

# BS2243 – Lecture 3

## Strategy and game theory

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(Dr. Sumon Bhaumik)

Based on: Rasmusen, Eric (1992) *Games and Information*, Oxford, UK and Cambridge, Mass.: Blackwell; Chapters 1 & 2.

# Games – what are they?

- “Game theory is concerned with the actions of individuals who are conscious that their actions affect each other.”
- Examples
  - OPEC members deciding how much to produce every year
  - Chinese government purchasing steel from Arcelor Mittal
  - A large manufacturer of DVD players and a large manufacturer of DVD deciding on whether or not to adopt the Blu-ray standard

# Games – essential elements

- Players
- Actions
- Information
- Strategies
- Payoffs
- Outcomes
- Equilibria

# Games – Example 1

- Game:
  - OPEC members deciding how much to produce every year
- Players:
  - Saudi Arabia (S) and Others (O)
- Nature:
  - “Nature” is a non-player who takes random actions at well defined points in time, with well defined probabilities
  - World demand for oil (D) can be *Weak* or *Strong*, with probabilities of 0.7 and 0.3, respectively

# Games – Example 1 (contd.)

- Actions:
  - Both Saudi Arabia and Others can choose to produce either *High* (H) or *Low* (L)
- Order of play:
  - Nature picks demand for oil, which can be *Weak* or *Strong*
  - Saudi Arabia and Others simultaneously choose between *High* and *Low* outputs
- Information:
  - Saudi Arabia knows whether the world demand for oil is weak or strong, but Others do not

# Games – Example 1 (contd.)

- Strategy:
  - A rule that tells a player what (s)he should do at any point in the game, *given the information at his/her disposal*
    - A plausible strategy for Saudi Arabia is: choose *Low* output if demand is *Weak*, and choose *High* output if demand is *Strong*
- Payoff:
  - Expected profit earned by a player as a consequence of actions chosen both by him/her *and by other players*

# Games – Example 1 (contd.)

- Outcomes:
  - Set of payoffs for the players once the game has played itself out
- Equilibrium:
  - Combination of strategies chosen by the players to individually maximise their own payoffs

# Games – Example 1 (contd.)

- *The same outcome may be associated with two different strategy combinations*
- Case 1:
  - Both Saudi Arabia and Others choose *Low* output no matter what
- Case 2:
  - Both Saudi Arabia and Others have a tit-for-tat strategy, i.e., each chooses *High* output if the other player chooses *High* output and vice versa

# Games – Example 1 (contd.)

Payoff matrix			
		Others	
		Low	High
Saudi Arabia	Low	(10, 10)	(7, 12)
	High	(12, 7)	(9, 9)

- $\{High, High\}$  is a dominant strategy equilibrium

# Games – Example 2

- Two firms A and B are trying to maximise their respective market shares by choosing between the product designs N and S. Firm A has a marketing advantage and would like to compete with Firm B head-to-head. Firm B, however, would like to operate in a niche market.

# Games – Example 2 (contd.)

Payoff matrix			
		Firm B	
		N	S
Firm A	N	(2, -2)	(2, -2)
	S	(1, -1)	(3, -3)

- It is a zero sum game
- $\{N\}$  is a weakly dominant strategy for Firm B
- $\{N, N\}$  is the equilibrium

# Games – Example 3

- Two competing firms, X and Y, want the same industry-wide standard for their products, but each wants a different standard, e.g., VHS and Beta

# Games – Example 3 (contd.)

Payoff matrix			
		Firm Y	
		VHS	Beta
Firm X	VHS	(2, 1)	(-1, -1)
	Beta	(-5, -5)	(1, 2)

- Neither firm has a dominant strategy
- $\{VHS, VHS\}$  and  $\{Beta, Beta\}$  are the Nash equilibria
- First mover advantage matters

# Games – Example 4

- Two mobile phone companies, X and Y, have to choose between GSM and an alternative protocol. If they can choose the same protocol then each would sell more mobile handsets.

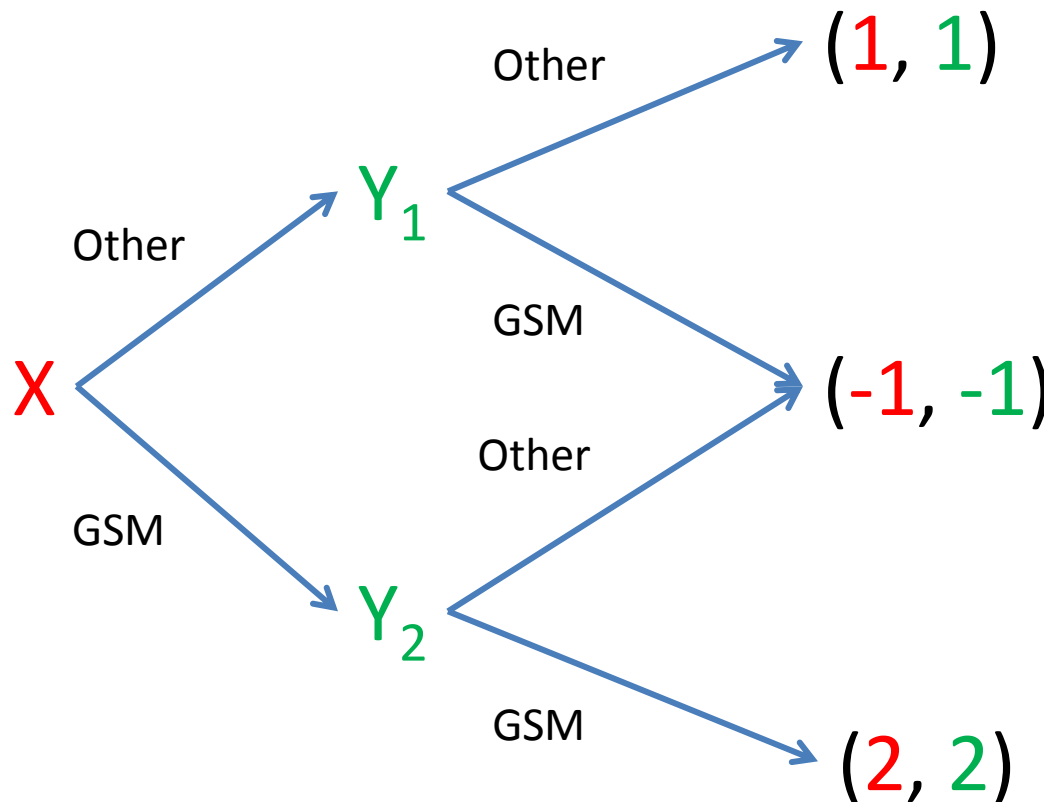
# Games – Example 4 (contd.)

Payoff matrix			
		Firm Y	
		GSM	Other
Firm X	GSM	(2, 2)	(-1, -1)
	Other	(-1, -1)	(1, 1)

- Neither firm has a dominant strategy
- $\{GSM, GSM\}$  and  $\{Other, Other\}$  are the Nash equilibria
- Can the firms communicate to ensure  $\{GSM, GSM\}$  equilibrium?

# Games – Example 4 (contd.)

- Assumption: Firm X moves first



In this sequential game,  $\{GSM, GSM\}$  is the only possible Nash equilibrium

# Repeated games

- Finitely repeated
- Infinitely repeated
  - Grim strategy
    - Choose Cooperate to start with
    - Continue to Cooperate until the other prisoner Cheats, and then choose Cheating forever
  - Tit-for-tat strategy
    - Choose Cooperate to start with
    - In each successive period, choose the strategy chosen by the other player in the previous period