.g., De Pinto et al. 2013; Brunette et al. 2020; Villacis et al. 2021)
- Schneider and Sutter (2026) link (higher-order) risk preferences empirically to adolescents' eco-friendly (stated) behavior.
 - Survey measures of risk predict real-world behavior not because they capture risk aversion alone, but because they implicitly reflect multiple higher-order risk preferences such as prudence and temperance.
- Higher-order risk preferences rarely examined outside of investment and finance: very limited evidence on their behavioral predictive power.
- Open question: Do prudence and temperance predict real, incentivized climate action beyond risk aversion?
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Core question & contribution

Research question

Do higher-order risk preferences predict **real** climate action and climate attitudes?

- Real donation task tied to a meaningful carbon-offset benchmark (\$38).
- Demand-effects mitigation: donation decision taken **three months prior** to the risk elicitation task.
- Incentivized risk elicitation with high stakes (up to \$110).
- Broad set of outcomes: donation, willingness-to-contribute (WTC), beliefs, norms, skepticism, behaviors.

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Two-phase design (demand-effects mitigation)

- 1 **Phase 1 (behavior & attitudes):** subjects allocate \$38 between self and *Compensators* (verified CO₂ reductions); plus survey modules on climate attitudes/behaviors.
- 2 **Phase 2 (risk elicitation):** higher-order risk preferences elicited three months later using incentivized tasks with sizable stakes.

Key design choice

Separating phases reduces the risk that subjects infer any “desired” relationship between risk preferences and climate outcomes.

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- Pre-registered design (AEARCTR-0015642); two-phase panel study conducted 3 months apart.
- Sample recruited via Forthright Access (balanced U.S. panel suited for political and environmental research [Stagnaro et al. 2024](#)).
- Phase 1 (Jan 2025): 882 participants with complete responses.
- Phase 2 (Apr 2025): 705 recontacts; 607 complete both waves (576 with full demographics).
- Climate allocation decision measured separately from risk preferences.
- Temporal separation designed to reduce experimenter demand effects and subjects' inferring the 'right' choice.

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Phase 1 Main outcomes

- **Incentivized:** donation amount to climate mitigation for 20 randomly selected respondents (Phase 1).
- **Unincentivized widely used financial support:** WTC 1% or 0.5% of monthly income.
- **Social norms:** Own efforts to fight climate change (descriptive) and beliefs about whether others in the U.S. should act (normative).
- **Pro-climate behaviors:** Reducing meat, avoiding flights, using clean transport, green electricity, low-carbon shopping, political support.
- **Climate policy views:** Support for stronger government action against global warming.
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Note: Wording follows Andre et al. (2024b, 2024a).

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Phase 2: Eliciting higher-order risk preferences

- Domains: **outcome risk** and **delay risk** (binary choice tasks across domains).
- Measures (7 choices/domain; 42 choices in total):
 - Risk aversion
 - Prudence (third-order)
 - Temperance (fourth-order)
- High stakes: tasks with payoffs up to \$110 [5 Ebert (2021)].
- 10% chance of being selected for payment (Ahles et al. 2024).
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Choice task examples: Risk Aversion

Please choose the option that determines the payment that will be transferred to your Forthright account in a week from now.

Choice 8



I prefer option LEFT (L)



I prefer option RIGHT (R)



Choice task examples: Risk Aversion

Please choose the option which determines when you will receive \$70:

Choice 3

I prefer option LEFT (L)



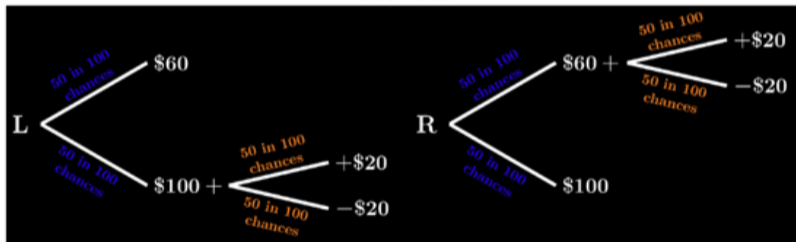
I prefer option RIGHT (R)



Choice task examples: Prudence

Please choose the option that determines the payment that will be transferred to your Forthright account in a week from now.

Choice 22



I prefer option LEFT (L)



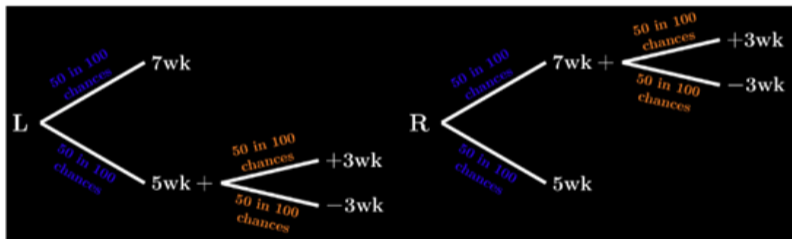
I prefer option RIGHT (R)



Choice task examples: Prudence

Please choose the option which determines when you will receive \$70:

Choice 17



I prefer option LEFT (L)



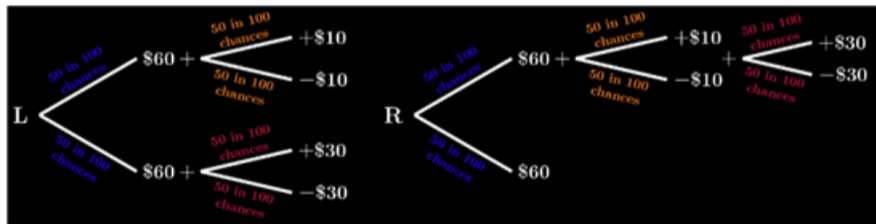
I prefer option RIGHT (R)



Choice task examples: Temperance

Please choose the option that determines the payment that will be transferred to your Forthright account in a week from now.

Choice 37



I prefer option LEFT (L)



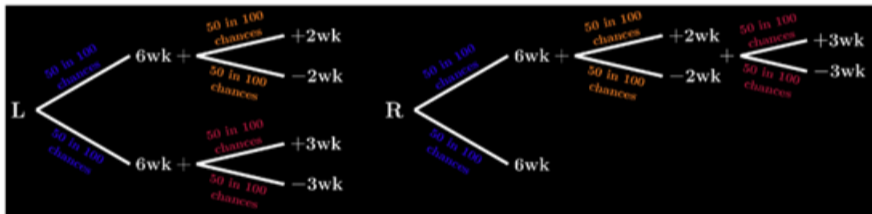
I prefer option RIGHT (R)



Choice task examples: Temperance

Please choose the option which determines when you will receive \$70:

Choice 29



I prefer option LEFT (L)



I prefer option RIGHT (R)



Phase 2: Lottery choice tasks

| Risk Preferences | Left Option (State 1 ; State 2) | Right Option (State 1 ; State 2) |
|--|---------------------------------------|---------------------------------------|
| For Wealth (fixed delay = 1 week) | | |
| Wealth risk aversion | $(X - x_1 ; X - x_2)$ | $(X - x_1 - x_2 ; X)$ |
| Wealth prudence | $(X - x_1 ; X + \tilde{w}_2)$ | $(X - x_1 + \tilde{w}_2 ; X)$ |
| Wealth temperance | $(X + \tilde{w}_1 ; X + \tilde{w}_2)$ | $(X + \tilde{w}_1 + \tilde{w}_2 ; X)$ |

Notes: This table summarizes the risk preference traits elicited for wealth (top) and delay (bottom). x is a wealth endowment, x_1, x_2 fixed amounts, and \tilde{w}_1, \tilde{w}_2 independent zero-mean wealth risks. t is base delay (weeks), d_1, d_2 fixed increases, and \tilde{d}_1, \tilde{d}_2 independent zero-mean delay risks.

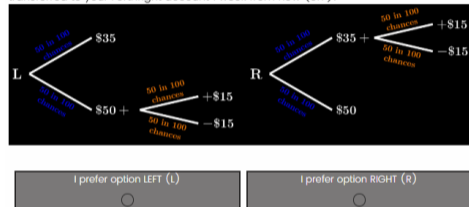
Phase 2: Lottery choice tasks

| Risk Preferences | Left Option (State 1 ; State 2) | Right Option (State 1 ; State 2) |
|--|---------------------------------------|---------------------------------------|
| For Wealth (fixed delay = 1 week) | | |
| Wealth risk aversion | $(x - x_1 ; x - x_2)$ | $(x - x_1 - x_2 ; x)$ |
| Wealth prudence | $(x - x_1 ; x + \tilde{w}_2)$ | $(x - x_1 + \tilde{w}_2 ; x)$ |
| Wealth temperance | $(x + \tilde{w}_1 ; x + \tilde{w}_2)$ | $(x + \tilde{w}_1 + \tilde{w}_2 ; x)$ |
| Risk Preferences | Left Option (State 1 ; State 2) | Right Option (State 1 ; State 2) |
| For Delay (fixed amount = \$70) | | |
| Delay risk aversion | $(t + d_1 ; t + d_2)$ | $(t + d_1 + d_2 ; t)$ |
| Delay prudence | $(t + d_1 ; t + \tilde{d}_2)$ | $(t + d_1 + \tilde{d}_2 ; t)$ |
| Delay temperance | $(t + \tilde{d}_1 ; t + \tilde{d}_2)$ | $(t + \tilde{d}_1 + \tilde{d}_2 ; t)$ |

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Choice tasks: Instructions

Example Decision. Please select the option you would prefer. This is just an example, but similar selections you will do later could determine the payment that will be transferred to your Forthright account 1 week from now (on):



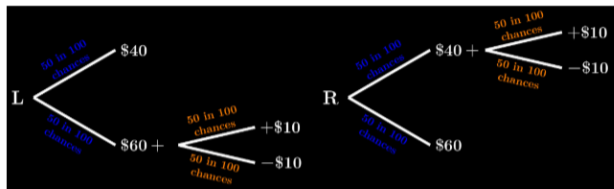
If you select the **LEFT (L)** option, then you have a 50% chance of yielding a payment of **\$35** AND a 50% chance of yielding a payment of **\$50 plus or minus \$15**. Thus, you have:

- **50%** chances of winning **\$35**
- **50%** x **50%** = 25% chances of winning **50 + 15 = \$65**
- **50%** x **50%** = 25% chances of winning **50 - 15 = \$35**

If you select the **RIGHT (R)** option, then you have a 50% chance of yielding a payment of **\$35 plus or minus \$15** AND a 50% chance of yielding a payment of **\$50**. Thus, you have:

- **50%** x **50%** = 25% chances of winning **35 + 15 = \$50**
- **50%** x **50%** = 25% chances of winning **35 - 15 = \$20**
- **50%** chances of winning **\$50**

Choice tasks: Comprehension Qs



I prefer option LEFT (L)



I prefer option RIGHT (R)



Suppose you chose **RIGHT (R)** and the **Upper blue branch** and the **Lower orange branch** were randomly selected. How much additional earnings will be transferred to your Forthright account in 1 week from now (type a number without the \$ sign)?

Choice tasks: Comprehension Qs



- Comprehension checks were **module-specific** (repeat-until-correct).
- Risk aversion (wealth & delay): 3 questions before each task.
- Prudence & temperance (wealth & delay): 2 questions before each task.
- **Total:** 14 comprehension items embedded throughout Phase 2.

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| Question | Wealth risk | Delay risk |
|---------------------------|-----------------|-----------------|
| Risk aversion (RA) | | |
| RA-Q1 | 74.67% (91.45%) | 75.66% (92.93%) |
| RA-Q2 | 62.66% (88.82%) | 77.14% (88.98%) |
| RA-Q3 | 77.63% (94.57%) | 83.72% (95.72%) |
| Prudence (PR) | | |
| PR-Q1 | 54.93% (87.01%) | 77.30% (97.37%) |
| PR-Q2 | 68.26% (94.90%) | 56.74% (87.34%) |
| Temperance (TMP) | | |
| TMP-Q1 | 57.73% (93.09%) | 68.42% (96.05%) |
| TMP-Q2 | 68.91% (96.05%) | 67.93% (94.41%) |

Attrition

Phase I attrition is demographically selective.

- Completers are younger (-7.3 years), $p < 0.001$
- More likely to have children ($+12.9$ pp), $p < 0.001$
- More likely male ($+10.7$ pp; $p < 0.002$), less likely female (-12.5 pp $p < 0.001$)
- Less likely separated/divorced/widowed (-7.5 pp), $p = 0.016$

Phase II attrition largely balanced.

- Less likely < high school (-3.0 pp), $p = 0.023$
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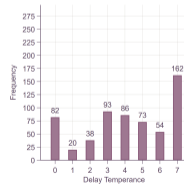
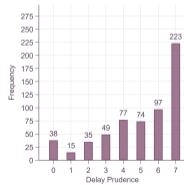
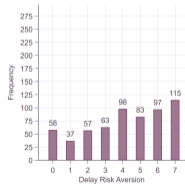
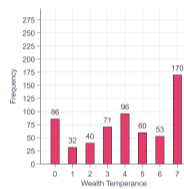
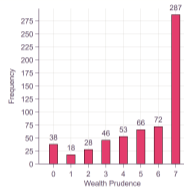
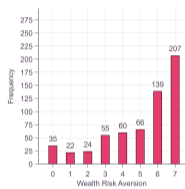
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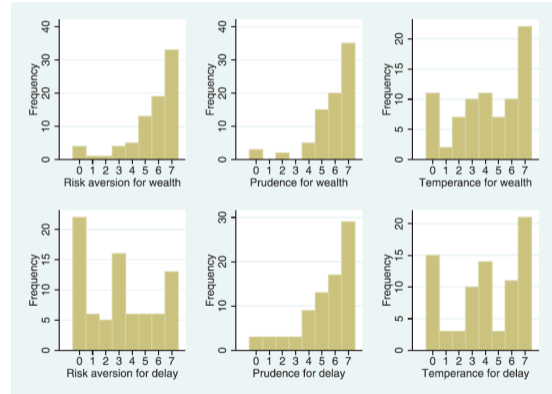
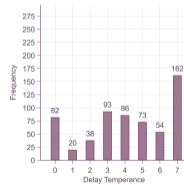
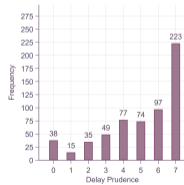
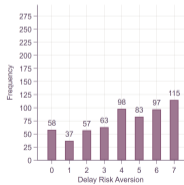
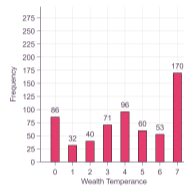
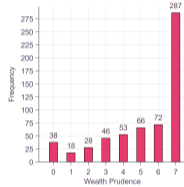
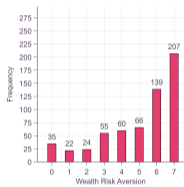
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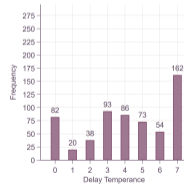
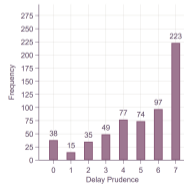
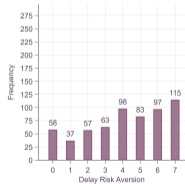
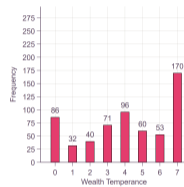
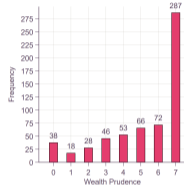
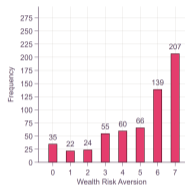
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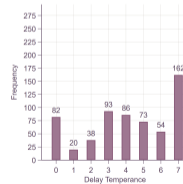
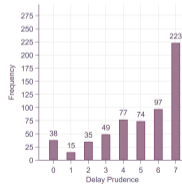
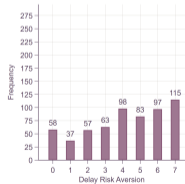
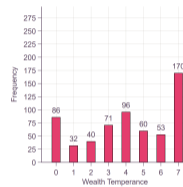
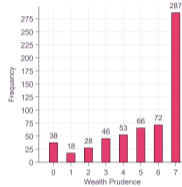
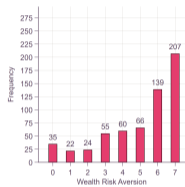


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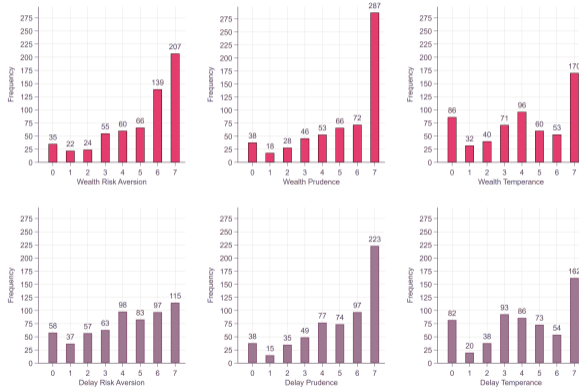
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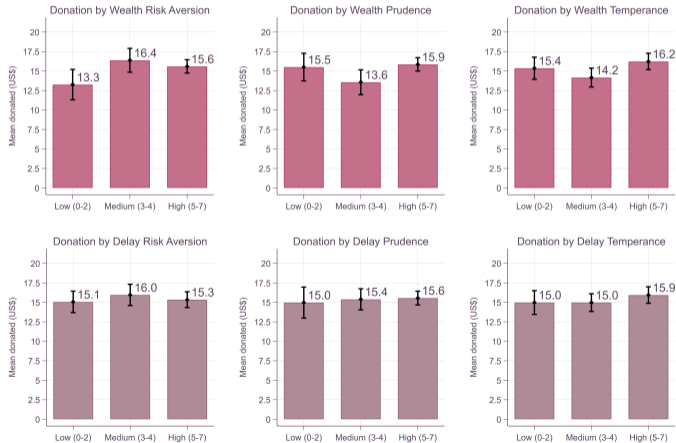
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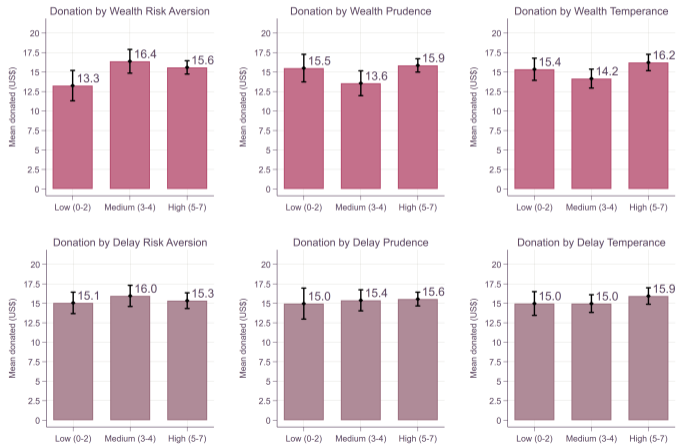
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Average donations by risk domain



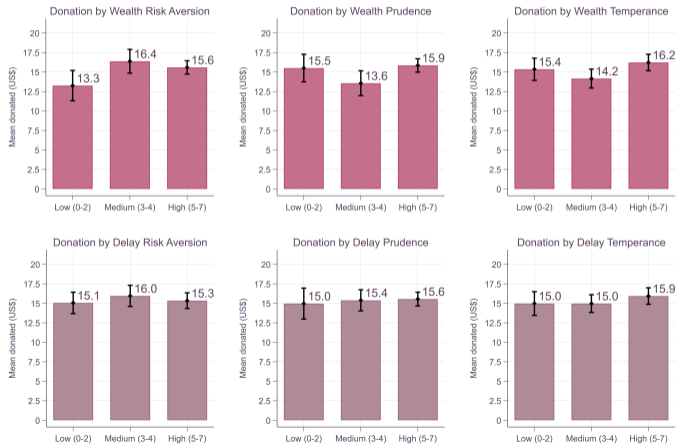
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- Two-step WTC question: 1% of income / if 'No', 0.5%
- Constructed 4-category ordered WTC measure
- 40.4% willing to contribute 1%
- 26.8% unwilling to contribute at all
- Distribution of responses by risk domain and intensity is roughly similar across the four WTC categories.

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Correlation matrix heatmap

Regression analysis

| | Donation (OLS) | | WTC (Ordered logit) | |
|----------------------------------|-------------------|-------------------|---------------------|-------------------|
| | (1) | (2) | (3) | (4) |
| Constant | 13.620 (1.784) | 15.096 (4.712) | - - | - - |
| Wealth Risk Aversion | 0.235 (0.299) | 0.274 (0.298) | -0.063 (0.045) | -0.106 (0.047) |
| Delay Risk Aversion | -0.026 (0.256) | -0.065 (0.267) | -0.054 (0.036) | -0.010 (0.040) |
| Wealth Prudence | 0.005 (0.258) | 0.035 (0.270) | -0.008 (0.039) | 0.014 (0.044) |
| Delay Prudence | 0.016 (0.297) | -0.217 (0.302) | -0.037 (0.042) | -0.092 (0.049) |
| Wealth Temperance | 0.051 (0.259) | 0.047 (0.269) | 0.045 (0.035) | 0.037 (0.039) |
| Delay Temperance | 0.097 (0.267) | 0.097 (0.270) | 0.029 (0.037) | 0.000 (0.040) |
| Political Ideology: Moderate | - - | -2.128 (1.278) | - - | -0.394 (0.205) |
| Political Ideology: Conservative | - - | -7.060 (1.382) | - - | -1.205 (0.211) |
| Demographic controls | No | Yes | No | Yes |
| N | 607 | 576 | 607 | 576 |
| R-squared | 0.003 | 0.114 | - | - |
| Adj. R-Squared | -0.007 | 0.066 | - | - |
| AIC | 4796.362 | 4525.937 | 1524.682 | 1403.872 |
| BIC | 4827.221 | 4660.976 | 1564.359 | 1547.624 |

Notes: $p < 0.1$, $p < 0.05$, $p < 0.01$.
 OLS uses HC3 robust SEs; ordered logit uses robust (sandwich) SEs.

Logit regressions of climate-related beliefs, social norms, political activism, self-reported behaviors, and climate skepticism

Conclusions #1

Interpretation

Higher-order risk preferences may matter for risk allocation decisions, but not for these climate outcomes.

Climate attitudes/actions appear primarily aligned with political identity rather than individual risk traits.

Implication: interventions targeting climate action may need to address ideological identity and social norms more than risk framing.

Risk-based framing (uncertainty, tail risks, precaution) may have limited traction (e.g., precautionary action needed, climate change is risky).

Use trusted in-group messengers e.g., veteran framing climate action as national security

Avoid triggering partisan identity defenses e.g., Climate change denial is a Republican problem; Democrats believe in climate change science.

Identity-neutral framing: Reducing emissions can improve energy efficiency and lower long-term costs; Reducing air pollution improves respiratory health for children and senior

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Implication: interventions targeting climate action may need to address ideological identity and social norms more than risk framing.

Risk-based framing (uncertainty, tail risks, precaution) may have limited traction (e.g., precautionary action needed, climate change is risky).

Use trusted in-group messengers e.g., veteran framing climate action as national security

Avoid triggering partisan identity defenses e.g., Climate change denial is a Republican problem; Democrats believe in climate change science.

Identity-neutral framing: Reducing emissions can improve energy efficiency and lower long-term costs; Reducing air pollution improves respiratory health for children and senior

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Takeaways

Incentivized higher-order risk measures (prudence/temperance) show predictive power for climate action.

Political ideology is the dominant correlate factor of climate action and attitudes.

Methodologically: we temporally separate behavior and preference elicitation to limit obvious cross-task inference.

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Thank you!

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Experimental parameters for Wealth risk preferences

| Parameter / Lottery No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------------------------|-----|-----|-----|-----|-----|-----|-----|
| Wealth Risk Aversion | | | | | | | |
| x | 90 | 100 | 100 | 120 | 120 | 130 | 130 |
| x ₁ | -30 | -30 | -10 | -50 | -40 | -40 | -20 |
| x ₂ | -30 | -50 | -70 | -50 | -40 | -60 | -80 |
| Wealth Prudence | | | | | | | |
| x | 70 | 80 | 90 | 90 | 90 | 100 | 110 |
| x ₁ | -20 | -40 | -60 | -40 | -20 | -40 | -60 |
| x ₂ | 30 | 20 | 10 | 30 | 30 | 20 | 10 |
| Wealth Temperance | | | | | | | |
| x | 60 | 60 | 60 | 70 | 80 | 80 | 80 |
| x ₁ | 10 | 10 | 20 | 20 | 10 | 10 | 20 |
| x ₂ | 20 | 30 | 20 | 30 | 30 | 40 | 30 |

Experimental parameters for Delay risk preferences

| Parameter / Lottery No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|----------------------------|---|---|---|---|---|---|---|
| Delay Risk Aversion | | | | | | | |
| t | 5 | 4 | 4 | 3 | 2 | 1 | 1 |
| d ₁ | 3 | 3 | 1 | 5 | 4 | 4 | 2 |
| d ₂ | 3 | 5 | 7 | 5 | 4 | 6 | 8 |
| Delay Prudence | | | | | | | |
| t | 7 | 6 | 5 | 5 | 5 | 4 | 3 |
| d ₁ | 2 | 4 | 6 | 4 | 2 | 4 | 6 |
| ~ 2 | 3 | 2 | 1 | 3 | 3 | 2 | 1 |
| Delay Temperance | | | | | | | |
| t | 8 | 8 | 8 | 7 | 6 | 6 | 6 |
| ~ 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 |
| ~ 2 | 2 | 3 | 2 | 3 | 3 | 4 | 3 |

Appendix: Attrition/Completion (Phase I & II)

| | (1) Phase I (P1 attrition) | | | | (2) Phase II (P2 attrition) | | | |
|----------------------------|-------------------------------|----------|--------|---------|--------------------------------|----------|--------|---------|
| | Incomplete | Complete | Di | p-value | Incomplete | Complete | Di | p-value |
| Age | 53.854 | 46.604 | 7.250 | < 0.001 | 45.635 | 47.041 | -1.406 | 0.242 |
| Race: white | 0.719 | 0.745 | -0.025 | 0.421 | 0.723 | 0.755 | -0.032 | 0.315 |
| Children in household | 0.174 | 0.303 | -0.129 | < 0.001 | 0.274 | 0.316 | -0.043 | 0.203 |
| Gender: | | | | | | | | |
| Male | 0.364 | 0.471 | -0.107 | 0.002 | 0.449 | 0.481 | -0.032 | 0.377 |
| Female | 0.621 | 0.496 | 0.125 | < 0.001 | 0.515 | 0.488 | 0.027 | 0.459 |
| Non-binary | 0.016 | 0.033 | -0.017 | 0.154 | 0.036 | 0.031 | 0.005 | 0.690 |
| Income: | | | | | | | | |
| Less than \$25,000 | 0.253 | 0.232 | 0.021 | 0.496 | 0.267 | 0.216 | 0.051 | 0.104 |
| \$25,000 to \$34,999 | 0.139 | 0.121 | 0.018 | 0.458 | 0.117 | 0.123 | -0.007 | 0.779 |
| \$35,000 to \$49,999 | 0.148 | 0.143 | 0.004 | 0.867 | 0.150 | 0.140 | 0.010 | 0.695 |
| \$50,000 to \$74,999 | 0.190 | 0.197 | -0.007 | 0.808 | 0.195 | 0.198 | -0.002 | 0.942 |
| \$75,000 to \$99,999 | 0.131 | 0.121 | 0.010 | 0.691 | 0.117 | 0.123 | -0.007 | 0.779 |
| > = \$100,000 to \$124,999 | 0.139 | 0.185 | -0.046 | 0.099 | 0.154 | 0.199 | -0.045 | 0.115 |

Notes: Entries report group means for incomplete vs. complete respondents by phase, the difference (Incomplete - Complete), and the associated p-value.

Appendix: Attrition/Completion (Phase I & II)

| | (1) Phase I (P1 attrition) | | | | (2) Phase II (P2 attrition) | | | |
|----------------------------|-------------------------------|----------|--------|---------|--------------------------------|----------|--------|---------|
| | Incomplete | Complete | Di | p-value | Incomplete | Complete | Di | p-value |
| Marital status: | | | | | | | | |
| Single | 0.304 | 0.347 | -0.043 | 0.245 | 0.384 | 0.331 | 0.053 | 0.136 |
| Living with partner | 0.077 | 0.124 | -0.046 | 0.061 | 0.129 | 0.121 | 0.008 | 0.733 |
| Married | 0.353 | 0.339 | 0.014 | 0.707 | 0.306 | 0.353 | -0.047 | 0.184 |
| Separated/divorced/widowed | 0.266 | 0.191 | 0.075 | 0.016 | 0.180 | 0.195 | -0.015 | 0.621 |
| Education: | | | | | | | | |
| < High school graduate | 0.028 | 0.034 | -0.006 | 0.615 | 0.055 | 0.025 | 0.030 | 0.023 |
| High school graduate | 0.233 | 0.226 | 0.007 | 0.807 | 0.234 | 0.222 | 0.011 | 0.714 |
| Some college | 0.435 | 0.406 | 0.028 | 0.419 | 0.401 | 0.409 | -0.007 | 0.843 |
| Bachelor's degree | 0.198 | 0.218 | -0.020 | 0.488 | 0.212 | 0.221 | -0.009 | 0.763 |
| Master's degree or higher | 0.107 | 0.116 | -0.009 | 0.690 | 0.099 | 0.124 | -0.025 | 0.283 |
| Urbanicity: | | | | | | | | |
| Urban | 0.249 | 0.307 | -0.058 | 0.082 | 0.287 | 0.316 | -0.029 | 0.389 |
| Suburban | 0.527 | 0.467 | 0.061 | 0.096 | 0.483 | 0.459 | 0.024 | 0.518 |
| Rural | 0.224 | 0.226 | -0.003 | 0.930 | 0.230 | 0.225 | 0.006 | 0.857 |

Notes: Entries report group means for incomplete vs. complete respondents by phase, the difference (Incomplete - Complete), and the associated p-value.

Appendix: Attrition/Completion (Phase I & II)

| | (1) Phase I (P1 attrition) | | | | (2) Phase II (P2 attrition) | | | |
|---------------------|-------------------------------|----------|--------|---------|--------------------------------|----------|--------|---------|
| | Incomplete | Complete | Di | p-value | Incomplete | Complete | Di | p-value |
| Region: | | | | | | | | |
| Northeast | 0.174 | 0.192 | -0.018 | 0.521 | 0.212 | 0.183 | 0.029 | 0.315 |
| Midwest | 0.209 | 0.205 | 0.004 | 0.889 | 0.197 | 0.209 | -0.012 | 0.680 |
| South | 0.360 | 0.393 | -0.033 | 0.341 | 0.361 | 0.407 | -0.046 | 0.200 |
| West | 0.257 | 0.210 | 0.047 | 0.113 | 0.230 | 0.201 | 0.029 | 0.330 |
| Political ideology: | | | | | | | | |
| Liberal | 0.328 | 0.380 | -0.052 | 0.130 | 0.325 | 0.405 | -0.080 | 0.023 |
| Moderate | 0.340 | 0.341 | -0.001 | 0.986 | 0.376 | 0.325 | 0.051 | 0.137 |
| Conservative | 0.332 | 0.279 | 0.053 | 0.103 | 0.299 | 0.270 | 0.029 | 0.374 |

Notes: Entries report group means for incomplete vs. complete respondents by phase, the difference (Incomplete - Complete), and the associated p-value.

Appendix: Sample size calculations (setup)

Baseline model $y_i = \mu + bx_i + \epsilon_i$

y_i : donation/willingness to allocate to Compensators

x_i : count of RA/PR/TMP choices (0{7) in a given domain

Test $H_0 : b = 0$ vs. one-sided $H_a : b > 0$

Error SD (given $y; x$):
$$= \sqrt{\frac{q}{y} b^2 \frac{2}{x}}$$
 (Dupont and Plummer 1998)

Define effect size:
$$= \frac{b}{\Delta} x$$

Design targets: $\alpha = 0:05$ (Type I), $\beta = 0:20$ (Type II), power = 1 - $\beta = 0:80$.

Appendix: Sample size calculations (power)

- Test statistic: $t = \frac{\rho_{\bar{n}} \hat{b}}{s}; \quad s = \frac{\hat{\quad}}{x}$
- Under H_0 : $t \sim t_{n-2}$
- Under H_a : $t \sim t_{n-2,\lambda}$ (noncentral t), with

$$= \rho_{\bar{n}}$$

- Power:

$$= 1 - T_{n-2,\lambda}(t_{n-2,1-\alpha})$$

Sample size n (or minimum detectable) is obtained by iteratively solving the power equation for given ; .

Appendix: Sample size calculations (assumptions & results)



- Calibration of outcome SD:

$$y = 12:41$$

(scaled from Andre et al. (2024b))

- Predictor dispersion:

$$x \geq [1.6; 2.6]$$

(counts SDs from Ebert (2021))

- Detectable slopes:

$$(b_a \quad b_0) \geq f[0.6; 0.8; 1.0]g; \quad b_0 = 0$$

- Interpretation: +1 choice) +\$0.6 to +\$1.0 donation

| $(b_a \quad b_0)$ | n | x | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 |
|-------------------|-----|-----|------------|------------|------------|------------|------------|------------|
| 0.6 | | | 1029 | 812 | 657 | 542 | 455 | 387 |
| 0.8 | | | 577 | 455 | 368 | 303 | 254 | 216 |
| 1.0 | | | 368 | 290 | 234 | 192 | 161 | 137 |

Notes: Cells report required n for 80% power at $\alpha = 0:05$ (one-sided), given $y = 12:41$ and x as shown.

Planned minimum sample: 455 subjects.