Intermediate Microeconomics. Lecture 20

Game Theory and Oligopoly

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What Is a Game?

Every game, no matter how simple or complex, shares three common elements: players, strategies, and payoffs

- **Players** are participants in an economic game who must decide on actions based on the actions of others
- A **strategy** is a player's plan of action for a game
- **Payoffs** are the outcomes players receive from playing the game

A payoff matrix, a table that lists the players, strategies, and payoffs of an economic game

Example: Prisoner's Dilemma and dominant strategies

		Player 2	
		Confess	Don't C
Player 1	C	-6, -6	0, -10
	DC	-10, 0	-1, -1

- A **dominant strategy** is an optimal choice of strategy for a player no matter what the other player does
- In this case the optimal strategy is "Confess"
- A **Nash Equilibrium** is an optimal outcome of a game where no player has an incentive to deviate from their chosen strategy after considering an opponent's choice

Example: Battle of the sexes

Imagine that Player 1 and Player 2 agreed to meet this evening, but cannot recall if they will be attending a Bach concert or a Stravinsky concert (and the fact that they forgot is common knowledge). Player 1 would prefer to go to the Stravinsky concert. Player 2 would rather go to the Bach concert. Both would prefer to go to the same place rather than different ones. If they cannot communicate, where should they go?

		Player 2	
		Stravinsky	Bach
Player 1	S	3, 2	0, 0
	B	0, 0	2, 3

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Stackelberg model

- The Stackelberg model is often used to describe industries in which there is a dominant firm, or a natural leader
- Suppose that firm 1 is the leader and that it chooses to produce a quantity q_1
- Firm 2 responds by choosing a quantity q_2
- Each firm knows that the equilibrium price in the market depends on the total output produced, $Q = q_1 + q_2$
- What output should the leader choose to maximize its profits? The answer depends on how the leader thinks that the follower will react to its choice

The Follower's Problem

The follower wants to maximize its profits

$$\max_{q_2} \; p(Q)q_2 - c_2(q_2)$$

FOC

$$\frac{\partial p(Q)}{\partial q_2} q_2 + p(Q) - \frac{dc_2(q_2)}{dq_2} = 0$$

$$MR_2 = MC_2$$

The follower wants to choose an output level such that marginal revenue equals marginal cost, $q_2 = f(q_1)$

The Leader's Problem

The profit-maximization problem for the leader becomes

$$\max_{q_1} \; p(Q)q_1 - c_1(q_1)$$

such that

$$q_2 = f(q_1)$$

Example: Stackelberg model

Suppose that the market demand is linear

$$p(Q) = a - bQ$$

and that marginal cost is constant and equal for both firms

$$MC_1 = MC_2 = c$$

The best responses are

$$\boxed{q_1^* = \frac{a-c}{2b}} \qquad \boxed{q_2^* = \frac{a-c}{3b}}$$

Bertrand model

- In the Bertrand model firms decide on prices rather than on quantities
- Firms set prices simultaneously
- When firms are selling identical products, the Bertrand equilibrium has a very simple structure
- It turns out to be the competitive equilibrium, where price equals marginal cost
- First we note that price can never be less than marginal cost since then either firm would increase its profits by producing less

Bertrand model

- Suppose that both firms are selling output at some price $\hat{p}$ greater than marginal cost
- If firm 1 lowers its price by any small amount ϵ and if the other firm keeps its price fixed at $\hat{p}$, all of the consumers will prefer to purchase from firm 1
- By cutting its price by an arbitrarily small amount, it can steal all of the customers from firm 2
- Thus any price higher than marginal cost cannot be an equilibrium; the only equilibrium is the competitive equilibrium