

Topic 12

Oligopoly, Game Theory & Strategic Behavior



Textbook: Ch. 17

In this topic,
look for the answers to these questions

1. What is **oligopoly**?
2. What **outcomes** are possible under oligopoly?
3. What is **game theory**?
4. What is a **dominant strategy**?
5. What is **prisoner's dilemma**? How does it apply to oligopoly and other issues?

Oligopoly

- **Oligopoly**: a market structure in which **only a few sellers** offer similar or identical products.
- Strategic behavior in oligopoly:
A firm's decisions about P or Q can **affect other firms** and cause them to react. The firm will consider these reactions when making decisions.
- **Game theory**: the study of how people behave in strategic situations.

17-1 Markets with Only a Few Sellers



17-1 a EXAMPLE: Mobile Phone Duopoly in Apple Town

P	Q
\$0	140
5	130
10	120
15	110
20	100
25	90
30	80
35	70
40	60
45	50

- Apple Town has 140 residents
- The “good”:
mobile phone service with unlimited anytime minutes and free phone
- Apple Town’s demand schedule
- Two firms: A-Mobile, B-Mobile
(**duopoly**: an oligopoly with two firms)
- Each firm’s costs: $FC = \$0$, $MC = \$10$

EXAMPLE: Mobile Phone Duopoly in Apple Town

P	Q	Revenue	Cost	Profit
\$0	140	\$0	\$1,400	-1,400
5	130	650	1,300	-650
10	120	1,200	1,200	0
15	110	1,650	1,100	550
20	100	2,000	1,000	1,000
25	90	2,250	900	1,350
30	80	2,400	800	1,600
35	70	2,450	700	1,750
40	60	2,400	600	1,800
45	50	2,250	500	1,750

Competitive
outcome:
 $P = MC = \$10$
 $Q = 120$
Profit = \$0

Monopoly
outcome:
 $P = \$40$
 $Q = 60$
Profit = \$1,800

17-1 b Competition, Monopolies, and Cartels



Corbis

EXAMPLE: Mobile Phone Duopoly in Apple Town

- One possible duopoly outcome: collusion
- **Collusion**: an agreement among firms in a market about quantities to produce or prices to charge
- A-Mobile and B-Mobile could agree to **each produce half of the monopoly output**:
 - For each firm: $Q = 30$, $P = \$40$, profits = \$900
- **Cartel**: a group of firms acting in unison, e.g., A-Mobile and B-Mobile in the outcome with collusion
- e.g. OPEC (organization of petroleum exporting countries)
- **Is it easy for oligopoly firms to form their cartels and honor their agreements?**

ACTIVE LEARNING 1

Collusion vs. self-interest

P	Q
\$0	140
5	130
10	120
15	110
20	100
25	90
30	80
35	70
40	60
45	50

Duopoly outcome with collusion:
Each firm agrees to produce $Q = 30$,
earns profit = \$900.

If A-Mobile reneges on the agreement and produces $Q = 40$, what happens to the market price? A-Mobile's profits?

Is it in A-Mobile's interest to renege on the agreement?

If both firms renege and produce $Q = 40$, determine each firm's profits.

ACTIVE LEARNING 1

Answers

P	Q
\$0	140
5	130
10	120
15	110
20	100
25	90
30	80
35	70
40	60
45	50

If both firms stick to agreement,
each firm's profit = _____

If A-Mobile reneges on agreement and
produces $Q = 40$:

Market quantity = _____, $P =$ _____

A-Mobile's profit = _____

A-Mobile's profits are _____ if it reneges.

B-Mobile will conclude the same, so
both firms renege, each produces $Q = 40$:

Market quantity = _____, $P =$ _____

Each firm's profit = _____

Collusion vs. Self-Interest

- Both firms would be better off if both stick to the cartel agreement.
- But each firm has incentive to renege on the agreement.
- Lesson:
It is difficult for oligopoly firms to form cartels and honor their agreements.

ACTIVE LEARNING 2

The oligopoly equilibrium

<i>P</i>	<i>Q</i>
\$0	140
5	130
10	120
15	110
20	100
25	90
30	80
35	70
40	60
45	50

If each firm produces $Q = 40$,
market quantity = 80

$$P = \$30$$

each firm's profit = \$800

Is it in A-Mobile's interest to increase its
output further, to $Q = 50$?

Is it in B-Mobile's interest to increase its
output to $Q = 50$?

ACTIVE LEARNING 2

Answers

P	Q
\$0	140
5	130
10	120
15	110
20	100
25	90
30	80
35	70
40	60
45	50

If each firm produces $Q = 40$,
then each firm's profit = \$800.

If A-Mobile increases output to $Q = 50$:

Market quantity = _____, $P =$ _____

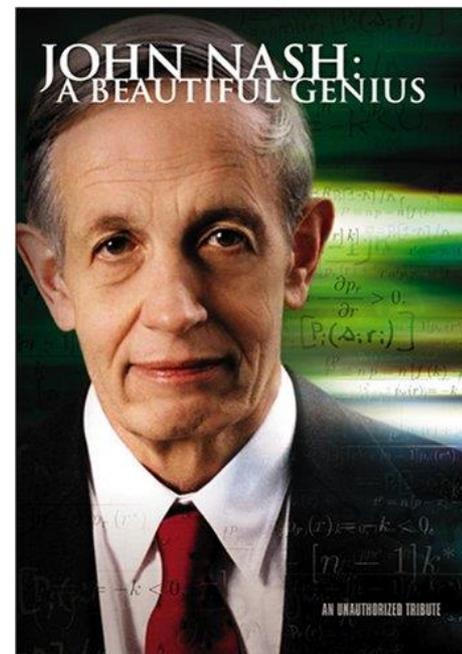
A-Mobile's profit = _____

A-Mobile's profits are _____ at $Q = 40$
than at $Q = 50$.

The same is true for B-Mobile.

17-1c The Equilibrium for an Oligopoly

- **Nash equilibrium**: a situation in which economic participants
 - *interacting with one another*
 - each choose their *best* strategy
 - *given* the strategies that all the others have chosen
- Our duopoly example has a **Nash equilibrium** in which each firm produces **$Q = 40$** .
 - Given that B-Mobile produces **$Q = 40$** , A-Mobile's best move is to produce **$Q = 40$** .
 - Given that A-Mobile produces **$Q = 40$** , B-Mobile's best move is to produce **$Q = 40$** .



John Nash

17-1d How the Size of an Oligopoly Affects the Market Outcome



A Comparison of Market Outcomes

When firms in an oligopoly individually choose production to maximize profit,

- oligopoly Q (80) is greater than monopoly Q (60) but smaller than competitive Q (120).
- oligopoly P (\$30) is greater than competitive P (\$10) but less than monopoly P (\$40).

EXAMPLE: Cell Phone Duopoly in Apple Town

P	Q	Revenue	Cost	Profit
\$0	140	\$0	\$1,400	-1,400
5	130	650	1,300	-650
10	120	1,200	1,200	0
15	110	1,650	1,100	550
20	100	2,000	1,000	1,000
25	90	2,250	900	1,350
30	80	2,400	800	1,600
35	70	2,450	700	1,750
40	60	2,400	600	1,800
45	50	2,250	500	1,750

Competitive outcome:

$$P = MC = \$10$$

$$Q = 120$$

$$\text{Profit} = \$0$$

Monopoly outcome:

$$P = \$40$$

$$Q = 60$$

$$\text{Profit} = \$1,800$$

Oligopoly outcome:

$$P = \$30$$

$$Q = 80$$

$$\text{Profit} = \$1,600$$

The Output & Price Effects

- Increasing output has two effects on a firm's profits:
 - **Output effect:**
If $P > MC$, increasing output raises profits.
 - **Price effect:**
Raising output increases market quantity, which reduces price and reduces profit on all units sold.
- If output effect $>$ price effect,
the firm increases production & profit.
- If price effect $>$ output effect,
the firm reduces production & profit.

The Size of the Oligopoly

- As the number of firms in the market increases,
 - the price effect becomes smaller
 - the oligopoly looks more and more like a competitive market
 - P approaches MC
 - the market quantity approaches the socially efficient quantity

Another benefit of international trade:

Trade increases the number of firms competing, increases Q , brings P closer to marginal cost

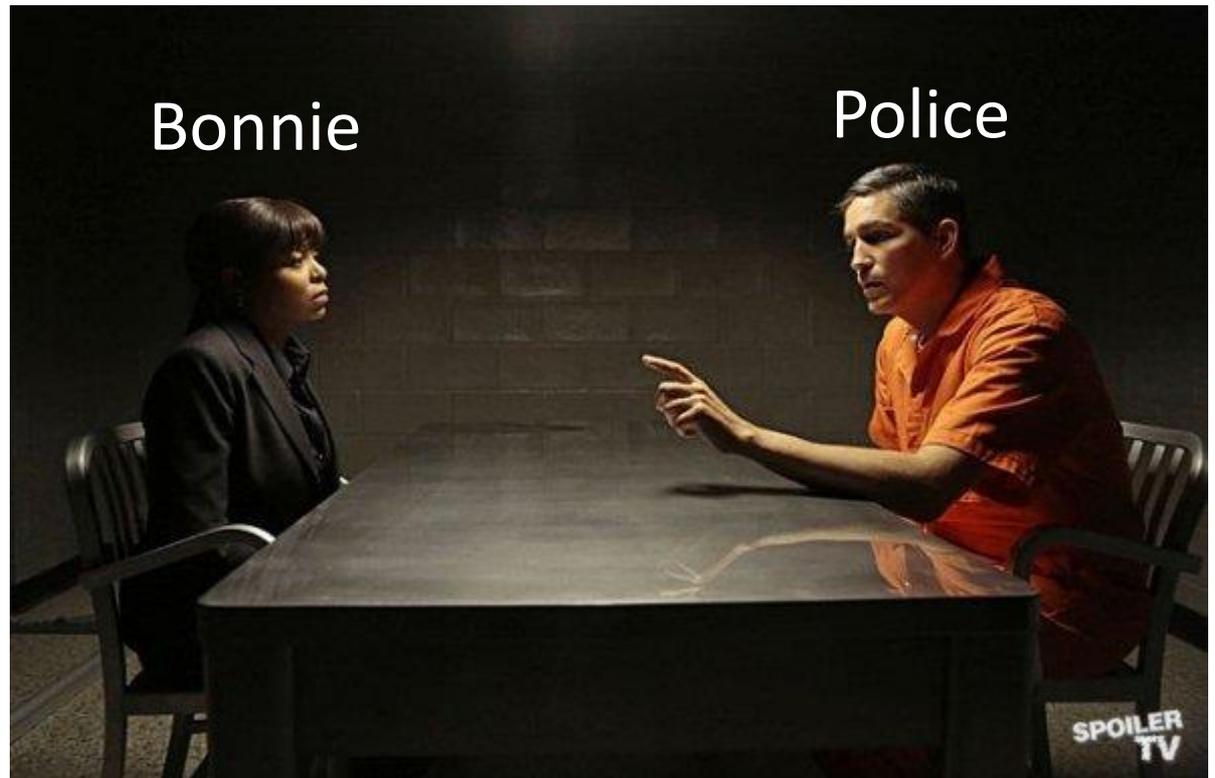
CONCLUSION

- Oligopolies can end up looking like monopolies or like competitive markets, depending on the number of firms and how cooperative they are.

Game Theory

- **Game theory** helps us understand oligopoly and other situations where “players” **interact** and **behave strategically**.
- **Dominant strategy**: a strategy that is best for a player in a game regardless of the strategies chosen by the other players
- **Prisoners’ dilemma**: a “game” between two captured criminals that illustrates why cooperation is difficult even when it is mutually beneficial

Prisoners' Dilemma



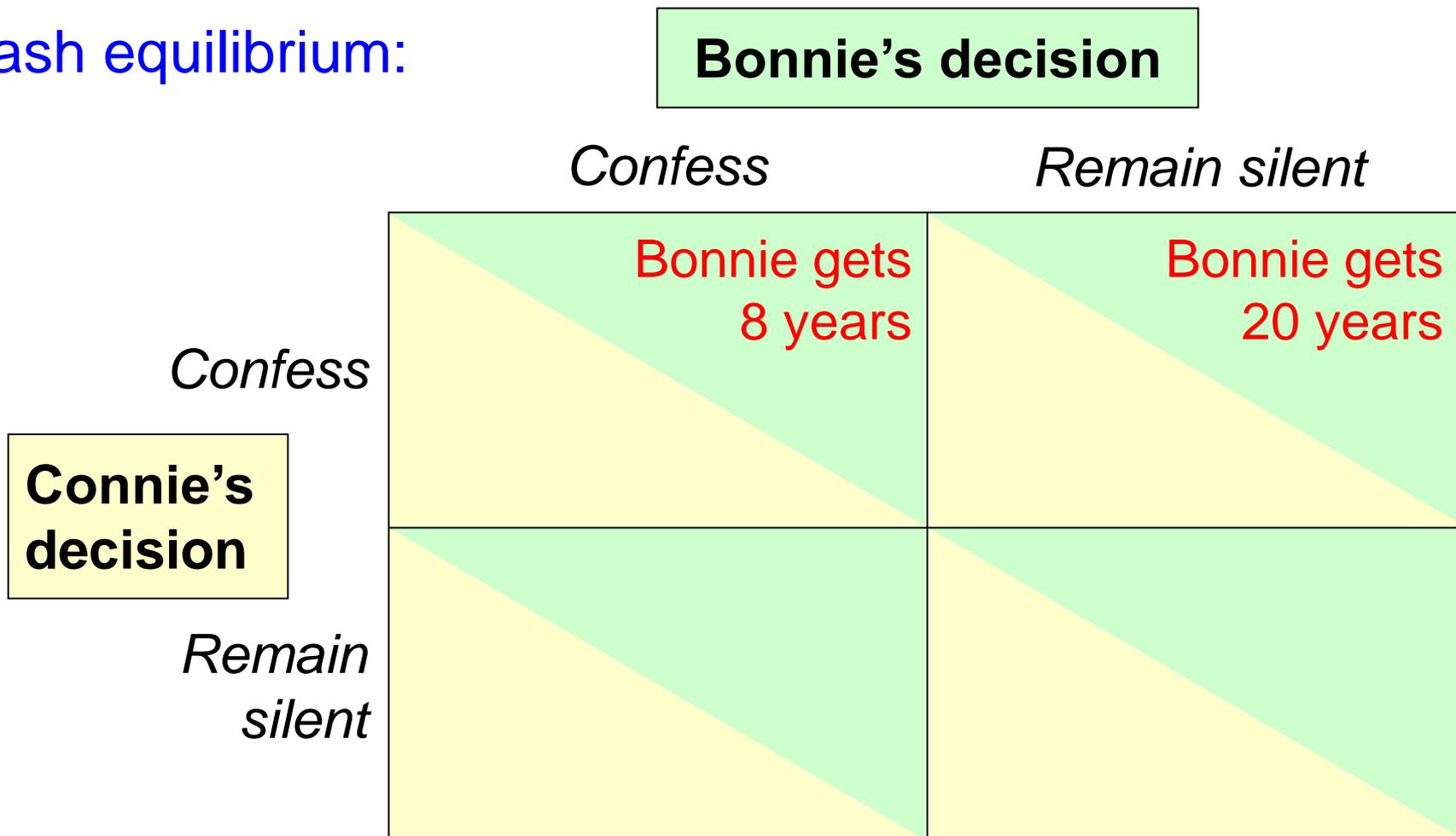
17-2a Prisoners' Dilemma Example

- The police have caught Bonnie and Connie, two suspected bank robbers, but only have enough evidence to imprison each for 1 year.
- The police question each in separate rooms, offer each the following deal:
 - If you confess and implicate your partner, you go free.
 - If you do not confess but your partner implicates you, you get 20 years in prison.
 - If you both confess, each gets 8 years in prison.
 - If you both remain silent (i.e., not confess), each gets 1 year. (no enough evidence)

Prisoners' Dilemma Example

Confessing is the dominant strategy for both players.

Nash equilibrium:



Prisoners' Dilemma Example

- **Outcome:** Bonnie and Connie both confess, each gets 8 years in prison.
- Both would have been **better off** if both remained silent.
- But even if Bonnie and Connie had agreed before being caught to remain silent, the **logic of self-interest** takes over and leads them to confess.

17-2b Oligopolies as a Prisoners' Dilemma

- When oligopolies form a **cartel** in hopes of reaching the monopoly outcome, they become players in a prisoners' dilemma.
- Our earlier example:
 - A-Mobile and B-Mobile are duopolists in Apple Town.
 - The cartel outcome maximizes profits:
Each firm agrees to serve $Q = 30$ customers.
- Here is the “payoff matrix” for this example...

A-Mobile & B-Mobile in the Prisoners' Dilemma

Each firm's dominant strategy: renege on agreement, produce $Q = 40$.

		A-Mobile	
		$Q = 30$ (cooperate)	$Q = 40$ (not cooperate)
B-Mobile	$Q = 30$ (cooperate)	A-Mobile's profit = \$900 B-Mobile's profit = \$900	A-Mobile's profit = \$1000 B-Mobile's profit = \$750
	$Q = 40$ (Not cooperate)	A-Mobile's profit = \$750 B-Mobile's profit = \$1000	A-Mobile's profit = \$800 B-Mobile's profit = \$800

ACTIVE LEARNING 3

The fare wars game

The players: Continental Airlines and United Airlines

The choice: cut fares by 50% (Lower price) or leave fares alone (Higher price)

- If both airlines cut fares, each airline's profit = \$400 million
- If neither airline cuts fares, each airline's profit = \$600 million
- If only one airline cuts its fares, its profit = \$800 million
the other airline's profits = \$200 million

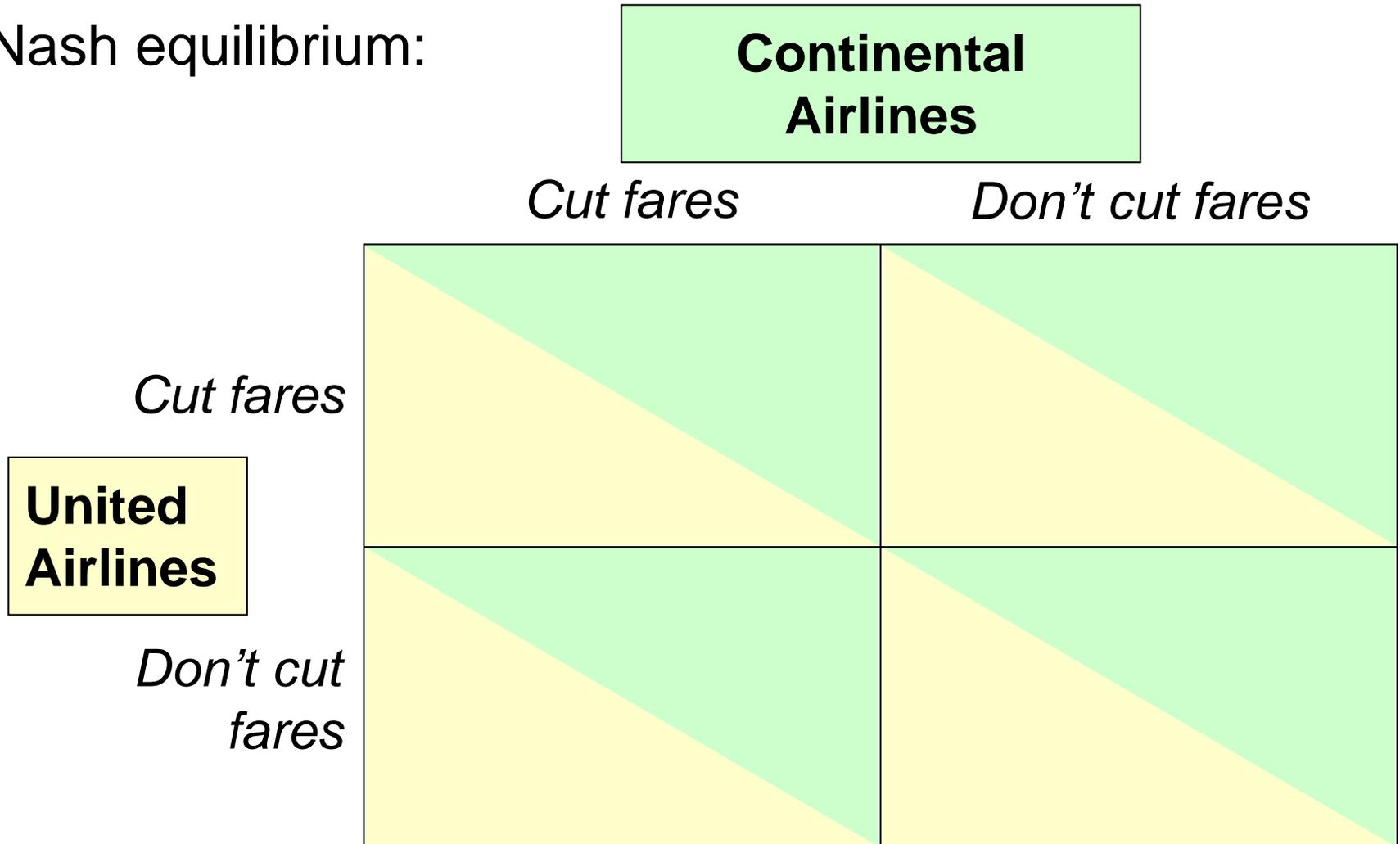
Draw the payoff matrix, find the dominant strategy & Nash equilibrium.



ACTIVE LEARNING 3

Answers

Nash equilibrium:



Other Examples of the Prisoner's Dilemma



17-2c Other Examples of the Prisoners' Dilemma

Ad Wars

Two firms spend millions on TV ads to steal business from each other. Each firm's ad cancels out the effects of the other, and both firms' profits fall by the cost of the ads.

Organization of Petroleum Exporting Countries

Member countries try to act like a cartel, agree to limit oil production to boost prices and profits. But agreements sometimes break down when individual countries renege.

17-2c Other Examples of the Prisoners' Dilemma

Arms race between military superpowers

Each country would be better off if both disarm, but each has a dominant strategy of arming.

Common resources

All would be better off if everyone conserved common resources, but each person's dominant strategy is overusing the resources.

17-2d Prisoners' Dilemma and Society's Welfare

- **The noncooperative oligopoly equilibrium**
 - Bad for oligopoly firms:
prevents them from achieving monopoly profits
 - Good for society:
 Q is closer to the socially efficient output
 P is closer to MC
- **In other prisoners' dilemmas**, the inability to cooperate may reduce social welfare.
 - e.g., arms race, overuse of common resources

Another Example: Negative Campaign Ads

- Election with two candidates, “R” and “D.”
- If R runs a negative ad attacking D,
3000 fewer people will vote for D:
1000 of these people vote for R, the rest abstain.
- If D runs a negative ad attacking R,
R loses 3000 votes, D gains 1000, 2000 abstain.
- R and D agree to refrain from running attack ads.
Will each of them stick to the agreement?

Another Example: Negative Campaign Ads

Each candidate's dominant strategy: **run attack ads.**

R's decision

Do not run attack ads (cooperate)

Run attack ads (defect)

Do not run attack ads (cooperate)

D's decision

Run attack ads (defect)

no votes lost or gained	R gains 1000 votes
no votes lost or gained	D loses 3000 votes
R loses 3000 votes	R loses 2000 votes
D gains 1000 votes	D loses 2000 votes

Another Example: Negative Campaign Ads

- **Nash eq'm:** both candidates run attack ads.
- **Effects on election outcome:** NONE.
Each side's ads cancel out the effects of the other side's ads.
- **Effects on society:** NEGATIVE.
Lower voter turnout, higher apathy about politics, less voter scrutiny of elected officials' actions.

ACTIVE LEARNING 4

You and a classmate are assigned a project on which you will receive one combined grade. You each want to receive a good grade, but you also want to avoid hard work. In particular, here is the situation:

- If **both of you work hard**, you both get an A, which gives your classmate and you 80 and 65 units of happiness respectively.
- If **only one of you works hard**, you both get a B, which gives your classmate and you 50 and 30 units of happiness respectively.
- If **neither of you works hard**, you both get a D, which gives each of you 10 units of happiness.
- Working hard **costs 25 units of happiness**.

A. Fill in the payoffs in the following decision box:

Your decision

Work

Shirk

Work

**Classmate's
decision**

Shirk

	<p>_____ units of happiness</p>	<p>_____ units of happiness</p>
	<p>_____ units of happiness</p>	<p>_____ units of happiness</p>
	<p>_____ units of happiness</p>	<p>_____ units of happiness</p>
	<p>_____ units of happiness</p>	<p>_____ units of happiness</p>

B. Does your classmate have a dominant strategy?
Do you have a dominant strategy? Explain.

C. Is there a Nash equilibrium for this scenario?
Explain.

ACTIVE LEARNING 5

Sinotech and Nippotech are the only two firms in a specific high-tech industry. They face the following payoff matrix as they decide upon the size of their research budget:

		Sinotech	
		<i>Large budget</i>	<i>Small budget</i>
Nippotech's decision	<i>Large budget</i>	Sinotech gains \$40 min Nippotech gains \$40 m	Sinotech gains \$10 min Nippotech gains \$10 m
	<i>Small budget</i>	Sinotech gains \$20 min Nippotech gains \$20 m	Sinotech gains \$30 min Nippotech gains \$25 m

A. Does Sinotech have a dominant strategy? Does Nippotech have a dominant strategy? Explain.

B. Is / are there a Nash equilibrium / equilibria for this scenario? Explain.

17-2e Why People Sometimes Cooperate

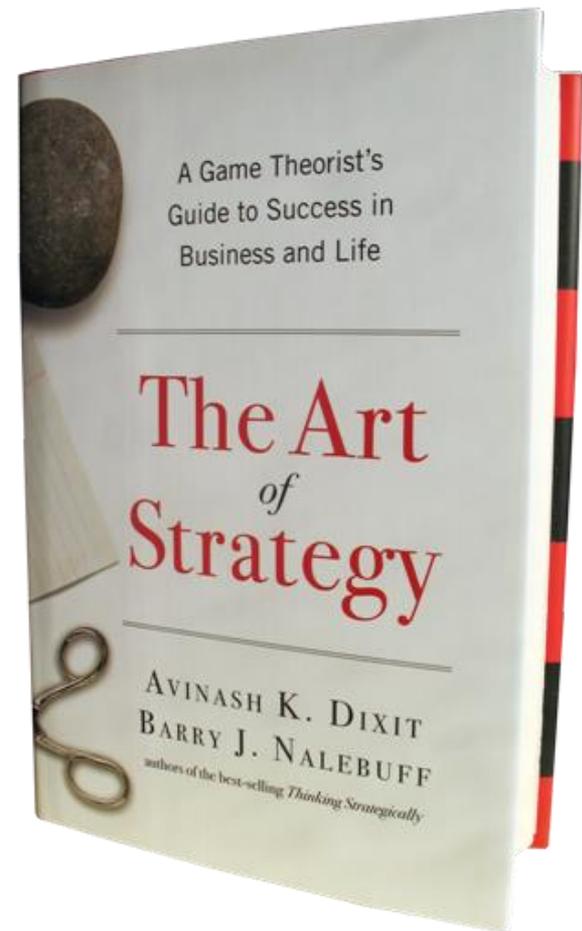
- When the game is repeated **many times**, cooperation may be possible.
- Two strategies that may lead to cooperation:
 - If your rival reneges in one round, you renege in all subsequent rounds.
 - **“Tit-for-tat”** (biblical strategy of “an eye for an eye, a tooth for a tooth”)
Whatever your rival does in one round (whether renege or cooperate), you do in the following round.

CONCLUSION

- The prisoners' dilemma shows **how difficult it is for firms to maintain cooperation**, even when doing so is in their best interest.

Read more about game theory

This introduction to game theory discusses how all people – from corporate executives to criminals under arrest – should and do make strategic decisions.



Topic 12 True/False Statements

- a) Duopolists can maximize their total profits if they form a cartel and act in unison.
- b) An oligopolist will charge a higher price and operate less efficiently than a competitive firm.
- c) The non-cooperative oligopoly equilibrium can be bad for oligopoly firms but good for society.



Summary

- Oligopolists can maximize profits if they form a cartel and act like a monopolist.
- Yet, self-interest leads each oligopolist to a higher quantity and lower price than under the monopoly outcome.
- The larger the number of firms, the closer will be the quantity and price to the levels that would prevail under competition.
- The prisoners' dilemma shows that self-interest can prevent people from cooperating, even when cooperation is in their mutual interest. The logic of the prisoners' dilemma applies in many situations.