Higher-order risk preferences and climate action

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Roadmap

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.
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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
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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?
- Demand-effects: possible confound when eliciting both together.

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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 CO_2 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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Methods

- 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 $\times$ Ebert (2021)].
- 10% chance of being selected for payment (Ahles et al. 2024).
- 1 of 42 choices was randomly chosen to determine their payoff.

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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

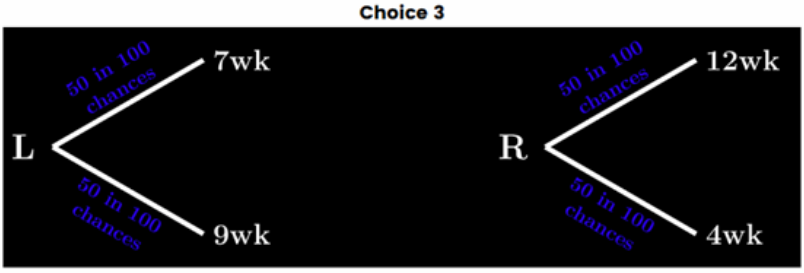


I prefer option LEFT (L) ○

I prefer option RIGHT (R) ○

Choice task examples: Risk Aversion

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



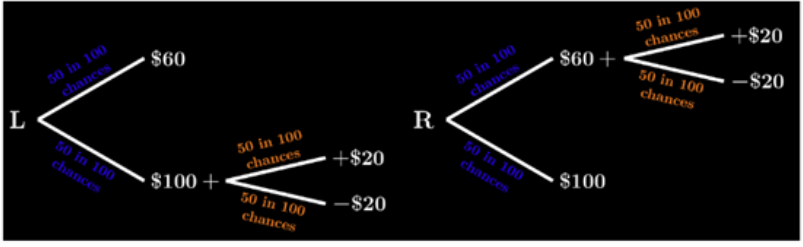
I prefer option LEFT (L) ○

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



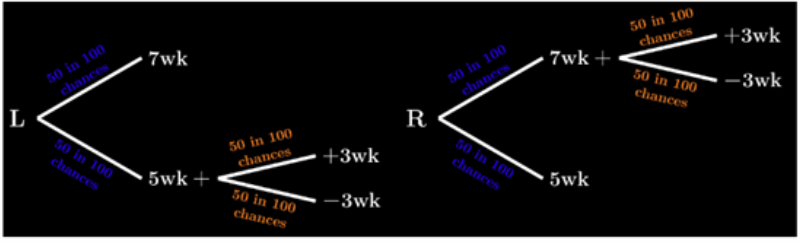
I prefer option LEFT (L) ○

I prefer option RIGHT (R) ○

Choice task examples: Prudence

Please choose the option which determines <u>when</u> you will receive <u>$70</u>:

Choice 17



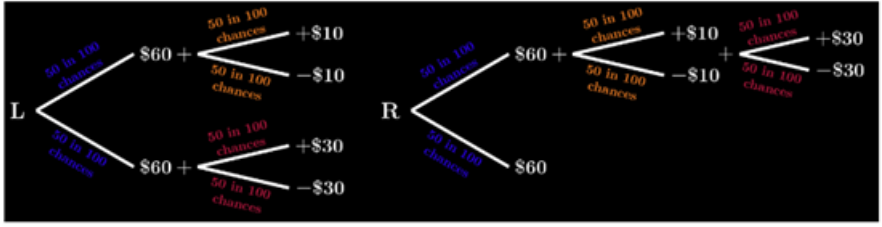
I prefer option LEFT (L) ○

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



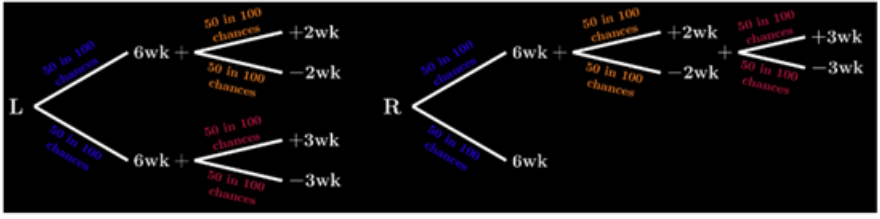
I prefer option LEFT (L) ○

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	$(x - x_1 \; ; \; x + \tilde{\varepsilon}_2)$	$(x - x_1 + \tilde{\varepsilon}_2 \; ; \; x)$
Wealth temperance	$(x + \tilde{\varepsilon}_1 \; ; \; x + \tilde{\varepsilon}_2)$	$(x + \tilde{\varepsilon}_1 + \tilde{\varepsilon}_2 \; ; \; x)$

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 $\tilde{\varepsilon}_1, \tilde{\varepsilon}_2$ independent zero-mean wealth risks. t is base delay (weeks), d_1, d_2 fixed increases, and $\tilde{\tau}_1, \tilde{\tau}_2$ independent zero-mean delay risks.

Parameters of Wealth Risk | Parameters of Delay Risk

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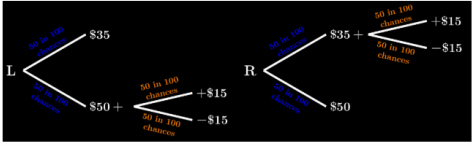
Risk Preferences	Left Option (State 1 ; State 2)	Right Option (State 1 ; State 2)
For Delay (fixed amount = $70)		
Delay risk aversion	$(t + d_1 \; ; \; t + d_2)$	$(t + d_1 + d_2 \; ; \; t)$
Delay prudence	$(t + d_1 \; ; \; t + \tilde{\tau}_2)$	$(t + d_1 + \tilde{\tau}_2 \; ; \; t)$
Delay temperance	$(t + \tilde{\tau}_1 \; ; \; t + \tilde{\tau}_2)$	$(t + \tilde{\tau}_1 + \tilde{\tau}_2 \; ; \; t)$

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Parameters of Wealth Risk | Parameters of Delay Risk

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 I week from now (on):

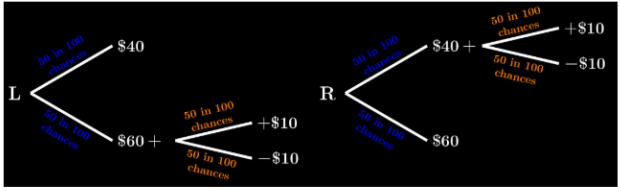


I prefer option LEFT (L) ○ | I prefer option RIGHT (R) ○

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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- No other statistically significant differences

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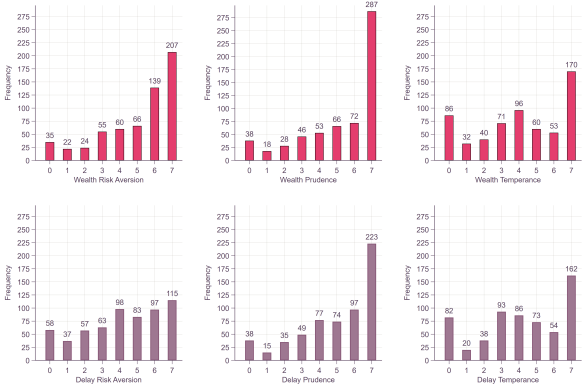
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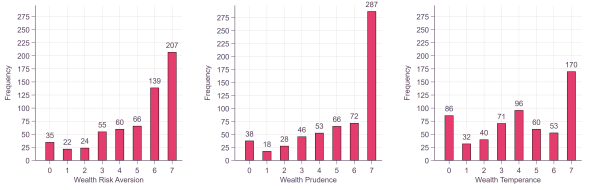
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Demographics

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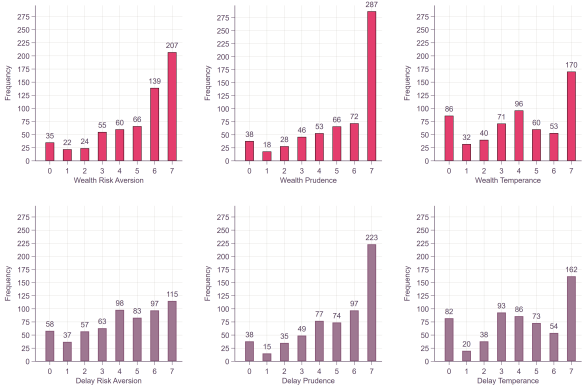


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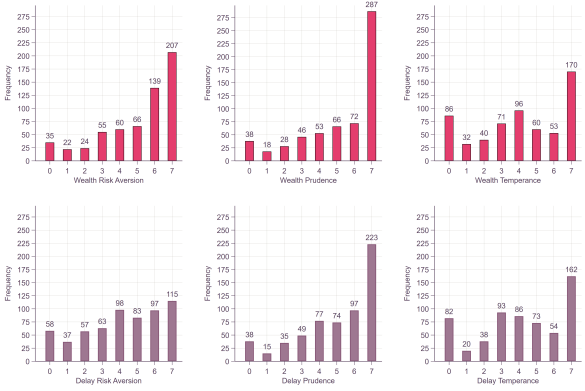


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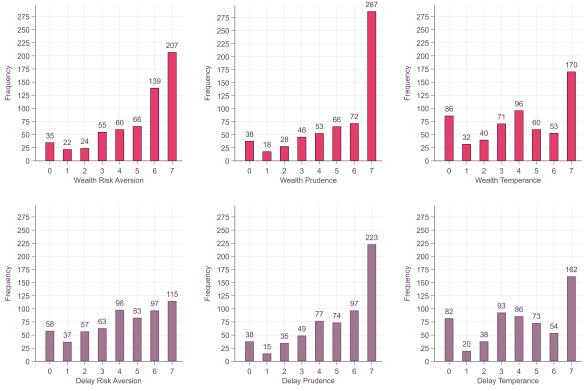
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- Wilcoxon matched-pairs signed-rank test: Wealth RA $\neq$ Delay RA ($p < 0.001$); Wealth PR $\neq$ Delay PR ($p = 0.026$); Wealth TEMPER = Delay TEMPER ($p = 0.837$).

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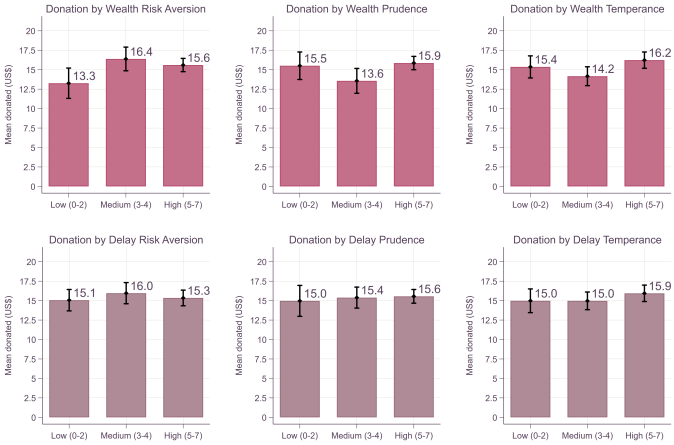
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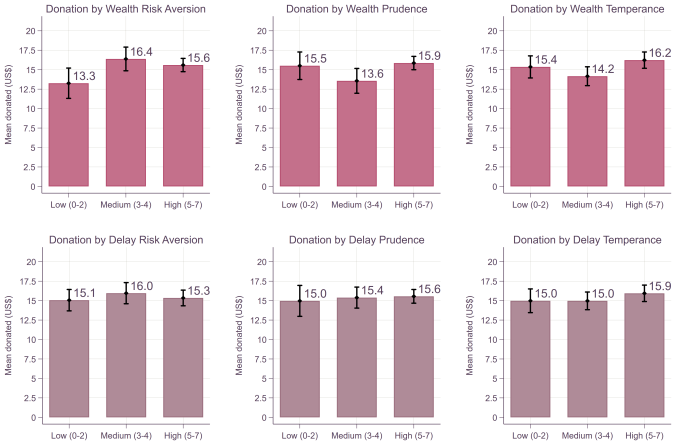
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Average donations by risk domain



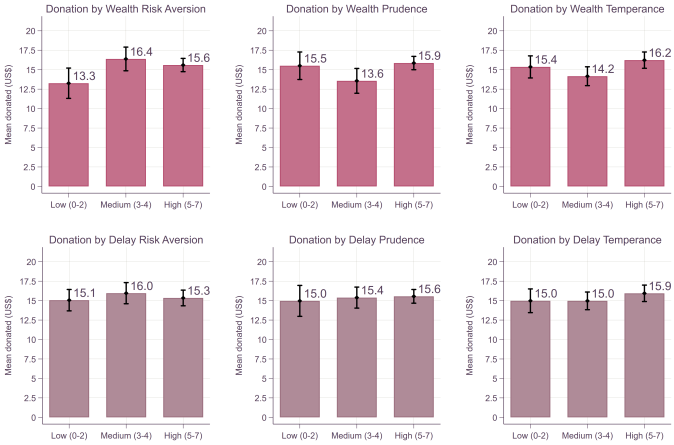
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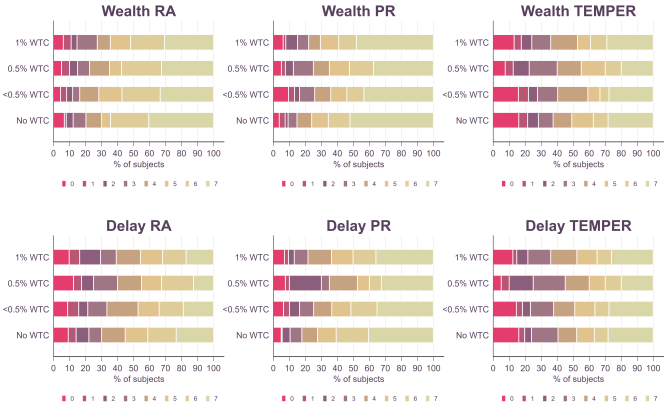
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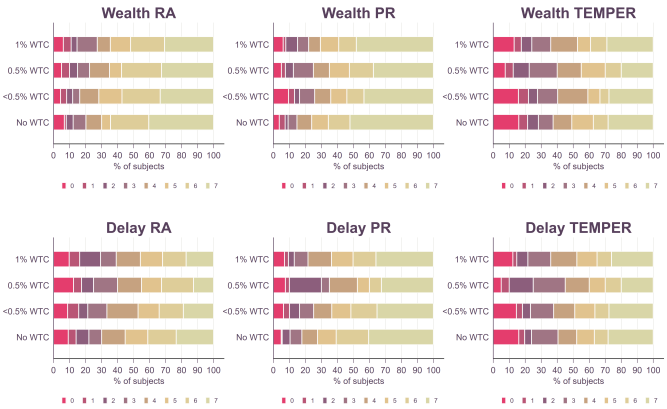


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Willingness-to-contribute to fight global warming

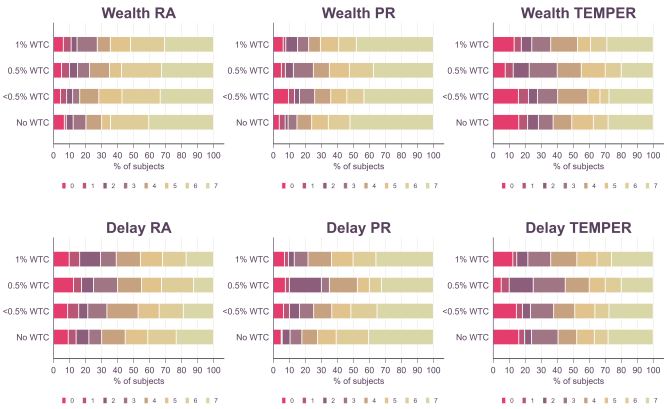


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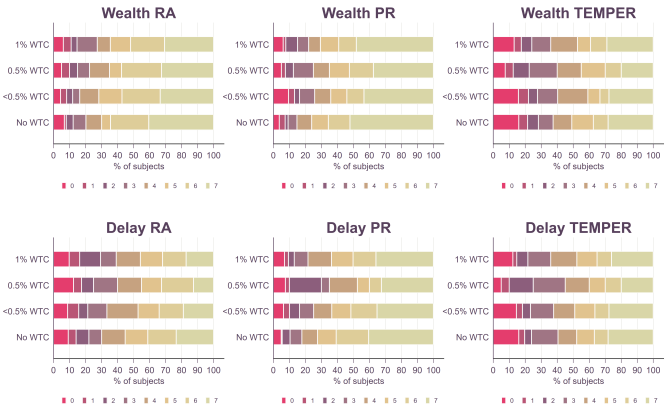
- Two-step WTC question: 1% of income → if 'No', 0.5%
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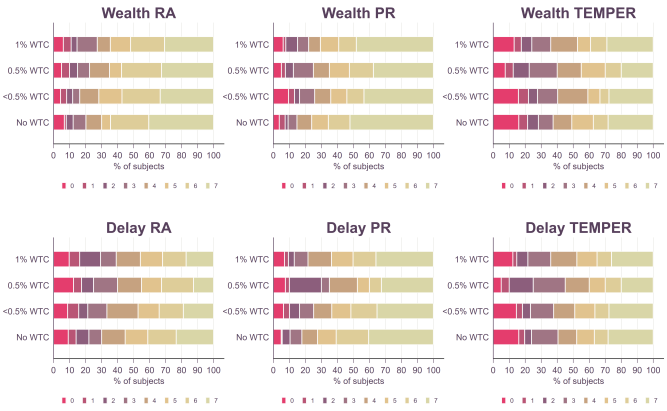
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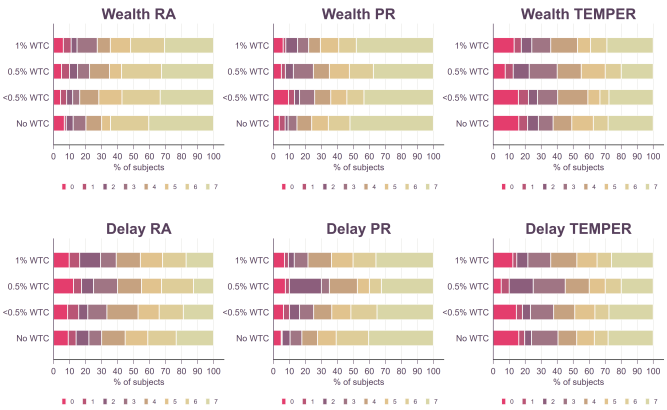
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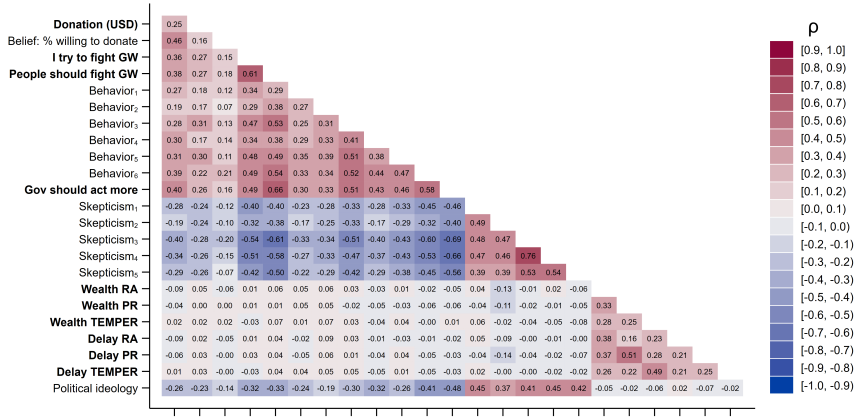
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Correlation matrix heatmap



Regression analysis

	Donation (OLS)		WTC (Ordered logit)	
	(1)	(2)	(3)	(4)
Constant	13.620***	15.096***	-	-
	(1.784)	(4.712)	-	-
Wealth Risk Aversion	0.235	0.274	-0.063	-0.106**
	(0.299)	(0.298)	(0.045)	(0.047)
Delay Risk Aversion	-0.026	-0.065	-0.054	-0.010
	(0.256)	(0.267)	(0.036)	(0.040)
Wealth Prudence	0.005	0.035	-0.008	0.014
	(0.258)	(0.270)	(0.039)	(0.044)
Delay Prudence	0.016	-0.217	-0.037	-0.092*
	(0.297)	(0.302)	(0.042)	(0.049)
Wealth Temperance	0.051	0.047	0.045	0.037
	(0.259)	(0.269)	(0.035)	(0.039)
Delay Temperance	0.097	0.097	0.029	0.000
	(0.267)	(0.270)	(0.037)	(0.040)
Political Ideology: Moderate	-	-2.128*	-	-0.394*
	-	(1.278)	-	(0.205)
Political Ideology: Conservative	-	-7.060***	-	-1.205***
	-	(1.382)	-	(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 seniors

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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 seniors

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Conclusions #2

Takeaways

1. Incentivized higher-order risk measures (prudence/temperance) show **no predictive power** for climate action.
2. Political ideology is the **dominant correlate** factor of climate action and attitudes.
3. Methodologically: we temporally separate behavior and preference elicitation to limit obvious cross-task inference.

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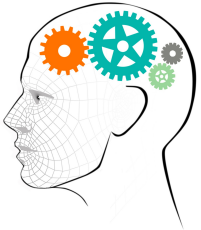
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Experimental parameters for Wealth risk preferences

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
$\tilde{\varepsilon}_2$	± 30	± 20	± 10	± 30	± 30	± 20	± 10
Wealth Temperance							
x	60	60	60	70	80	80	80
$\tilde{\varepsilon}_1$	± 10	± 10	± 20	± 20	± 10	± 10	± 20
$\tilde{\varepsilon}_2$	± 20	± 30	± 20	± 30	± 30	± 40	± 30

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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
$\tilde{\tau}_2$	± 3	± 2	± 1	± 3	± 3	± 2	± 1
Delay Temperance							
t	8	8	8	7	6	6	6
$\tilde{\tau}_1$	± 1	± 1	± 2	± 2	± 1	± 1	± 2
$\tilde{\tau}_2$	± 2	± 3	± 2	± 3	± 3	± 4	± 3

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Appendix: Attrition/Completion (Phase I & II)

	(1) Phase I (P1 attrition)				(2) Phase II (P2 attrition)			
	Incomplete	Complete	Diff	p-value	Incomplete	Complete	Diff	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.

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Appendix: Attrition/Completion (Phase I & II)

	(1) Phase I (P1 attrition)				(2) Phase II (P2 attrition)			
	Incomplete	Complete	Diff	p-value	Incomplete	Complete	Diff	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	Diff	p-value	Incomplete	Complete	Diff	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.

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Appendix: Sample size calculations (setup)

- Baseline model: $y_i = \gamma + bx_i + e_i$
  - 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 σ_y, σ_x): $\sigma = \sqrt{\sigma_y^2 - b^2\sigma_x^2}$ (Dupont and Plummer 1998)
- Define effect size: $\delta = \dfrac{b\,\sigma_x}{\hat{\sigma}}$

Design targets: $\alpha = 0.05$ (Type I), $\beta = 0.20$ (Type II), power $= 1 - \beta = 0.80$.

Appendix: Sample size calculations (power)

- Test statistic: $t = \dfrac{\sqrt{n}\,\hat{b}}{s}, \qquad s = \dfrac{\hat{\sigma}}{\sigma_x}$
- Under H_0: $t \sim t_{n-2}$
- Under H_a: $t \sim t_{n-2,\lambda}$ (noncentral t), with

$$\lambda = \sqrt{n}\,\delta$$

- Power:

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

Sample size n (or minimum detectable δ) is obtained by iteratively solving the power equation for given α, β.

Appendix: Sample size calculations (assumptions & results)

- Calibration of outcome SD:

$$\sigma_y = 12.41$$

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

- Predictor dispersion:

$$\sigma_x \in [1.6,\ 2.6]$$

(counts SDs from Ebert (2021))

- Detectable slopes:

$$(b_a - b_0) \in \{0.6, 0.8, 1.0\}, \quad b_0 = 0$$

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

$(b_a - b_0) \setminus \sigma_x$	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 $\sigma_y = 12.41$ and σ_x as shown.

Planned minimum sample: ≥ 455 subjects.