Overview: Game Theory and Competitive Strategy I

Small Numbers and Strategic Behavior
• Fun and games with a duopoly example
  – Simultaneous vs. sequential choice
  – One-time vs. repeated game
  – Quantity vs. price as the choice variable
  – Homogeneous vs. differentiated good
• Review of the analytics

Key Ideas
• Know strategic situation (What is the game?).
• Your competitor is just as smart as you are!
• Think about the response of others
• Nash equilibrium: all participants do the best they can, given the behavior of competitors.
The Game (a)

- Objective: Max. your profit
- # of plays: 1 only
- Good: Homogeneous
- Choice variable: Quantity
- Timing of choice: Simultaneous

Game Payoffs

<table>
<thead>
<tr>
<th></th>
<th>Firm 2 (competitor)</th>
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<tbody>
<tr>
<td>15</td>
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## Game Payoffs

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The Game (a*)

- Objective: Max. your profit
- # of plays: 2
- Good: Homogeneous
- Choice variable: Quantity
- Timing of choice: Simultaneous
The Game (a**)  

- Objective: Max. your profit  
- # of plays: 10  
- Good: Homogeneous  
- Choice variable: Quantity  
- Timing of choice: Simultaneous
Analytics: Simultaneous Cournot

- Homogeneous good, simultaneous choice
- Choosing quantity, Q
- Objective: Max. your profit
- Market demand:
  \[ P = 60 - Q \]
- Production:
  \[ Q = Q_1 + Q_2 \]
  \[ MC_1 = MC_2 = 0 \]

What Is the Firm’s Reaction Curve?
(Firm 1 example)

- To max profit, set MR = MC
  \[ R_1 = PQ_1 = (60 - Q)Q_1 \]
  \[ = 60Q_1 - (Q_1 + Q_2)Q_1 \]
  \[ = 60Q_1 - (Q_1)^2 - Q_2 Q_1 \]
  \[ MR_1 = dR_1/dQ_1 = 60 - 2Q_1 - Q_2 \]
  Set \[ MR_1 = MC = 0 \], which yields
  \[ Q_1 = 30 - \frac{1}{2} Q_2 \] (Firm 1 reaction curve)
Cournot Equilibrium

- Symmetric reaction curves:
  \[ Q_1 = 30 - \frac{1}{2} Q_2 \quad \text{(Firm 1)} \]
  \[ Q_2 = 30 - \frac{1}{2} Q_1 \quad \text{(Firm 2)} \]
- Equilibrium: \( Q_1 = Q_2 = 20 \)
- Total quantity: \( Q = Q_1 + Q_2 = 40 \)
- Price: \( P = 60 - Q = 20 \)
- Profits: \( \Pi_1 = \Pi_2 = 20 \cdot 20 = 400 \)
Duopoly: Graphical Version

Firm 1’s Reaction Curve

Firm 2’s Reaction Curve

Cournot Equilibrium

Collusive Outcomes

Q₁

Q₂
Duopoly Analytics -- Collusion

Demand: \( P = 60 - Q \)

\[ \Pi = P \cdot Q - \text{Costs} = (60 - Q) \cdot Q \]

\[ \frac{d\Pi}{dQ} = 60 - 2Q = 0 \]

\[ \Rightarrow Q = Q_1 + Q_2 = 30, \; P = 30 \]

Total joint \( \Pi = 30(30) = 900 \)

If split equally, \( \Pi_1 = \Pi_2 = 450 \)
The Game (b)

- Objective: Max. your profit
- # of plays: 1
- Good: Homogeneous
- Choice variable: Q
- Timing of choice: Someone goes first

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Analytics with a First Mover
(Decision variable is Q)

- Suppose Firm 1 moves first
- In setting output, Firm 1 should consider how Firm 2 will respond
- We know how Firm 2 will respond! It will follow its Cournot reaction curve:
  \[ Q_2 = 30 - \frac{1}{2} Q_1 \]
- So Firm 1 will maximize taking this information into account
First Mover: Max $\Pi$ given the Reaction of the Follower

- Firm 1 revenue:
  \[ R_1 = Q_1P = Q_1(60 - [Q_1 + Q_2]) \]
  \[ = 60Q_1 - (Q_1)^2 - Q_1Q_2 \]
  \[ = 60Q_1 - (Q_1)^2 - Q_1(30 - \frac{1}{2}Q_1) \]
  \[ = 30Q_1 - \frac{1}{2}(Q_1)^2 \]

- Firm 1 marginal revenue:
  \[ MR_1 = \frac{dR_1}{dQ_1} = 30 - Q_1 \]

First Mover - The Result

- Firm 1 marginal revenue:
  \[ MR_1 = 30 - Q_1 \]
  Set $MR_1 = MC (= 0)$, and
  \[ Q_1 = 30 \]
  \[ Q_2 = 30 - \frac{1}{2}Q_1 = 15 \]

- Price: \[ P = 60 - (Q_1 + Q_2) = 15 \]
- Profits: \[ \Pi_1 = 30 \cdot 15 = 450 \]
  \[ \Pi_2 = 15 \cdot 15 = 225 \]
The Game (c)

- Objective: Max. your profit
- # of plays: 1
- Good: Homogeneous
- Choice variable: Price
- Timing of choice: Simultaneous
Strategic Substitutes vs Complements

- Strategic Complement: reactions match – e.g. lower price is reaction to competitor’s lower price
- Strategic Substitute: opposite reactions – e.g. lower quantity is reaction to competitor’s higher quantity
- Competition tends to be more aggressive with strategic complements than with substitutes.

The Game (c*)

- Objective: Max. your profit
- # of plays: 1
- Good: Differentiated
- Choice variable: Price
- Timing of choice: Simultaneous
Take Away Points

- Game theory allows the analysis of situations with interdependence.
- Nash Equilibrium: Each player doing the best he/she can, given what the other is doing.
- Competition in strategic complements (price) tends to be tougher than in substitutes (quantity).
- Commitment is important since you change the rules of the game. It can lead to a first-mover advantage.
- Repetition can lead to cooperation, but only when the end-game is uncertain or far away.

Preparation for Next Time

Regarding “Lesser Antilles Lines” Case:

- Good case for developing game and payoff analysis (assumptions, payoffs, etc.).

- You do NOT need to prepare this for class (part of Problem Set 5).