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

		Firm 2 (competitor)	
		15	20
Firm 1 (you)	15		
	20		

Game Payoffs

Firm 2 (competitor) across the top; Firm 1 (you) down the side.

Firm 1 (you) \ Firm 2 (competitor)	15	20	22.5	30
15	450, 450	375, 500	338, 506	225, 450
20	500, 375	400, 400	350, 394	200, 300
22.5	506, 338	394, 350	338, 338	125, 150
30	450, 225	300, 200	150, 125	0, 0

The Game (a*)

- Objective: Max. your profit
- # of plays: 2
- Good: Homogeneous
- Choice variable: Quantity
- Timing of choice: Simultaneous

The Game (a**)

- Objective: Max. <u>your</u> 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. <u>your</u> 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

$R_1 = PQ_1 = (60 - Q)Q_1$

$= 60Q_1 - (Q_1 + Q_2)Q_1$

$= 60Q_1 - (Q_1)^2 - Q_2Q_1$

$MR_1 = dR_1/dQ_1 = 60 - 2Q_1 - Q_2$

Set $MR_1 = MC = 0$, which yields

$Q_1 = 30 - ½\, Q_2$ (Firm 1 reaction curve)

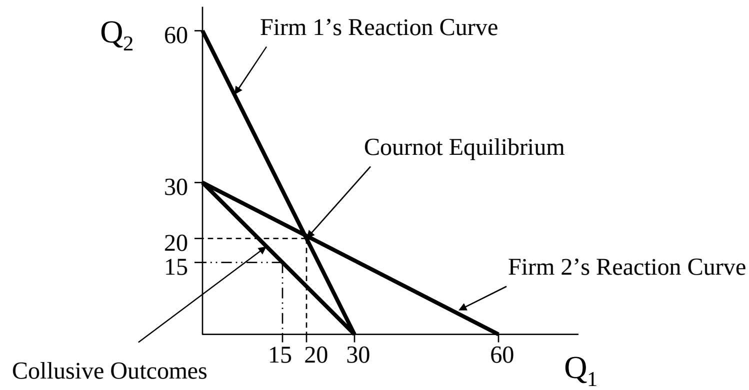
Cournot Equilibrium

- Symmetric reaction curves:

  $Q_1 = 30 - 1/2\ Q_2$ (Firm 1)

  $Q_2 = 30 - 1/2\ Q_1$ (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



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. <u>your</u> profit
- # of plays: 1
- Good: Homogeneous
- Choice variable: Q
- Timing of choice: Someone goes first

Game Payoffs

		Firm 2 (competitor)			
		15	20	22.5	30
Firm 1 (you)	15	450, 450	375, 500	338, 506	225, 450
	20	500, 375	400, 400	350, 394	200, 300
	22.5	506, 338	394, 350	338, 338	125, 150
	30	450, 225	300, 200	150, 125	0, 0

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:

  $Q_2 = 30 - 1/2\ Q_1$
- So Firm 1 will maximize taking this information into account

First Mover: Max Π *given* the Reaction of the Follower

- Firm 1 revenue:

$R_1 = Q_1 P = Q_1(60 - [Q_1 + Q_2])$

$= 60Q_1 - (Q_1)^2 - Q_1 Q_2$

$= 60Q_1 - (Q_1)^2 - Q_1 (30 - ½ Q_1)$

$= 30Q_1 - ½ (Q_1)^2$

Firm 2's Reaction

- Firm 1 marginal revenue:

$MR_1 = dR_1/dQ_1 = 30 - Q_1$

First Mover - The Result

- Firm 1 marginal revenue:
  $MR_1 = 30 - Q_1$
- Set $MR_1 = MC$ (= 0), and
  $Q_1 = 30$
  $Q_2 = 30 - ½ Q_1 = 15$
- 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. <u>your</u> 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. <u>your</u> 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).