Game Theory and Strategic Behavior

1. Modeling Strategic Behavior
2. Prisoner’s Dilemma
3. A Game of Chicken
4. A Soccer Game
5. Win Midterm Points

Modeling Strategic Thinking

• Up until now, we have assumed that each person or firm solved his or her economic problem not taking into account the actions of others.
• However in many economic decisions, one must take into account the actions of others.
• Game theory is the branch of microeconomics concerned with the analysis of optimal decision making in competitive situations.
• Why a game? If you are playing chess, your moves will depend on the moves of the other player. It would be dumb to move your pieces ignoring what you opponent is doing (or you expect her to do).

The Prisoner’s Dilemma

• The classic game ...
• Two suspects in crime are arrested and placed in separate cells.
• The police, who have no real evidence against either, privately give each prisoner the chance to confess and implicate the other suspect for the crime.
• They tell each prisoner that
  – if neither confesses, both will be convicted on a minor charge and spend 2 years in jail.
  – if both confess, both will be convicted on a more serious charge and spend 5 years in jail.
  – if one confesses and the other doesn’t, the one who confesses will go free while the one who does not confess will spend 10 years in jail.
• We can display this game in a payoff matrix which is a table showing the payoff for each player given her decision and the decision of the other player.
A Payoff Matrix

<table>
<thead>
<tr>
<th>Suspect One</th>
<th>confess</th>
<th>don’t confess</th>
</tr>
</thead>
<tbody>
<tr>
<td>confess</td>
<td>-5, -5</td>
<td>0, -10</td>
</tr>
<tr>
<td>don’t confess</td>
<td>-10, 0</td>
<td>-2, -2</td>
</tr>
</tbody>
</table>

- **A dominant strategy** is a strategy that is better than any other a player might choose, no matter what strategy the other player follows.
- The dominant strategy for each prisoner is to confess. Why?
- **A dominated strategy** is a strategy such that the player has another strategy that gives a higher payoff no matter what the other player does.
- We want to eliminate the dominated strategies.
- **The Nash equilibrium** is the outcome in which each player chooses the strategy that yields the highest payoff given the strategies chosen by the other player.
  - Each player asks himself, taking as given what the other player is doing, do I want to change my decision?
  - If each player answers no, we have found a Nash equilibrium.

Comments on the Prisoner’s Dilemma

- The prisoner’s dilemma there is a tension between the collective interest of all of the players and the self-interest of individual players.
- Earlier in the course we argued that individual pursuit of self-interest promotes the greatest good for all. This is Adam Smith’s celebrated insight of the invisible hand.
- But as the prisoner’s dilemma shows, there are cases in which rational individuals acting in their own self interest can result in outcomes that no one favors.
- This occurs particularly when relative performance rather than absolute outcomes matter.
- See Robert Frank’s New York Times article on hockey players in the reading packet.

Other Examples of the Prisoner’s Dilemma

- Sling Mud in a political race ...
  - If both candidates run a positive campaign and refuse to engage in negative ads, they both have a 50-50 chance of winning.
  - If one candidate runs a negative campaign while the other doesn’t, their odds of winning become 60-40 in favor of the negative candidate.
  - If both candidates run a negative campaign, they both have a 50-50 chance of winning.
Politician Two
dirty campaign clean campaign
Politician One dirty campaign clean campaign

<table>
<thead>
<tr>
<th></th>
<th>dirty campaign</th>
<th>clean campaign</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%, 50%</td>
<td>60%, 40%</td>
<td></td>
</tr>
<tr>
<td>40%, 60%</td>
<td>50%, 50%</td>
<td></td>
</tr>
</tbody>
</table>

Arms Races ...

India
bigger military smaller military

Pakistan
bigger military smaller military

<table>
<thead>
<tr>
<th></th>
<th>bigger military</th>
<th>smaller military</th>
</tr>
</thead>
<tbody>
<tr>
<td>−5, −5</td>
<td>0, −10</td>
<td></td>
</tr>
<tr>
<td>−10, 0</td>
<td>−2, −2</td>
<td></td>
</tr>
</tbody>
</table>

Collusion with a competing firm ...

Company Two
set price low set price high

Company One set price low set price high

<table>
<thead>
<tr>
<th></th>
<th>set price low</th>
<th>set price high</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2, $2</td>
<td>$10, $1</td>
<td></td>
</tr>
<tr>
<td>$1, $10</td>
<td>$5, $5</td>
<td></td>
</tr>
</tbody>
</table>

The Game of Chicken

- Two teenagers each get into their cars at opposite ends of the road and begin to drive toward each other at break-neck speed.
- If one car swerves before the other, the one that did not swerve (i.e. stays) proves his manhood and becomes a hero to his friends. The one who swerved loses face and becomes the 'chicken'.
- If both swerve, nothing happens. Neither gain status, but neither are a chicken.
- If both stay, both end up in the hospital with serious injuries.
**Other Examples of the Game of Chicken**

- Often occurs in economics when two firms compete in a market that can profitably support only one firm.
- Consider the satellite radio market
  - Two companies: XM and Sirius
  - Almost all the costs to running the firm are fixed costs. The marginal cost of an additional subscriber is close to zero.
  - Need LOTS of subscribers to be profitable.

<table>
<thead>
<tr>
<th></th>
<th>Sirius</th>
<th>XM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stay</td>
<td>$-200$, $-200$</td>
<td>$300$, $0$</td>
</tr>
<tr>
<td>Exit</td>
<td>$0$, $300$</td>
<td>$0$, $0$</td>
</tr>
</tbody>
</table>

**Pure versus Mixed Strategies**

- Consider a soccer game in which the game is tied and may be decided by a single penalty kick.
  - If the goalie dives (to the kicker’s) right, and the kicker aims right, goal is blocked and game continues.
  - If the goalie dives left, and the kicker aims left, goal is blocked and game continues.
  - If the goalie dives right, and the kicker aims left, goal is made and game is over.
  - If the goalie dives left, and the kicker aims right, goal is made and game is over.
• This game does not appear to have a Nash equilibrium.
  – If the goalie believes the kicker will aim right, the goalie’s best strategy is dive right.
  – But if the kicker believes that the goalie believes that the kicker will aim right (and thus dive right), the kicker’s best strategy is to kick left.
  – Well if the goalie believes that the kicker believes that the goalie believes that the kicker will aim right (and thus dive right); then the goalie believes the kicker’s will aim left and the goalie will dive left.
  – And so on to madness ...

• We want to distinguish between pure strategies and mixed strategies
  – A pure strategy is a strategy in which a player makes a specific choice of takes a specific action.
  – A mixed strategy is a strategy in which a player makes a random choice among two or more possible actions, based on a set of chosen probabilities.

• This game does not have a Nash equilibrium in pure strategies, but it does have a Nash equilibrium in mixed strategies.
  – The kicker should “aim right” 1/2 of the time and “aim left” 1/2 of the time.
  – The goalie should “dive right” 1/2 of the time and “dive left” 1/2 of the time.

• Unpredictability can have strategic value.

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Win Midterm Points

• Everyone gets a index card.
• Each will choose a number between 0 and 50.
• We will take an average of all the chosen numbers.
• The person who chooses a number closest to 1/2 of the average wins that many extra points on the midterm

• Example:
  – 3 people play
  – one chooses 15; another 25; the third 35.
  – average is 25, so 1/2 of 25 is 12.5.
  – player who picked 15 wins 12.5 extra points on their midterm