CHAPTER 14 LECTURE - GAME THEORY AND STRATEGIC BEHAVIOR

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1

GAME ELEMENTS

Players: Agents participating in the - *Toyota and Honda*)
Strategies: Actions that each player may take under any possible circumstance - (*Build or don't build*)
Outcomes: The various possible results of the game - *Four, each represented by one cell of matrix*
Payoffs: The benefit that each player gets from each possible outcome of the game - *The profits entered in each cell of the matrix*

Information: A full specification of who knows what when - *Full information*
Timing: Who can take what decision when and how often the game is repeated - *Simultaneous or one-shot*
Solution concept of the game: "What is the likely outcome"?

2

2

WHAT IS HAPPENING HERE?

		Toyota: Build a New Plant	Toyota: Do Not Build
Honda	Build a New Plant	16, 16	20, 15
	Do Not Build	15, 20	18, 18

- A Nash equilibrium occurs when each player chooses a strategy that gives him/her the highest payoff, given the strategy chosen by the other player(s) in the game
  - "Rational self-interest"
- Toyota vs. Honda
  - A Nash equilibrium: each firm builds a new plant

3

3

WHAT IS HAPPENING HERE?

Modified Capacity Expansion Game between Toyota and Honda

Dominated Strategy: A strategy such that the player has another strategy that gives a higher payoff no matter what the other player does

		Toyota: Build Large	Toyota: Build Small	Toyota: Do Not Build
Honda	Build Large	0, 0	12, 8	18, 9
	Build Small	8, 12	16, 16	20, 15
	Do Not Build	9, 18	15, 20	18, 18

4

4

FINDING A NASH EQUILIBRIUM BY IDENTIFYING DOMINANT STRATEGIES AND ELIMINATING DOMINATED STRATEGIES

- Whenever both players have a dominant strategy, those strategies will constitute the Nash equilibrium in the game.
- If just one player has a dominant strategy, that strategy will be the player's Nash equilibrium strategy.
- We can find the other player's Nash equilibrium strategy by identifying that player's best response to the first player's dominant strategy.
- If neither player has a dominant strategy, but both have dominated strategies, we can often deduce the Nash equilibrium by eliminating the dominated strategies and thereby simplifying the analysis of the game.

5

5

WHAT IS HAPPENING HERE AND WHAT IS THE OUTCOME?

Price Competition between Coke and Pepsi*

		Coke			
		$10.50	**$11.50**	**$12.50**	**$13.50**
Pepsi	**$6.25**	66, 190	68, 199	70, 198	73, 191
	$7.25	79, 201	82, 211	85, 214	89, 208
	$8.25	82, 212	86, 224	90, 229	95, 225
	$9.25	75, 223	80, 237	85, 244	91, 245

* Payoffs are in millions of dollars.

		$10.50	$11.50	$12.50	$13.50
	$6.25	~~66, 190~~	~~68, 199~~	~~70, 198~~	~~73, 191~~
	$7.25	~~79, 201~~	~~82, 211~~	~~85, 214~~	~~89, 208~~
Pepsi	$8.25	82, 212	86, 224	90, 229	95, 225
	$9.25	~~75, 223~~	~~80, 237~~	~~85, 244~~	~~91, 245~~

*Payoffs are in millions of dollars.

6

6

PRISONER'S DILEMMA

Famous example of game theory.

- Strategies must be undertaken without the full knowledge of what other players will do.
- Players adopt dominant strategies, but they don't necessarily lead to the best outcome.

- Two prisoners (A and B)are held in separate cells for a serious crime that they did in fact commit.
- The prosecutor has only enough hard evidence to convict them of a minor offense, for which the penalty is a year in jail.
- Each prisoner is told that if one confesses while the other remains silent, the confessor will get parole while the other spends life years in prison.
- If both confess, they will both get a sentence of 20 years.

7

7

PRISONER'S DILEMMA

Prisoner A's Strategies	Prisoner B's Strategies: Do Not Confess	Prisoner B's Strategies: Confess
Do Not Confess	1 Year (B) / 1 Year (A)	Parole (B) / Life (A)
Confess	Life (B) / Parole (A)	20 Years (B) / 20 Years (A)

http://ingrimayne.com/econ/IndividualGroup/PrisDilm.html

8

8

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GAMES WITH MORE THAN ONE NASH EQUILIBRIUM
(No Dominant Strategies)

	Attack East City	Attack West City
Defend East City	(0,1)	(1,0)
Defend West City	(1,0)	(0,1)

http://speezepearson.github.io/intro-to-game-theory/2-fast.html

9

9

GAMES WITH MORE THAN ONE NASH EQUILIBRIUM
(GAME OF CHICKEN)

	SWERVE	STRAIGHT
SWERVE	0 , 0	-1 , 1
STRAIGHT	1 ,-1	-5 ,-5

https://boundlessrationality.wordpress.com/2011/05/24/politics-and-chicken/

10

10

BANK RUNS

This table shows the payoffs in a bank-run game. That is, it shows you what you get back depending on your choice and everybody else's choice about whether to run on the bank. If everyone else leaves money in the bank, then you should do the same, but if everyone else runs on the bank, you are better running as well

The Bank Run Game*

		Depositor 2	
		Withdraw	**Don't Withdraw**
Depositor 1	**Withdraw**	25, 25	50, 0
	Don't Withdraw	0, 50	110, 110

* Payoffs are in dollars.

11

11

A SIMPLE PROBLEM

What Are the Nash Equilibria?

		Player 2		
		Strategy *D*	**Strategy *E***	**Strategy *F***
Player 1	**Strategy *A***	4, 2	13, 6	1, 3
	Strategy *B*	11, 2	0, 0	15, 10
	Strategy *C*	12, 14	4, 11	5, 4

12

12

MIXED STRATEGIES

This game does not appear to have a Nash equilibrium. If the Chinese goalie believes the U.S. kicker will aim right, the goalie's best strategy is to dive to the kicker's right. But if the U.S. kicker believes the Chinese goalie will dive to the kicker's right, the kicker's best strategy is to aim left. And if the kicker aims left, the goalie's best response is to dive to the kicker's left. There is no **pure strategy** A specific choice of a strategy from the player's possible strategies in a game.

U.S. Kicker versus Chinese Goalie in the 1999 Women's World Cup

		U.S. Kicker	
		Aim Right	**Aim Left**
Chinese Goalie	**Dive to Kicker's Right**	0, 0	−10, 10
	Dive to Kicker's Left	−10, 10	0, 0

13

13

MIXED STRATEGIES

This game does not have a Nash equilibrium in pure strategies, but there is a Nash equilibrium in mixed strategies. The U.S. kicker should "aim right" with probability 1/2 and "aim left" with probability 1/2. The Chinese goalie should "dive right" with probability 1/2 and "dive left" with probability 1/2. If the U.S. kicker believes that the Chinese goalie will dive right or left with probability 1/2, the U.S. kicker can do no better than to choose to aim left or right with probability 1/2. Similarly, if the Chinese goalie believes that the U.S. kicker will aim right or left with probability 1/2, the goalie can do no better than to choose to dive left or right with probability 1/2. Thus, when the players choose these mixed strategies, each is doing the best it can, given the actions of the other.

Mixed strategy A choice among two or more pure strategies according to prespecified probabilities.

U.S. Kicker versus Chinese Goalie in the 1999 Women's World Cup

		U.S. Kicker	
		Aim Right	**Aim Left**
Chinese Goalie	**Dive to Kicker's Right**	0, 0	−10, 10
	Dive to Kicker's Left	−10, 10	0, 0

14

14

TIT-FOR-TAT STRATEGIES

- ***Tit-for-tat strategy:*** The first time you interact with someone, you cooperate. In each subsequent interaction you simply do what that person did in the previous interaction. Thus, if your partner defected on your first interaction, you would then defect on your next interaction with her. If she then cooperates, your move next time will be to cooperate as well.
  - Requirement: there not be a known, fixed number of future interactions.

15

15

SEQUENTIAL GAMES

- ***Sequential game:*** one player moves first, and the other is then able to choose his strategy with full knowledge of the first player's choice.
  - Example - United States and the former Soviet Union (USSR) during much of the cold war.
- *Strategic entry deterrence* – they change potential rivals' expectations about how the firm will respond when its market position is threatened.

16

16

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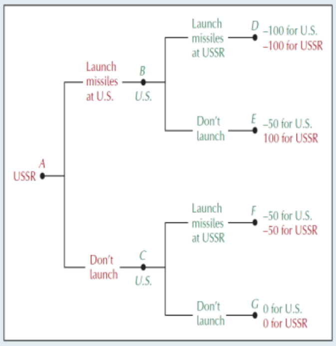
NUCLEAR DETERRENCE AS A SEQUENTIAL GAME

Nuclear Deterrence as a Sequential Game

If the USSR attacks, the best option for the United States is not to retaliate (point *E*). If the USSR doesn't attack, the best option for the United States is also not to attack (point *G*). Since the USSR gets a higher payoff at *E* than at *G*, it will attack. If the United States is believed to be a payoff maximizer, its threat to retaliate against a first strike will not be credible.



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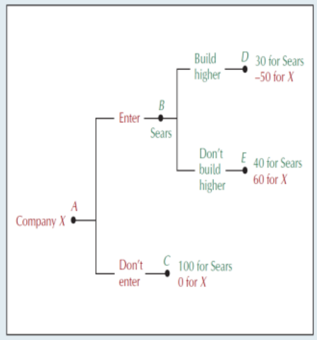
17

THE DECISION TO BUILD THE TALLEST BUILDING



The Decision to Build the Tallest Building

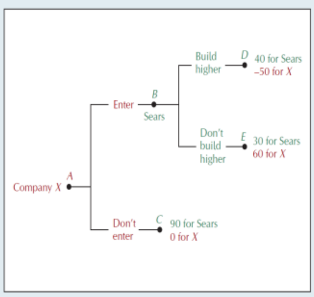
If company *X* builds a skyscraper taller than the Sears Tower, Sears must decide whether to build higher (point *D*) or yield its status as the tallest building (point *E*). Because Sears earns a higher payoff at *E* than at *D*, it will not build higher. And since *X* knows that, it will enter the market despite Sears's threat to build a taller building.

18

18

STRATEGIC ENTRY DETERRENCE

Now suppose that before Sears had originally built its tower, it had the option of building a platform atop the building on which it could build an addition that would make the building taller. Building this platform costs 10 units, but reduces the cost of building a taller building by 20 units



Strategic Entry Deterrence

Had it originally built a platform atop its building at a cost of 10 units, Sears would have reduced the cost of building a taller building by 20 units. Then company *X* would have calculated that it would not be worthwhile to build a taller building, because it then would have been in Sears's interest to respond with an addition. The Nash equilibrium of the altered game occurs at point *C*.

19

19

AN ENTRY GAME

Suppose you own a firm that is considering entry into the digital camera business, where you will compete head to head with Kodak (which, let's say, currently has a monopoly). Kodak can react in one of two ways: It can start a price war or it can be accommodating. You can enter this business on a large scale or a small scale. The table shows the payoffs you and Kodak are likely to get under the various scenarios that could unfold.

Problem: Should you enter this business on a large scale or a small scale?

Entry into the Digital Camera Business*

		Kodak	
		Accommodate	**Price War**
You	**Small**	4, 20	1, 16
	Large	8, 10	2, 12

* Payoffs are in millions of dollars.

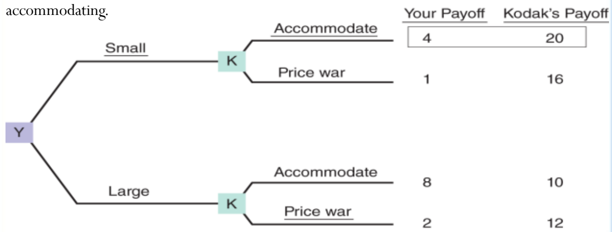
If you and Kodak choose your strategies simultaneously, the Nash equilibrium is for you to enter on a large scale and for Kodak to launch a price war. You can see this most easily by noting that "large" is your dominant strategy. Given that you choose this, Kodak will respond by launching a price war. At this Nash equilibrium, your profit will be $2 million per year.

20

20

AN ENTRY GAME

But you can do better if you can turn this into a sequential-move game. The figure shows the game tree if you can commit to your scale of operation in advance, before Kodak decides what to do. If you choose "large," Kodak's best response, as we just saw, is to fight a price war, and you get a payoff of $2 million per year. But if you choose "small," Kodak's best response is "accommodate," and you get a payoff of $4 million per year. Thus, if you can move first, your optimal strategy is "small." The Nash equilibrium in the sequential-move game is for you to enter on a small scale and for Kodak to respond by accommodating.



21

21

PAYOFFS IN A GAME WITH MULTIPLE EQUILIBRIA

		Mark: Party	Mark: Movie
Carolyn	Party	Carolyn gets 2 units Mark gets 1 unit	Each loses 2 units
	Movie	Each gets 2 units	Carolyn gets 1 unit Mark gets 2 units

22

22

Examples of Nash Equilibrium

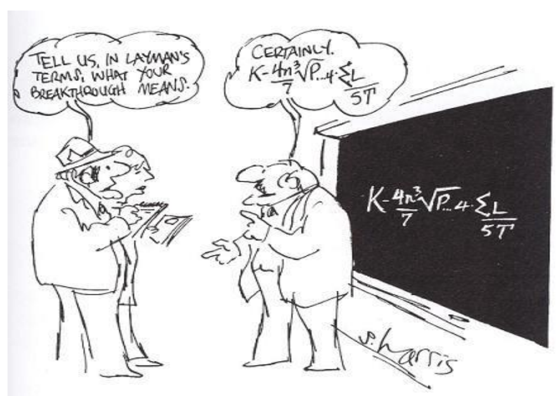
	Mum	Fink
Mum	-1,-1	-9,0
Fink	0,-9	-6,-6

	L	C	R
T	0,4	4,0	5,3
M	4,0	0,4	5,3
B	3,5	3,5	6,6

	Opera	Fight
Opera	2,1	0,0
Fight	0,0	1,2

23

23



https://medium.com/@elainewu98/still-deciding-67399036aa66

24

24