Lecture 2: Game Theory Basics

Primary reference: Dixit and Skeath, Games of Strategy, Ch. 2 and 4.
A framework for understanding behavior by players who are mutually aware that they behave in a setting of strategic interdependence.


Strategy: an action or set of actions chosen by a player.

Interdependence: actions have cross-effects on outcomes.
  - Without interdependence, there really is no game.

Mutual Awareness: the players incorporate cross-effects into their thinking.
  - Price-taking behavior is inconsistent with mutual awareness.
Which Businesses Play Games?

- Look for markets with a small number of major players.
  - Monopolist/Entrant
  - Duopoly (including cases where there are other, far smaller, players)
  - Possibly 3 firms if they are of roughly equal size.

- Is the environment such that players are sufficiently aware of each other’s presence and intentions?
  - Do the companies reference rivals in their advertisements?
  - Do the companies routinely benchmark their products against rivals’ products?
Defining a game

- This can be a bit fuzzy.
- Suppose you are opening a coffee shop and your main decision is where to locate. Are you in a game?
- If you locate in an area where you will be the only coffee shop for certain then no, you are not in a game. You are merely making a decision. (Monopoly)
- If you locate in an area where the only other coffee shops are owned by large national chains whose strategies do not consider minor local competitors, then no, you are not in a game. You are merely making a decision. (Perfect Competition)
- If you attempt to locate where a single other firm is dominant, you are likely to find yourself in a game.
Coffee at the Athens Farmers Market

- There is one coffee vendor at the Athens Farmers Market, 1000 Faces Coffee.
- Jittery Joe’s applied to serve the Athens Farmers Market in 2009 but was denied.
  - “The current coffee vendor in the market has been a member and a sponsor since our opening day in 2008 and is by comparison [to Jittery Joe’s] just getting started. As was also stated the current market coffee vendor is on the Board of Directors.” - Jay Payne, President, Board of Directors, Athens Farmers Market, 7/22/2009. (Emphasis mine)
Examples of Games Businesses Play

- The markets that NBCU and Comcast sell in *typically* include a small number of players. It is not at all unreasonable to consider game-theoretic moves like foreclosure or exercise of market power (raising prices) in these markets.

- **Athens**... what are some other examples?

- **Your Hometown**... what are some examples?

- **Nationally**... what are some examples?
The Theory: Rules

- Timing of moves.
- Nature of actions and the cross-effects of actions on payoffs.
- Information.
- Enforceability of contracts (is the game non-cooperative?)
Timing: Simultaneous-move games

- Players act “at the same time.”
  - Throwing rock, paper or scissors.
  - Bidding in a sealed-bid auction.

- There are many environments where moves are not literally simultaneous, but assuming simultaneity (for analytical purposes) is reasonable.
  - Do I confess in a Prisoner’s Dilemma game?
  - How many heirloom tomatoes do I bring to the farmer’s market this week?
  - How deeply do I discount prices on Black Friday?
Timing: **Sequential-move games**

- Players act asynchronously (i.e. one after the other).
  - Chess, checkers.
  - Alternating offers in bargaining.

- There are many environments where some aspects of moves are not sequential, but assuming sequential moves (for analytical purposes) is reasonable.
  - How do I decide how much manufacturing capacity to build in my new plant?
  - How do I design the next generation smartphone?

- Intuitively, irreversible actions, observed by the other players, are the defining characteristic of a sequential-move game.
  - Prices are not costly to change.
  - A venture-specific investment—going “all in”—is costly to change.
Timing: Repeated simultaneous games

- Players act simultaneously in each period of a multi-period game.
  - Rock, paper scissors (best 2 out of 3).
  - Repeat interaction in auctions.
- These games are useful for helping us understand dynamic rivalry when key strategic actions are easily changed often.
  - Price wars.
  - Collusion.
  - Signaling.
Signaling and collusion in auctions

- In 1999, the German government auctioned off 10 blocks of electromagnetic spectrum using a “simultaneous ascending” format.
- The key rule was any new bid had to exceed the previous bid by at least 10%.
- Two credible bidders: Mannesman and T-Mobil.
- Mannesman’s opening bids:
  - Blocks 1-5: 18.18 million DM per MHz.
  - Blocks 6-10: 20.00 million DM per MHz.
- What is 10% of 18.18? 1.818! T-Mobil then bids 20 million DM per MHz for blocks 1-5 and the bidding ends.
- “There were no agreements with Mannesman. But [T-Mobil] interpreted Mannesman’s bids as an offer.” (T-Mobil manager)
An action

- A single choice in a single stage of a game.
- The “Pawn to King Four” opening move in chess.
- Continuous choices like price or output.
- Discrete choices like “enter the market” or “don’t enter the market.”
A strategy: a set of actions

- A single action in a non-repeated simultaneous-move game such as “rock” in a rock-paper-scissors game.
  - Action and (pure) strategy are completely synonymous in such cases.

- A set of conditional actions in a sequential-move or repeated-simultaneous game.
  - “Enter if the other firm doesn’t enter” and “Don’t enter if the other firm does enter.”
  - Very specific—must account for all contingencies. Much more specific than “counter the Ruy Lopez (pawn to king four opening plus standard subsequent moves) with the Schliemann defense.”
  - Making a split-the-difference offer in the third round of alternating-offer bargaining.

- Game theory allows for strategies to mix actions probabilistically (a mixed strategy).
  - For example, “hit first serve down the T 50% of the time, out wide 50% of the time.”
Cross Effects

- Many games are such that one player’s loss is another player’s gain. These are called zero sum games.
  - Poker, sports.

- Sometimes a payoff-increasing action hurts the other player but sometimes not. Games can (and often do) have win-win or lose-lose outcomes.

- This is relatively more common in business situations.
  - Two-sided markets (video games—consoles and games) create complementarities. Producing and selling a lot of game consoles increases the gains to making more and better games, which increases the gains to selling consoles, etc. Recently, complements have come to be known as the “sixth force,” complementing a Porter analysis.

- Price wars are destructive to all competitors.
Information

- Who knows what?

- Game theory assumes that rules, player identities, contract enforceability, etc. are common knowledge. This ensures mutual awareness of strategic interdependence.
  - I know that you know, you know that I know that you know, ...

- It leaves room for private information about payoff-relevant variables.
  - I know how much oil my geologist estimates is in a tract to be bid upon, but not how much others estimate.
  - I do know the distribution of other players' values...that is common knowledge.

- Private information may be one-sided (market for lemons, health insurance) or multi-sided (oil auction case).
Enforceability

- **Non-cooperative** game theory assumes away agreements that implement jointly optimal strategies.
  - Businesses are often forbidden from overt joint-profit maximizing agreements (collusion).
  - Breach of contract is common and may be good strategy (and even efficient!) in some circumstances.
  - Some things may be non-contractible (e.g. effort may be difficult to monitor or quantify).

- In such settings, cooperation (win-win outcomes) will emerge only if it is in the participants’ separate and individual interests to continue to take the prescribed actions.
- Alternatively, **cooperative** game theory can be a useful shorthand for thinking about certain aspects of bargaining.
Summary: Game theory and competitive strategy

- Simultaneous-move games.
  - Prisoner’s dilemmas.
  - Rivalry in oligopoly (prices, output).
  - A key building block of any industry analysis (center square in P5F), and helps us understand competitive advantage.

- Sequential-move games.
  - Bargaining - a second key building block of any industry analysis (suppliers and customers).
  - Commitment, Entry.

- Repeated simultaneous games.
  - Dynamic rivalry in oligopoly.
  - Price wars.
  - Tacit coordination.

- “Strategic” decisions.
  - Monopoly pricing.
  - Price discrimination, bundling.
The Prisoner’s Dilemma

- The classic simultaneous-move game.
- Suppose two people collaborate in an armed robbery and are arrested by the police.
- The police do not have direct evidence that these people committed the armed robbery but do have evidence of weapons violations.
- They question the suspects separately. Each suspect may “confess” or “deny,” and does not know what strategy the other suspect chooses when making her choice.
  - If both confess, they both get 5 years in jail.
  - If neither confesses, they both get 2 years in jail.
  - If one confesses while the other denies, the confessor gets 1 year in jail while the denier gets 10 years in jail.
### Prisoner’s Dilemma

The matrix representation of the game is called the **normal form**.

<table>
<thead>
<tr>
<th></th>
<th>Person 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Deny</td>
<td>-2, -2</td>
<td>-10, -1</td>
</tr>
<tr>
<td>Confess</td>
<td>-1, -10</td>
<td>-5, -5</td>
</tr>
</tbody>
</table>

- Person 1’s **payoff** is the first number of the pair, person 2’s payoff is the second.
Confess: A Dominant Strategy

- Regardless of what person 2 chooses, person 1 is better off choosing “Confess.” We say “Confess” is a **best response** to “Deny” and to “Confess.”

- The same is true for person 2’s choice.

- When a strategy is *always* a best-response, we say it is a **dominant** strategy.

- In playing a game, if you have a dominant strategy, use it. If your opponent has a dominant strategy, expect her to use it.
Solving the Prisoner’s Dilemma

- Each player finds it optimal to “Confess.”
- We say a **Nash equilibrium** is a set of strategies such that every player’s strategy is a best-response.
- If two players have dominant strategies, then that forms a unique Nash equilibrium.
Lessons from the Prisoner’s Dilemma

- The outcome is a lousy one for the players. They are both better off if they both deny.
- This is not a good game to be a player in.
- If it is possible to engineer a game where other players have dominant strategies, you can steer them toward your preferred outcome.
- If is possible to change the rules (e.g. introducing alternative strategies), that could be worth trying.
Lessons from the Prisoner’s Dilemma

- Prisoner’s Dilemmas are everywhere.
- Tobacco companies and advertising bans.
  - Tobacco advertising not very effective in getting non-smokers to smoke, but is effective at getting existing smokers to switch brands.
  - Advertising is a best-response regardless of whether other firms advertise.
  - Advertising is also costly.
  - Equilibrium involves advertising by all firms, but advertising costs shrink the pie.
  - After 1970 ban on television ads, advertising expenditure fell $63 million, profits rose $91 million.

- Other Examples?