Rationality-based Preference Aggregation

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Introduction

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- Long-standing interests in group decision making (DM):
  - Households, Committees, Social choice theory
    e.g., Chiappori, 1992; Feddersen & Pesendorfer, 1998; Arrow, 1951

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- Individual rationality is a foundational assumption for understanding group DM
- Marked heterogeneity in individual rationality, with connection to real-life DM
  e.g., Samuelson, 1938; Choi et al., 2007,2014; Echenique et al., 2011; Halevy et al., 2018

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$\Rightarrow$ How does individual rationality affect group DM?

Imperfect Measurement & Causality in a Typical Approach

- Growing evidence on the role of individual DM ability in household outcomes
  e.g., Behrman et al., 2012; Yilmazer et al., 2015; Guiso et al., 2023; Gu et al., 2023

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- Common approach: Proxy of individual DM ability $\overset{\text{correlation}}{\longleftrightarrow}$ Household DM
  - Proxy: education, cognitive ability, financial literacy, etc
  - Correlation: household endogenously formed, and sustained

In This Paper

- Individual rationality $\xrightarrow{\text{causation}}$ Group DM

  1. Conduct a large-scale **lab-in-the-field experiments** in 12 public schools
  - Measure individual rationality based on revealed preference approach

  2. Groups randomly formed; exogenous variation in individual rationality
  - Focus on the minimum unit of group = **pair**

- We find that individual rationality is an important source of:
  1. the **quality** of group DM, and
  2. individual (bargaining) **power** in group DM

- Propose a nonparametric, revealed-preference measure of **individual power**

Outline

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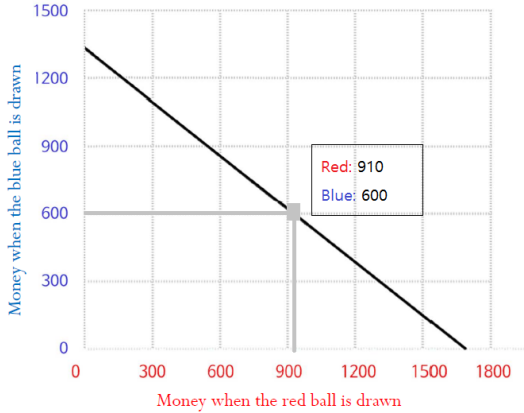
  - Due to attrition, the final sample consists of 652 groups (1,304 individuals)
- Complementary data from administrative record and survey
  - Demographic characteristics - Height, gender, etc
  - Cognitive/non-cognitive characteristics - Math score, BIG 5 Personality
  - Friendship survey

Decision Problem

Choi et al. (2007)

Allocate income over two Arrow securities (equally probable states).

$$\text{choose } (x_1, x_2) \quad \text{s.t.} \quad p_1 x_1 + p_2 x_2 = 1 \tag{1}$$



Experimental Procedures

Stage 1
(Individual DM)

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

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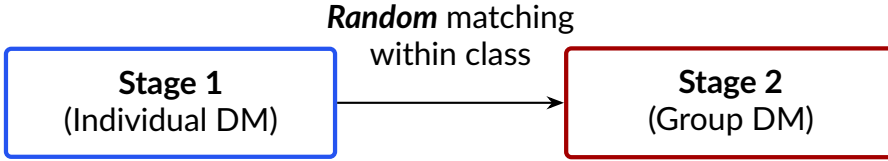

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- Students in pair sit side by side
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- 1 min 30 sec of discussion
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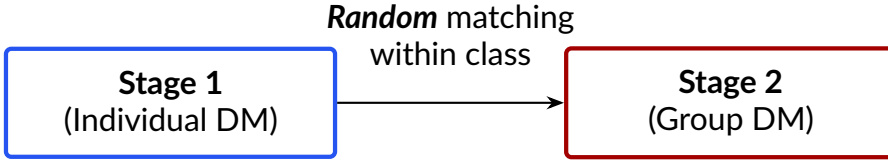

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- No feedback during the experiment;
- Subjects learn only the total payoff of two stages at the end

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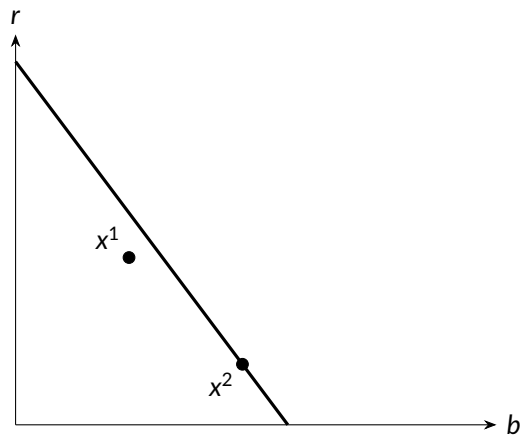

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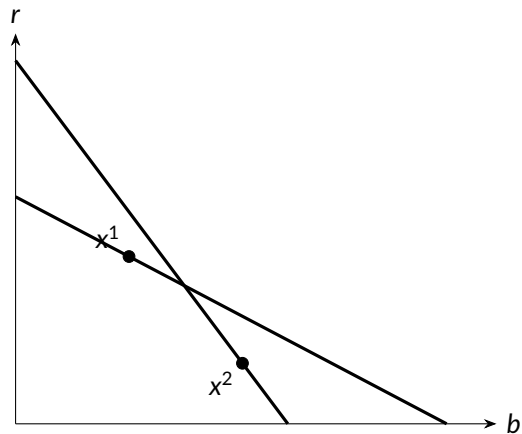

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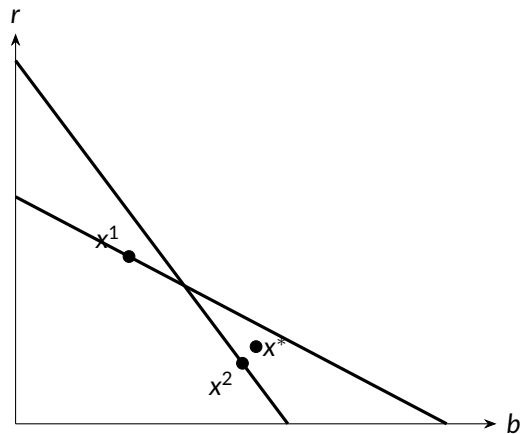

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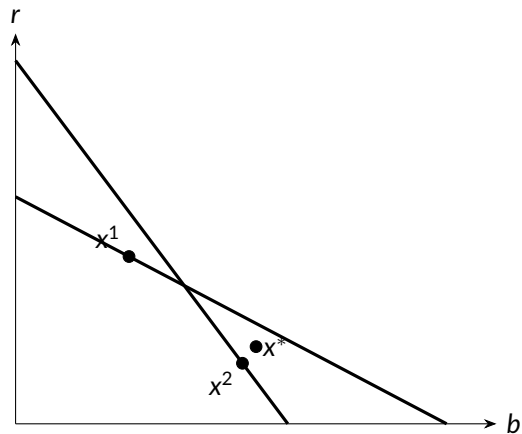

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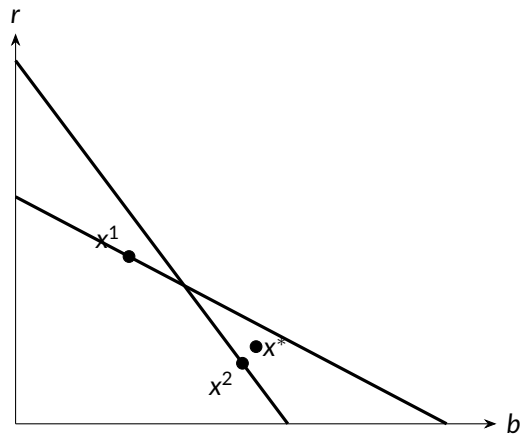
- Afriat's Theorem: Choices satisfying GARP $\iff$ $\exists$ a well-behaving utility function



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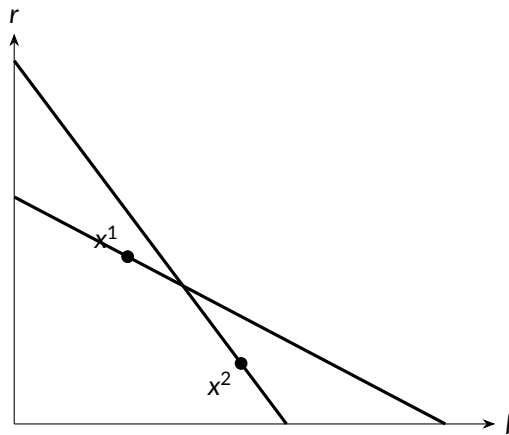
- Afriat's **Critical Cost Efficiency Index (CCEI)**
  - By which each budget must be relaxed to remove all GARP violations;



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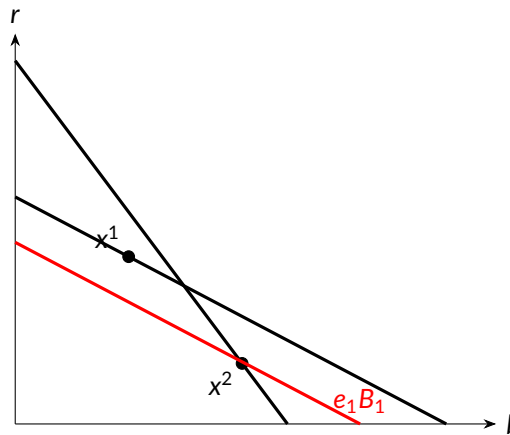

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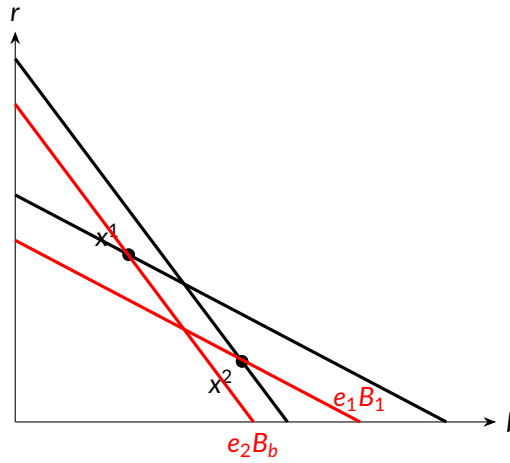

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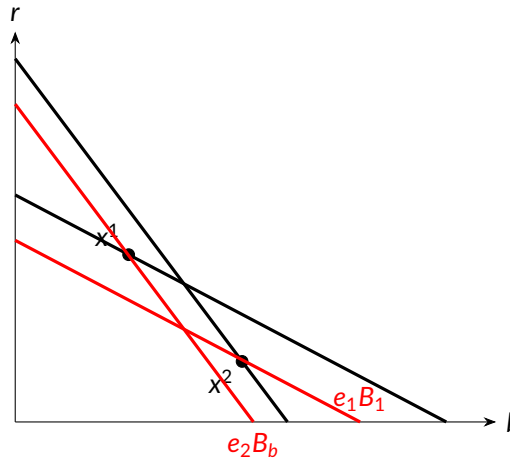
  - Minimum waste to rationalize?
    $CCEI = max(e_1, e_2)$
- CCEI $\in [0, 1]$ (higher $\Rightarrow$ more rational)



Summary Statistics

	Individual		Collective	
	mean	sd	mean	sd
	Panel A: Baseline			
CCEI	0.9	0.13	0.91	0.14
RA	0.32	0.13	0.29	0.15
	Panel B: Endline			
CCEI	0.93	0.12	0.93	0.13
RA	0.29	0.14	0.26	0.15

Notes: N of individuals = 1304, N of pairs = 652

Revealed (Bargaining) Power

- Can measure bargaining power by extending revealed preference approach?
  - c.f.) $\alpha U_i + (1 - \alpha) U_j$ and get α? Assumes rationality for both *i* and *j*
- **Revealed preference distance** between an individual's and the group's dataset
- How close are an individual's choices to group choices?

Revealed (Bargaining) Power

- Let g denote group data; h (l) the more (less) rational individual
- For any dataset S, let CCEI_S be the CCEI computed from S

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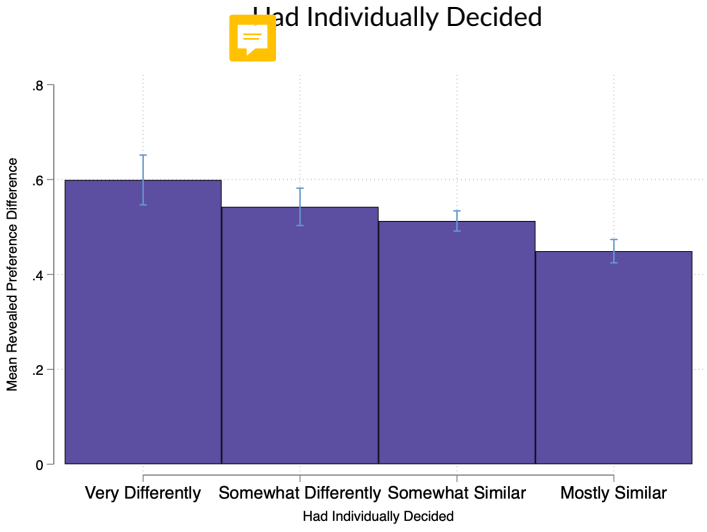
- The maximum gap relevant for distance is $\text{CCEI}_g - \text{CCEI}_{g\cup h\cup l}$
- **Revealed preference distance:**

$$I_{hg}^{h\to g} = \frac{\text{CCEI}_g - \text{CCEI}_{g\cup h}}{\text{CCEI}_g - \text{CCEI}_{g\cup h\cup l}}, I_{lg}^{h\to g} = 1 - I_{hg}^{h\to g},\ I_{hg}^{h\to g} \in [0,1] \tag{2}$$

  - calculate $I_{hg}^{l\to g}, I_{lg}^{l\to g}$ similarly then take the average
  - the smaller, the larger bargaining power

Validation Using Reported Bargaining Weight



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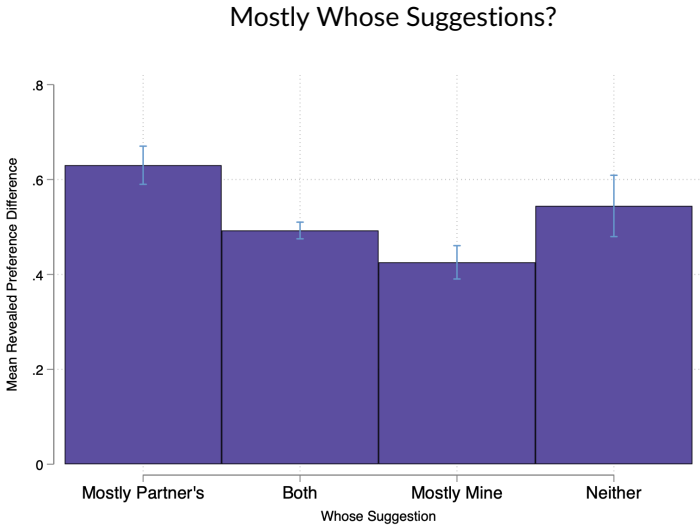

Measuring Risk Preferences

- Nonparametric RA for each budget:

$$\text{RA} = \frac{x_{\text{expensive}}}{x_{\text{expensive}} + x_{\text{cheap}}} \in [0, 0.5]$$

  - Highly risk averse: RA=0.5
  - ~~Highly risk neutral: RA=1~~

- For each individual/group: average RA over 18 rounds
- ~~The higher, the more risk neutral~~

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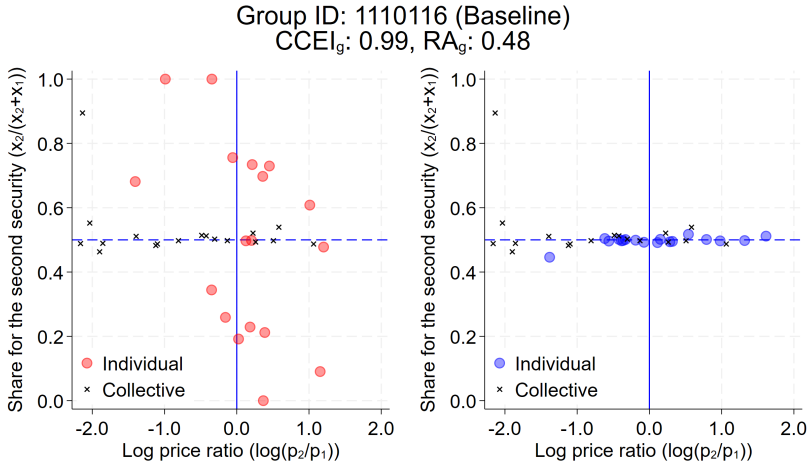
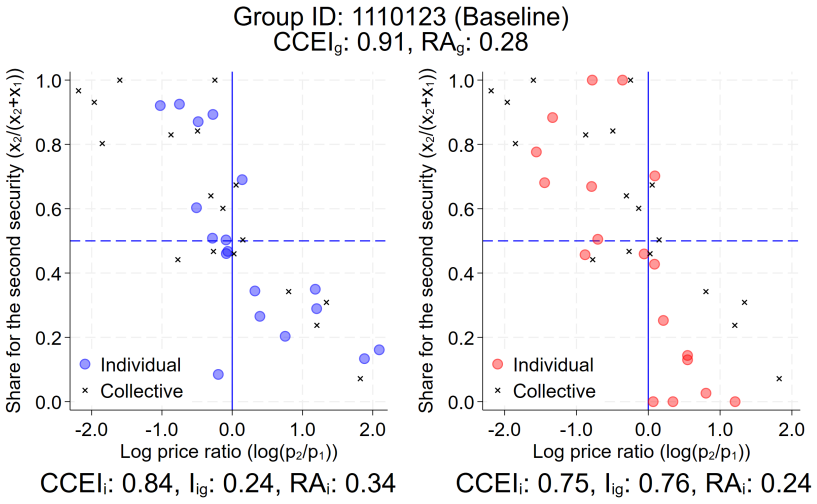
When The More Rational Takes All Bargaining Power

... Individual rationality a source of group rationality and bargaining power?



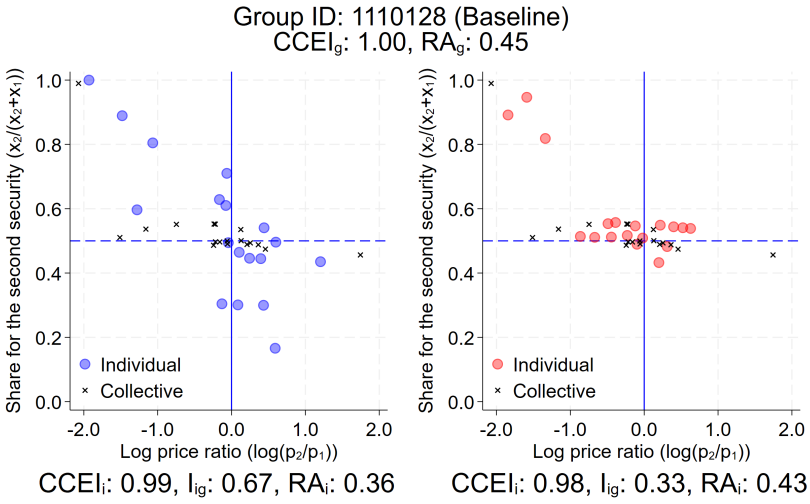
Similarly Rational Individually, Balanced Bargaining Power

+ Individual risk preference a source of group risk preference?



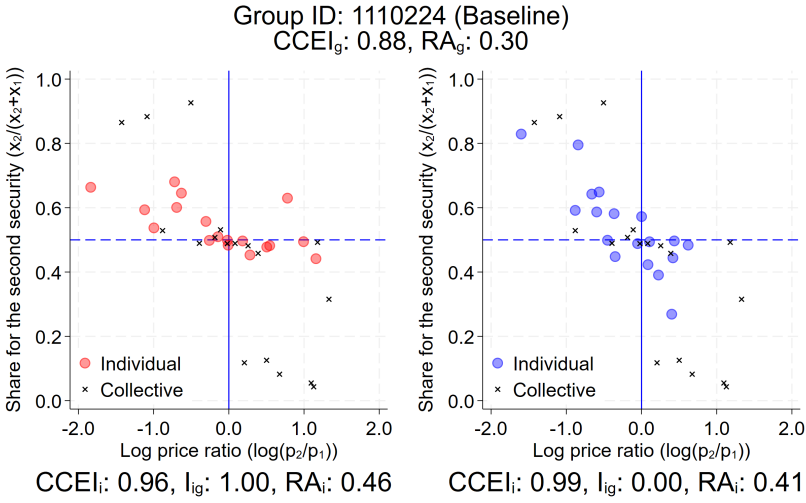
Both Rational Individually, But Why the Right One?

... What else explain bargaining power beyond individual rationality?



Failure of Preference Aggregation?

... Individual rationality (risk preference) a source group rationality (risk preference)?



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Random Matching Test: $y_{igc} = \beta y_{jgc} + \tau_c + \epsilon_{igc}$

Outcome Variable	β	(SE)	P-value
	(1)	(2)	(3)
Panel A: Measures from the Experiment			
CCEI	0.054	(0.047)	0.247
Risk Aversion	-0.007	(0.042)	0.874
Panel B: Other Characteristics			
Male	0.048	(0.042)	0.252
Height	0.010	(0.040)	0.812
Friendship Network:			
Out-Degree	-0.030	(0.043)	0.489
In-Degree	0.003	(0.041)	0.951
Math Score	-0.066	(0.041)	0.109
Big 5 Personality:			
Outgoing	0.020	(0.043)	0.639
Opened	0.002	(0.042)	0.969
Joint test: $\beta_k = 0\ \forall k$	$\chi^2(12) = 8.55$, P-value = 0.741		

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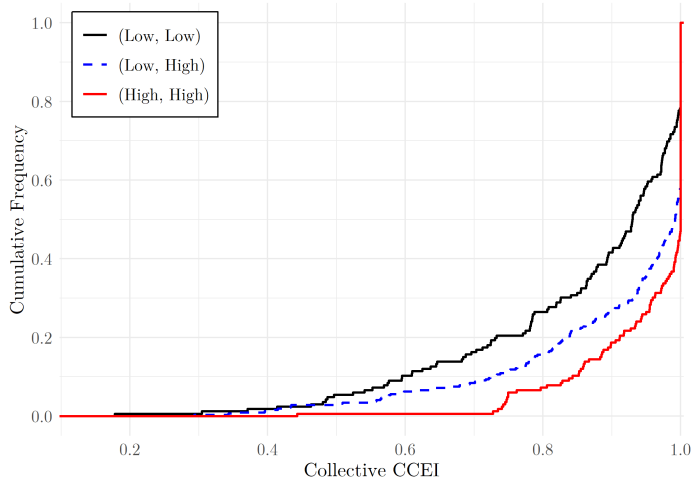

Quantifying Rationality Extension

$$CCEI_{gct} = \alpha + \beta_1 \, \text{CCEI}_{\text{max},gt} + \beta_2 \, \text{CCEI}_{\text{dist},gt} + \gamma X_{gt} + \tau_c + \varepsilon_{gct}, \tag{3}$$

- Pair g, class c, and time t
- $\text{CCEI}_{\text{max},gt}$ maximum CCEI between the two individuals
- $\text{CCEI}_{\text{dist},gt}$ difference in individual CCEIs
- X_{gt}: gender, height, math score, Big 5, friendship
- τ_c: class FE
- ε_{gct}: clustered at class

More Rational Individuals Make Group Decisions More Rational

$CCEI_g$ (mean= 0.912, sd=0.141)	(1)	(2)
Group and Individual Char., Friendship	No	Yes
Group FE	No	No
$CCEI_{max,gt}$	0.350**	
	(0.096)	
$CCEI_{dist,gt}$	-0.271**	
	(0.057)	
$Math\ Score_{max,gt}$		0.010*
		(0.004)
$Math\ Score_{dist,gt}$		-0.003
		(0.003)
One-sided Friendship		0.011
		(0.013)
Mutual Friendship		-0.029+
		(0.016)
N	1304	1304
R-squared	0.169	0.124

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Group and Individual Char., Friendship	No	Yes	Yes
Group FE	No	No	No
$CCEI_{max,gt}$	0.350**		0.323**
	(0.096)		(0.092)
$CCEI_{dist,gt}$	-0.271**		-0.263**
	(0.057)		(0.056)
Math $Score_{max,gt}$		0.010*	0.005
		(0.004)	(0.004)
Math $Score_{dist,gt}$		-0.003	-0.001
		(0.003)	(0.003)
One-sided Friendship		0.011	0.008
		(0.013)	(0.012)
Mutual Friendship		-0.029+	-0.026
		(0.016)	(0.016)
N	1304	1304	1304
R-squared	0.169	0.124	0.195

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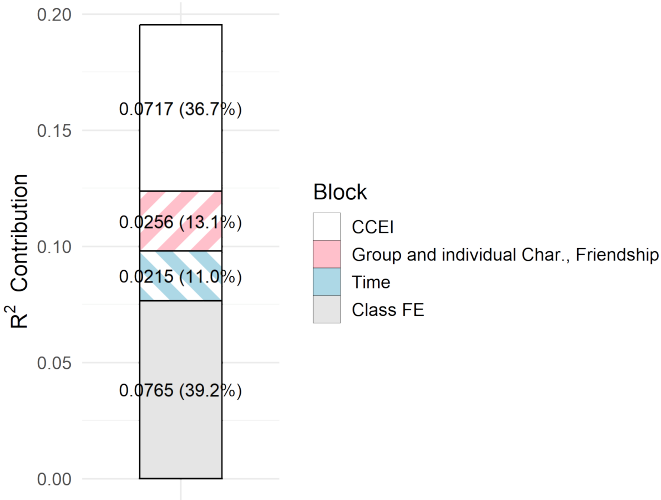
$CCEI_g$ (mean= 0.912, sd=0.141)	(1)	(2)	(3)	(4)
Group and Individual Char., Friendship	No	Yes	Yes	Yes
Group FE	No	No	No	Yes
$CCEI_{max,gt}$	0.350**		0.323**	0.242*
	(0.096)		(0.092)	(0.106)
$CCEI_{dist,gt}$	-0.271**		-0.263**	-0.162**
	(0.057)		(0.056)	(0.044)
Math $Score_{max,gt}$		0.010*	0.005	0.007
		(0.004)	(0.004)	(0.006)
Math $Score_{dist,gt}$		-0.003	-0.001	0.002
		(0.003)	(0.003)	(0.005)
One-sided Friendship		0.011	0.008	-0.008
		(0.013)	(0.012)	(0.015)
Mutual Friendship		-0.029+	-0.026	-0.032
		(0.016)	(0.016)	(0.025)
N	1304	1304	1304	1304
R-squared	0.169	0.124	0.195	0.639

Individual Rationality is Most Important Determinant of Group Rationality



More Rational Individual Takes Larger Bargaining Power

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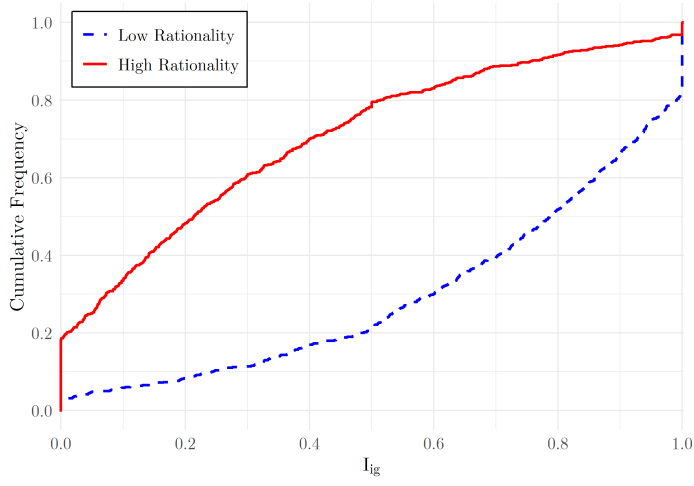


Quantifying Individual Rationality's Effect on Bargaining Power

$$I_{igt} = \alpha + \beta_1 \, 1(\text{Higher CCEI})_{it} + \beta_2 \, 1(\text{Endline})_t + \beta_3 \, (1(\text{Higher CCEI})_{it} \times 1(\text{Endline})_t) + \gamma_1 X_{igt} + \tau_c + \varepsilon_{igt} \quad (4)$$

- Individual i, Pair g, class c, and time t
- $1(\text{Higher CCEI})_{it}$, i has higher CCEI within pair g
- X_{igt}: gender, height, math score, Big 5 personality, friendship
- τ_c: class FE

More Rational Individual Takes Larger Bargaining Power

I_{ig}	(1)	(2)
Group and Individual Char., Friendship	No	Yes
Individual FE	No	No
$1(\text{Higher CCEI})_{it}$	-0.411**	
	(0.024)	
$1(\text{Endline})_t$	0.036+	
	(0.018)	
$1(\text{Higher CCEI})_{it} \times 1(\text{Endline})_t$	-0.071+	
	(0.037)	
$\textit{Math Score}_i$		-0.001
		(0.001)
$\textit{Math Score}_i - \textit{Math Score}_j$		-0.021**
		(0.006)
$\textit{Popularity}_i - \textit{Popularity}_j$		0.000
		(0.003)
N	2228	2228
R-squared	0.384	0.039

More Rational Individual Takes Larger Bargaining Power

I_{ig}	(1)	(2)
Group and Individual Char., Friendship	No	Yes
Individual FE	No	No
$1(\text{Higher CCEI})_{it}$	-0.411**	
	(0.024)	
$1(\text{Endline})_t$	0.036+	
	(0.018)	
$1(\text{Higher CCEI})_{it} \times 1(\text{Endline})_t$	-0.071+	
	(0.037)	
$\textit{Math Score}_i$		-0.001
		(0.001)
$\textit{Math Score}_i - \textit{Math Score}_j$		-0.021**
		(0.006)
$\textit{Popularity}_i - \textit{Popularity}_j$		0.000
		(0.003)
N	2228	2228
R-squared	0.384	0.039

More Rational Individual Takes Larger Bargaining Power

I_{ig}	(1)	(2)
Group and Individual Char., Friendship	No	Yes
Individual FE	No	No
$1(\text{Higher CCEI})_{it}$	-0.411**	
	(0.024)	
$1(\text{Endline})_t$	0.036+	
	(0.018)	
$1(\text{Higher CCEI})_{it} \times 1(\text{Endline})_t$	-0.071+	
	(0.037)	
$\textit{Math Score}_i$		-0.001
		(0.001)
$\textit{Math Score}_i - \textit{Math Score}_j$		-0.021**
		(0.006)
$\textit{Popularity}_i - \textit{Popularity}_j$		0.000
		(0.003)
N	2228	2228
R-squared	0.384	0.039

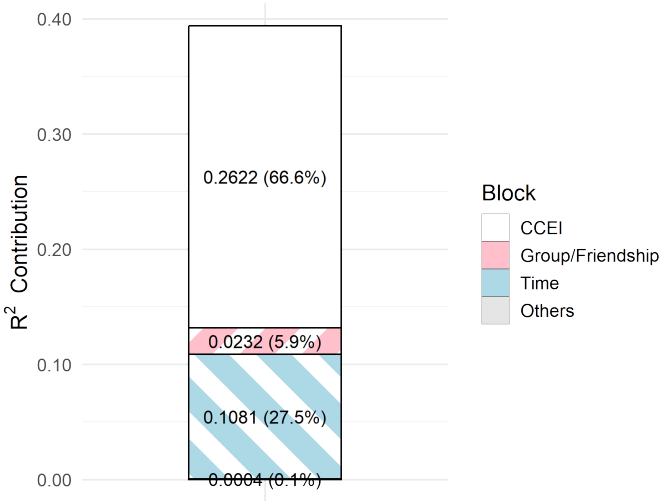
More Rational Individual Takes Larger Bargaining Power

I_{ig}	(1)	(2)	(3)
Group and Individual Char., Friendship	No	Yes	Yes
Individual FE	No	No	No
$1(\text{Higher CCEI})_{it}$	-0.411**		-0.405**
	(0.024)		(0.024)
$1(\text{Endline})_t$	0.036+		0.034+
	(0.018)		(0.018)
$1(\text{Higher CCEI})_{it} \times 1(\text{Endline})_t$	-0.071+		-0.067+
	(0.037)		(0.036)
$\textit{Math Score}_i$		-0.001	-0.000
		(0.001)	(0.000)
$\textit{Math Score}_i - \textit{Math Score}_j$		-0.021**	-0.012*
		(0.006)	(0.005)
$\textit{Popularity}_i - \textit{Popularity}_j$		0.000	-0.002
		(0.003)	(0.002)
N	2228	2228	2228
R-squared	0.384	0.039	0.396

More Rational Individual Takes Larger Bargaining Power

I_{ig}	(1)	(2)	(3)	(4)
Group and Individual Char., Friendship	No	Yes	Yes	Yes
Individual FE	No	No	No	Yes
$1(\text{Higher CCEI})_{it}$	-0.411**		-0.405**	-0.421**
	(0.024)		(0.024)	(0.022)
$1(\text{Endline})_t$	0.036+		0.034+	
	(0.018)		(0.018)	
$1(\text{Higher CCEI})_{it} \times 1(\text{Endline})_t$	-0.071+		-0.067+	
	(0.037)		(0.036)	
$\textit{Math Score}_i$		-0.001	-0.000	-0.001
		(0.001)	(0.000)	(0.001)
$\textit{Math Score}_i - \textit{Math Score}_j$		-0.021**	-0.012*	-0.001
		(0.006)	(0.005)	(0.007)
$\textit{Popularity}_i - \textit{Popularity}_j$		0.000	-0.002	0.002
		(0.003)	(0.002)	(0.005)
N	2228	2228	2228	2228
R-squared	0.384	0.039	0.396	0.731

Individual Rationality is Most Important Determinant of Revealed Bargaining Power



Risk Preference Aggregation

$$RA_{gt} = \alpha + \beta_1 RA_{i_1^{CCEI}gt} + \beta_2 RA_{i_2^{CCEI}gt} + \beta_3 RA_{i_1^{CCEI}gt} \times 1(\text{Endline})_t + \beta_4 RA_{i_2^{CCEI}gt} \times 1(\text{Endline})_t + \Sigma_l \gamma_l RA_{i_1^{l}gt} + \tau_c + \varepsilon_{gct}. \quad (5)$$

- $RA_{i_1^{CCEI}gt}$ RA of more rational individual
- $RA_{i_2^{CCEI}gt}$ RA of less rational individual
- $\beta_1, \beta_2 > 0$: Both individuals' RA matter
- $\beta_1 > \beta_2$: The more rational one's RA matters more

Individual RP (Esp. The More Rational One's) Determines Group RP

RA_g (mean= 0.297, sd= 0.142)	(1)	(2)	(3)	(4)	(5)
Group and Individual Char., Friendship	No	No	Yes	Yes	Yes
Group FE	No	No	No	No	Yes
$RA_{HighCCEI}$	0.472**	0.421**		0.323**	0.307**
	(0.028)	(0.037)		(0.076)	(0.092)
$RA_{LowCCEI}$	0.355**	0.352**		0.280**	0.243**
	(0.036)	(0.036)		(0.061)	(0.085)
Endline		-0.037**		-0.039**	
		(0.013)		(0.014)	
Endline $\times$ $RA_{HighCCEI}$		0.084+		0.091*	
		(0.043)		(0.044)	
$RA_{HighMathScore}$			0.388**	0.073+	0.026
			(0.059)	(0.043)	(0.047)
$RA_{LowMathScore}$			0.316**		
			(0.062)		
$RA_{HighPopularity}$			-0.023	-0.027	-0.029
			(0.050)	(0.051)	(0.060)
N	1304	1304	1304	1304	1304

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N	1304	1304	1304	1304	1304

Why Larger Bargaining Power for More Rational Individual?

- Greater rationality: more consistent and “clearer” preferences
- Importance communication in group deliberation (Burnstein et al. 1973, Goeree & Yariv 2011)
- More rational individual has larger bargaining power when communication is easier?

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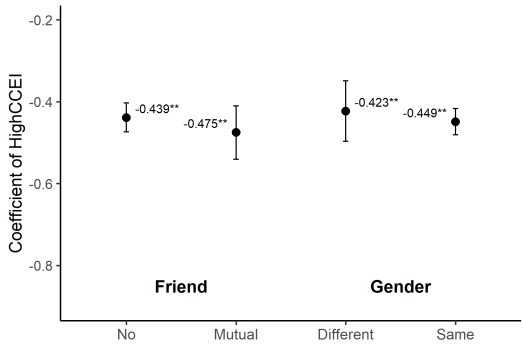

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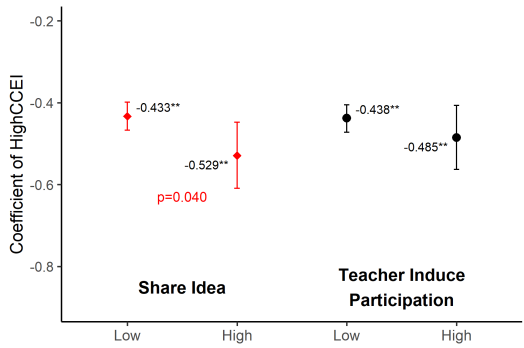

What Did We Do

- Individual DM ability (rationality) $\xrightarrow{\text{causation}}$ Group DM
  - Large-scale panel experiments on individual and group DM with random pairing
- Nonparametric, revealed-preference measure of **individual (bargaining) power**

What Did We Learn?

1. Marked heterogeneity in group's rationality
   e.g., Samuelson, 1938; Choi et al., 2007,2014; Echenique et al., 2011; Halevy et al., 2018

2. Individual rationality is a main source of bargaining power, and quality of group DM
   e.g., Chiappori, 1992; Feddersen & Pesendorfer, 1998; Arrow, 1951

3. Individual rationality matters the most, with other characteristics' less explanatory power
   e.g., Behrman et al., 2012; Yilmazer et al., 2015; Guiso et al., 2023; Gu et al., 2023

Thank you!

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