# Economics 101A
# (Lecture 21)

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Outline

1. Oligopoly?

2. Game Theory

3. Oligopoly: Cournot

# 1 Oligopoly?

- Extremes:

  - Perfect competition

  - Monopoly

- Oligopoly if there are $n$ (two, five...) firms

- Examples:

  - soft drinks: Coke, Pepsi;

  - cellular phones: Sprint, AT&T, Cingular,...

  - car dealers

- Firm $i$ maximizes:

$$\max_{y_i} p\left(y_i + y_{-i}\right) y_i - c\left(y_i\right)$$

where $y_{-i} = \sum_{j \neq i} y_j$.

- First order condition with respect to $y_i$:

$$p_Y'\left(y_i + y_{-i}\right) y_i + p - c_y'\left(y_i\right) = 0.$$

- Problem: what is the value of $y_{-i}$?

  - simultaneous determination?

  - can firms $-i$ observe $y_i$?

- Need to study strategic interaction

# 2 Game Theory

- Nicholson, Ch. 8, pp. 236-252 (*better* than Ch. 15, pp. 440–449, 9th).

- Unfortunate name

- Game theory: study of decisions when payoff of player $i$ depends on actions of player $j$.

- Brief history:

  - von Neuman and Morgenstern, Theory of Games and Economic Behavior (1944)

  - Nash, Non-cooperative Games (1951)

  - ...

  - Nobel Prize to Nash, Harsanyi (Berkeley), Selten (1994)

- Definitions:

    - Players: $1, ..., I$

    - Strategy $s_i \in S_i$

    - Payoffs: $U_i\left(s_i, s_{-i}\right)$

- Example: Prisoner's Dilemma

  - $I = 2$

  - $s_i = \{D, ND\}$

  - Payoffs matrix:

$$
\begin{array}{c|cc}
1 \setminus 2 & D & ND \\
D & -4, -4 & -1, -5 \\
ND & -5, -1 & -2, -2
\end{array}
$$

- What prediction?

- Maximize sum of payoffs?

- Choose dominant strategies

- **Equilibrium in dominant stategies**

- Strategies $s^* = \left( s_i^*, s_{-i}^* \right)$ are an Equilibrium in dominant stategies if

$$U_i \left( s_i^*, s_{-i} \right) \geq U_i \left( s_i, s_{-i} \right)$$

for all $s_i \in S_i$, for all $s_{-i} \in S_{-i}$ and all $i = 1, ..., I$

- Battle of the Sexes game:

| He $\backslash$ She | Ballet | Football |
|---|---|---|
| Ballet | $2, 1$ | $0, 0$ |
| Football | $0, 0$ | $1, 2$ |

- Choose dominant strategies? Do not exist

- **Nash Equilibrium**.

- Strategies $s^* = \left( s_i^*, s_{-i}^* \right)$ are a Nash Equilibrium if

$$U_i \left( s_i^*, s_{-i}^* \right) \geq U_i \left( s_i, s_{-i}^* \right)$$

for all $s_i \in S_i$ and $i = 1, ..., I$

- Is Nash Equilibrium unique?

- Does it always exist?

- Penalty kick in soccer (matching pennies)

| Kicker \ Goalie | L | R |
|:---:|:---:|:---:|
| L | 0, 1 | 1, 0 |
| R | 1, 0 | 0, 1 |

- Equilibrium always exists in mixed strategies $\sigma$

- Mixed strategy: allow for probability distibution.

- Back to penalty kick:

  - Kicker kicks left with probability $k$

  - Goalie kicks left with probability $g$

  - utility for kicker of playing $L$ :

$$
\begin{aligned}
U_K(L, \sigma) &= gU_K(L, L) + (1 - g)\, U_K(L, R) \\
&= (1 - g)
\end{aligned}
$$

  - utility for kicker of playing $R$ :

$$
\begin{aligned}
U_K(R, \sigma) &= gU_K(R, L) + (1 - g)\, U_K(R, R) \\
&= g
\end{aligned}
$$

- Optimum?

  - $L \succ R$ if $1 - g > g$ or $g < 1/2$

  - $R \succ L$ if $1 - g < g$ or $g > 1/2$

  - $L \sim R$ if $1 - g = g$ or $g = 1/2$

- Plot best response for kicker

- Plot best response for goalie

- Nash Equilibrium is:

  - fixed point of best response correspondence

  - crossing of best response correspondences

# 3   Oligopoly: Cournot

- Nicholson, Ch. 14, pp. 524-530 (*better* than Ch. 14, pp. 418–419, 421–422, 9th)

- Back to oligopoly maximization problem

- Assume 2 firms, cost $c_i(y_i) = cy_i$, $i = 1, 2$

- Firms choose simultaneously quantity $y_i$

- Firm $i$ maximizes:

$$\max_{y_i} p(y_i + y_{-i}) y_i - cy_i.$$

- First order condition with respect to $y_i$:

$$p'_Y\left(y_i^* + y_{-i}^*\right) y_i^* + p - c = 0, \; i = 1, 2.$$

- Nash equilibrium:

  - $y_1$ optimal given $y_2$;

  - $y_2$ optimal given $y_1$.

- Solve equations:

$$p_Y' \left(y_1^* + y_2^*\right) y_1^* + p - c = 0 \text{ and}$$

$$p_Y' \left(y_2^* + y_1^*\right) y_2^* + p - c = 0.$$

- Cournot -> Pricing above marginal cost

# 4 Next lecture

- Oligopoly: Bertrand

- Dynamic games

- Stackelberg duopoly

- Auctions