6. Bargaining

Ryan Oprea

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Extensive Form Games
The Ultimatum Game
The Dictator Game and Social Preferences
Markets vs. Bargaining
Strange Results from Dictator Games
Reciprocity

- **Individual choice experiments**
  - Test assumptions about Homo Economicus

- **Strategic interaction experiments**
  - Test game theory

- **Market experiments**
  - Test classical notions of competitive equilibrium
Extensive Form Games

Idea: Many strategic problems unfold **sequentially** over time in stages

Instead of studying **normal form games** (as we did last week) we can study **extensive form games**.

- Instead of representing in a **matrix**, we represent in a **game tree**/
Components of an extensive form games:

A list of players.
Extensive Form Games

Components of an extensive form game:

A set of decision nodes.
Components of an extensive form game:

A set of links representing consequences of decisions at each node.
Extensive Form Games

Components of an extensive form game:

A set of **terminal nodes** showing earnings consequences of the sequence of play.
Extensive Form Games

Components of an extensive form game:

Extensive form games can also be divided into subgames (for each decision node, includes everything following the node).
Subgame Perfection

How do you solve these games?

Nash equilibrium can be calculated just as in any game.

However we can refine Nash equilibrium to take account of the fact that decisions precede other decisions.

Subgame Perfect Nash Equilibrium

- Choose only strategies that are Nash Equilibria in every proper subgame of the game.
Backwards Induction

An intuitive way to find subgame perfect Nash equilibria:

- Fold back the game tree starting at terminal decision nodes
- Keep only actions that survive.
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Ultimatum Bargaining

A very simple bargaining game, studying the effect of bargaining power on outcomes.

**Proposer** chooses an offer on how to split a fixed pool of money (i.e. $10)

- Example: I give you $4 and keep $6 for myself.

**Responder** chooses whether to accept or reject the offer.

- If rejected, neither player earns anything!
Ultimatum Bargaining

What does game theory predict?

Proceed by backwards induction:

1. What does the proposer want the responder to choose?
**Ultimatum Bargaining**

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1. What does the proposer want the responder to choose?
   - Right!

2. What does the proposer have to do to make the responder do that?
Ultimatum Bargaining

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   - Any $x > 0$

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2. What does the proposer have to do to make the responder do that?
   - Any $x > 0$

3. So what will the proposer offer?
   - $x = 1$ (or whatever the smallest increment available is)
Ultimatum Bargaining

Is this what happens in actual (one-shot) ultimatum games?

Proposer

Responder

0 10

(0,0) (10-x,x)

Proposers rarely make low offers (usually closer to $4 or $5).

Why do proposers make such high offers? Two basic classes of explanation:

1. Proposers are altruistic (or averse to inequity).
2. Proposers foresee that responders will be angry about low offers and, backwards inducting, make higher offers.

No! Low offers are rejected by Responders and...
Ultimatum Bargaining

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Dictator Game

How do we design a game that separates these two explanations?

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Dictator Game

What happens in a typical Dictator Game?
Dictator Game

What happens in a typical Dictator Game?

![Graph showing frequency of different offers in standard Dictator Game, Double Blind, and Earned Position+Double Blind conditions.](image_url)
Social Preferences

Several theories have been advanced to explain these types of results.

A prominent approach is simply to modify the typical utility function:

- **Altruism:** $U(y_{mine}, y_{yours})$
- **Inequity Aversion:** $U(y_{mine}, |y_{mine} - y_{yours}|)$

Adjustments like this to standard theory seem to account for dictator game and ultimatum results.

But results from other experiments suggest things are more complicated (and interesting)!
Roth et al (1991) study a market game in which there are multiple proposers (usually 9) and one responder.

- The responder chooses to accept or reject the best offer.

What is the subgame perfect Nash equilibrium?
The Market Game

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- Proposers should send the maximum amount possible (i.e. everything)!
- Notice results are hugely unequal, just as in a standard ultimatum game!

Details of the experiment
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Details of the experiment

- Roth et al (1991) ran in multiple countries
- Ran both market games and ultimatum games for comparison!
Ultimatum Results
Market Results

YUGOSLAVIA, ROUND 1
(400,000 DIN, NUMBER OF OBSERVATIONS = 36)

JAPAN, ROUND 1
(2,000 YEN, NUMBER OF OBSERVATIONS = 36)

ISRAEL, ROUND 1
(20 IS, NUMBER OF OBSERVATIONS = 36)

YUGOSLAVIA, ROUND 10

JAPAN, ROUND 10

ISRAEL, ROUND 10

Prašnikar 12/14/88, 12/28/89
Okuno 5/17/89, 5/19/89
Zanik 4/4/89
Market Game

Two environments (markets and bargaining) with identical levels of equilibrium inequity.

But results are totally different
- Subjects learn to conform with theory in markets
- but not in bargaining!

Why?
- One explanation is that the “impersonal nature” of markets reduces the impact of “social preferences.”
- Fehr and Schmidt (1999) argue that this pattern of results is actually consistent inequity aversion models!
Cherry et al. (2002) design a dictator game experiment that calls standard explanations into question:
Cherry et al.

Run the experiment “double blind” (experimenter doesn’t see who did what):

![Graph showing frequency of offers in different conditions: Standard Dictator Game, Double Blind, Earned Position+Double Blind. The graph shows a higher frequency of offers in the Double Blind condition compared to the Standard Dictator Game and Earned Position+Double Blind conditions.](image)
Double blind, but also make people earn the right to be dictator:
Give both players $5 and then allow the Proposer to make an allocation decision:

- **Baseline**: give between $0 and $5.
- **Take($1)**: as above, but also have option to **take** $1!
- **Take($5)**: as above, but can **take** up to $5!
- **Earnings**: Like Take($5) but subjects earned their money!
Fig. 1.—Baseline treatment (data online table B1)
Fig. 2.—Treatment Take ($1) (data online table B2)
Fig. 3.—Treatment Take ($5) (data online table B3)
Fig. 4.—Treatment earnings (data online table B4)
Berg et al. (1995) introduced the “investment game”:

1. Proposers decides on an amount, \(0 \geq x \leq 10\) (just as in Dictator or Ultimatum games) but
2. Receiver gets \(3x\) (instead of \(x\))
3. and decides on an amount \(y\) to return.

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2. Receiver gets $3x$ (instead of $x$)
3. and decides on an amount $y$ to return.

What is the subgame perfect Nash equilibrium?

- What $y$ should Responder choose for each $x$?
- What should Proposer do given this?
- Is this efficient?
Investment Game

Baseline results:

![Bar chart showing the distribution of Amount Sent, Total Return, and Payback. The chart includes data points indicating the maximum, average, and total return values.]
Investment Game

Tell subjects about past outcomes first (social history treatment):
Investment Game

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Investment Game

What is this type of experiment trying to test?

Why do Responders return money?

Why do Proposers send money in the first place?

Two prominent explanations:

• Subjects have one another's payoffs in their utility functions (e.g. altruism, inequity aversion).

• Responders reciprocate to the pro-cooperative intentions signaled by the Proposer's act of trust.

How do we test each of these theories?
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Trust Game

Common to simplify by moving from the investment game to the trust game

What is the subgame perfect Nash equilibrium?
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What is the subgame perfect Nash equilibrium?

- Responder would choose left so
- Proposer chooses right, effectively ending the game.

What happens in a typical experiment?
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What happens in a typical experiment?
Given these conditional probabilities, would it be **irrational** for the Proposer to choose “down?”

What is the expected value of going down vs. going right?
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What is the expected value of going down vs. going right?

- $11.25 > 10$
- A risk neutral Proposer has a good reason to choose down
- Of course it is riskier to do so (given 25% Responder chooses left).
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How might we modify this game to study whether the Responder is altruistic vs. responding to pro-social intentions?

McCabe et al. (2003) compare the standard trust game to an involuntary trust game.
Involuntary Trust Game

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Involuntary Trust Game

What is the hypothesis under the theory that

- This pattern of behavior is altruism/inequity aversion vs.
- an intentionality effect?
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- an intentionality effect?

Instead of most Responders choosing right, most choose left!

- Strong evidence that intentionality really matters.
- (see also the difference between extensive form social dilemmas and normal form social dilemmas)
Charness and Rabin (2003)

**Idea:** Run subjects through a lot of different simple games

- How often are decisions consistent with a broader set of models of decision making?

- **Narrow self-interest:** Make choice that maximizes my own earnings.
- **Competitive:** Make choice that ensures I earn more than others (while maintaining own payoffs).
- **Difference Aversion:** Make choice that minimizes difference in payments.
- **Social welfare:** Make choice that maximizes sum total of earnings.
## Dictator Games

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### Strange Results from Dictator Games

- Berk29: Strongest evidence of difference aversion (no countervailing motives).
- Berk23: No ultimatum-like punishment of inequality!
- Berk 2, 17: Sacrifice money to increase difference!
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**Table II: Consistency of Behavior with Distributional Models**

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<td>636</td>
<td>579</td>
<td>671</td>
<td>661</td>
</tr>
<tr>
<td></td>
<td>(94%)</td>
<td>(86%)</td>
<td>(100%)</td>
<td>(99%)</td>
<td></td>
</tr>
<tr>
<td>A’s behavior, correct predictions by A</td>
<td>671</td>
<td>466</td>
<td>488</td>
<td>603</td>
<td>649</td>
</tr>
<tr>
<td></td>
<td>(69%)</td>
<td>(73%)</td>
<td>(90%)</td>
<td>(97%)</td>
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</tr>
<tr>
<td>All behavior, any predictions by A</td>
<td>1574</td>
<td>1326</td>
<td>1158</td>
<td>1356</td>
<td>1497</td>
</tr>
<tr>
<td></td>
<td>(84%)</td>
<td>(74%)</td>
<td>(86%)</td>
<td>(95%)</td>
<td></td>
</tr>
<tr>
<td>All behavior, correct predictions by A</td>
<td>1574</td>
<td>1156</td>
<td>1067</td>
<td>1288</td>
<td>1485</td>
</tr>
<tr>
<td></td>
<td>(73%)</td>
<td>(68%)</td>
<td>(82%)</td>
<td>(94%)</td>
<td></td>
</tr>
</tbody>
</table>

- Dictator games: Social welfare seems best overall explanation!
6. Bargaining

Economics 176

Extensive Form Games

The Ultimatum Game

The Dictator Game and Social Preferences

Markets vs. Bargaining

Strange Results from Dictator Games

Reciprocity

Dictator Games

### Consistency of Behavior with Distributional Models
When the Prediction Is Unique
(Entries are chances taken over total chances.)

<table>
<thead>
<tr>
<th>Class of games</th>
<th>Narrow self-interest</th>
<th>Competitive</th>
<th>Difference aversion</th>
<th>Social welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>B's behavior in the dictator games</td>
<td>132/206</td>
<td>104/196</td>
<td>49/106</td>
<td>54/62</td>
</tr>
<tr>
<td></td>
<td>(64%)</td>
<td>(53%)</td>
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<td>(87%)</td>
</tr>
<tr>
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<td>350/517</td>
<td>304/363</td>
</tr>
<tr>
<td></td>
<td>(72%)</td>
<td>(58%)</td>
<td>(68%)</td>
<td>(84%)</td>
</tr>
<tr>
<td>B's behavior in all games</td>
<td>478/685</td>
<td>423/747</td>
<td>399/623</td>
<td>358/425</td>
</tr>
<tr>
<td></td>
<td>(70%)</td>
<td>(57%)</td>
<td>(64%)</td>
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</tr>
<tr>
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</tr>
<tr>
<td></td>
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</tr>
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</tr>
<tr>
<td>All behavior, any predictions by A</td>
<td>650/911</td>
<td>635/1051</td>
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## Dictator Games

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- Dictator games: Social welfare seems best overall explanation!
### Reciprocity Games

<table>
<thead>
<tr>
<th>Two-person response games—</th>
<th>Out</th>
<th>Enter</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>B's sacrifice helps A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Barc3 (42)</strong></td>
<td>.74</td>
<td>.26</td>
<td>.62</td>
<td>.38</td>
</tr>
<tr>
<td>A chooses (725,0) or lets B choose (400,400) vs. (750,375)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Barc4 (42)</strong></td>
<td>.83</td>
<td>.17</td>
<td>.62</td>
<td>.38</td>
</tr>
<tr>
<td>A chooses (800,0) or lets B choose (400,400) vs. (750,375)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Berk21 (36)</strong></td>
<td>.47</td>
<td>.53</td>
<td>.61</td>
<td>.39</td>
</tr>
<tr>
<td>A chooses (750,0) or lets B choose (400,400) vs. (750,375)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Barc6 (36)</strong></td>
<td>.92</td>
<td>.08</td>
<td>.75</td>
<td>.25</td>
</tr>
<tr>
<td>A chooses (750,100) or lets B choose (300,600) vs. (700,500)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Barc9 (36)</strong></td>
<td>.69</td>
<td>.31</td>
<td>.94</td>
<td>.06</td>
</tr>
<tr>
<td>A chooses (450,0) or lets B choose (350,450) vs. (450,350)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Berk25 (32)</strong></td>
<td>.62</td>
<td>.38</td>
<td>.81</td>
<td>.19</td>
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<tr>
<td>A chooses (450,0) or lets B choose (350,450) vs. (450,350)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Berk19 (32)</strong></td>
<td>.56</td>
<td>.44</td>
<td>.22</td>
<td>.78</td>
</tr>
<tr>
<td>A chooses (700,200) or lets B choose (200,700) vs. (600,600)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Berk14 (22)</strong></td>
<td>.68</td>
<td>.32</td>
<td>.45</td>
<td>.55</td>
</tr>
<tr>
<td>A chooses (800,0) or lets B choose (0,800) vs. (400,400)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Barc1 (44)</strong></td>
<td>.96</td>
<td>.04</td>
<td>.93</td>
<td>.07</td>
</tr>
<tr>
<td>A chooses (550,550) or lets B choose (400,400) vs. (750,375)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Berk13 (22)</strong></td>
<td>.86</td>
<td>.14</td>
<td>.82</td>
<td>.18</td>
</tr>
<tr>
<td>A chooses (550,550) or lets B choose (400,400) vs. (750,375)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Berk18 (32)</strong></td>
<td>.00</td>
<td>1.00</td>
<td>.44</td>
<td>.56</td>
</tr>
<tr>
<td>A chooses (0,800) or lets B choose (0,800) vs. (400,400)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Reciprocity Games

<table>
<thead>
<tr>
<th>Four-person response games—B’s sacrifice hurts A</th>
<th>Out</th>
<th>Enter</th>
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<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barc11 (35) A chooses (375,1000) or lets B choose (400,400) vs. (350,350)</td>
<td>.54</td>
<td>.46</td>
<td>.89</td>
<td>.11</td>
</tr>
<tr>
<td>Berk22 (36) A chooses (375,1000) or lets B choose (400,400) vs. (250,350)</td>
<td>.39</td>
<td>.61</td>
<td>.97</td>
<td>.03</td>
</tr>
<tr>
<td>Berk27 (32) A chooses (500,500) or lets B choose (800,200) vs. (0,0)</td>
<td>.41</td>
<td>.59</td>
<td>.91</td>
<td>.09</td>
</tr>
<tr>
<td>Berk31 (26) A chooses (750,750) or lets B choose (800,200) vs. (0,0)</td>
<td>.73</td>
<td>.27</td>
<td>.88</td>
<td>.12</td>
</tr>
<tr>
<td>Berk30 (26) A chooses (400,1200) or lets B choose (400,200) vs. (0,0)</td>
<td>.77</td>
<td>.23</td>
<td>.88</td>
<td>.12</td>
</tr>
</tbody>
</table>
Reciprocity Games

<table>
<thead>
<tr>
<th>Games with the choice between (400,400) and (750,400)</th>
<th>(400,400)</th>
<th>(750,400)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berk29 (26) B chooses (400,400) vs. (750,400)</td>
<td>.31</td>
<td>.69</td>
</tr>
<tr>
<td>Barc7 (36) A chooses (750,0) or lets B choose (400,400) vs. (750,400)</td>
<td>.06</td>
<td>.94</td>
</tr>
<tr>
<td>Barc5 (36) A chooses (550,550) or lets B choose (400,400) vs. (750,400)</td>
<td>.33</td>
<td>.67</td>
</tr>
</tbody>
</table>

- Compare Berk29 to Barc7 – large effect of intentionality!
Reciprocity Games

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<thead>
<tr>
<th>Games with the choice between (400,400) and (750,400)</th>
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<td>Barc5 (36) A chooses (550,550) or lets B choose (400,400) vs. (750,400)</td>
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<td>.67</td>
</tr>
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</table>

- Compare Berk29 to Barc7 – large effect of intentionality!
- Compare Barc5 to Berk29 and Barc7 – no punishment (overall a lot less costly punishment than you would think in this data)! 

bigskip