Chapter 15: Strategic Games

Summary of main points

- A Nash equilibrium is a pair of strategies, one for each player, in which each strategy is a best response against the other.
- When players act rationally, optimally, and in their own self-interest, it's possible to compute the likely outcomes (equilibria) of games. By studying games, we learn not only where our strategies are likely to take us, but also how to modify the rules of the game to our own advantage.
- Equilibria of sequential games, where players take turns moving, are influenced by who moves first (a potential first-mover advantage, or disadvantage), and who can commit to a future course of action. Credible commitments are difficult to make because they require that players threaten to act in an unprintable way—against their self-interest.
- In simultaneous-move games, players move at the same time.

Summary of main points

- In the prisoners' dilemma, convict and cooperation are in tension—self-interest leads to outcomes that reduce both players' payoffs. Cooperation can improve both players' payoffs.
- In a repeated prisoners' dilemma, it is easier for players to learn to cooperate. Here are some general rules of thumb:
  - Be nice: No first strikes.
  - Be easily provoked: Respond immediately to rivals.
  - Be forgiving: Don't try to punish competitors too much.
  - Don't be envious: Focus on your own slice of the port pie, not on your competitor's.
  - Be clear: Make sure your competitors can easily interpret your actions.

Nash Equilibria

- Named for John Nash, mathematician and Nobel laureate in economics.
  - Nash is known as the "father" of non-cooperative game theory
  - He proved the existence of equilibrium in all well-defined games in his doctoral dissertation at Princeton.
- Definition
  - A set of strategies, one for each player, such that no player has incentive to من جانب واحد unilaterally change her action.
  - Players are in an equilibrium if a change in strategies by any one of them would lead that player to earn less than if she remained with her current strategy.

Entry “game”

- Suppose a potential متحمل entrant مشارك is deciding whether to enter an industry in competition with an incumbent الحالية firm/monopoly.   الاحتكار
- If the entrant decides to enter the industry, the incumbent has two paths of action:
  - Accommodate the entry; or
  - Fight the entry.
- By modeling the situation using game theory, we find that accommodating استيعاب an entrant leads to profits while fighting an entrant leads to losses.

Modeling entry decision

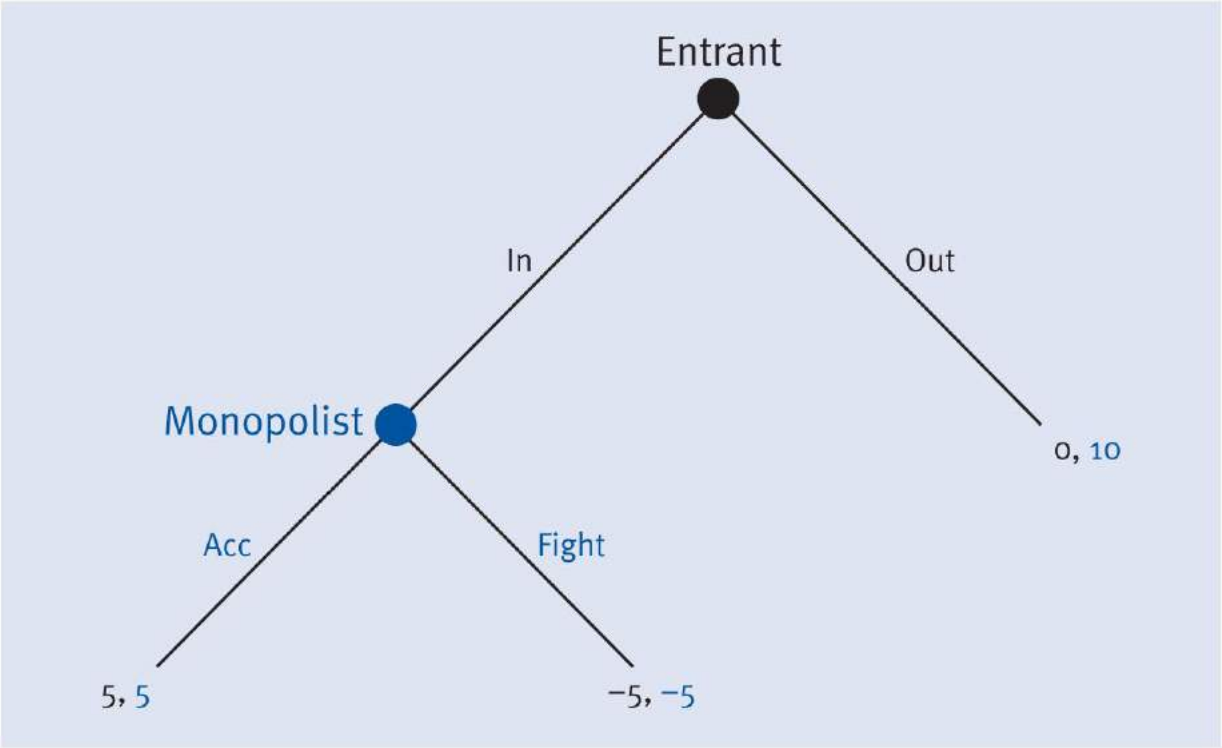

FIGURE 15-1 Entry Game

Modeling entry decision (cont.)

- To find the best strategy in a sequential game put two lines through the paths that present suboptimal choices.
- In this game, equilibrium is {In, Acc}:

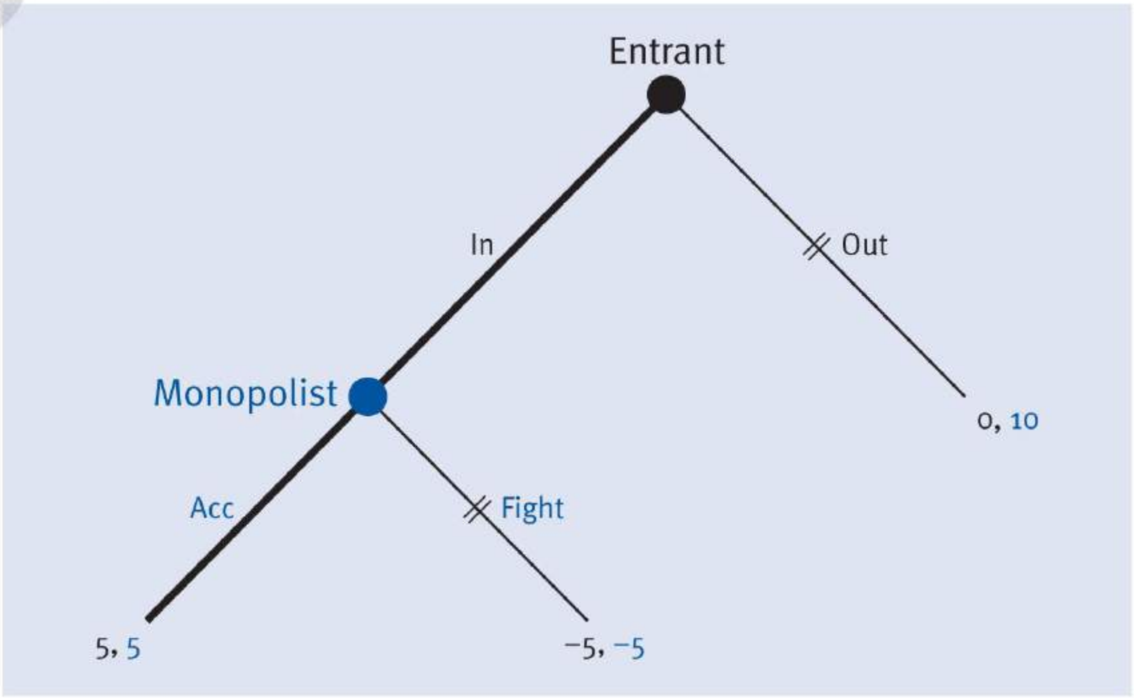

FIGURE 15-2 Entry Accommodation

Deterring ردع او منع Entry

- Part of game theory is figuring out how to change the game to your own advantage.
  - In the current game, if the incumbent firm can deter entry, it would earn $10 profit, instead of only $5.
- One way of deterring entry is to threaten (in such a manner as to be truly believable) to “commit” to fight the entry and price low.
  - To model this commitment, take away one of the incumbent’s options, the ability to accommodate entry.
- By committing to fight entry, the incumbent can benefit.
  - Expansion, Advertising, Pricing.

Types of games: Simultaneous متزامنة -move

- The second type of game is **simultaneous-move**. In this type of game players move simultaneously.
  - This does not literally require players moving at same time, just that each player plans a move without knowing the other player's move in advance
- To analyze a simultaneous-move game we use a matrix or "reduced-form" of the game.
- Again the likely outcomes are Nash equlibria, where no player has an incentive to change, i.e., each player is doing the best they can.

Simultaneous-move games (cont.)

- In a two-player game, each player's payoffs can be modeled in a table/matrix by assigning player One to choose row strategies and player Two to choose column strategies.
- If player one's strategy payoffs are in rows 1,2,3,4,5 and player two's strategy payoffs are in columns A,B,C,D,E then the actual payoff can be found by locating the cell in which the two strategy decisions (row, column) meet.
- Compute Nash Equilibrium by finding pairs of strategies where both players are choosing the best possible response to their competitor's strategy

Modeling simultaneous-move games

TABLE 15-1 Sample Payoff Matrix

		PLAYER COLUMN				
		V	**W**	**X**	**Y**	**Z**
	A	9, 9	7, 1	5, 6	3, 4	1, 1
	B	7, 8	5, 2	3, 6	1, 4	3, 3
Player Row	**C**	5, 6	3, 3	1, 8	9, 7	1, 5
	D	3, 9	1, 9	9, 4	7, 9	5, 9
	E	1, 2	9, 8	7, 7	5, 6	3, 7

Analyzing simultaneous-move games

- For player one:
  - For each of player Two's strategies (each column), select the row (underline it) that maximizes One's profits.
  - For example if Two plays column A, One would do best to use strategy 1, which earns a nine dollar payoff. For each column underline player one's best response.
- For player two:
  - Examine each of player One's strategies (each row) and select the column strategy that maximizes player Two's profits
  - For example on row 4, player Two would be indifferent between A,B,D, and E because each earns a $9 payoff. Underline all four best responses.
- To find the game equilibria, locate the cell (or cells) in which both numbers have been underlined—these are best responses to each other.

Finding equlibria

TABLE 15-3 Adding Player Column's Best Strategies

		PLAYER COLUMN				
		V	W	X	Y	Z
	A	**9**, **9**	7, 1	5, 6	3, 4	1, 1
	B	7, **8**	5, 2	3, 6	1, 4	3, 3
Player Row	C	5, 6	3, 3	1, **8**	**9**, 7	1, 5
	D	3, **9**	1, **9**	**9**, 4	7, **9**	**5**, **9**
	E	1, 2	**9**, **8**	7, 7	5, 6	3, 7

- This game has three equilbria, where each player is responding optimally to their rival, i.e., neither player has incentive to change strategy

The prisoners' dilemma game

- The police suspect that Frank and Jesse robbed a bank, but they have no direct evidence. They picked them up in their car, a parole violation which carries a sentence of two years. The US attorney offers both the same deal:
  - If only one confesses, the one who confesses goes free, while the other one receives ten years in jail.
  - If they both confess, each receives five years in jail.
  - If neither confesses, they both serve two years for violating parole.

TABLE 15-4 Prisoners' Dilemma

		FRANK	
		Confess	Say Nothing
Jesse	Confess	−5, −5	0, −10
	Say Nothing	−10, 0	−2, −2

Why the PD is interesting

- The only equilibrium is for both to confess and serve five years
- But BOTH would be better off if neither confessed
- By following self interest, the players thus make the group worse off
- The tension between conflict (self interest) and cooperation (group interest) is inherent in the prisoners' dilemma game.
- If the players/prisoners could cooperate, they make themselves better off.
  - Prosecutors separate defendants for precisely this reason, i.e., to make cooperation more difficult.

The Prisoners' Dilemma in business

- A pricing dilemma frequently faced by businesses selling substitute products has the same logical structure as the prisoners' dilemma (In the book as well as the table below from the book, the bottom right cell should have payoffs (2,2) and NOT (2,-2))
  - Two competing firms would both be better off if they could price high and get payoffs (2,2)
    - BUT that outcome is not an equilibrium, the equilibrium is (0,0) – try and reason why – its similar to the previous example
  - If the competing firms could "coordinate" pricing, they would make themselves better off - BUT that is illegal

		Coke	
		Price Low	Price High
Pepsi	Price Low	0 , 0	4 , −2
	Price High	−2 , 4	2 , 2

Don’t break the antitrust laws

- Advice from an antitrust prosecutor:
  - Do not discuss prices with your competitors. That is one of those “black-and-white,” areas. The enforcement authorities can be counted on to bring a criminal prosecution if they learn that you have met with you competitors to fix prices or any other terms of sale. Jail time is increasingly common.
- Other illegal solutions to the prisoners’ dilemma are to allocate customers, rig bids, or agree not to compete in each other’s areas. Again the advice is:
  - Do not agree with your competitor to stay out of each other’s markets. It may be tempting to seek freedom of action in one part of the country by agreeing with a competitor not to go west if he will not come east. Avoid that temptation. The consequences of the discovery of such behavior by the enforcement authorities are likely to be the same as the unearthing of a price-fixing conspiracy.

A (potentially) legal solution

- One way to break the prisoners' dilemma pricing (low, low) is for the two competing firms to merge.
- HOWEVER, if the only incentive to merge is to eliminate competition, the merger may violate antitrust laws.
- The Clayton Act outlaws any merger that substantially lessens competition, and a merger to get firms out of a prisoners' dilemma could be viewed as anticompetitive.
- <u>Rule of thumb</u>: Your merger is not likely to be challenged by the competition agencies if (i) there is a pro-competitive justification for it; (ii) if it is not likely to result in higher prices; and (iii) if customers are not complaining about its anticompetitive effects

Advertising dilemma

- In advertising too, there is a dilemma firms face that can be modeled after the prisoners' dilemma.
- For these two cigarette companies, both could make more money by not advertising, BUT given the share-stealing nature of the advertisements (structured to steal market share from rivals rather than increase demand) the {don't advertise, don't advertise} cell is not an equilibrium – either firm does better by advertising

TABLE 15-7 Advertising Dilemma

		RJR	
		Advertise	**Don't Advertise**
Phillip Morris	**Advertise**	<u>0</u>, <u>0</u>	<u>4</u>, −2
	Don't Advertise	−2, <u>4</u>	2, 2

The game of chicken

- The classic game of "chicken" has two equilibria:

TABLE 15-10 Game of Chicken

		JAMES	
		Go Straight	**Swerve**
Dean	**Go Straight**	−10, −10	**3**, **0**
	Swerve	**0**, **3**	0, 0

- Dean can make himself better off by committing to going straight (which changes a simultaneous-move game into a sequential move game with a first-mover advantage).
- Coordination is REALLY important in this game.

Game of Chicken (cont.)

- By committing to going straight, Dean exploits the inherent first-mover advantage. If James moves first and selects “straight,” Dean is forced to swerve.
- But convincing your competitor that you have committed to a position can be difficult
- Do you have to hit him to convince him you are going straight?

The game of chicken in business

- In 2000, a company (A) was deciding between Italy and South Africa as locations for which to develop a new strain of hybrid grapes.
- The Italian market was bigger so A preferred Italy as a growing site, but A's only competitor (B) was facing the same choice for the same strain of grapes.
- Both would prefer to be the sole entrant, and both would prefer Italy to South Africa.
- This is essentially a game of chicken.

TABLE 15-11 Market Entry Game of Chicken

		A	
		Italy	South Africa
B	Italy	0, 0	100, 50
	South Africa	50, 100	−50, −50

Growing grapes (cont.)

- If **A** can find a way to move first and go into Italy, **B** will choose S. Africa

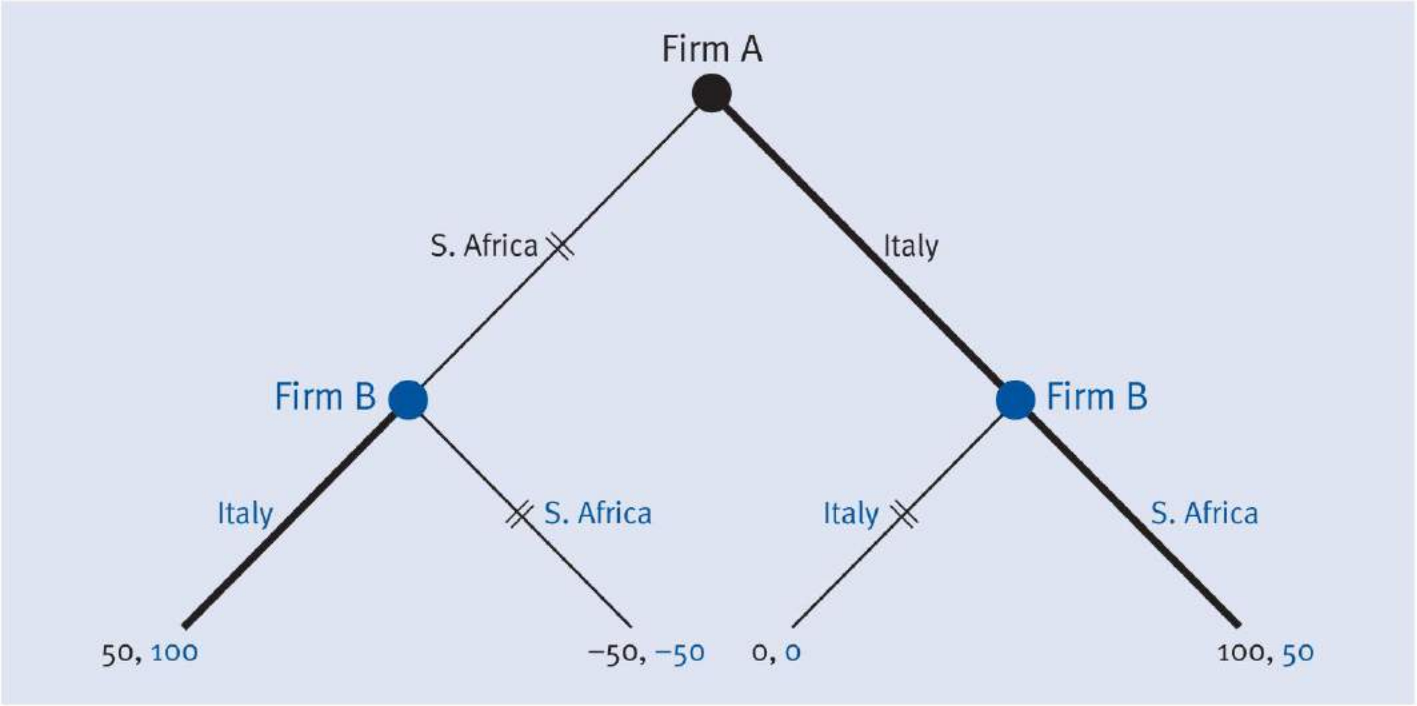

FIGURE 15-5 Sequential Market Entry

Shirking/Monitoring Game

- How to manage workers can be seen as a game between the employer and employee.

TABLE 15-14 Shirking/Monitoring Game

		EMPLOYEE	
		Shirk	**Work Hard**
Manager	**Monitors**	−1, 0	5, 5
	No Monitoring	−10, 10	10, 5

- This game has no equilibrium in "pure strategies"f
  - Instead, players randomly choose actions, called "mixing"
  - Idea is to keep your opponent guessing
  - The employer could combine random monitoring with an incentive based compensation scheme – such as rewarding the employee with a bonus when/if the employer finds her hard at work.
  - Or if found shirking, the employer could dismiss, demote or fine the employee