Lecture 4: Bargaining

Primary reference: McAfee, *Competitive Solutions*, Ch. 14
Bargaining

- A fundamental part of executing business plans.
- Often characterized by a high degree of strategic interdependence.
- Typically sequential in nature, so it requires forward thinking and backward reasoning.
- An extreme version of bargaining, which is realistic in some settings, is the take-it-or-leave-it offer...
The Ultimatum Game

- One unit of surplus is to be divided.
- One player, the “proposer,” names a division of the surplus.
  - For example, 50/50, 90/10, 99/1, etc.
- The other player, the “responder,” then chooses to accept or reject the offer.
- If the offer is accepted, the surplus is divided according to the proposer’s offer.
- If the offer is rejected, both players get nothing.
Management and labor negotiate over how to divide the profits.

The season lasts 101 days and each day yields a $1,000 profit.

One offer may be made per day, so if an offer is rejected, the profit to share shrinks by $1,000.

The union makes the first offer, just prior to the first day of the season.

How do we expect this game to play out?
To solve the game, think forward and reason backwards.

Start with the last day...the union would be making the offer...what would they offer?

What would management accept? (A penny more than) nothing.

Note that we are back in the world of rational players.

So the union’s last day offer is to keep $1,000 for themselves and let management have zero.

Working back a period, in the second-to-last period, management must offer the union at least $1,000, as the union could always reject their offer and move to the final period. So management is best off offering a 50/50 split, $1,000 for each.
Alternating Offers - Working Backwards

<table>
<thead>
<tr>
<th>Days to go</th>
<th>Offer By</th>
<th>Union’s Share</th>
<th>Mgmt’s Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Per Day</td>
<td>Total</td>
</tr>
<tr>
<td>1</td>
<td>Union</td>
<td>1,000</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Management</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>3</td>
<td>Union</td>
<td>2,000</td>
<td>1,000</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>Management</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>101</td>
<td>Union</td>
<td>51,000</td>
<td>50,000</td>
</tr>
</tbody>
</table>

- Although the game *could* last the entire summer, in equilibrium the parties reach an agreement at the first offer.
- Note that the surplus split (when the union makes the offer) gets more and more "fair" as the number of periods increases.
Suppose the players are dividing $1. Suppose they discount future payoffs and let the number of periods be infinite.

- The pie could be getting smaller because time is of the essence.
- Discounting can also be interpreted as representing some probability that one of players loses interest in the project.

Let the players be Ann (A) and Bob (B). Let Ann discount the future at rate $a$, so that $1$ in the next period is worth $1-a$ in the current period. Similarly, let Bob discount the future at rate $b$.

- Higher levels of discounting can also be interpreted as indicating a longer time between offers.
What to offer?

- With the infinite horizon, the game is simpler in that Bob and Ann face the “same” problem (differences in $a$ and $b$ notwithstanding).

- Suppose it is Bob’s turn to make the offer. Let $A$ be the smallest amount Ann will accept. Then Bob will offer this. Similarly, let $B$ be the smallest amount Bob will accept when Ann makes the offer. Then Ann will offer this.

- We find:

$$A = (1 - a) \times (1 - B)$$

$$B = (1 - b) \times (1 - A).$$

- “smallest amount Ann will accept” = “what she would get by waiting a period and offering the smallest amount Bob would accept.”
Solving For The Equilibrium

▶ Two equations in two unknowns.
▶ We find:

\[
A = \frac{(1-a)b}{1-(1-a)(1-b)}
\]

\[
B = \frac{(1-b)a}{1-(1-a)(1-b)}
\]

▶ If \(a = b\), then the offers are the same...but the surplus is \textit{not} split 50/50. The person making the offer gets more, because it is the responder who must wait until the pie shrinks before making an offer.

▶ If \(a = b\) \textit{and} offers can be made instantaneously, or if \(a = b = 0\), then the surplus is split 50/50.

▶ If \(a < b\), then Ann is “more patient.” She will receive more. For example, if \(a = .05\) and \(b = .1\), then Bob would offer Ann .655 (keeping .345 for himself) while Ann would offer Bob .31 (keeping .69 for herself).
Outside Options and Value Added

- In both examples we have considered, the players had no alternative way of obtaining part of the surplus.

- Revisiting the resort example, suppose now that the union can earn $300 per day (working different jobs) and management can earn $500 per day (hiring replacement workers).

- The union will never accept any offer for less than $300 per day, and management will accept no offer less than $500 per day.

- It is no longer appropriate to think about $1,000 as the amount to be divided. Rather, it is now $1,000 - $300 - $500 = $200. This is the **bargaining surplus**. Intuitively, the bargaining surplus is the extra surplus realized from the bargain, over the surplus realized absent a bargain.

- For the union, $300 is its **threat point** (or **disagreement point** or **walkaway point** or **Best Alternative To a Negotiated Agreement (BATNA)**).
Consider two players, denoted 1 and 2. Let the threat points be $u_1$ and $u_2$.

Let the payoffs under bargaining be $u_1$ and $u_2$ and require $u_1$ and $u_2$ to be in some set of possibilities, $\mathcal{U}$.

For example, in the resort case, the total payoffs could not exceed $1,000$.

The Nash bargaining solution is denoted $(u_1^*, u_2^*)$, which solves

$$\max_{(u_1, u_2)} (u_1 - u_1)(u_2 - u_2)$$

The outcome is efficient. The largest possible pie is created.
The outcome also yields a symmetric division of the bargaining surplus. Each player gets her threat point plus half of the bargaining surplus.

In the resort example, let the union be player 1 and let management be player 2. Then

\begin{align*}
\text{Union gets } u_1^* &= 300 + \frac{1}{2} (1,000 - 300 - 500) = 400. \\
\text{Management gets } u_2^* &= 500 + \frac{1}{2} (1,000 - 300 - 500) = 600.
\end{align*}

This closely approximates the solution under alternating offers for cases where the sides have similar levels of patience, they are not overly impatient, and the number of periods played is high.
Cooperative Bargaining - A Convenient Shorthand

- With this shorthand notion of the outcome of bargaining, it is easier to focus on the problem of how to improve your outcomes, taking as a given how bargaining itself will play out.

- Generally, if there’s 1,000 maximum surplus available, player $i$’s payoff is

$$u_i^* = u_i + \frac{1}{2}(1,000 - u_i - u_j).$$

- It is easy to adjust this formula to account for the phenomenon where one party is somehow better at bargaining:

$$u_i^* = u_i + \beta(1,000 - u_i - u_j).$$

- Let $\beta$ be person $i$’s bargaining power. If $\beta = 1$, person $i$ is exceptional at bargaining (or has some structural advantage, like being the offerer in an ultimatum game).
Improving One’s Bargaining Position

- A player’s payoff is increasing in her threat point and decreasing in the other player’s threat point.
- Hence, if you can increase your own threat point or lower the other player’s threat point, you improve your own payoff.
- What matters is the relative effect of an action. In the resort example, if the union sacrifices $100 per day of its outside option to set up a picket line, and this costs management $200, the union will wind up earning $450 per day in bargaining instead of $400.
Oil refineries are typically set up to process a particular type of oil.

Oil with low sulfur is called “sweet” (high-sulfur oil is called “sour”).

“Light” crude contains a higher proportion of valuable material than “heavy” crude.

“Light sweet crude” is the most valuable oil.
The north slope of Alaska held large deposits of ANS, a fairly light, sweet crude. Many California refineries were set up to process ANS.

As supplies of ANS began to decline in the 1990s, the price of ANS rose. But prices charged by BP (the largest seller of ANS) varied by refinery.

Refineries set up more flexibly—that is, able to process alternative varieties of oil—received lower prices.

This is an example of the holdup problem. Refineries whose investments and assets were highly specific to ANS were “held up,” because they had no alternatives. Refineries with greater flexibility had superior threat points in negotiations.
The Holdup Problem Generally

- Holdup problems are widespread phenomena. Investments capable of creating enormous value are often specific to one party.
- Holdups tend to occur when two conditions are present:
  - Contracts are incomplete.
  - Investments are highly specific.
- When contracts are incomplete, they tend to be renegotiated. Hence, bargaining determines ultimate outcomes.
- When investments raise the total surplus of an enterprise, but the division of surplus occurs via bargaining, the investing party *splits* the surplus with the other party. As a result, it tends to make inefficient investments.
The Holdup Problem Generally - Avoiding Both Bad Bargaining Positions and Underinvestment

- Intel, the pioneer of integrated circuit production, sells to manufacturers who must spend resources to tailor their products to Intel’s chips.
- By tailoring, firms risk being locked in...so in early years Intel feared that this might make firms reluctant to do so.
- Their solution was to “second source” their technology to firms like Advanced Micro Devices (AMD).
- In many instances, a good solution to hold-up problems is vertical integration.
  - Power plants located near coal mines are subject to holdup problems. Such plants and mines are frequently jointly owned (see Joskow 1985, 1987).
The Card Game

- An example of bargaining with more than 2 players.
- I have 26 black cards. The 26 red cards are distributed among 26 individuals. Each pair of cards turned in is worth $100.
- Students cannot get together and bargain as a group. They must bargain individually.
- How will the surplus be split?
- If I offer you $20, should you take it, or reject and wait for another offer?
- Who “holds all the cards?”
You should reject my offer of $20 and be patient. I need you
to get value from one of my black cards.

If each of you are patient, you should expect to roughly split
the surplus evenly.

But what if I were to destroy 3 cards?
Adding Value

- If I destroy 3 cards, now there is just $2300 in value, less than $2600.

- However, I have changed the game dramatically. When there were 26 black cards, each red card added $100 in value (without it, there’s no pair). With only 23 cards, each of you adds zero value at the margin.

- I don’t need any individual one of you. I have outside options, while you do not.

- If I offer you $20, you should take it.

- By being on the short side of the market, I dramatically increase the amount of value I capture from bargaining.