Rationality-Based Preference Aggregation

Syngjoo Choi
(SNU)

Byunghun Hahn
(SNU)

Booyuel Kim
(SNU)

Minseon Park
(Michigan)

Yoonsoo Park
(SMU)

Euncheol Shin
(KAIST)

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Introduction

- Long-standing interests in group decision making (DM)
  - Households (e.g., McEloy and Horney, 1981; Chiappori, 1992; Lundberg and Pollak, 1996);
  - Committees (e.g,, Austen-Smith and Banks, 1996; Feddersen and Pesendorfer, 1998))
  - Social choice theory (e.g., Arrow, 1951; Sen, 1970), etc.
- Individual rationality is a foundational assumption in understanding group decision making.
- Growing evidence on the role of individual DM ability, proxied by education, cognitive ability, or financial literacy, in household outcomes
  - e.g., Behrman et al. (2012), Yilmazer et al. (2015), Guiso et al. (2023), Gu et al. (2023)

In This Paper

- We argue that lack of individual rationality is an important source of (1) the quality of and (2) individual (bargaining) power on group decision-making.
- Conduct large-scale panel experiments over two periods with a four-month interval
- Propose a nonparametric, revealed preference measure of individual power on group decision making
- Make a causal inference on the effect of individual rationality on group outcomes.

Sampling

- 1,573 students from 12 middle schools in South Korea in the baseline study (in August); 1,468 revisited in the endline study (in December)

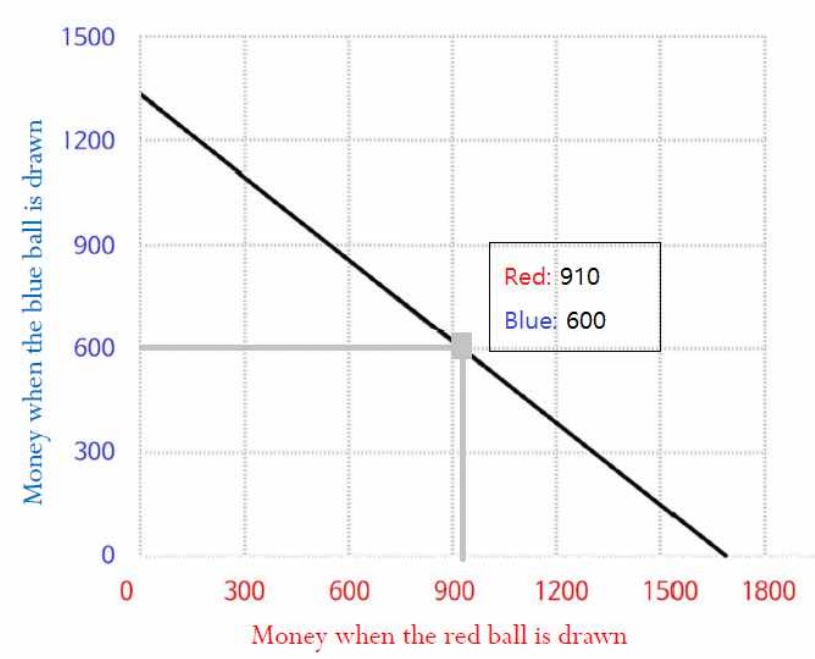
- In each study, they completed two stages of decision making under risk at the individual level and at the collective level.

  - Pairs were randomly formed within classroom for collective choices in the baseline
  - They were kept unchanged in the endline
  - Due to attrition or group mismatching, the final sample consists of 652 groups (1,304 individuals) in both studies.

- We also collected their individual characteristics (height, gender, math score, personality, etc) and friendship information.

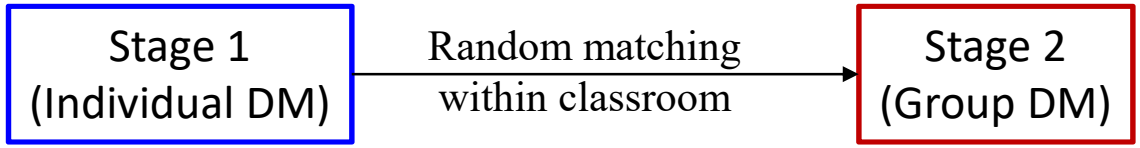
Decision Problem

- Follow Choi et al. (2007)
  - Allocate an income over two Arrow securities (associated with equally probably two states): choose (x_1, x_2) subject to $p_1 x_1 + p_2 x_2 = 1$



Experimental Procedures

- Participants: students from 12 middle schools in South Korea



- 18 rounds of individual choices with exogenous price variations
- 1 randomly selected round for payoffs

- Randomly matched students in pair sit side by side
- 1 min 30 sec of discussion
- 18 rounds of collective choices with exogenous price variations
- 1 randomly selected round for payoffs (doubled and divided equally)

- No feedback is given during the experiment, and subjects are informed only the sum of payoffs from the two stages at the end of the study.

Measuring Rationality

- Test whether each choice data are consistent with utility maximization: Generalized Axiom of Revealed Preference (GARP)

- Afriat's Critical Cost Efficiency Index (CCEI)

  - Measuring the exact amount by which each budget must be relaxed to remove all GARP violations;
  - CCEI $\in [0,1]$: the smaller it is, the more severe violation of GARP.

- Basic statistics of individual and collective CCEIs

	Baseline	Endline
Individual	0.900	0.932
	(0.133)	(0.120)
Collective	0.912	0.936
	(0.141)	(0.128)

Measuring Risk Preferences

- Simple nonparametric measure of risk aversion (RA)
  - For each budget, the fraction of money on a more expensive asset: $\frac{x_{\text{expensive}}}{x_1+x_2}$
  - For each individual and each group, compute the average of the fraction of money on a more expensive asset over 18 rounds
  - RA $\in [0, 0.5]$: higher (lower) degree of risk aversion when it is closer to 0.5 (0).
- Basic statistics of individual and collective RAs

	Baseline	Endline
Individual	0.322	0.297
	(0.134)	(0.153)
Collective	0.297	0.265
	(0.142)	(0.154)

Balance Test

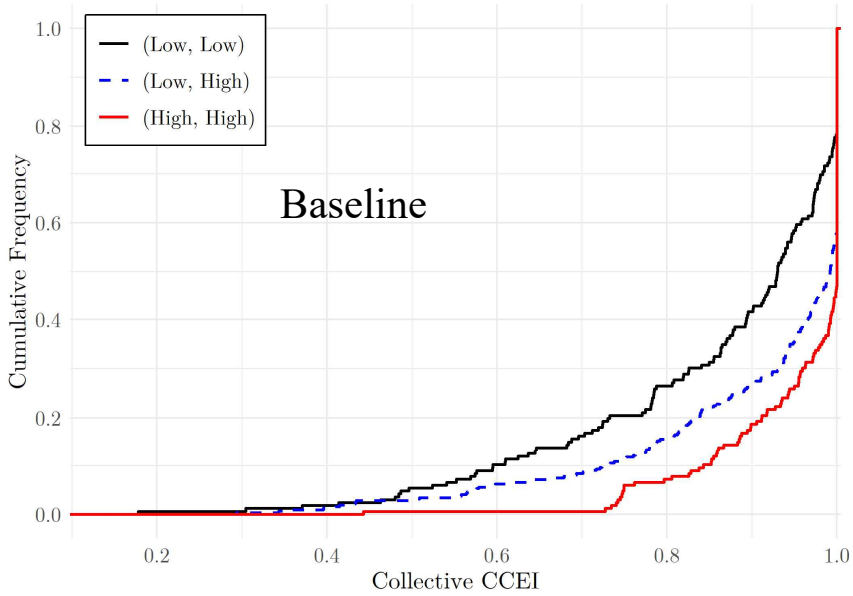
Outcome Variable	Summary Statistics			Balance Test		
	N	Mean	SD	β	(SE)	P-value
	(1)	(2)	(3)	(4)	(5)	(6)
CCEI	1,304	0.900	0.133	0.054	(0.047)	0.247
Risk Aversion	1,304	0.322	0.134	-0.007	(0.042)	0.874
Math Score	1,286	2.657	1.515	-0.066	(0.041)	0.109
Male	1,304	0.608	0.488	0.048	(0.042)	0.252
Outgoing	1,286	3.570	1.006	0.020	(0.043)	0.639
Opened	1,286	3.568	0.865	0.002	(0.042)	0.969
Agreeable	1,286	2.848	0.744	0.058	(0.043)	0.179
Conscientious	1,286	3.386	0.859	0.045	(0.044)	0.309
Stable	1,286	2.500	0.810	0.003	(0.041)	0.943
Height	1,304	163.513	8.187	0.010	(0.040)	0.812
Out-Degree Friendship	1,304	4.630	2.535	-0.030	(0.043)	0.489
In-Degree Friendship	1,304	4.623	2.692	0.003	(0.041)	0.951
Joint test: $\beta_k = 0 \; \forall k$				$\chi^2(12) = 8.55$, P-value $= 0.741$		

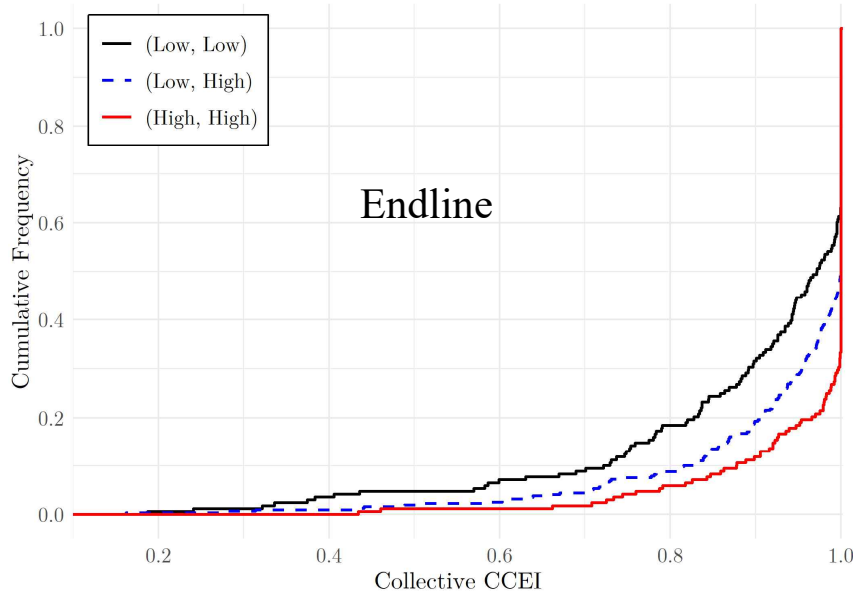
- Random group formation makes an individual's CCEI / RA / other variables not correlated with those of the other individual in the same group.

Rationality Extension

Q1: Do more rational individuals make group decisions more rational?

- Divide subjects into two groups w.r.t. individual CCEIs
  - **High** (**Low**) group: **above** (**below**) the median of CCEI





Rationality Extension

Collective CCEI	**Pooled OLS**			
	(1)	(2)	(3)	(4)
$\max\{CCEI_i, CCEI_j\}$	0.403***	0.385***	0.316***	0.305***
	(0.081)	(0.095)	(0.078)	(0.092)
$\lvert CCEI_i - CCEI_j \rvert$	-0.258***	-0.281***	-0.198***	-0.239***
	(0.050)	(0.060)	(0.040)	(0.055)
Endline		-0.003		0.007
		(0.175)		(0.183)
Endline × $\max\{CCEI_i, CCEI_j\}$		0.008		-0.009
		(0.176)		(0.184)
Endline × $\lvert CCEI_i - CCEI_j \rvert$		0.048		0.081
		(0.073)		(0.074)
Constant	0.561***	0.577***	0.714***	0.726***
	(0.080)	(0.093)	(0.148)	(0.159)
Class Fixed Effect	No	No	Yes	Yes
Individual Characteristics	No	No	Yes	Yes
School Characteristics	No	No	Yes	Yes
Friendship	No	No	Yes	Yes
Risk Aversion	No	No	Yes	Yes
Observations	1,304	1,304	1,304	1,304
R-squared	0.105	0.107	0.195	0.197

- The CCEI of the group increases with the CCEI of more rational individual and decreases with the difference between the CCEIs of the two individuals, even after controlling for confounds.

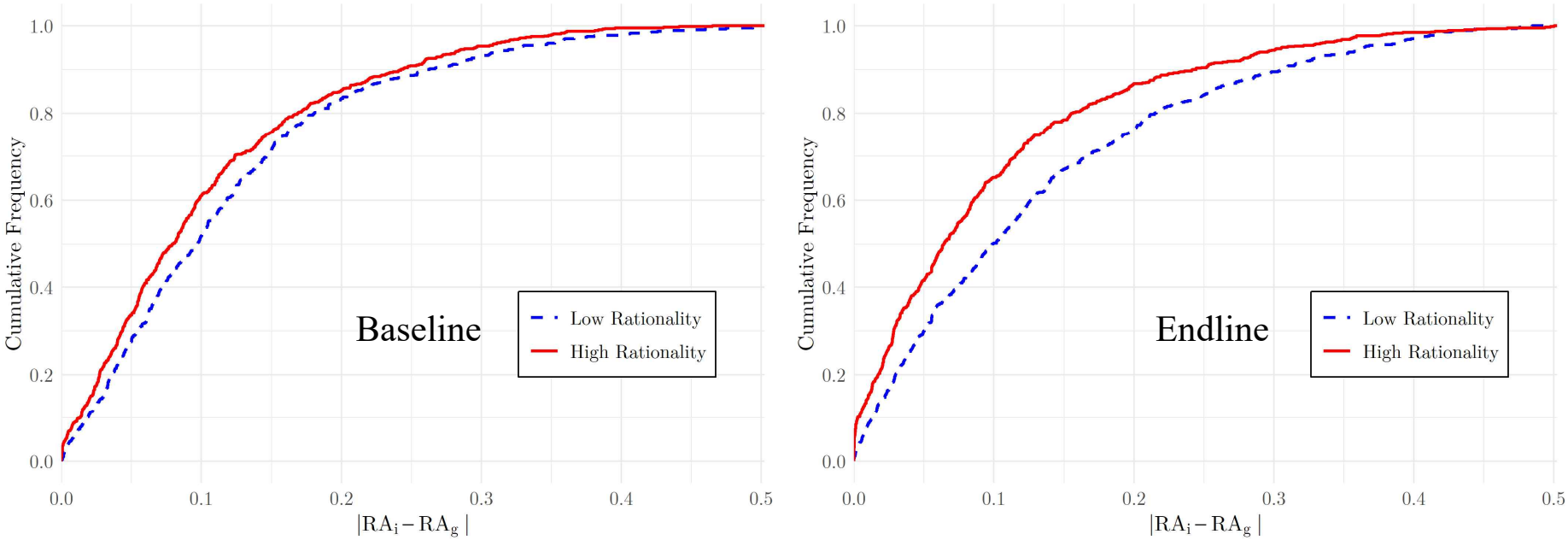
Does Preference Aggregation Depend on Rationality?

Q2: Is the preference of the group closer to that of the more rational individual?

- Individual with higher (lower) CCEI in the group: $i = h(\text{high}), l(\text{low})$
- Two approaches:
  1. Compute the distance of risk aversion between individual i and the group
  2. Revealed preference approach of individual (bargaining) power on group decisions.

Does Preference Aggregation Depend on Rationality?

- Draw the distributions of $|RA_i - RA_g|$ for $i = h, l$.



- The preference gap between a more rational individual and the group is smaller than that between a less rational individual and the group.

Does Preference Aggregation Depend on Rationality?

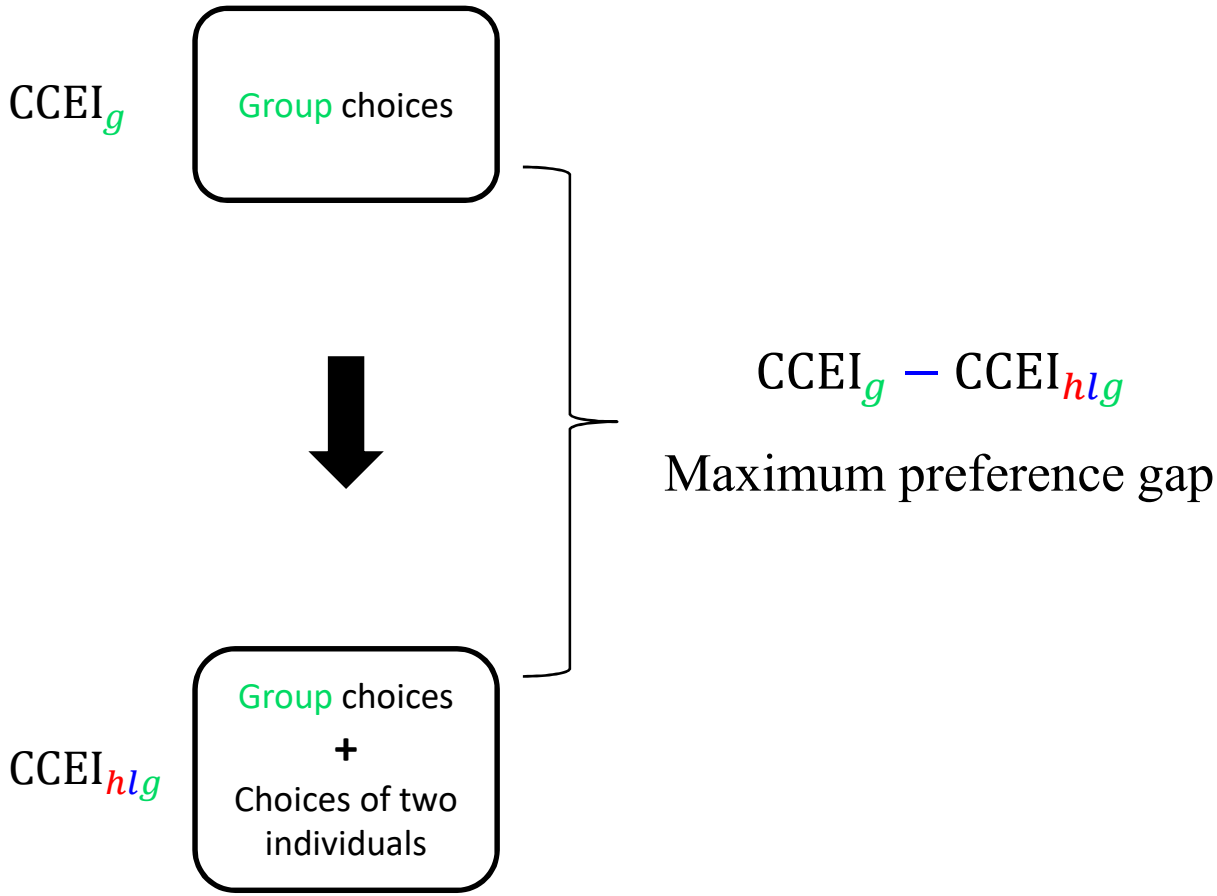
$\lvert RA_i - RA_g \rvert$	Pooled OLS			
	(1)	(2)	(3)	(4)
High	-0.025***	-0.014***	-0.022***	-0.012***
	(0.005)	(0.004)	(0.004)	(0.004)
Endline		0.012**		0.012**
		(0.005)		(0.005)
High × Endline		-0.021***		-0.020***
		(0.007)		(0.007)
Constant	0.127***	0.121***	0.127***	0.120***
	(0.004)	(0.004)	(0.008)	(0.008)
Class Fixed Effect	No	No	Yes	Yes
Individual Characteristics	No	No	Yes	Yes
School Characteristics	No	No	Yes	Yes
Friendship	No	No	Yes	Yes
Observations	2,608	2,608	2,608	2,608
R-squared	0.013	0.015	0.082	0.085

- Collective risk preference is closer to the individual risk preference of the more rational individual.
- This becomes stronger in the endline study.

Revealed (Bargaining) Power

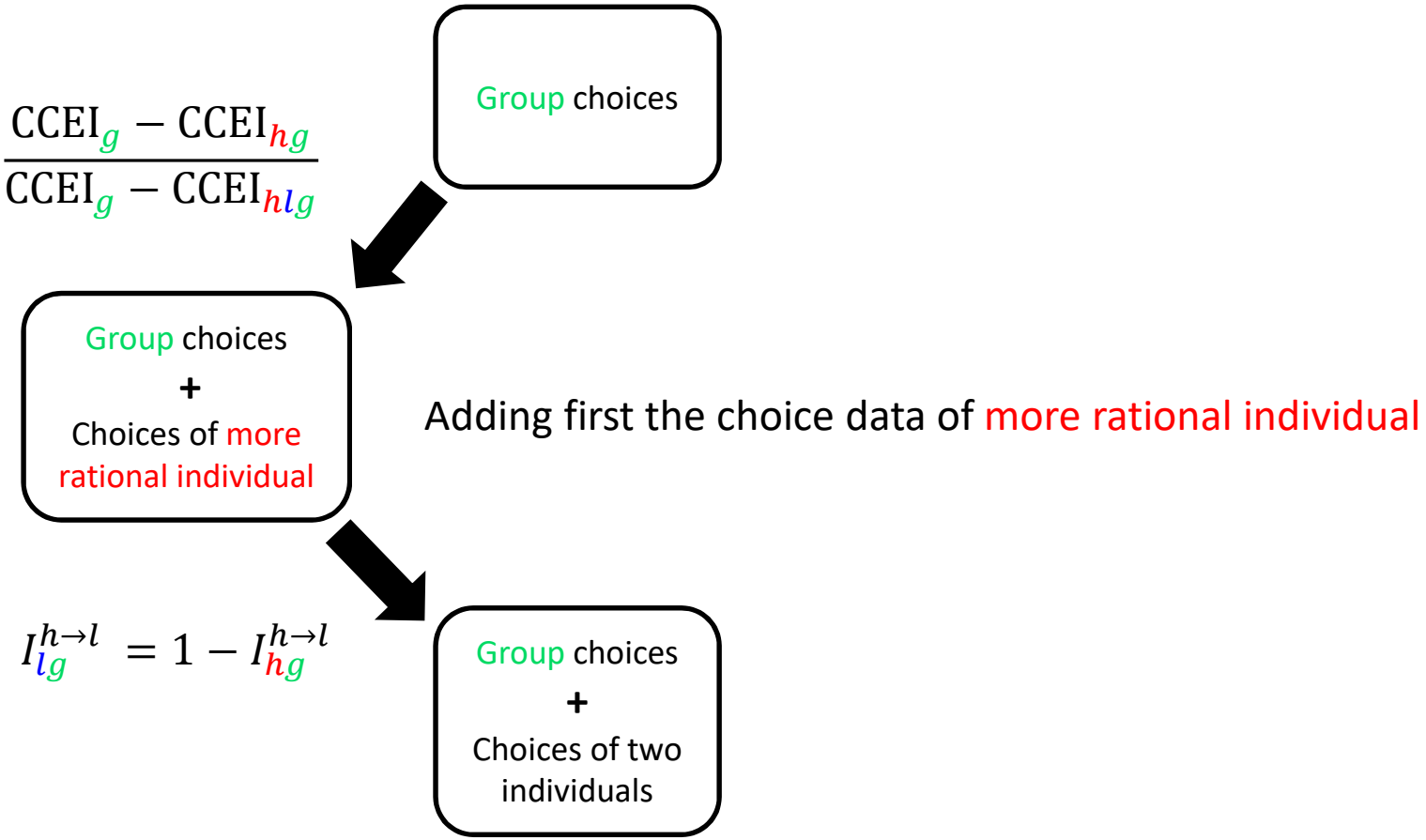
- **Revealed preference approach**
  - Revealed preference distance between an individual's choice data and the group choice data
  - How close are an individual's choices to group choices?
- An individual is said to make a larger revealed (bargaining) power if her choice data is "closer" to the data of group choices.

Revealed Preference Distance



Revealed Preference Distance

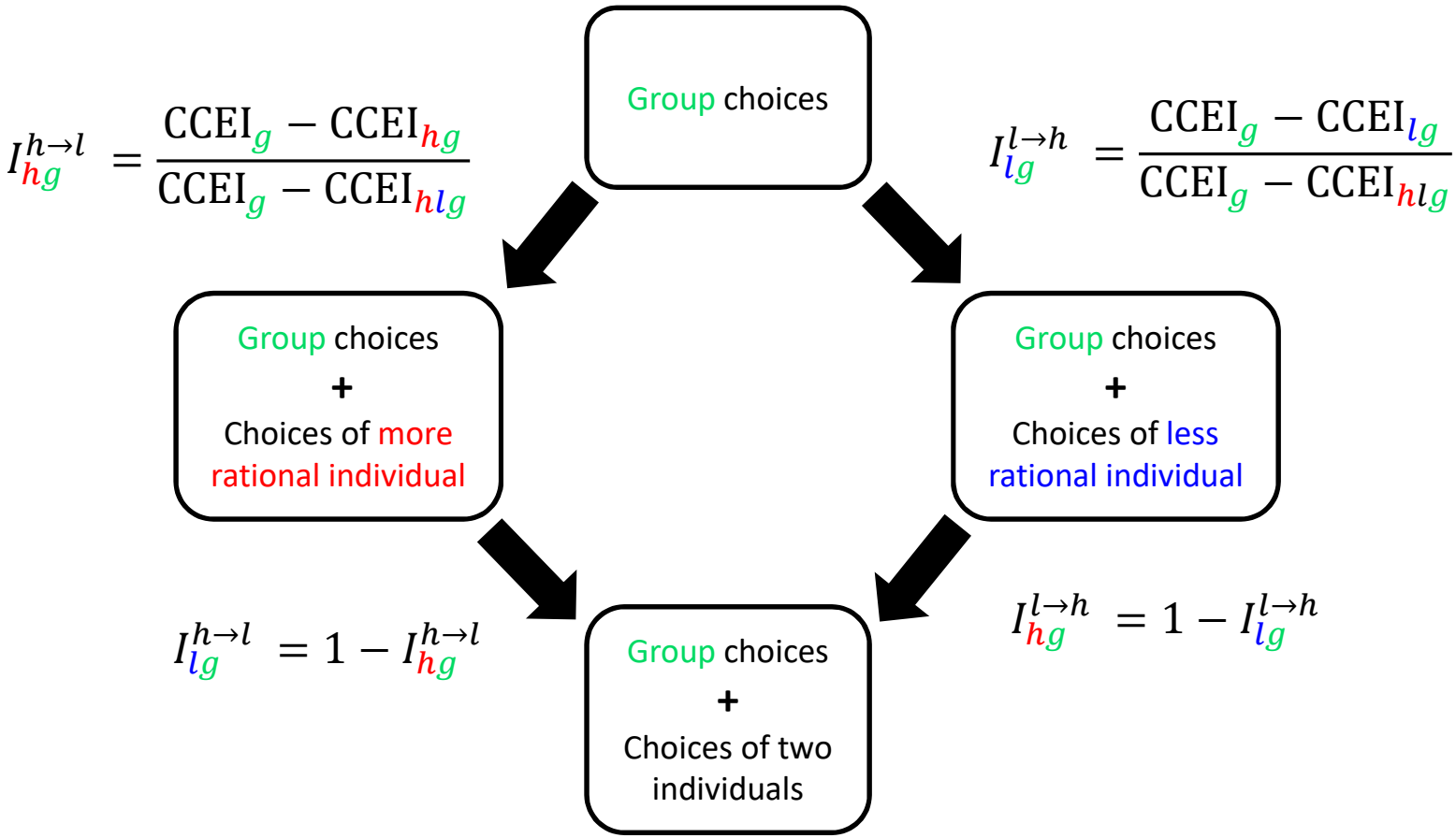
$$I_{hg}^{h\to l} = \frac{\mathrm{CCEI}_g - \mathrm{CCEI}_{hg}}{\mathrm{CCEI}_g - \mathrm{CCEI}_{hlg}}$$



Adding first the choice data of more rational individual

$$I_{lg}^{h\to l} = 1 - I_{hg}^{h\to l}$$

Revealed Preference Distance: Path Dependence



Revealed (Bargaining) Power

- We consider the path-independent measure of revealed preference distance, I_{hg} and I_{lg}, by taking the average.

$$I_{hg}^{h\to l} = \frac{\mathrm{CCEI}_g - \mathrm{CCEI}_{hg}}{\mathrm{CCEI}_g - \mathrm{CCEI}_{hlg}}$$

$$I_{lg}^{h\to l} = 1 - I_{hg}^{h\to l}$$

$$I_{hg}^{l\to h} = 1 - I_{lg}^{l\to h}$$

$$I_{lg}^{l\to h} = \frac{\mathrm{CCEI}_g - \mathrm{CCEI}_{lg}}{\mathrm{CCEI}_g - \mathrm{CCEI}_{hlg}}$$

$$I_{hg} = \frac{1}{2} I_{hg}^{h\to l} + \frac{1}{2} I_{hg}^{l\to h}$$

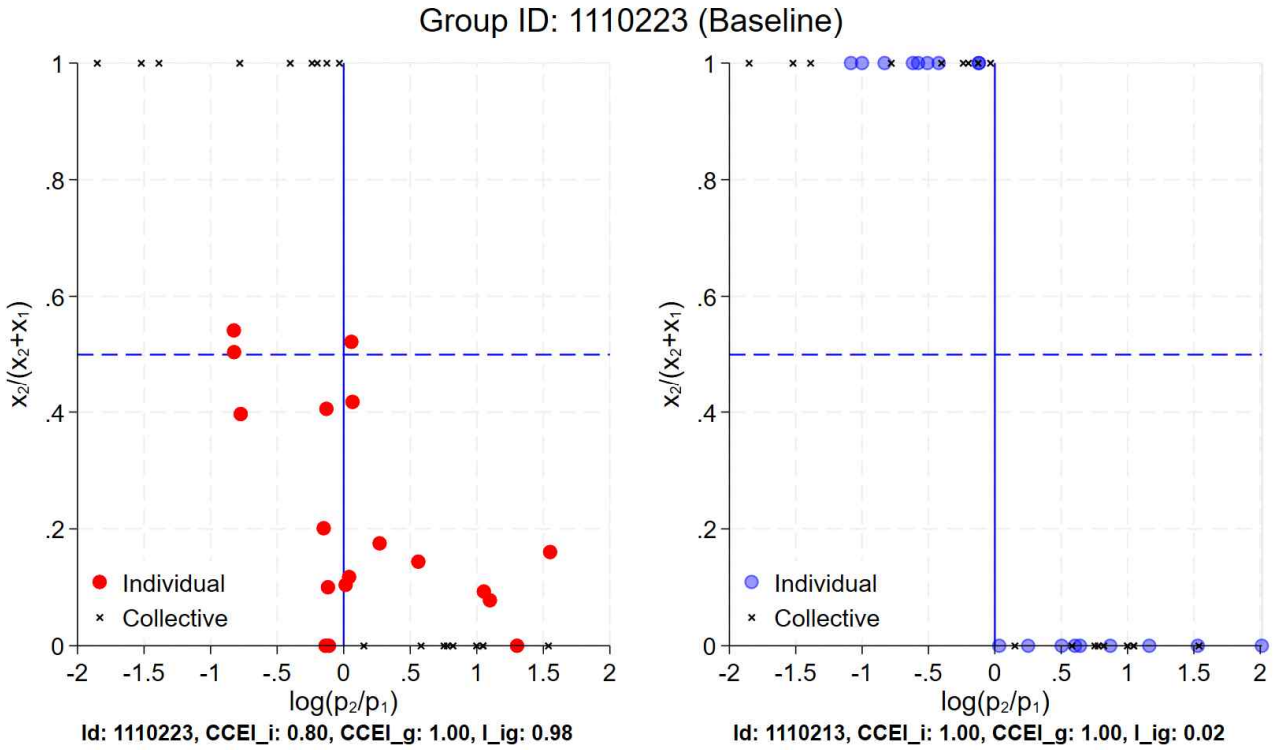
$$I_{lg} = \frac{1}{2} I_{lg}^{h\to l} + \frac{1}{2} I_{lg}^{l\to h}$$

$$(Note: I_{hg} + I_{lg} = 1)$$

Revealed (Bargaining) Power

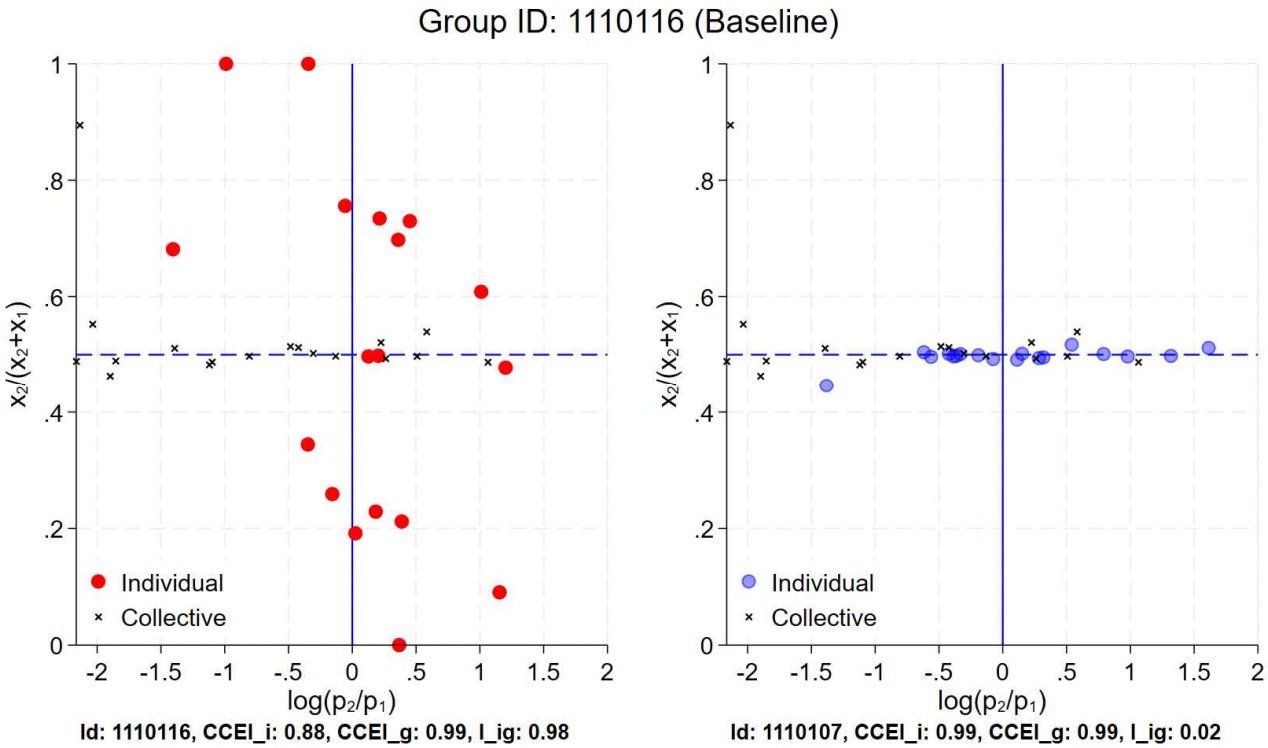
- These revealed preference distance measures, I_{hg} and I_{lg}, range between 0 and 1.
  - The closer I_{hg} is to zero, the choice data of more rational individual are more consistent with the group choice data.
  - If $I_{hg} < I_{lg}$ (i.e., $I_{hg} < 0.5$), then the more rational individual is said to make a larger revealed bargaining power on group decision-making than the less rational individual.
    - 72% of the groups in the baseline data; 74% in the endline data
- These indices are not defined when
  - All three datasets have a common preference; or
  - The group data contains the most severe violation of GARP
  - About 50 pairs in each of baseline and endline samples

Selective Group 1



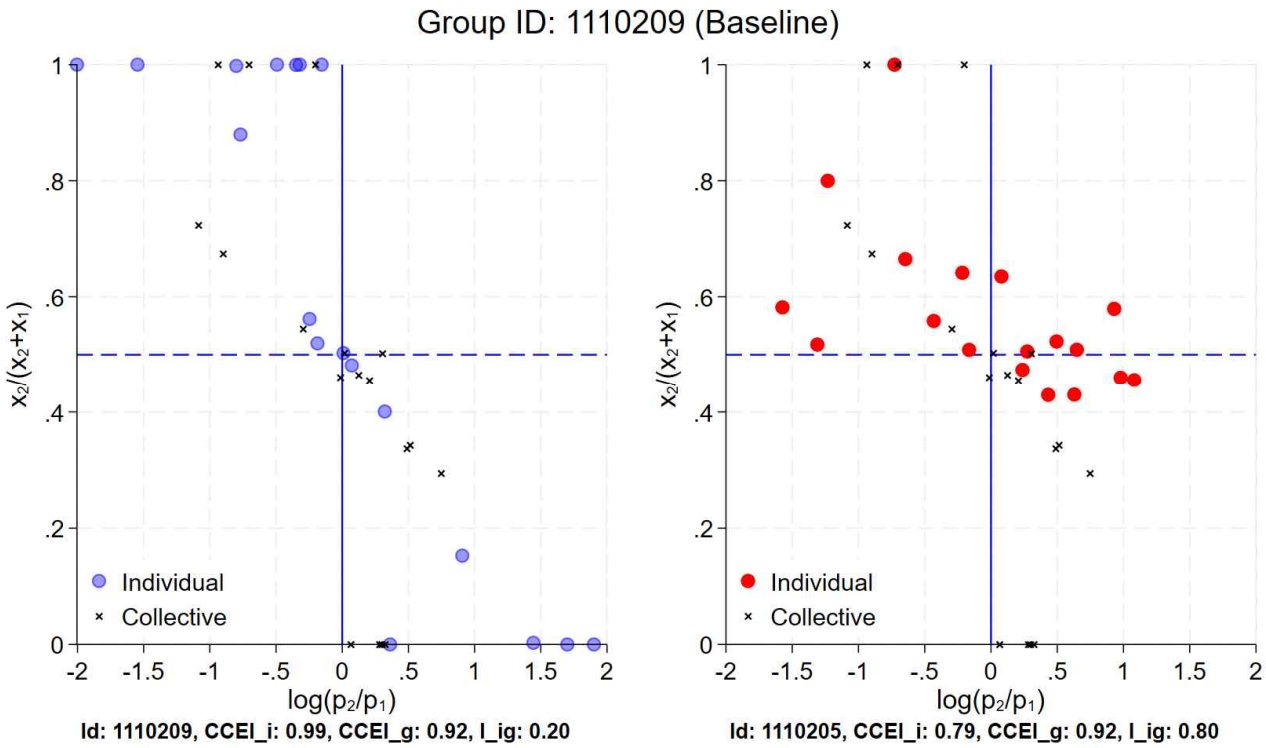
- The more rational individual (right; blue) and the group behave the same.
- $I_{hg} = 0.02,\ I_{lg} = 0.98$

Selective Group 2



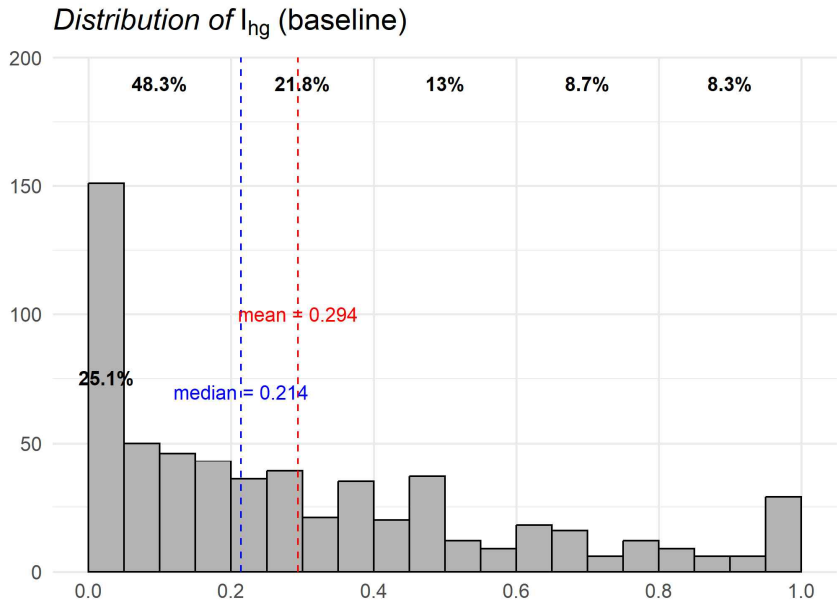
- $I_{hg} = 0.02,\ I_{lg} = 0.98$

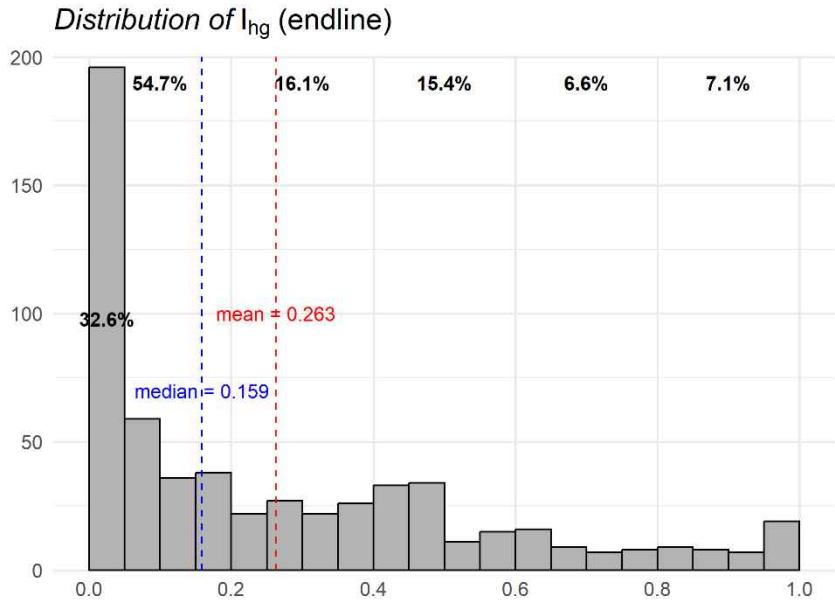
Selective Group 3



- $I_{hg} = 0.20,\ I_{lg} = 0.80$

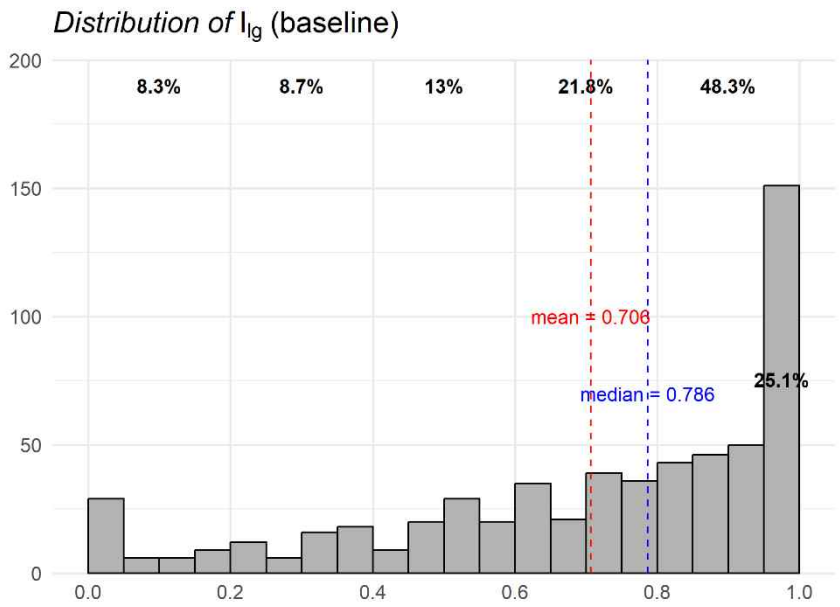
Revealed Preference Distance: **More Rational Individual**

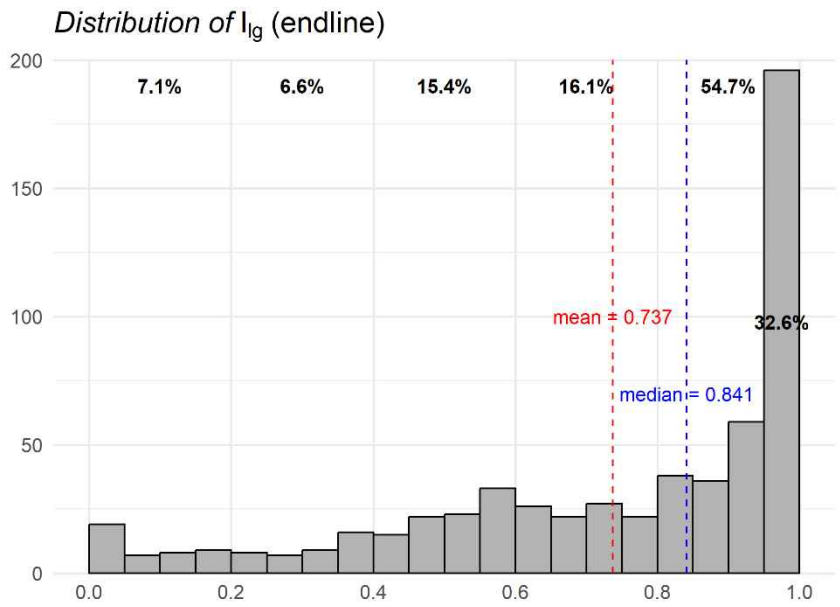




- The average of I_{hg} is 0.294 in the baseline and 0.263 in the endline.

Revealed Preference Distance: **Less Rational Individual**





- The average of I_{lg} is 0.706 in the baseline and 0.737 in the endline.

Revealed Preference Distance

I_{ig}	Pooled OLS					
	(1)	(2)	(3)	(4)	(5)	(6)
High CCEI	-0.443***	-0.412***	-0.362***	-0.437***	-0.407***	-0.353***
	(0.015)	(0.024)	(0.025)	(0.015)	(0.024)	(0.025)
Endline		0.031*	0.050***		0.030	0.051***
		(0.018)	(0.018)		(0.018)	(0.018)
High × Endline		-0.062*	-0.067*		-0.060	-0.066*
		(0.036)	(0.035)		(0.036)	(0.035)
$CCEI_i$			-0.344***			-0.368***
			(0.034)			(0.036)
RA_i			0.238***			0.250***
			(0.051)			(0.057)
Constant	0.722***	0.706***	0.913***	0.767***	0.750***	0.955***
	(0.008)	(0.012)	(0.036)	(0.031)	(0.034)	(0.052)
Class Fixed Effect	No	No	No	Yes	Yes	Yes
Individual Characteristics	No	No	No	Yes	Yes	Yes
School Characteristics	No	No	No	Yes	Yes	Yes
Friendship	No	No	No	Yes	Yes	Yes
Observations	2,406	2,406	2,406	2,406	2,406	2,406
R-squared	0.378	0.380	0.404	0.390	0.392	0.417

- Mean of a less rational individuals' I_{ig} (i.e., I_{lg}) = 0.722
  - On average, I_{hg} is 61.4% lower than I_{lg} within the same group
- This rationality-based distance effect becomes larger in the endline.

Conclusion

- Large-scale, panel experiments about individual and group decision-making
  - Random group formation leads to infer the effects of individual rationality on the quality of group decision-making and individual power on group decision-making.
- Provide a nonparametric, revealed preference measure of individual (bargaining) power on group decisions.
- Findings
  - The quality of group decisions increases with the CCEI of more rational one and decreases with the gap of CCEIs between two individuals.
  - The more rational individual makes a larger revealed (bargaining) power on group decision-making.