EE481: Industrial Economics

Game Theory (Static Game)

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Game Theory

- In many circumstances, there are more than 1 player.
- The decision of 1 player can affect the payoffs to other players.
- Game theory analyzes how each player makes strategic decisions

Strategic decisions =

Static Game =

Elements of a Game

- Game = Situation in which players (participants) make strategic decisions that make into account each other's actions and responses.
- Players = Those who participate in the game, whose actions can affect other players' outcomes.
- Payoff = Outcome of a game that generates rewards or benefits for the players.
- Action = Choice of each player.
- Strategy =
- Optimal Strategy = Strategy that maximizes player's expected payoff.

Noncooperative vs. Cooperative Games

- Cooperative game = Participants can negotiate _____ that allow them to make joint-strategies.

Example:

- Noncooperative game = Negotiation and enforcement of binding contracts between players is _____.

Example:

Dominant and Dominated Strategies

- Dominant Strategy =
- Dominated Strategy =
- For a game, each player "may" or "may not" have any **dominant** strategy.
- For a game, each player "may" or "may not" have any **dominanted** strategy.

Find Dominant Strategies

		Column Player: Cooperate	Column Player: Defect
Row Player	Cooperate	3,3	0,4
	Defect	4,0	1,1

Payoff (row player, column player)

- Defect is ...
- This game is a _____ type of game. Why?

Nash Equilibrium

Nash Equilibrium = A solution concept for a game proposed by Prof.John Nash.

- Dominant Strategies: I'm doing the best I can _____ *what another person do.* You're doing the best you can _____ *what I do*.
- Nash Equilibrium: I'm doing the best I can_____ *what you are doing.* You're doing the best you can _____ *what I am doing.*
  - At the Nash Equilibrium, ...

Nash Equilibrium

- Let s_i be the strategy taken by player i, s_i be the strategy taken by other player(s).
- Let $s_i = B_i(s\_i)$ be ...

- The Nash equilibrium is $s_i^* = B_i(s\_i^*)$ where s_i^* is ...

- At the Nash equilibrium $\pi_i(s_i^*, s\_i^*) \geq \pi_i(s_i', s\_i^*)$.

Pure Strategies vs. Mixed Strategies

- Pure Strategy = Players make specific choice or take a specific action.
- Mixed Strategy =

Example: Amy

		John: Micro	John: Macro
Amy: Micro		9,9	0,8
Amy: Macro		8,0	7,7

Payoff (Amy, John)

- How many Nash Equilibria are there in this game?

Finding Mixed Strategies

- Let the probability that John ..
- Let the probability that Amy ..

		John: Micro ( )	John: Macro ( )
Amy: Micro ( )		9,9	0,8
Amy: Macro ( )		8,0	7,7

Payoff (Amy, John)

- If Amy believes that John will choose Micro with 100% certainty ($y = 1$), then Amy would choose Micro $x = 1$.
- If Amy believes that John will choose Macro with 100% certainty ($y = 0$), then Amy would choose Macro $x = 0$.
- At a value of "y", ...

Finding Mixed Strategies

For Amy, she would choose Micro if

		John: Micro (y)	John: Macro ($1-y$)	E(Amy's Payoff)
Amy	Micro (x)	9,9	0,8	
	Macro ($1-x$)	8,0	7,7	

Payoff (Amy, John)

$$E(\text{Amy's payoff from Micro}) > E(\text{Amy's payoff from Macro})$$
$$>$$
$$>$$
$$>$$

- **When $y = \frac{7}{8}$, Amy is indifferent between Micro and Macro.**

Finding Mixed Strategies

For John, she would choose Micro if

		John: Micro (y)	John: Macro ($1-y$)
Amy	**Micro (x)**	**9,9**	**0,8**
	Macro ($1-x$)	**8,0**	**7,7**

$E(\textbf{John's Payoff})$

Payoff (Amy, John)

$$E(\text{John's payoff from Micro}) > E(\text{John's payoff from Macro})$$
$$>$$
$$>$$
$$>$$

- **When $x = \frac{7}{8}$, John is indifferent between Micro and Macro.**

Best Response Function ($BR_i(s\_i)$)

Describing all Nash Equilibria

Cournot Nash Equilibrium

Assume that there are 2 firms. The output of each firm are q_1 and q_2. Thus, the total demand is $Q = q_1 + q_2$. Let the marginal cost (MC) be constant and is the same for both firms (for ease of computation). Let the market demand be where $P = a - bQ$. Find the best response function of each firm $BR_1(q_2)$ and $BR_2(q_1)$ Then, plot them on a graph with q_1 on the y-axis and q_2 on the x-axis.

Cournot Nash Equilibrium (BR-Graph)

Bertrand Nash Equilibrium

- Each firm independently choose price. **They do not cooperate or fail to cooperate.**
- Bertrand is a static (single-period) game of a homogenous product market.
- Results:
  - Since firms do not cooperate, the result is a ...
  - **P = MC** ...
  - If firms do not have the same MC, ...

Bertrand Nash Equilibrium (BR-Graph)

- Find the best response function of each firm $BR_1(p_2)$ and $BR_2(p_1)$ Then, plot them on a graph with p_1 on the y-axis and p_2 on the x-axis.

Reference and Further Reading I


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