EE481: Industrial Economics

Game Theory (Static Games)

Asst. Prof. Dr. Pornthep Benyaapikul

Faculty of Economics, Thammasat University

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Game Theory: Definitions

- Concerned with actions of decision makers who are *conscious that their actions affect each other.*
- Examples of situations that can be modeled using game theory framework
- Game theory analyzes how each player makes strategic decisions

Strategic decisions = decisions that take into account each other's actions and responses.

Static Game = One-shot game. No player can observe the others' decisions.

Dynamic vs. Static

- Static Game = One-shot game. No player can observe the others' decisions (Players made decision simultaneously).
- Dynamic Game = More realistic, players meet and compete more than 1 time
  - Repeated Game
    - Finitely repeated
    - Infinitely repeated
  - Sequential Game

Elements of a game

- **P**layers: individual who make decisions. Goal is to maximize his utility by choice of actions.
- **I**nformation: players' knowledge at a particular time of the values of different variables.... what players know and do not know
- **M**ove: or players' actions (or strategies)
- **P**ayoff: utility each player receives after all players have picked their strategies and the game has been played out.

"If you're on the Game, get yourself a P.I.M.P"

Nash Equilibrium

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

- Dominant Strategies: I'm doing the best I can *no matter what another person do.* You're doing the best you can *no matter what I do*.
- Nash Equilibrium: I'm doing the best I can *given what you are doing*. You're doing the best you can *given what I am doing*.
  - At the Nash Equilibrium, no player has an incentive to unilaterally change their decision.

Normal Form Game

- Players
- Information
- Moves or actions or strategies
- Payoff
- Examples: technology adoption game, Prisoner dilemma, price competition gameActions are taken and payoffs are received over and over again.
- Increase a possibility to enforce an agreement (firms compete in more than 1 period).

Example: Price-fixing Game

Firm 2

Cooperate Defect

Example Technology Adoption Game

- "Two researchers decide whether to adopt Microsoft Windows or Apple Mac OS X as their operating system. There are benefits to compatibility with a co-worker. Both researchers will be better off if they adopt the Mac as their operating system (it is superior). However, a researcher will only be willing to do so if she is confident that her colleague will coordinate with her."

Technology Adoption Game: Ingredients

- Players : Researchers1(Row)and2(Column).
- Moves : Each player chooses Windows or Mac simultaneously.
- Info : Players have a common understanding of the game and the payoffs, but each player does not know the move of his opponent when he chooses his own action.
- Payoffs : Represented in the "strategic form" payoff matrix.
- Strategies : Here strategies are no different from moves.

Technology Adoption Game: Representation

		Player 2	
		Windows	Mac
Player 1	Windows	5,5	4,2
	Mac	2,4	6,6

Payoff (Player 1, Player2)

- The players' strategies are rows and columns respective.
- Each cell of the payoff matrix represents a strategy profile.
- The leftis the row player's payoff . . .
  . . . and the right is the column player's payoff.

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“Chicken” or the “Hawk-Dove” Game

“Two combatants engage in a contest. A combatant can either fight (play “Hawk”) or can chicken-out and defer to his opponent (play “Dove”). A Hawk beats a Dove, wins the prize, and there is no conflict. Two Doves share the prize equally. Two Hawks destroy the prize and are damaged by fighting.”

“Chicken” or the “Hawk-Dove” Game

- “A combatant can fight (“Hawk”) or chicken out (“Dove”). A Hawk beats a Dove, wins the prize v and there is no conflict. Two Doves share nicely. Two Hawks destroy the prize and faces costs of c.”
- Write game ingredients and representation

Prisoners' Dilemma

"Two dodgy-looking 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 are solely contingent on any jail term they individually serve."

		Player 2	
		Cooperate	Defect
Player 1	Cooperate	-1,-1	-9,0
	Defect	0,-9	-6,-6

Payoff (Player 1, Player2)

Dominant Strategies

- Best response strategy (กลยุทธ์การโต้ตอบที่ดีที่สุด) : given other players' action, my "best response strategy" gives me highest payoff (or utility)
- Dominant strategy: the strategy is my dominant strategy if it is my best response to any strategies the other might pick.
- Dominant strategy = strategy that is optimal no matter what an opponent does.
- For a game, each player "may" or "may not" have any dominant strategy

Dominant Strategies

- Dominated strategy: For any strategy by other players, strategy s' is (weakly) dominated strategy if there is another strategy s* that never gives lower payoff than playing s'.
- s* (weakly) dominates s' or s' is (weakly) dominated by s*
- Example: Prisoners' dilemma game

Iterated deletion of strictly dominated strategies

Commentary

- An optimizing player would never play a dominated strategy.
- Hence an opponent anticipates it will not be played... and so deletes it from consideration.
- Nevertheless, this doesn't always give a unique answer.

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  - At the Nash Equilibrium, no player has an incentive to unilaterally change their decision.
- A **Nash equilibrium** strategy profile consists only of best responses
- Notice that there may be more than one Nash equilibrium.

Pure Strategies vs Mixed Strategies

- Pure strategies = Players make specific choice or take a specific action.
- Mixed strategy = Players make a random choice among two or more possible actions (based on a set of chosen probabilities)
- Examples