Risk Preferences in the Small for a Large Population

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Main Questions

- What is the relative importance of
  - ⋆ risk aversion
  - ⋆ loss aversion
  - ⋆ preferences for the timing of uncertainty resolution
  - ⋆ error-proneness

  for behaviour in risky choice experiments?

- How important is heterogeneity in these parameters?

- How much of the heterogeneity can be attributed to observable variables?

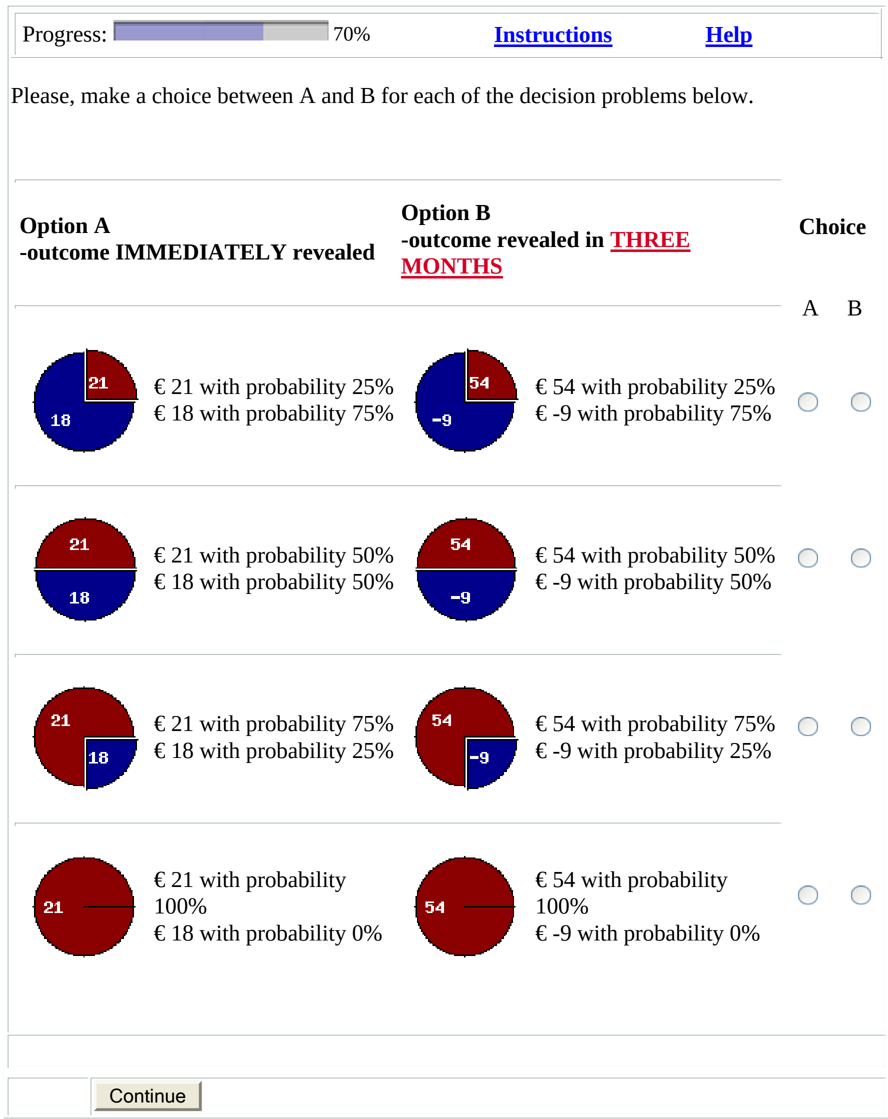
Outline

- Experimental setup and descriptives.
- A model of choice under risk.
- Econometric specification.
- Results.
- Summary & Conclusions.

Experimental Setup

- Subject pool: CentERpanel and Laboratory.
- Standard Multiple Price List Design.
- Modify it somewhat to lower cognitive load.

Screenshot of Lottery 5, First Screen



Payoffs from the Seven Lotteries

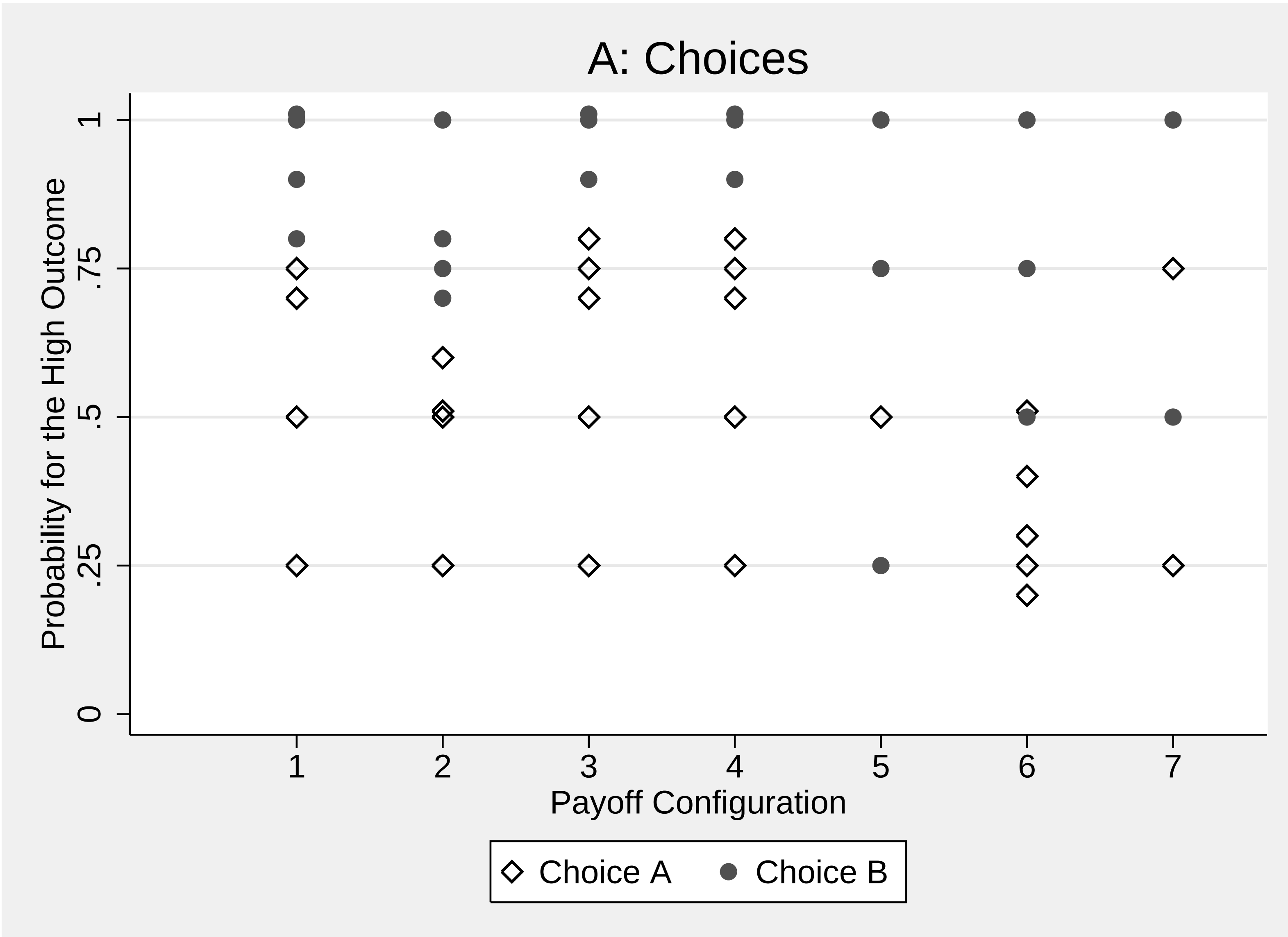
Payoff Configuration	Uncertainty Resolution, A	Payoff Low, A	Payoff High, A	Uncertainty Resolution, B	Payoff Low, B	Payoff High, B
1	early	27	33	early	0	69
2	early	39	48	early	9	87
3	early	12	15	early	-15	48
4	early	33	36	late	6	69
5	early	18	21	late	-9	54
6	early	24	27	early	-3	60
7	late	15	18	late	-12	51

Note: These values were shown in the high incentive and hypothetical treatments. For the low incentive treatment they were divided by three. The order was randomised.

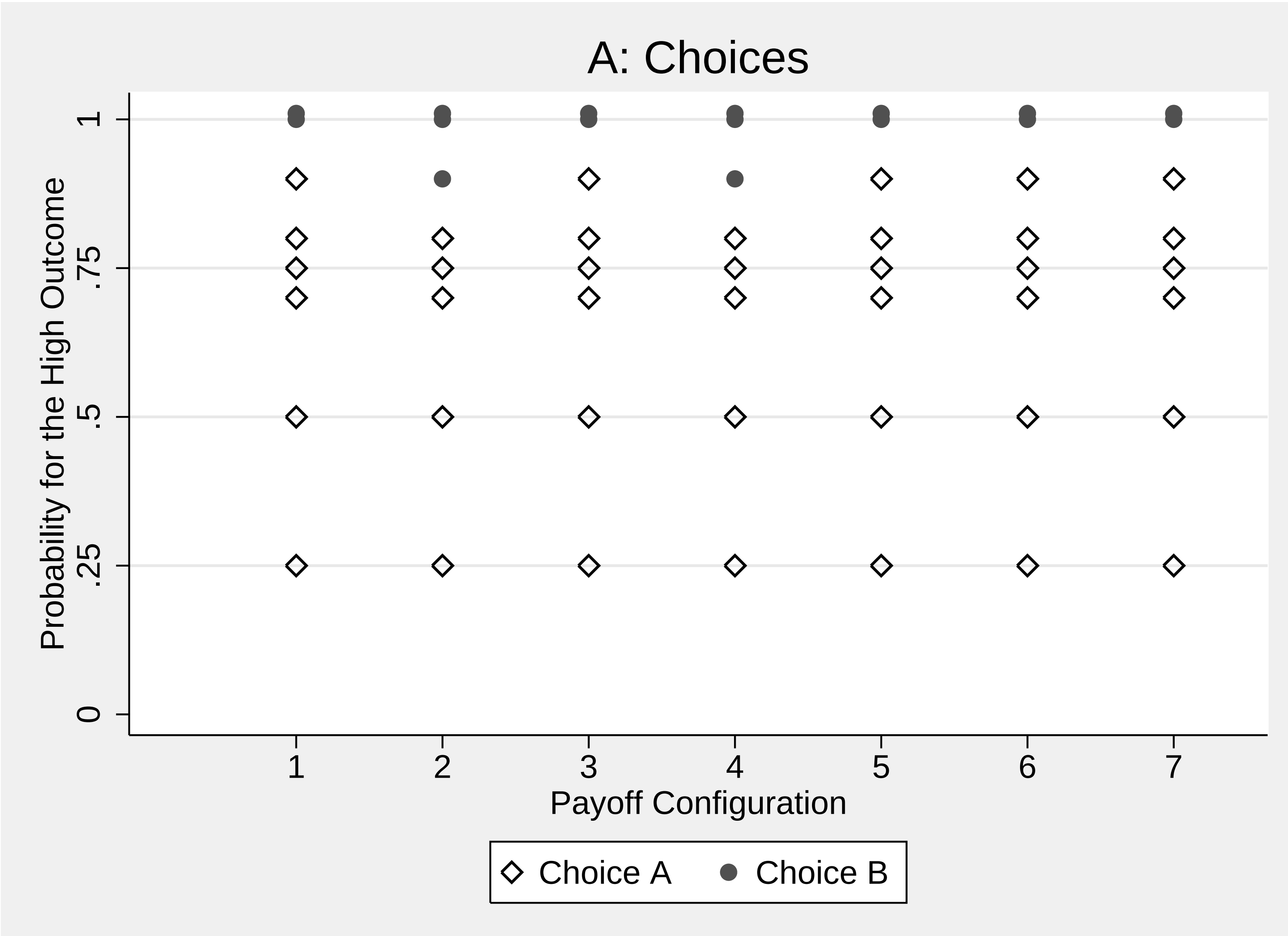
Structure of the Data

- We have $N = 1422$ (CentERpanel) and $N = 178$ (Lab).
- Unbalanced panel of binary decisions with $J \in \{28, 32, \ldots, 56\}$
- Core regressors: Constant, incentive treatments, covariance matrix of unobserved effects.
- (Demographic) controls: sex, age, education, household income, wealth, financial experience/knowledge, short / long completion time.

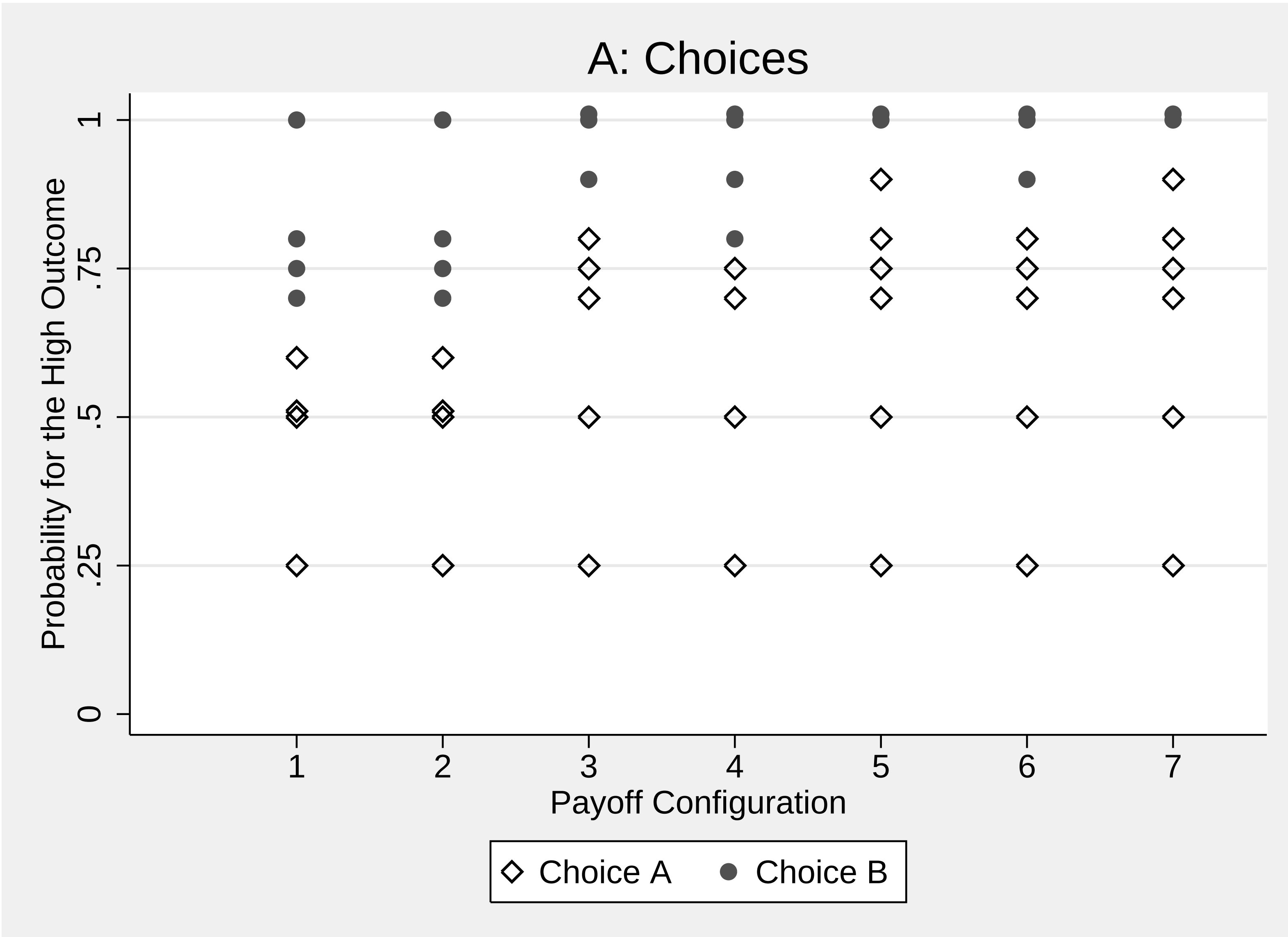
Descriptive Evidence: Choices of Individual 1



Descriptive Evidence: Choices of Individual 2

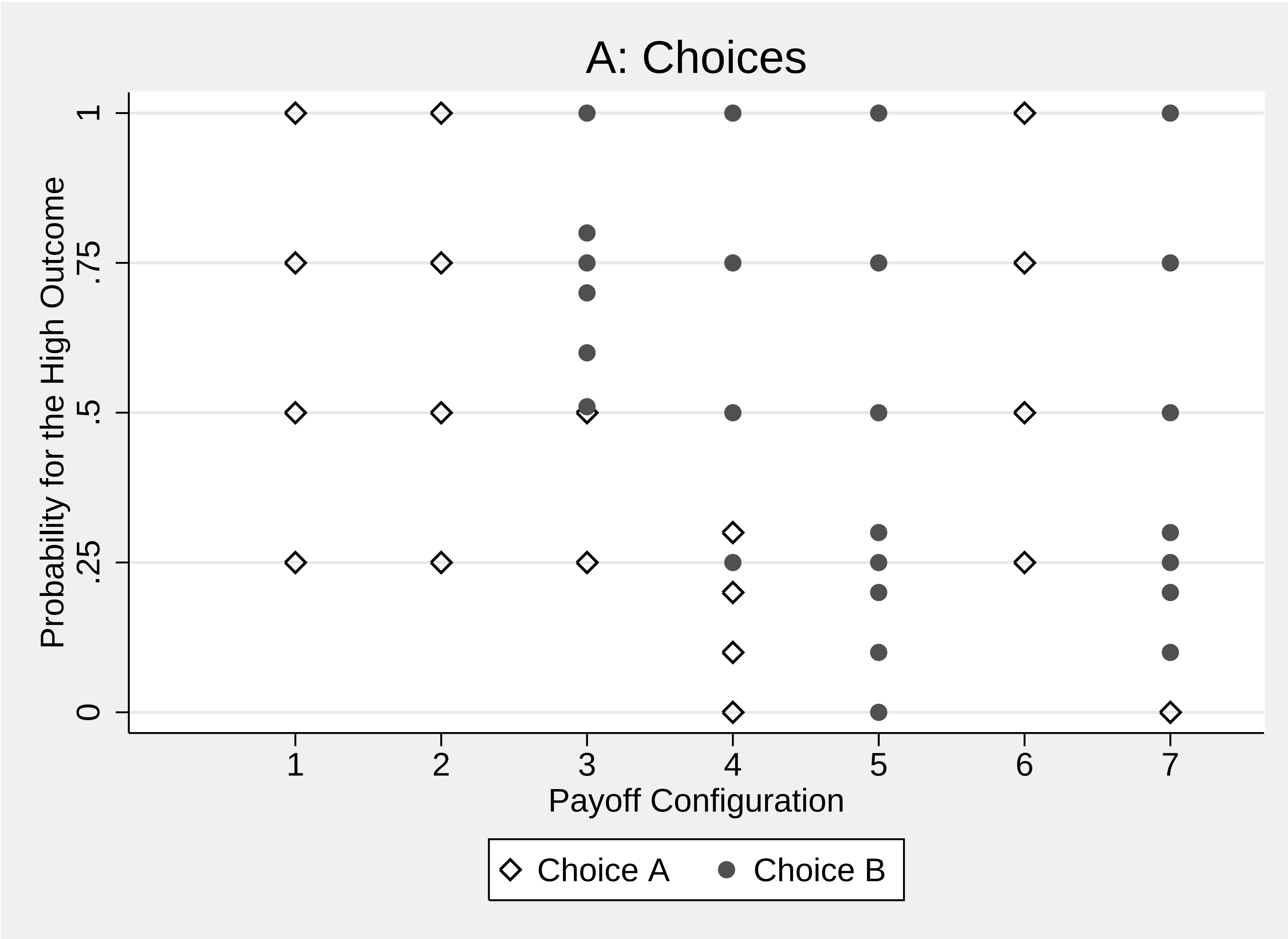


Descriptive Evidence: Choices of Individual 3



Descriptive Evidence: Choices of Individual 4

Descriptive Evidence: Choices of Individual 5



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Expected Utility of Income

- Start from a simple exponential utility model with loss aversion:

$$u(z,\gamma,\lambda) = \begin{cases} -\frac{1}{\gamma}e^{-\gamma z} & \text{for } z \geq 0 \\ \frac{\lambda-1}{\gamma} - \frac{\lambda}{\gamma}e^{-\gamma z} & \text{for } z < 0 \end{cases} \quad (1)$$

where $z \in \mathbb{R}$ denote lottery outcomes, $\gamma \in \mathbb{R}$ is the coefficient of absolute risk aversion, $\lambda \in \mathbb{R}_+$ is the loss aversion parameter

- Why not power utility? Problems around the origin, difficult to incorporate uncertainty resolution preferences with positive and negative payoffs. But some robustness checks in the paper (worse fit).

Uncertainty Resolution Preferences

- Kreps & Porteus (1978): Two periods, first one only serves to resolve uncertainty or not. The first period utility evaluation $V(\cdot)$ of a gamble π is given by:

$$V(\pi) = \begin{cases} \mathbb{E}[h(v(z,\cdot))] & \text{for early resolution} \\ h(\mathbb{E}[v(z,\cdot)]) & \text{for late resolution} \end{cases} \tag{2}$$

- $h(\cdot)$ convex (concave,linear) $\Leftrightarrow$ Early Resolution $\succ$ Late Res. $(\prec, \sim)$.

- For estimation reasons, want a one-parameter version of $h(\cdot)$.

- We use:

$$h(v(z,\cdot)) \quad = \quad -S(-S\,v(z,\cdot))^{\rho^{-S}} \tag{3}$$

with $\rho \in \mathbb{R}_+$ and S the following sign operator:

$$S \quad = \quad \begin{cases} \;\;1 & \text{for } \gamma \geq 0 \\ -1 & \text{for } \gamma < 0. \end{cases}$$

- For $\rho > 1$, early resolution is preferred to late resolution, indifference is obtained for $\rho = 1$, and late resolution is preferred for $\rho < 1$.

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- The second period utility function is a slightly modified version of equation (1):

$$v(z,\gamma,\lambda,\rho) \;=\; \begin{cases} \max\{-\frac{\lambda}{\gamma},0\} - \frac{1}{\gamma}e^{-\gamma\rho^{S}z} & \text{for } z \geq 0 \\ \max\{-\frac{\lambda}{\gamma},0\} + \frac{\lambda-1}{\gamma} - \frac{\lambda}{\gamma}e^{-\gamma\rho^{S}z} & \text{for } z < 0 \end{cases} \qquad (4)$$

Econometric Specification: Random Coefficients Model

- Binary choice between lotteries π^A and π^B. Take the difference in certainty equivalents between the lotteries for choice j by individual i:

$$\Delta \mathsf{CE}_{ij} = \mathsf{CE}(\pi^B_{ij}, \gamma_i, \lambda_i, \rho_i) - \mathsf{CE}(\pi^A_{ij}, \gamma_i, \lambda_i, \rho_i)$$

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- The actual choice is then: $Y_{ij} = \mathbb{I}\{\Delta\mathsf{CE}_{ij} + \tau\varepsilon_{ij} > 0\}; \quad \varepsilon_{ij} \sim \Lambda$

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- Likelihood of each observation:

$$l_{ij} = (1-\omega_i)\,\Lambda\left((2Y_{ij}-1)\frac{1}{\tau}\Delta\mathsf{CE}_{ij}\left(\pi^A_{ij}, \pi^B_{ij}, \gamma_i, \lambda_i, \rho_i\right)\right) + \frac{\omega_i}{2},$$

- Two sources of error: Monetary cost of "wrong" choice τ, probability for random behaviour ω_i.

- Write:
$$\eta_i = g_\eta(X_i^\eta \beta^\eta + \xi_i^\eta), \quad \eta_i = \{\gamma_i, \lambda_i, \rho_i, \omega_i\} \tag{5}$$

  where the $g_\eta(\cdot)$ serve to impose the theoretical parameter restrictions.

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  where the $g_\eta(\cdot)$ serve to impose the theoretical parameter restrictions.

- Assume joint normality of:

$$\begin{pmatrix} g_\gamma^{-1}(\gamma_i) \\ g_\lambda^{-1}(\lambda_i) \\ g_\rho^{-1}(\rho_i) \\ g_\omega^{-1}(\omega_i) \end{pmatrix} \sim N\left(\begin{pmatrix} X_i^\gamma \beta^\gamma \\ X_i^\lambda \beta^\lambda \\ X_i^\rho \beta^\rho \\ X_i^\omega \beta^\omega \end{pmatrix}, \ \Sigma'\Sigma \right), \tag{6}$$

- Write:
$$\eta_i \quad = \quad g_\eta(X_i^\eta \beta^\eta + \xi_i^\eta), \quad \eta_i = \{\gamma_i, \lambda_i, \rho_i, \omega_i\} \tag{5}$$
where the $g_\eta(\cdot)$ serve to impose the theoretical parameter restrictions.

- Assume joint normality of:
$$\begin{pmatrix} g_\gamma^{-1}(\gamma_i) \\ g_\lambda^{-1}(\lambda_i) \\ g_\rho^{-1}(\rho_i) \\ g_\omega^{-1}(\omega_i) \end{pmatrix} \sim N\left(\begin{pmatrix} X_i^\gamma \beta^\gamma \\ X_i^\lambda \beta^\lambda \\ X_i^\rho \beta^\rho \\ X_i^\omega \beta^\omega \end{pmatrix}, \; \Sigma'\Sigma \right), \tag{6}$$

- Group the 4 unobserved components in ξ_i, define $\xi^* = (\Sigma')^{-1}\xi$ and get the individual likelihood:
$$l_i \quad = \quad \int_{\mathbb{R}^4} \left[\prod_{j=1}^{J_i} l_{ij} \left(\pi_{ij}^A, \pi_{ij}^B, Y_{ij}, \tau, g(X_i\beta + \xi_i^*) \right) \right] \phi(\xi^*) d\xi^* \tag{7}$$

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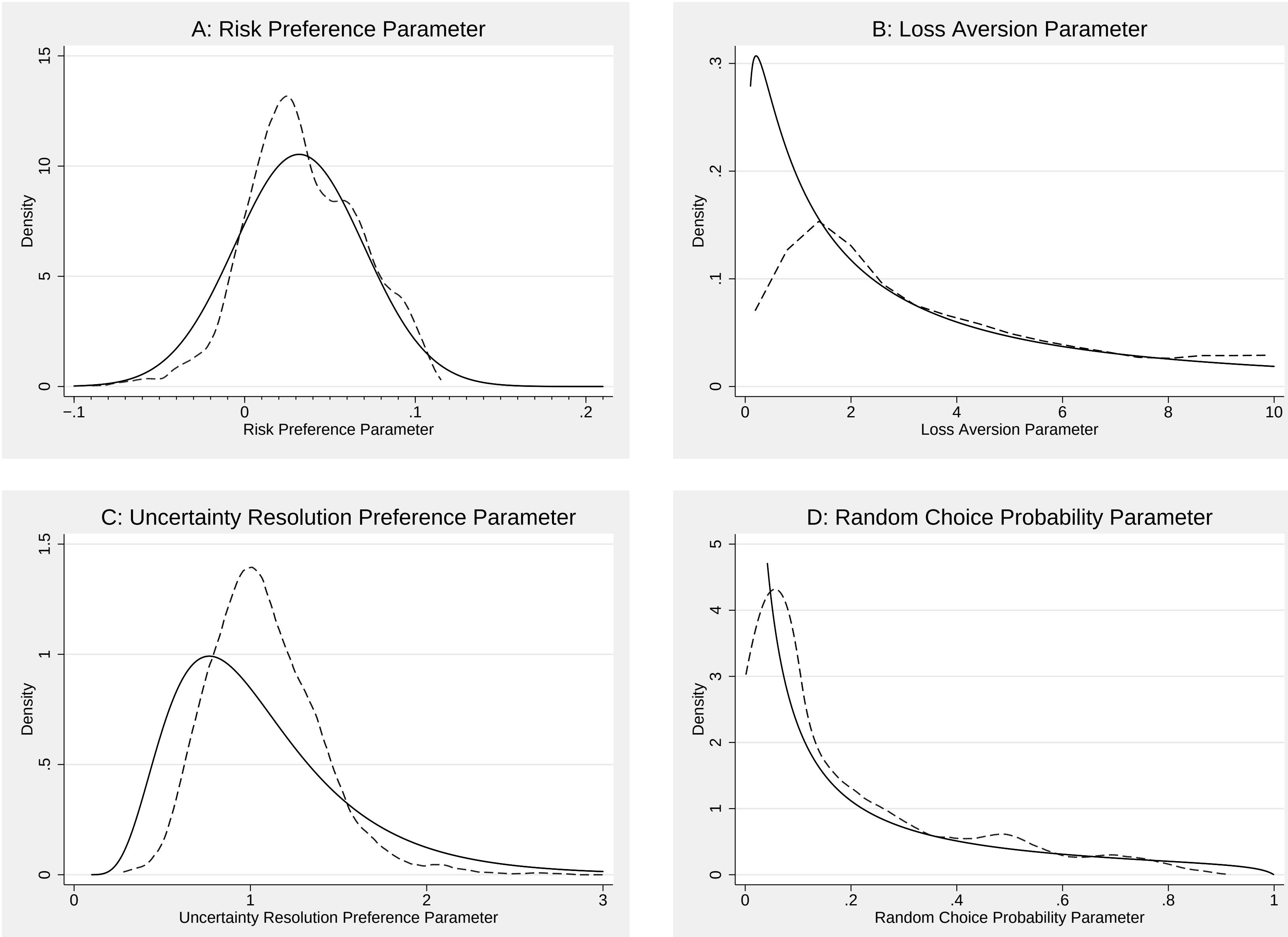
Observable Correlates: Results in a Nutshell

- Median utility function concave ($\gamma \approx .032$), has a kink at zero ($\lambda \approx 2.4$), no KP effects ($\rho \approx 1$), random choice propensity high ($\omega \approx 8.3\%$).
- Few important differences between high incentive and hypothetical treatment, utility curvature more pronounced in the low incentive treatment.
- Women: more risk averse and loss averse, more inconsistencies.
- Positive age gradient of risk aversion and error frequency. Loss aversion peaks at ages 35-44 and decreases thereafter.
- Higher educated persons: less risk averse, substantially fewer mistakes.
- Little effects of income and wealth – but errors decrease in wealth.
- No significant associations for uncertainty resolution preferences.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Risk Preference Parameter
B: Loss Aversion Parameter
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Loss Aversion Parameter
C: Uncertainty Resolution Preference Parameter
Density
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Uncertainty Resolution Preference Parameter
D: Random Choice Probability Parameter
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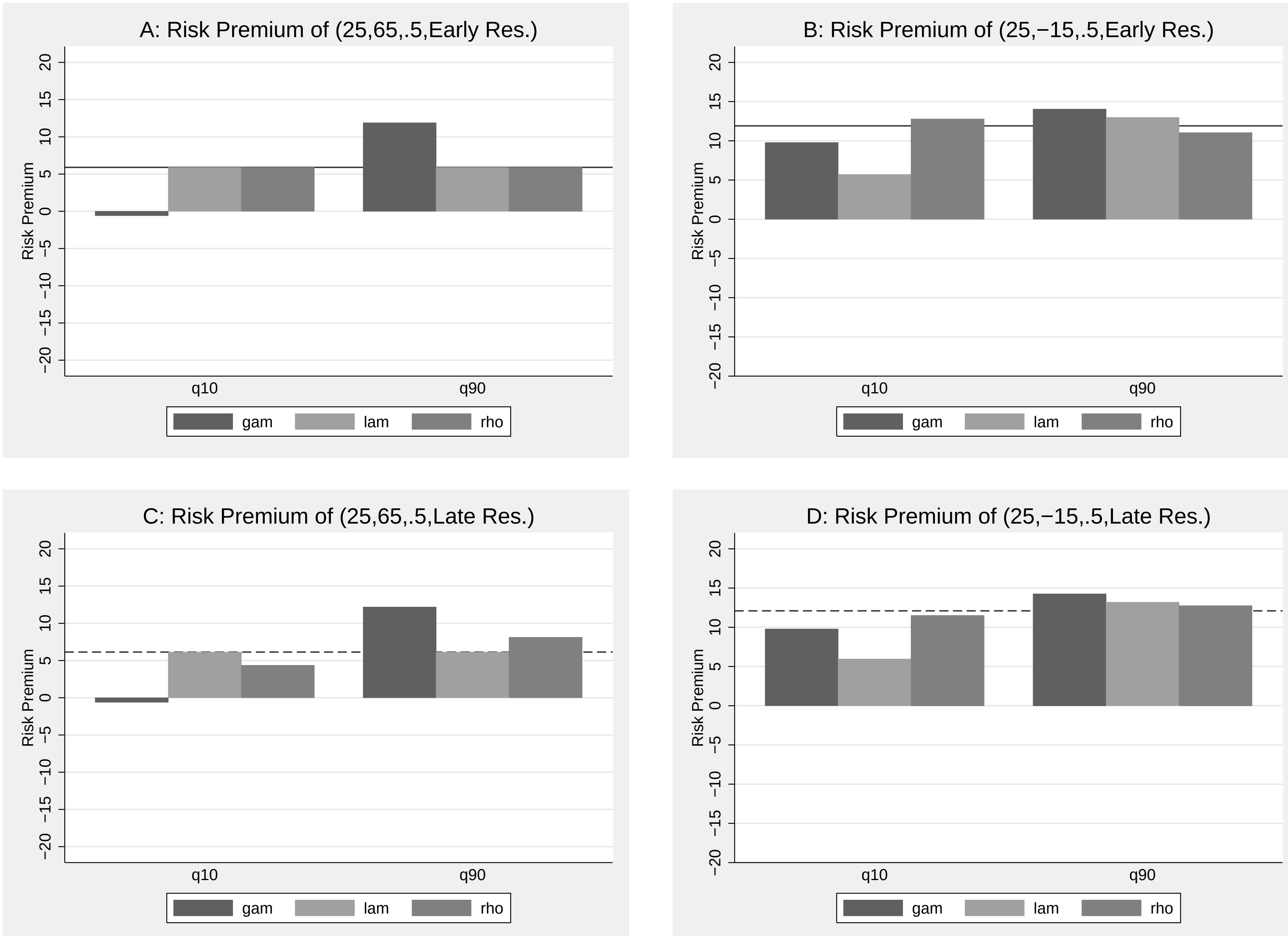
Random Choice Probability Parameter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B: Risk Premium of (25,−15,.5,Early Res.)
C: Risk Premium of (25,65,.5,Late Res.)
D: Risk Premium of (25,−15,.5,Late Res.)
Risk Premium
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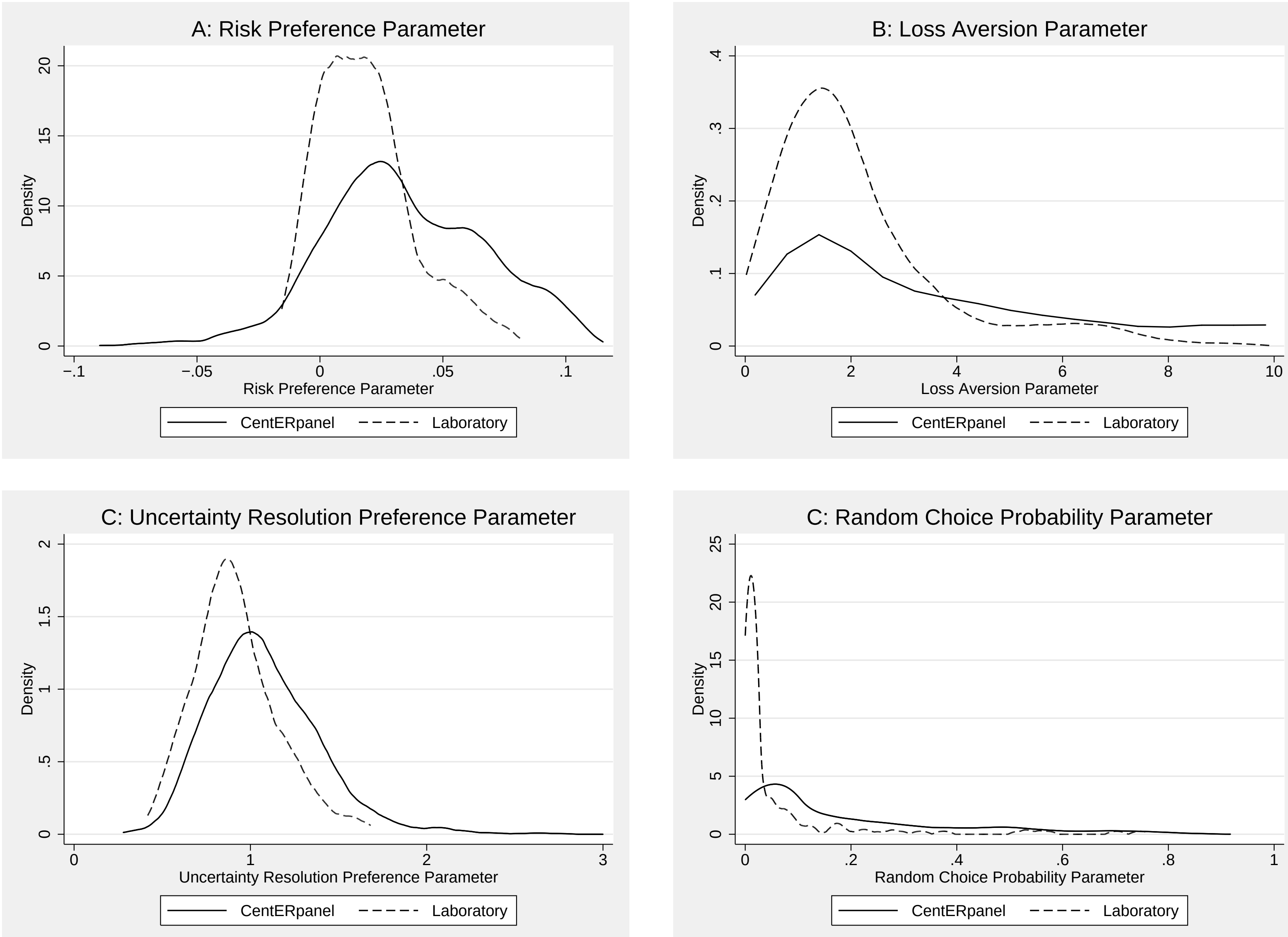
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Risk Preference Parameter
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Laboratory
B: Loss Aversion Parameter
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Loss Aversion Parameter
CentERpanel
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C: Uncertainty Resolution Preference Parameter
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Uncertainty Resolution Preference Parameter
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C: Random Choice Probability Parameter
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Random Choice Probability Parameter
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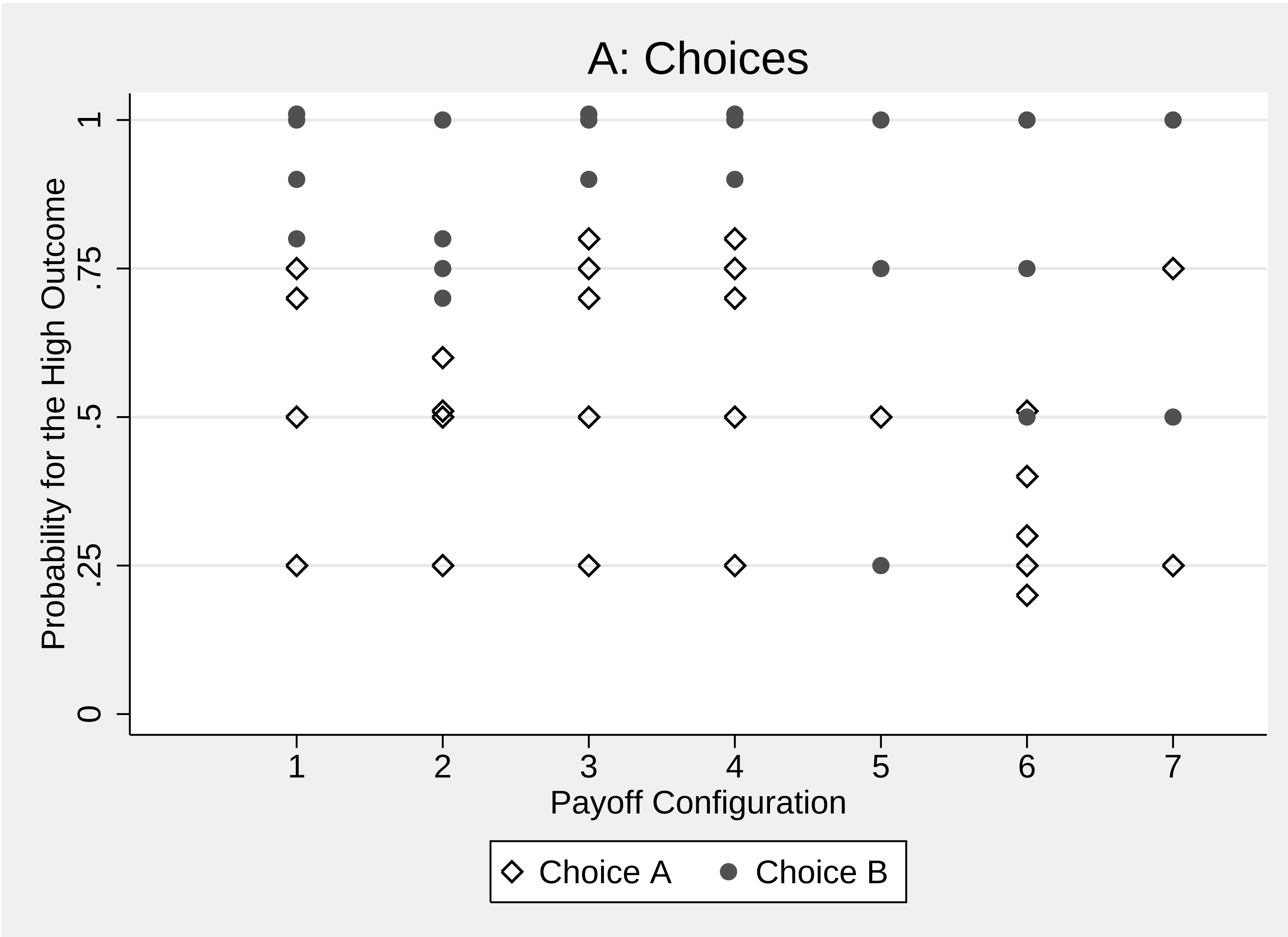
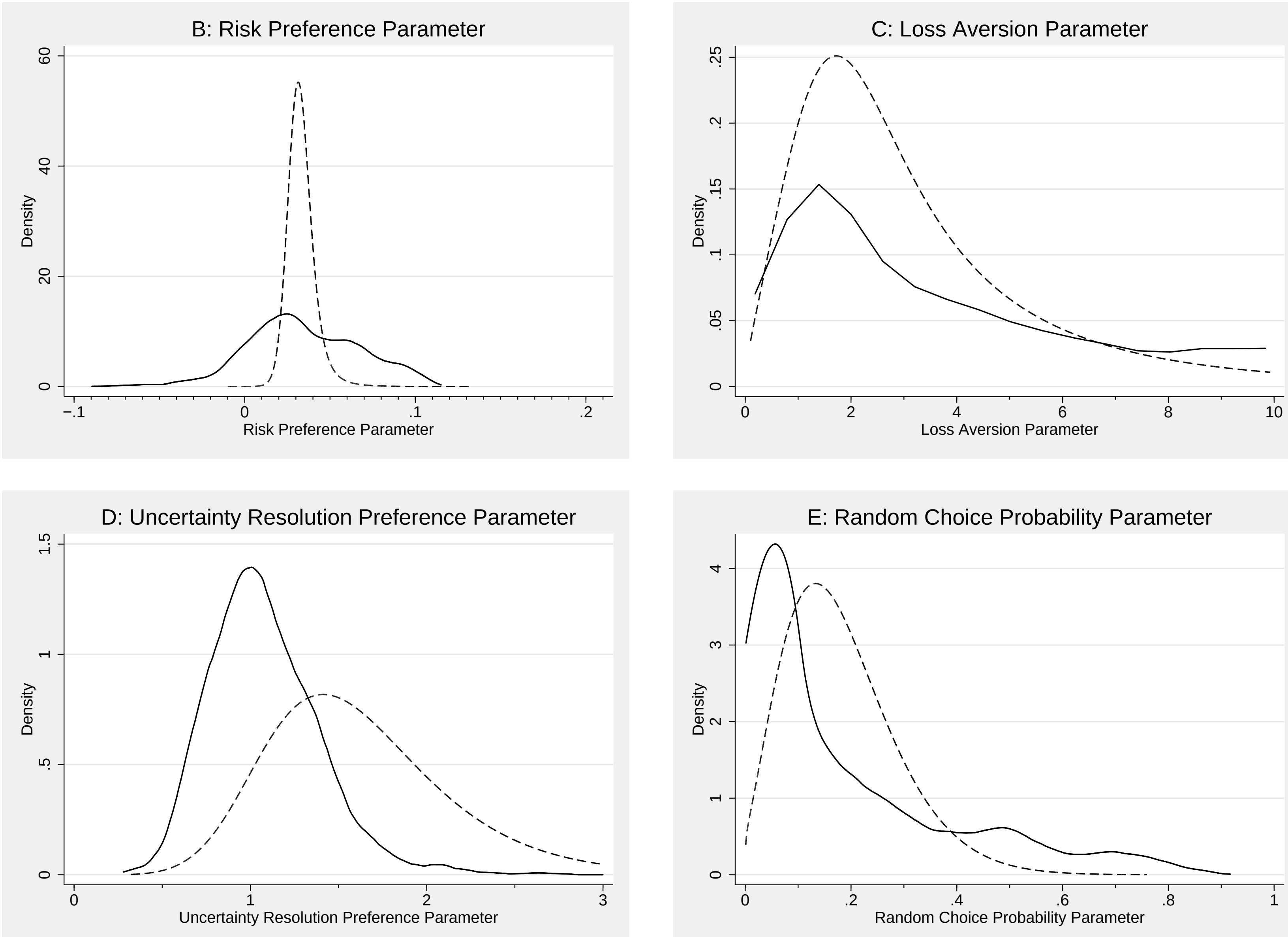
Laboratory

Descriptive Evidence: Choices of Individual 1

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Risk Preference Parameter
C: Loss Aversion Parameter
Density
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Loss Aversion Parameter
D: Uncertainty Resolution Preference Parameter
Density
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Uncertainty Resolution Preference Parameter
E: Random Choice Probability Parameter
Density
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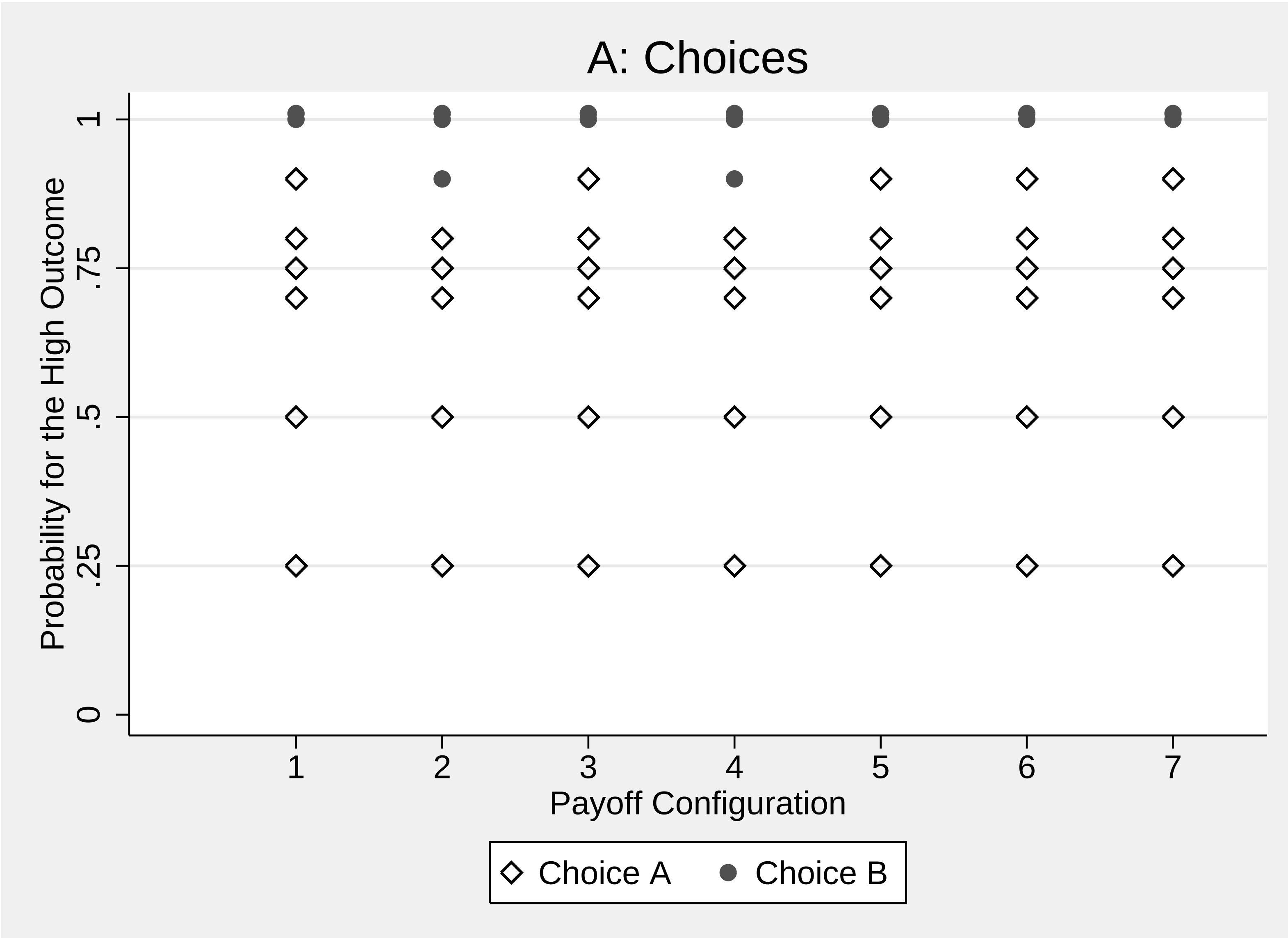
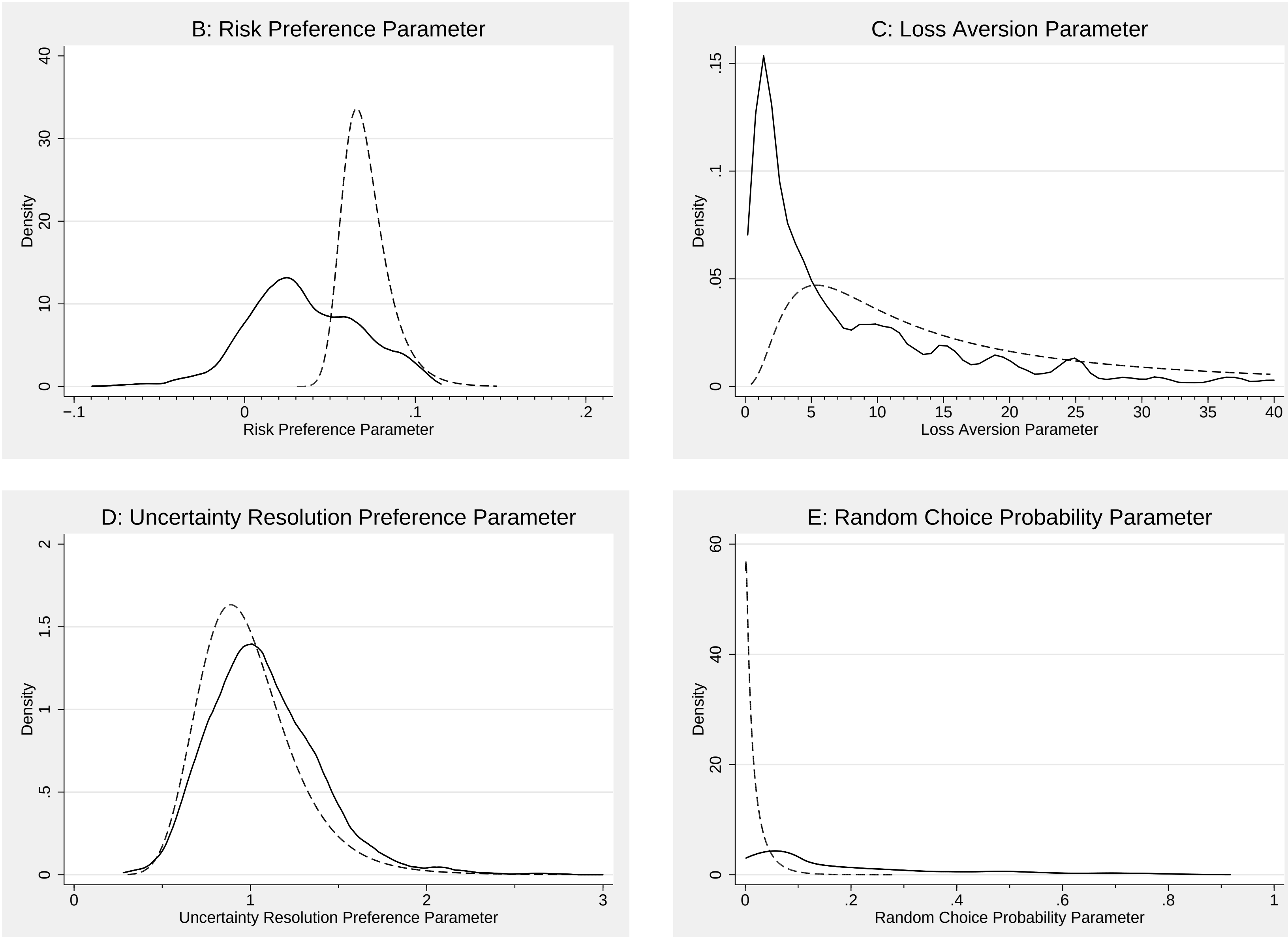
Random Choice Probability Parameter

Descriptive Evidence: Choices of Individual 2

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Risk Preference Parameter
C: Loss Aversion Parameter
Density
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10
15
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25
30
35
40
Loss Aversion Parameter
D: Uncertainty Resolution Preference Parameter
Density
0
.5
1
1.5
2
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3
Uncertainty Resolution Preference Parameter
E: Random Choice Probability Parameter
Density
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20
40
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.2
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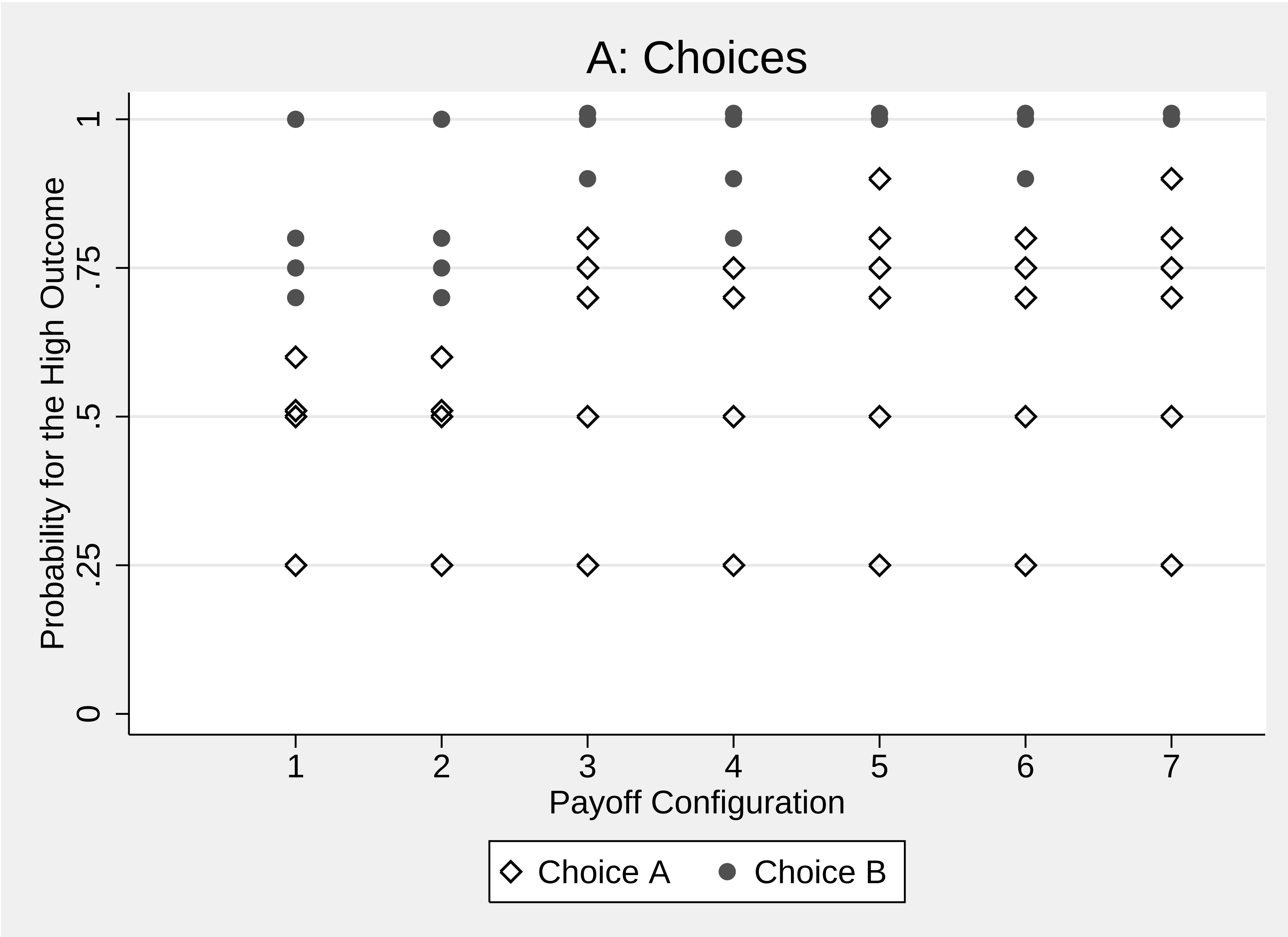
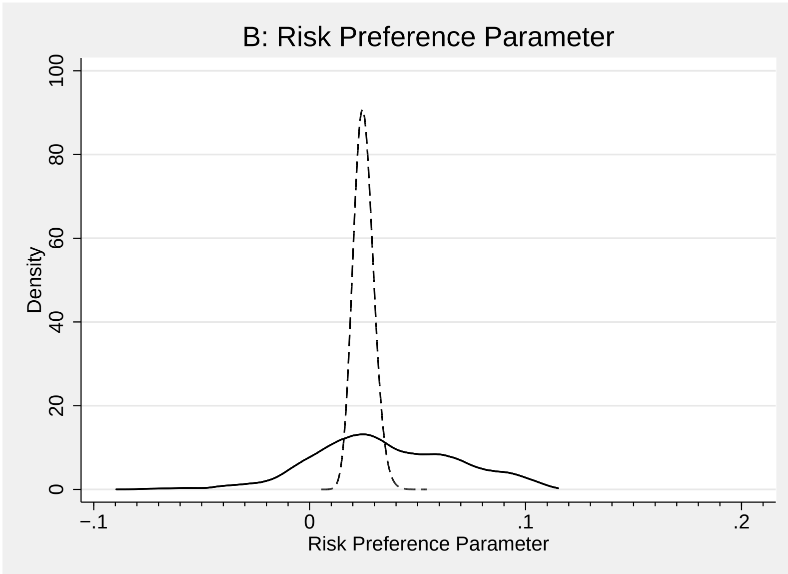
Random Choice Probability Parameter

Descriptive Evidence: Choices of Individual 3

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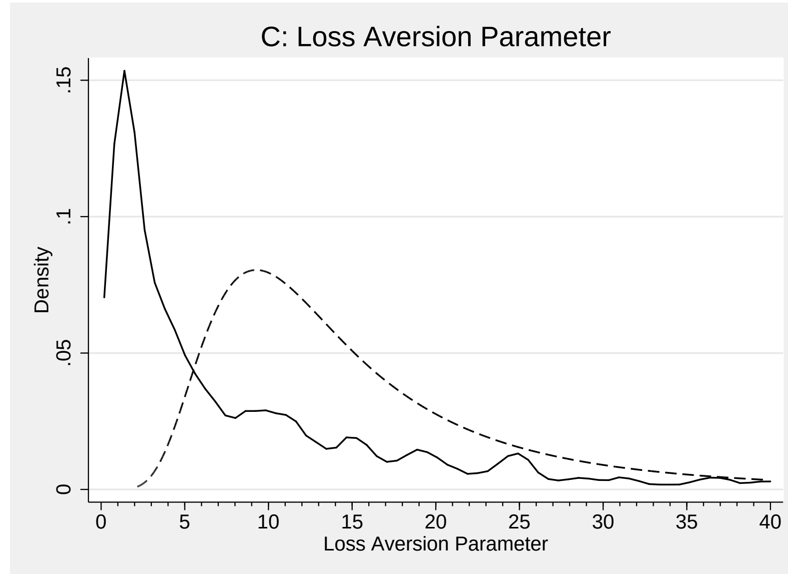
Risk Preference Parameter


C: Loss Aversion Parameter
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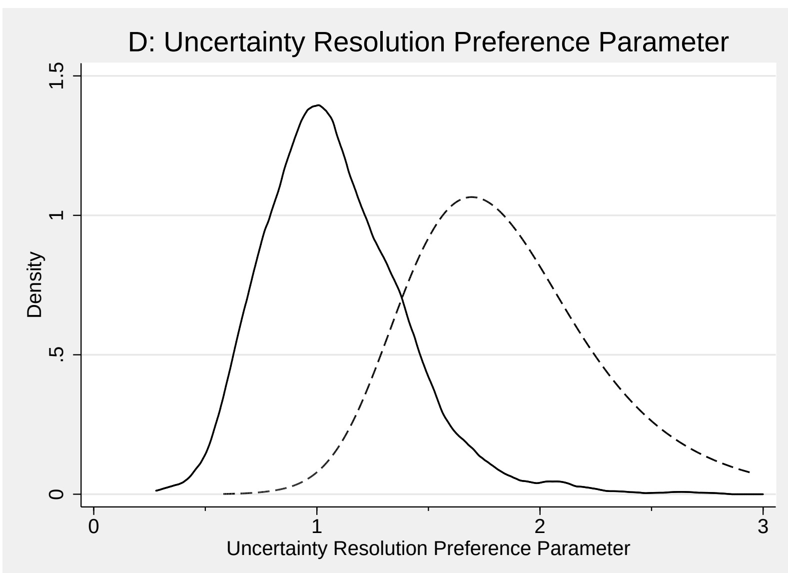
Loss Aversion Parameter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Density
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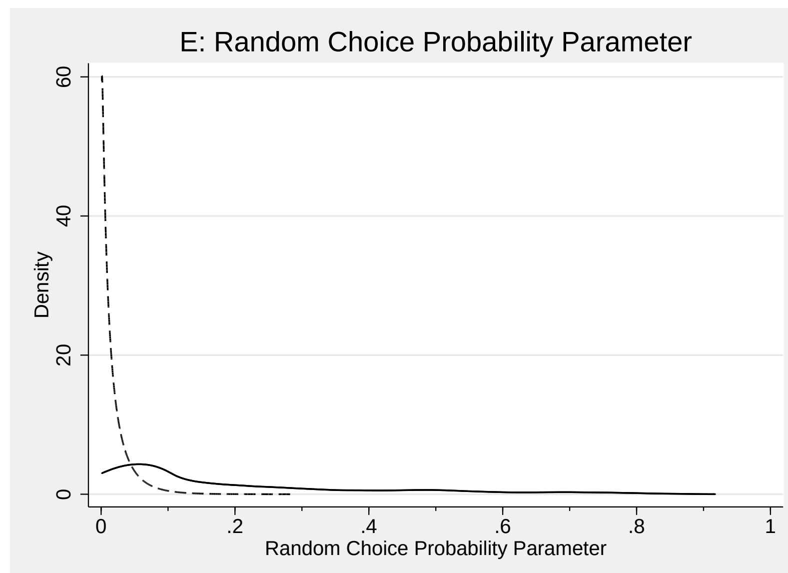
Uncertainty Resolution Preference Parameter


E: Random Choice Probability Parameter
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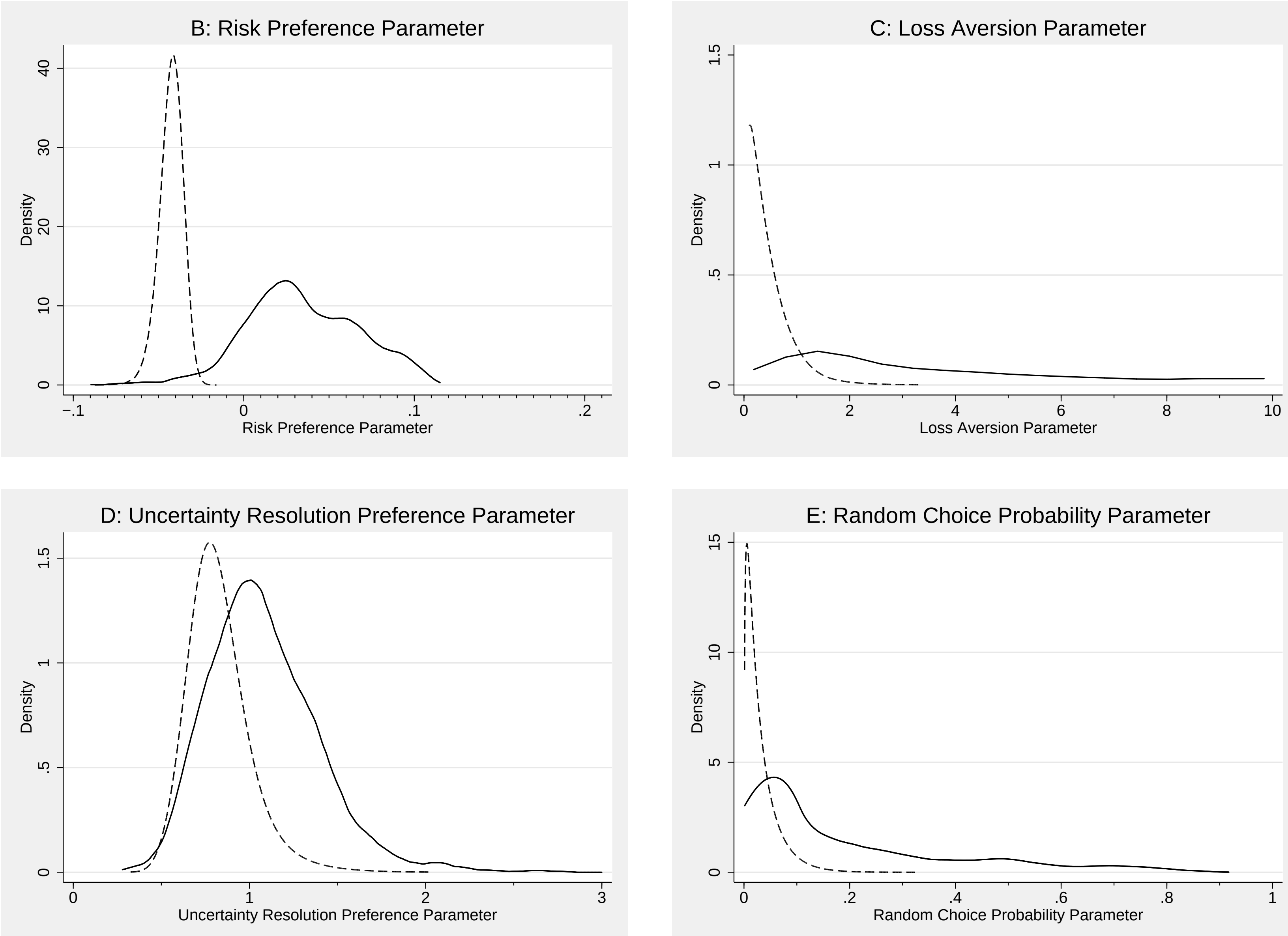
Random Choice Probability Parameter

Descriptive Evidence: Choices of Individual 4


B: Risk Preference Parameter
Density
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Risk Preference Parameter
C: Loss Aversion Parameter
Density
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Loss Aversion Parameter
D: Uncertainty Resolution Preference Parameter
Density
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Uncertainty Resolution Preference Parameter
E: Random Choice Probability Parameter
Density
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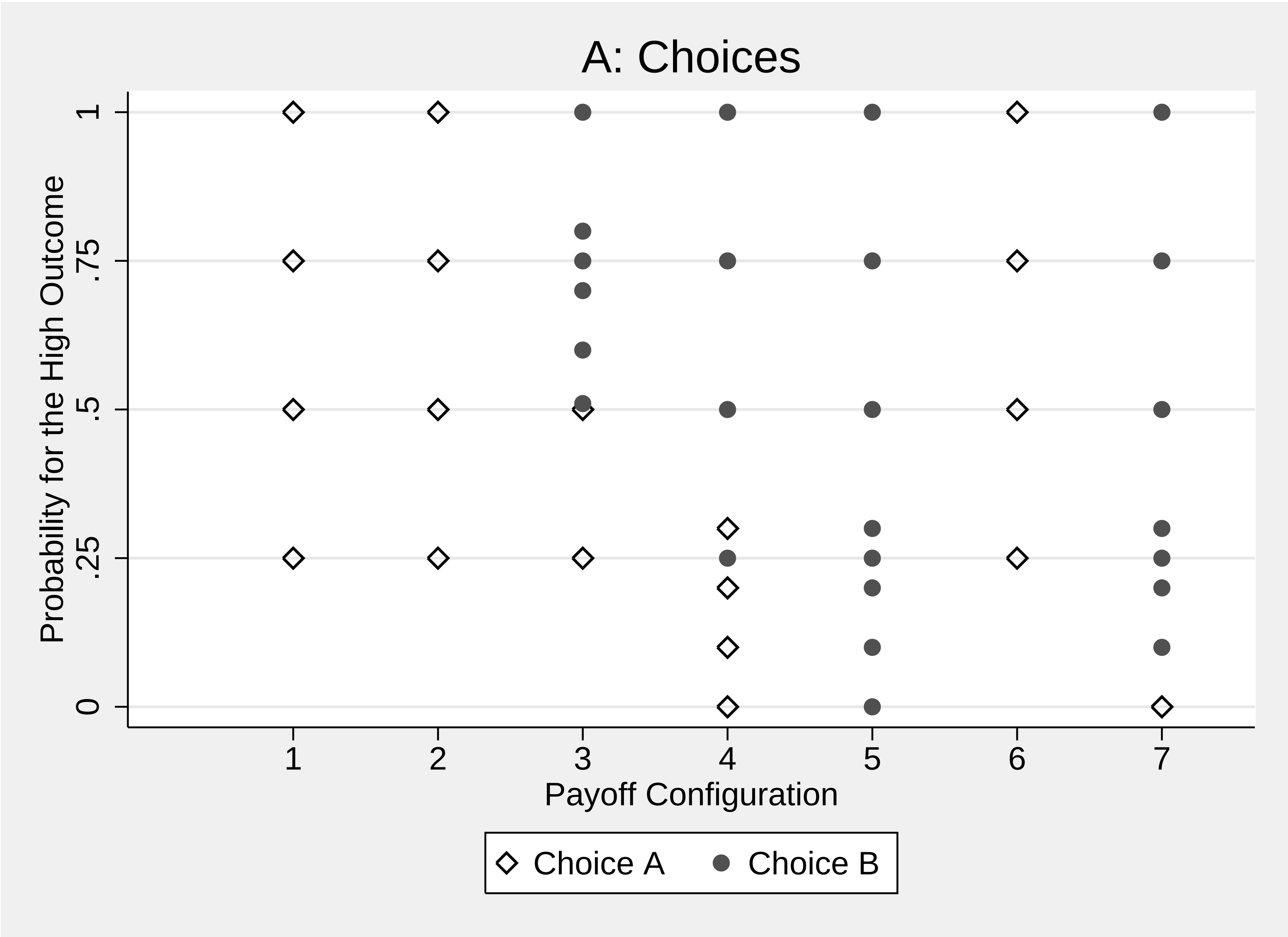
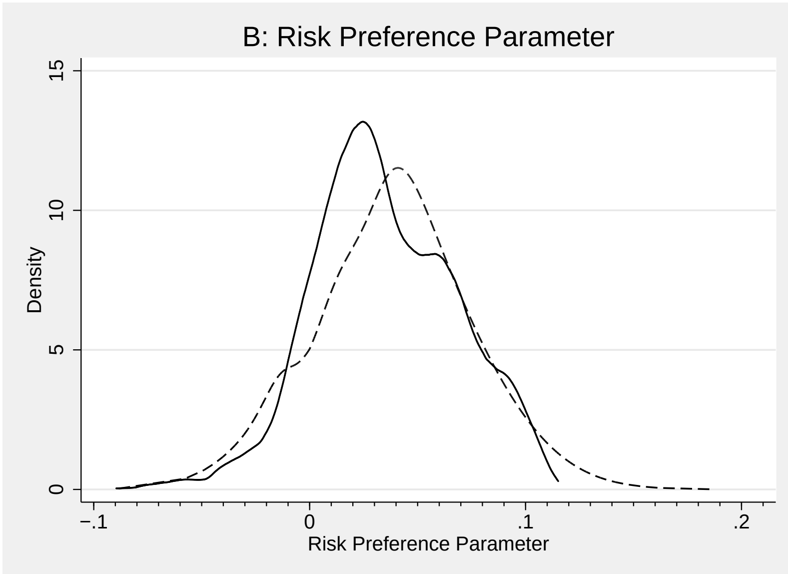
Random Choice Probability Parameter

Descriptive Evidence: Choices of Individual 5

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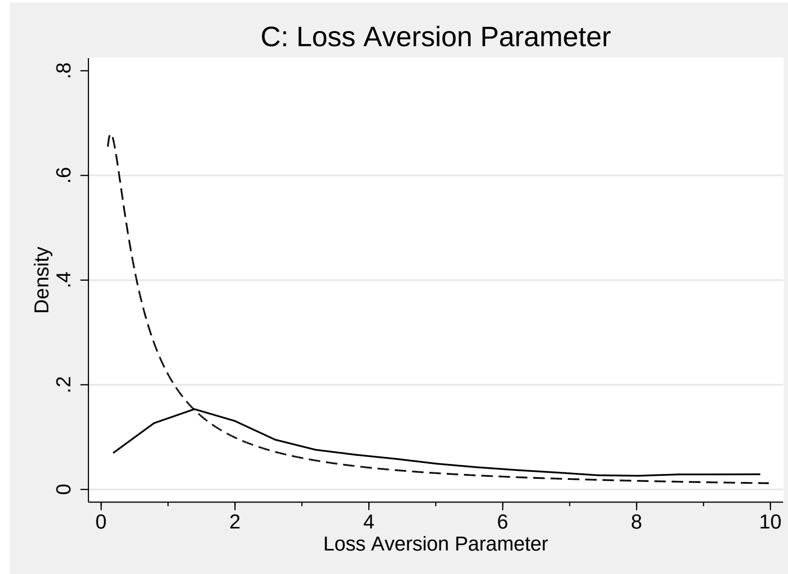
Risk Preference Parameter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Density
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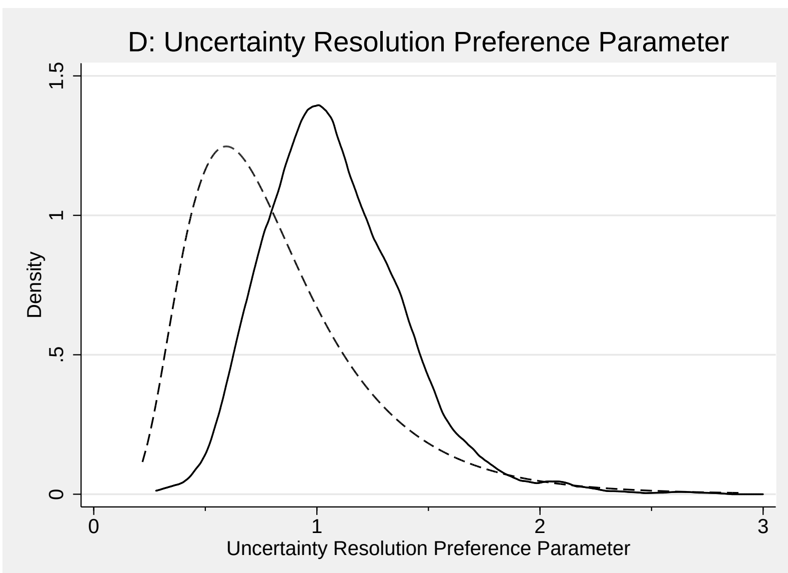
Loss Aversion Parameter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Density
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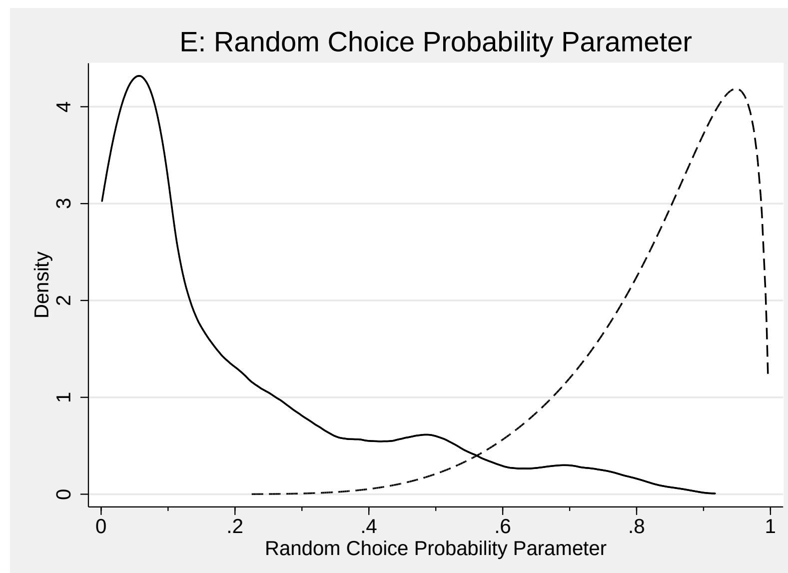
Uncertainty Resolution Preference Parameter


E: Random Choice Probability Parameter
Density
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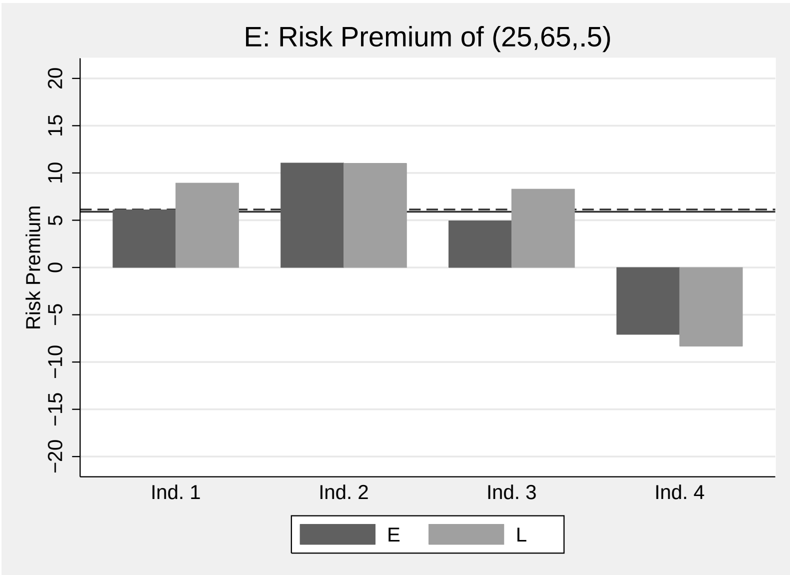
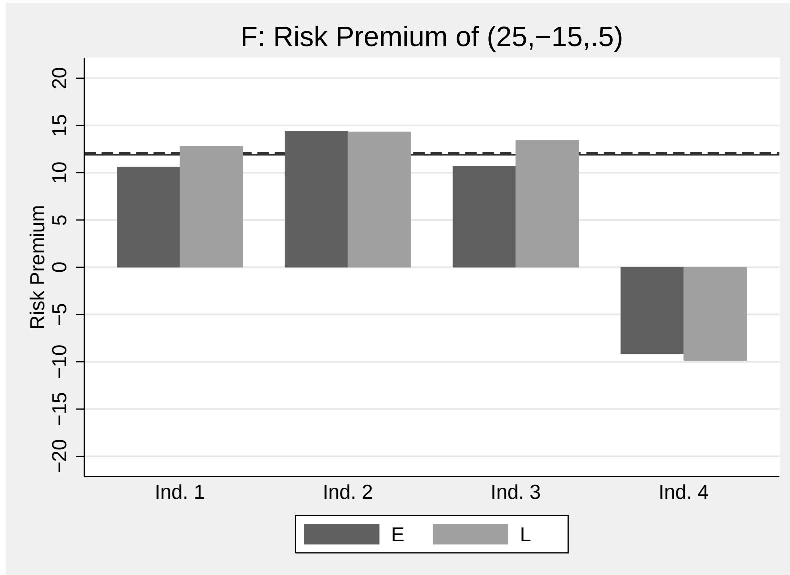
Random Choice Probability Parameter

Risk Premia for Implied Conditional Average Parameters





Summary & Conclusions

- Individual heterogeneity in risk aversion and loss aversion plays a substantial role in decision-making under risk. This is less the case for uncertainty resolution preferences.

- In terms of design, experiments aimed at "eliciting" parameters should aim to generate overidentifying information and seek to allow subjects to make mistakes.

- This is all the more important in a non-student population.

- Idiosyncratic heterogeneity in preferences and errors appears to be much more important than associations with observable characteristics.

Appendix: Alternative Utility Specifications

- Simple CARA

$$u(z,\gamma) \quad = \quad -\frac{1}{\gamma}e^{-\gamma z}$$

- CARA including loss aversion

$$u(z,\gamma,\lambda) \quad = \quad \begin{cases} -\frac{1}{\gamma}e^{-\gamma z} & \text{for } z \geq 0 \\ \frac{\lambda-1}{\gamma} - \frac{\lambda}{\gamma}e^{-\gamma z} & \text{for } z < 0 \end{cases}$$

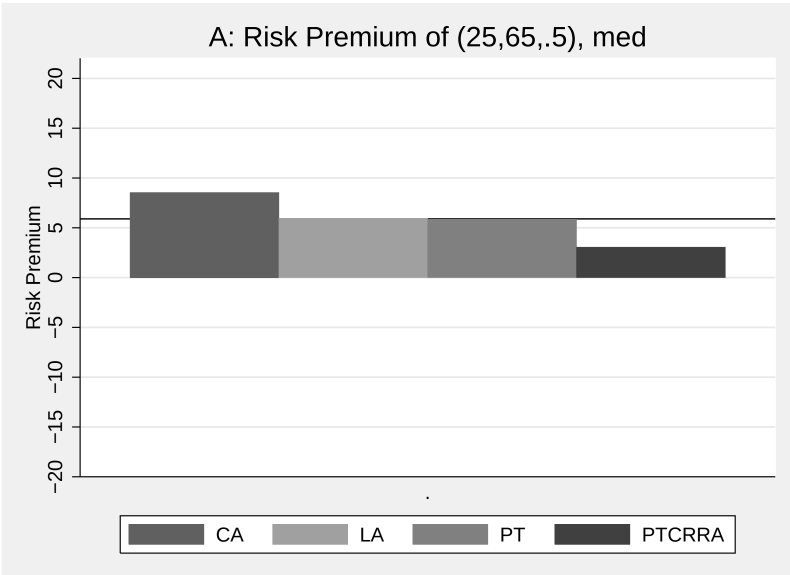
- CARA, Prospect-Theory Type

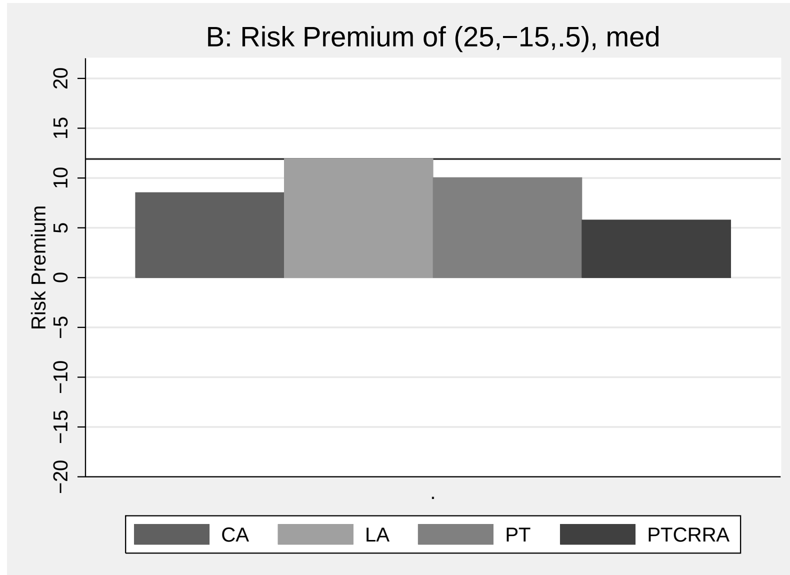
$$u(z,\gamma,\lambda) \quad = \quad \begin{cases} \frac{1}{\gamma} - \frac{1}{\gamma}e^{-\gamma z} & \text{for } z \geq 0 \\ \frac{\lambda}{\gamma} - \frac{\lambda}{\gamma}e^{-\gamma z} & \text{for } z < 0 \wedge \gamma < 0 \\ -\frac{\lambda}{\gamma} + \frac{\lambda}{\gamma}e^{\gamma z} & \text{for } z < 0 \wedge \gamma > 0 \end{cases}$$

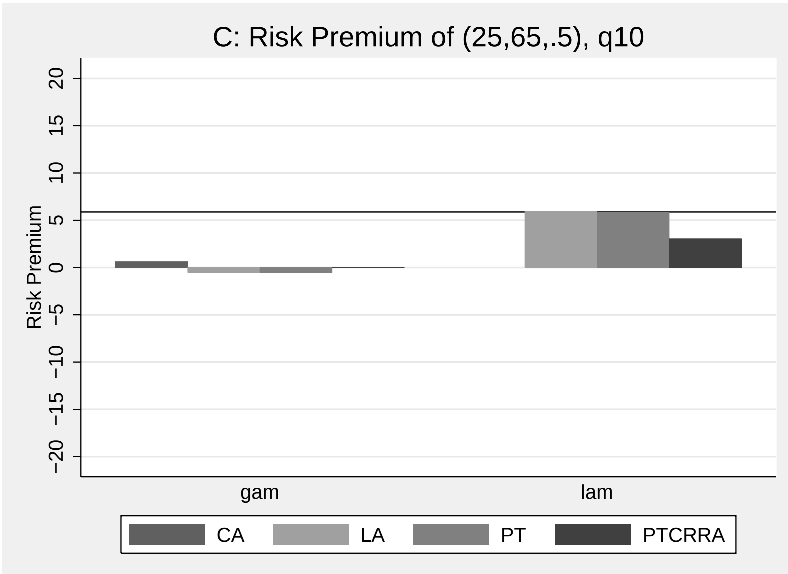
- CRRA, Prospect-Theory Type

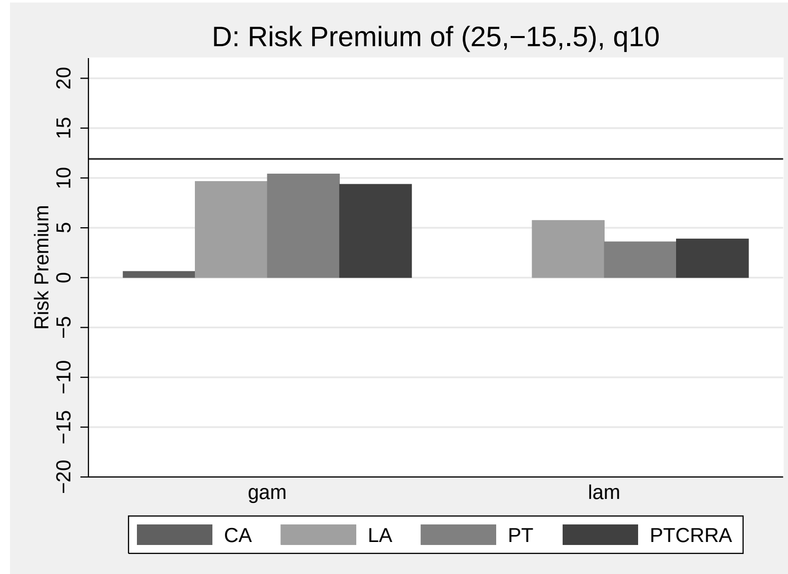
$$u(z,\gamma,\lambda) \quad = \quad \begin{cases} z^{1-\gamma} & \text{for } z \geq 0 \\ -\lambda \cdot (-z)^{1+\gamma} & \text{for } z < 0 \wedge \gamma < 0 \\ -\lambda \cdot (-z)^{1-\gamma} & \text{for } z < 0 \wedge \gamma > 0 \end{cases}$$

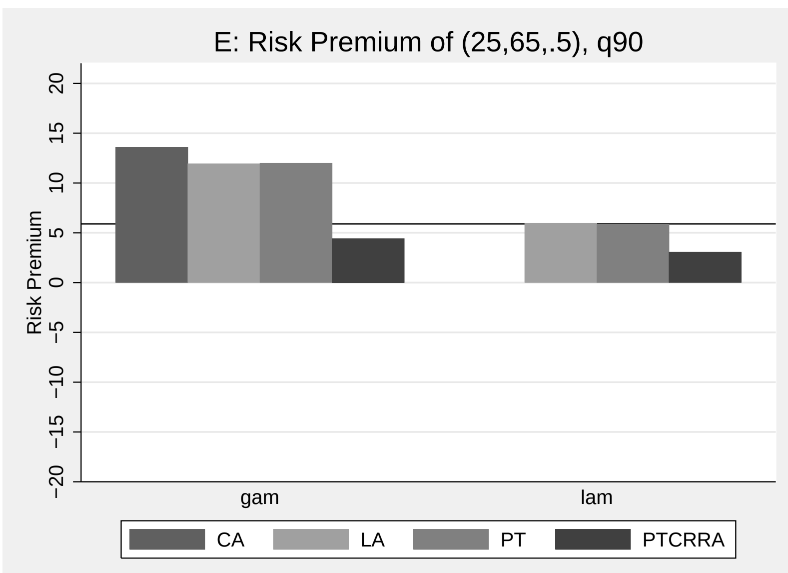
Risk Premia for Median Parameters, Alternative Models






C: Risk Premium of (25,65,.5), q10
Risk Premium
−20 −15 −10 −5 0 5 10 15 20
gam
lam
CA
LA
PT
PTCRRA


D: Risk Premium of (25,−15,.5), q10
Risk Premium
−20 −15 −10 −5 0 5 10 15 20
gam
lam
CA
LA
PT
PTCRRA


E: Risk Premium of (25,65,.5), q90
Risk Premium
−20 −15 −10 −5 0 5 10 15 20
gam
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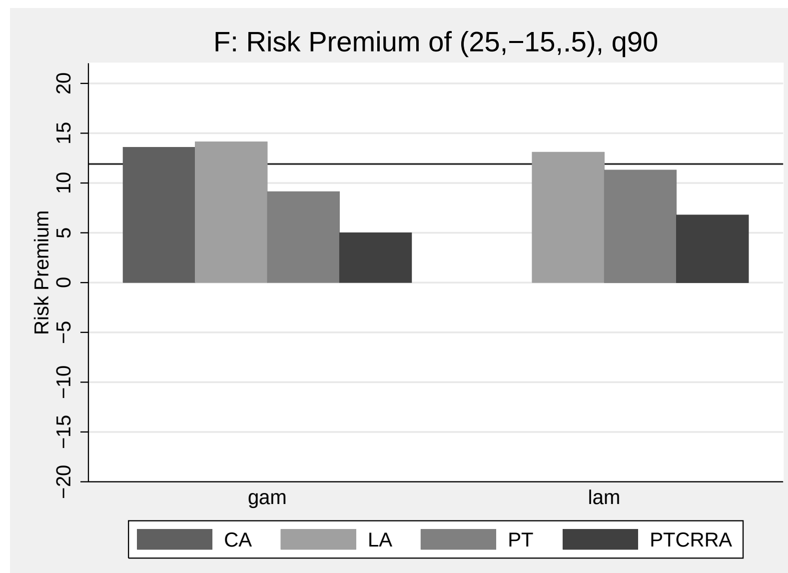
PTCRRA


F: Risk Premium of (25,−15,.5), q90
Risk Premium
−20 −15 −10 −5 0 5 10 15 20
gam
lam
CA
LA
PT
PTCRRA