14.01 Principles of Microeconomics, Fall 2007
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Lecture 27

Game Theory and Oligopoly

Outline

1. Chap 12, 13: *Game Theory*

2. Chap 12, 13: *Oligopoly*

1   Game Theory

In monopolistic competition market, there are many sellers, and the sellers do not consider their opponents' strategies; nonetheless, in oligopoly market, there are a few sellers, and the sellers must consider their opponents' strategies. The tool to analyze the strategies is game theory.

Game theory includes the discussion of noncooperative game and cooperative game. The former refers to a game in which negotiation and enforcement of binding contracts between players is not possible; the latter refers to a game in which players negotiate binding contracts that allow them to plan joint strategies.

A game consists of players, strategies, and payoffs.

Now assume that in a game, there are two players, firm A and firm B; their strategies are whether to advertise or not; consequently, their payoffs can be written as

$$\pi_A(A's\ strategy, B's\ strategy)$$

and

$$\pi_B(A's\ strategy, B's\ strategy)$$

respectively.

Now let's represent the game with a matrix (see Table 1). The first row is the situation that A advertises, and the second row is the situation that A does not advertise; the first column is the situation that B advertises, and the second column is the situation that B does not advertise. The cells provide the payoffs under each situation. The first number in a cell is firm A's payoff, and the second number is firm B's payoff.

Dominant strategy is the optimal strategy no matter what the opponent does. If we change the element $(20, 2)$ to $(10, 2)$, no matter what the other firm does, advertising is always better for firm A (and firm B). Therefore, both firms have a dominant strategy.

		Firm B	
		Advertise	Not Advertise
Firm A	Advertise	10,5	15,0
	Not Advertise	6,8	20,2

Table 1: Payoffs of Firm A and B.

When all players play dominant strategies, we call it equilibrium in dominant strategy.

Now back to original case, B has dominant strategy, but A does not, because

- if B advertises, A had better advertise;

- if B does not advertise, A had better not advertise.

So we see that not all games have dominant strategy. However, since B has dominant strategy and would always advertise, A would choose to advertise in this case.

Now consider another example. Two firms, firm 1 and firm 2, can produce crispy or sweet. If they both produce crispy or sweet, the payoffs are $(-5, -5)$; if one of them produces crispy while the other produces sweet, the payoffs are $(10, 10)$.

		Firm 2	
		Crispy	Sweet
Firm 1	Crispy	-5,-5	10,10
	Sweet	10,10	-5,-5

Table 2: Payoffs of Firm 1 and 2.

There is no dominant strategy for both firms. We define another equilibrium concept – Nash equilibrium.

Nash equilibrium is a set of strategies such that each player is doing the best given the actions of its opponents.

In this case, there are two Nash equilibriums, $(sweet, crispy)$ and $(crispy, sweet)$.

2 Oligopoly

Small number of firms, and production differentiation may exist.

Different Oligopoly Models

1. Cournot Model: firms produce the same good, and they choose the production quantity simultaneously.

2. Stackelberg Model: firms produce the same

3. Bertrand Model: firms produce the same good, and they choose the price.

2.1 Cournot Model

Example. Market has demand

$$P = 30 - Q,$$

with two firms, so

$$Q = Q_1 + Q_2,$$

and assume that there is no fixed cost and marginal cost,

$$MC_1 = MC_2 = 0.$$

Firm 1 would like to maximize its profit

$$P \times Q_1,$$

or

$$(30 - Q_1 - \overline{Q}_2) \times Q_1;$$

from the

$$\frac{d}{dQ_1}((30 - Q_1 - \overline{Q}_2) \times Q_1) = 0,$$

we have firm 1's reaction function

$$Q_1 = 15 - \frac{\overline{Q}_2}{2},$$

in which the $\overline{Q}_2$ is the estimation of firm 2's production by firm 1.
In the same way, firm 2's reaction function is

$$Q_2 = 15 - \frac{\overline{Q}_1}{2},$$

in which the $\overline{Q}_1$ is the expectation of firm 1's production by firm 2.
    At equilibrium, firm 1 and firm 2 have correct expectation about the other's production, that is,

$$\overline{Q}_1 = Q_1,$$
$$\overline{Q}_2 = Q_2.$$

Thus, at equilibrium,

$$Q_1 = 10,$$

and

$$Q_2 = 10.$$