Handout 9

1 Announcements

- EconLive: 49 hours left to submit a post on Tumblr!

- Fill out the course evaluation.

2 An Introduction to Game Theory

- **Game theory** is the study of how people *behave* in *strategic* situations.

- It **models** situations in which multiple players make **strategically interdependent**[1] decisions.

- We will focus on **normal form games** or "*game*" in short, where players' moves are **simultaneous** (everyone moves, make decisions, at the same time).

- A **game** ($\mathcal{G}$) consists of:

    1. players
    2. strategies (actions that each players can do)
    3. payoffs (outcomes, specified by *utility*, a *Bernoulli utility function*)

- **Common knowledge** assumption: everyone knows the *structure* and *payoffs* of the game and that everyone knows that everyone knows them, and so on. (**complete information**[2], e.g. playing Chess)

- **Dominated** strategy: a strategy that a player in a game will **never choose** regardless of the strategies chosen by the other players.

- **Best Response**: Given others action, the strategy that you are **most willing** to choose.

- **Nash equilibrium** (a collection of strategies = a strategy set = a strategy profile):

    1. Definition 1: a strategy profile from which **no player has a profitable unilateral deviation**.
        - a sample strategy profile in a *rock–paper–scissors* game is {*you play scissors, I play rock*}.
        - profitable unilateral deviation: I can benefit from playing other strategies.
    2. Definition 2: A collection of **mutual best response**.

- **Prisoner's Dilemma** with actions **C: cooperate** (remain silent), **D: defects** (confess):

    Two suspects are arrested for a crime, and interviewed separately. If they both keep quiet (they cooperate with each other) they go to prison for a year. If one suspect supplies incriminating evidence (defects) then that one is freed, and the other one is imprisoned for nine years. If both defect then they are imprisoned for six years. Their preferences depends on the jail term they individually serve.

		P_2	
		C	D
P_1	C	-1, -1	-9, 0
	D	0, -9	-6, -6

    - **Players:** The players are the two suspects: P_1 and P_2.
    - **Strategies:** The strategy set for P_1 is {C, D}. For P_2 is also {C, D}.
    - **Payoffs:** The payoffs are the numbers in the matrix with the format: (P_1's payoff, P_2's payoff).

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[1] strategically interdependent means the outcomes depend both on what you do and on what others do.
[2] The card game "Texas hold'em" is an **incomplete** but **perfect** information game.

- **Solving the game** (notice that P_1 and P_2 make decisions at the same time):

  1. When P_2 chooses C, P_1 is facing payoffs between -1 (chooses C) and 0 (chooses D). Since $0 > -1$, P_1 will choose D. So when P_2 chooses C, the best response for P_1 is to choose D.
  2. When P_2 chooses D, P_1's payoffs is -9 and -6. Since $-6 > -9$, the best response for P_1 given P_2 chooses D is to chooses D.
     $\implies$ No matter what P_2 chooses, P_1 always chooses D.
  3. When P_1 chooses C, P_2's payoffs is -1 and -0. Since $0 > -1$, the best response for P_2 is D.
  4. When P_1 chooses D, P_2's payoffs is -9 and -6. Since $-6 > -9$, the best response for P_2 is D.
     $\implies$ No matter what P_1 chooses, P_2 always chooses D.

  Finding the Nash equilibrium:

  I. Given P_2's actions, P_1's best response is to play D.
  II. Given P_1's actions, P_2's best response is to play D.
  III. Therefore, both players play D: {D, D} is a mutual best response strategy profile.
  IV. {P_1 plays D, P_2 plays D} is a Nash equilibrium.

3   Oligopoly

- Comparison:

  - Oligopoly: only a few sellers offer similar or identical products.
  - Monopolistic competition: many firms sell similar but not identical products.

- Concentration ratio: the percentage of the market's total output supplied by its four largest firms. (HHI[3]$\uparrow \implies$ competition$\downarrow$)

- Duopoly: an oligopoly with two firms.

- Collusion: an agreement among firms in a market about quantities to produce or prices to charge. However, it is difficult for oligopoly firms to form cartels and honor their agreements.

- Cartel: a group of firms acting in unison.

- Effects of increasing output:

  1. Output effect: If $P > MC$, selling more output raises profits.
  2. Price effect: Raising production increases market quantity, which reduces market price and reduces profit on all units sold.
  3. Comparison:
     - output effect > price effect: firm increases production.
     - output effect < price effect: firm decreases production.
  4. Asymptotic analysis: when the number of firms in market increases:
     (a) price effect $\downarrow$
     (b) oligopoly $\rightarrow$ competitive market
     (c) P drops $\rightarrow$ MC
     (d) market quantity $\rightarrow$ socially efficient quantity

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[3] HHI: Herfindahl-Hirschman Index.