

BS2243 – Lecture 4

Strategy and game theory

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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.

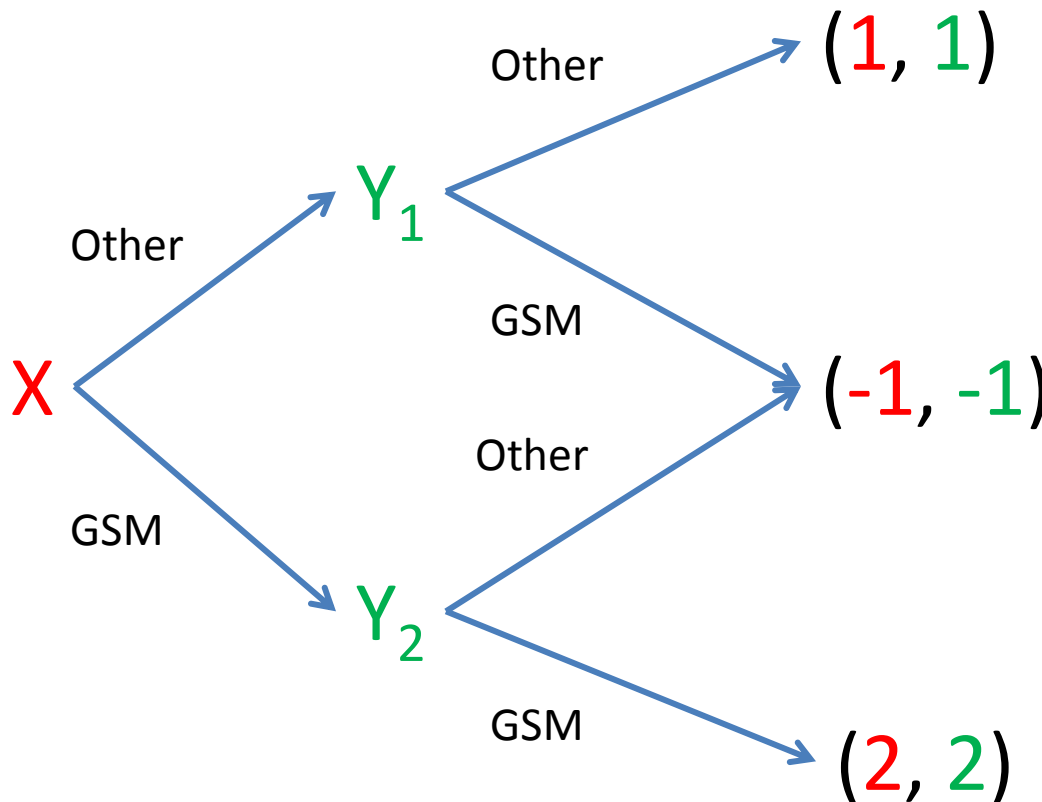
Games – Example 4 (contd.)

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