CHAPTER OUTLINE

1. Describe and identify oligopoly and explain how it arises.
   A. Small Number of Firms
      1. Interdependence
      2. Temptation to Collude
   B. Barriers to Entry
   C. Identifying Oligopoly

2. Explore the range of alternative price and quantity outcomes and describe the dilemma faced by firms in oligopoly.
   A. Monopoly Outcome
      1. Cartel to Achieve Monopoly Outcome
   B. Perfect Competition Outcome
   C. Other Possible Cartel Breakdowns
      1. Boeing Increases Output to 4 Airplanes a Week
      2. Airbus Increases Output to 4 Airplanes a Week
      3. Boeing Increases Output to 5 Airplanes a Week
   D. The Oligopoly Cartel Dilemma

3. Use game theory to explain how price and quantity are determined in oligopoly.
   A. What Is a Game?
   B. The Prisoners' Dilemma
      1. Rules
      2. Strategies
      3. Payoffs
      4. Equilibrium
      5. Not the Best Outcome
   C. The Duopolists' Dilemma
      1. The Payoff Matrix
      2. Equilibrium of the Duopolists' Dilemma
      3. Collusion is Profitable but Difficult to Achieve
   D. Advertising and Research Games in Oligopoly
      1. Advertising Game
      2. Research and Development Game
   E. Repeated Games
   F. Is Oligopoly Efficient?
CHAPTER ROADMAP

■ What’s New in this Edition?
Chapter 16 has several revisions. The discussion of alternative outcomes in oligopoly has been changed, though the thrust—that the outcomes range from producing the monopoly output all the way to producing the competitive output—remains the same. There is a new example of how game theory can be used to analyze issues other than price setting with a discussion of an advertising game between Pepsi and Coke.

■ Where We Are
In this chapter, we examine the last of the four market structures, oligopoly. The chapter starts by defining oligopoly. It then describes the range of output seen in oligopoly and develops the concept of game theory.

■ Where We’ve Been
The previous chapters studied firms in perfect competition, monopolistic competition, and monopoly. Some of the material from perfect competition and monopoly are used in this chapter when discussing the range of outcome of oligopoly.

■ Where We’re Going
The next chapter covers how the government chooses to regulate monopolies and antitrust law. The material in Chapter 17 depends on the subjects covered in this chapter, but more heavily uses results from Chapter 13, on perfect competition, and Chapter 14, on monopoly.

IN THE CLASSROOM

■ Class Time Needed
You can complete this chapter in two or perhaps more likely, three sessions. Probably most of the time will be spent on game theory because game theory is a set of entirely new concepts.

An estimate of the time per checkpoint is:

• 16.1 What is Oligopoly?—20 to 30 minutes
• 16.2 Alternative Oligopoly Outcomes—30 to 40 minutes
• 16.3 Game Theory—60 to 80 minutes
16.1 What is Oligopoly?

Oligopoly is characterized by having a small number of firms competing and natural or legal barriers preventing the entry of new firms.

**Small Number of Firms**
- Because there are a small number of firms, the firms are *interdependent* so that each firm’s actions influence the profits of the other firms.
- To maximize profit, firms in an oligopoly might choose to form a cartel. A *cartel* is a group of firms acting together to limit output, raise price, and increase economic profit. Cartels are illegal in the United States.

**Barriers to Entry**
- A natural oligopoly occurs when a few firms can supply the market more cheaply than many firms. A legal oligopoly exists when a legal barrier to entry protects the small number of firms in a market.
- A *duopoly* is a market with only two firms.

**Identifying Oligopoly**
The key feature that determines whether a market is an oligopoly is whether the firms are interdependent. As a practical matter, a market in which the HHI exceeds 1,800 is usually an example of oligopoly.

16.2 Alternative Oligopoly Outcomes

An oligopoly might operate like a monopoly, like perfect competition, or somewhere between these two alternatives.

**Monopoly Outcome**
- A monopoly outcome occurs when the firms produce the same level of output as a single-price monopoly at the intersection of the marginal cost and marginal revenue curves.
- The firms might form a cartel in order to reach the monopoly outcome.
- The price is highest and the joint total profit is the largest with this outcome.

**Perfect Competition Outcome**
- A competitive outcome occurs when the firms produce the level of output determined by the intersection of the industry supply curve (the marginal cost curve) and the market demand curve.
- The price is the lowest and the joint total profit is the smallest with this outcome.

**Oligopoly Cartel Dilemma**
- If an oligopoly has formed a cartel that sets the monopoly price and quantity, then each firm has the incentive to cheat on the agreement by increasing its output and cutting its price because this action boosts the firm’s profit. If all the firms cheat, the cartel can break down and the outcome will be closer to—or the same as—the perfectly competitive outcome.
16.3 Game Theory

Game theory is a tool for studying *strategic behavior*—behavior that takes into account the expected behavior of others and the recognition of mutual interdependence. Games have rules, strategies, payoffs, and outcomes.

The Prisoners’ Dilemma

- Art (A) and Bob (B) have been caught stealing cars. Both men are scheduled to sentenced to two years in jail for this crime. Both are suspected of committing a more serious crime for which the prosecutor has insufficient evidence for a conviction. The two men are each interrogated for the more serious crime in separate cells. Each prisoner is told that if he confesses and his partner denies, he will serve 1 year in jail and his partner will serve 15 years, while if both confess, both serve 4 years.

- The game’s payoff matrix is to the right. In it are the payoffs from each man’s strategies, which are to confess or deny involvement in the serious crime. In general, strategies are all the possible actions of each player.

- In the Nash equilibrium, player A takes the best possible action given the action of player B and player B takes the best possible action given the action of player A. The Nash equilibrium for the prisoners’ dilemma is for both players to confess. This outcome is bad for them because both would be better off if each denied.

The Duopolist’s Dilemma

- Firms in an oligopoly can face a prisoners’ dilemma game. Suppose there are two firms, A and B. The firms could make a collusive (and illegal) agreement to jointly boost their price and decrease their output. Once the agreement is made, each firm must select its strategy: cheat on the agreement or comply with the agreement.

- The payoff matrix is to the right. Each firm’s profit depends on its strategy and that of its competitor.

- The Nash equilibrium for the game is for both firms to cheat on the agreement. The outcome is bad for them because both would be better off if each complied with the agreement.

- Collusion is profitable but is difficult to maintain.
Advertising and Research Games in Oligopoly

- Firms’ decisions about advertising and conducting research and development can be studied using game theory.
- In an advertising game, two firms can advertise or not advertise. Advertising is costly but if one firm advertises and the other does not, the one not advertising loses market share and profit while the one advertising gains market share and profit. Both firms would be better if neither advertised but the Nash equilibrium is that both firms advertise.
- In a research and development (R&D) game, two firms can conduct or not conduct R&D. Each firm’s strategies are to conduct the R&D or not conduct the R&D. A firm that conducts the R&D must pay for the R&D. Both firms would be better if neither firm conducted research and development but the Nash equilibrium is that both firms conduct research and development.

Repeated Games

- If a game is played repeatedly, it is possible for players of the game to cooperate and make and share the monopoly profit. Because the game is played repeatedly, a player can use a tit-for-tat strategy, in which the player cooperates in the current period if the other player cooperated in the previous period, but cheats in the current period if the other player cheated in the previous period.
- A tit-for-tat strategy used with the previous payoff matrix leads to a cooperative equilibrium.

The OPEC oil cartel is an excellent example of how useful game theory can be to explain real world events. Use the prisoner’s dilemma game to illustrate the incentive each nation faces: whether to cheat on their agreement or comply with it. A tit-for-tat strategy makes all the nations (as a group) better off but the demand for oil fluctuates and it is difficult for each nation to determine whether the other nations are cheating on the agreement. This combination makes a cartel agreement difficult to monitor, which is why we see the price of oil fluctuate so much, even during peaceful times. Saudi Arabia is widely believed to be the market leader for the cartel. Its oil output decisions have waxed and waned significantly over time, so oil prices fall when its government needs the extra oil revenues (cheating) or rises when the political environment requires greater economic unity among the Arab nations (cooperating).

Is Oligopoly Efficient?

- If the oligopoly can restrict its output, it is inefficient.
Lecture Launchers

1. The prisoners’ dilemma is a great way to start this lecture. Tell students they get to play a game and get two students to volunteer to be the “criminals.” Give the entire class the story and rules. Don’t use a payoff matrix at this point, just write the options on the board. Then send one of your volunteers out of the room. Ask the remaining student what strategy he or she will take. Get your class to help. It usually takes a few minutes for everyone to agree that confessing is the best strategy. Send the first student from the room and then call in the second student. Ask this student what he or she will do. Because the class already knows what the first student has done, encourage them not to tell. Aid the students as they move toward choosing the equilibrium. Encourage students to remember this gaming strategy because it is the same material that you’ll use to describe a firm’s behavior.

2. You can actually play the prisoner’s dilemma game online. A good Web version of the game can be found on a site operated by a group called Serendip at Bryn Mawr College in Pennsylvania. The URL for the web site is http://serendip.brynmawr.edu/playground/pd.html. If you can use the Web in your classroom, open two browsers and go to this site twice. Get two teams trying to beat Serendip.

3. John Nash’s life makes for an interesting anecdote you can tell in class. Some of your students might have seen the movie A Beautiful Mind, which was the somewhat embellished story of Nash’s life. To recapitulate the story, Nash was an incredibly bright graduate student and assistant professor in the early 1950s. During this time he developed the concept of the Nash equilibrium. Tragically, he was taken severely ill with schizophrenia. Princeton, where he was employed, made a supremely human decision and kept him on the faculty even though he was totally disabled. He spent the next three decades riding buses around Princeton and wandering the buildings at night. Nash’s condition has improved in recent years. The Nobel Prize committee heard of his improving condition and called several of his friends to inquire if he would be able to accept the prize. He was and so the Nobel Prize was awarded to him in 1994.

Land Mines

1. The duopolist’s dilemma game on pages 406-408 and revisited on pages 413–414 has been carefully designed to get the maximum payoff from the knowledge your students have of the perfect competition and monopoly results of the two preceding chapters and to introduce them to game theory in a setting that is as close to the previously studied settings as possible. Instead of asserting a payoff matrix on pages 413-414, the numbers in the matrix come directly from monopoly profit-maximizing and competitive out-
comes calculated on the earlier pages. You need to do a bit of work to generate the payoff numbers, but the whole story hangs together so much better when the student can see where the numbers come from and can see the connection between the oligopoly set up and those of competition and monopoly. Start with Figure 16.2 on page 406 and after you’ve explained the cost and demand conditions shown in the figure, ask the students what they think the price and quantity will be in this industry. There will be differences of opinion. This diversity of opinion motivates the need for a model of the choices the firms make.

2. Determining the Nash equilibrium of a game is often difficult for students. I try to make the game more “practical” by pointing out to the students that in the real world, real firms are almost always doing “what if” analyses and that game theory is well designed for answering these sorts of “what if” questions. In the Airbus/Boeing game in the text, the two companies are trying to determine how many airplanes they should produce if their competitor produces 3 airplanes or if their competitor produces 4 airplanes. You can illustrate the equilibrium by starting with Airbus and stating that Airbus wants to determine what it should do if Boeing produces 4 airplanes. Then, after determining that Airbus will produce 4 airplanes, do the next “what if” by looking what Airbus should do if Boeing produces 3 airplanes. In this case, Airbus again wants to produce 4 airplanes. Therefore Airbus’s “what if” analysis has led to the conclusion that regardless of Boeing’s decision, Airbus wants to produce 4 airplanes. You can conduct the same “what if” for Boeing’s choices and determine that Boeing, too, will produce 4 airplanes regardless of Airbus’s choice.
CHECKPOINT 16.1 What is Oligopoly?

1. Though students can have different answers, some common oligopoly markets are CPUs for computers, long-distance telephone service, cellular telephone service, automobiles, cigarettes, and photographic film.

2. The HHI is relatively high for the chocolate industry, but there are a large number of chocolate producers. So based on the HHI, the industry seems oligopoly but based on the large number of firms (and the point that often the relevant market is local rather than national) the industry might be monopolistic competition.

CHECKPOINT 16.2 Alternative Oligopoly Outcomes

1a. The price equals $6, the same as the price when only two firms were in the cartel. The profit-maximizing price does not depend on the number of firms in the cartel, though the more firms in the cartel, the lower is each firm’s production quota.

1b. The price equals zero, once again the same price as before.

2a. The dilemma is that if each firm could trust the other to raise its price and cut its advertising, each firm’s profit would increase. But each firm worries that if it alone hikes its price and cuts its advertising, its profit will fall drastically as its competitor’s market share drastically increases.

2bi. If the firms adhere to the cartel agreement to restrict output, the price of film will rise. To the extent that one or both firms cheat on the agreement, the price of film will be less than when both firms comply.

2bii. To the extent the firms comply with the cartel agreement, advertising expenditures as well as research and development expenditures will be cut. To the extent that one or both firms cheat on the agreement, advertising expenditures and research and development expenditures will be greater than when both firms comply.
CHECKPOINT 16.3 Game Theory

1a. The payoff matrix is to the right with the entries in millions of dollars. If Bud and Wise both develop the drink, each earns normal profit, which is zero economic profit. If neither develops, both earn zero economic profit, while if one develops and the other does not, the developer earns $2 million economic profit and the non-developer incurs an economic loss of $1 million.

1b. The game has a Nash equilibrium in which both develop the drink. For instance, if Wise develops, Bud wants to develop the drink because otherwise he loses $1 million. And if Wise does not develop the drink, Bud wants to develop the drink so that he can earn an economic profit of $2 million. No matter what Wise does, Bud will develop the drink. Similar reasoning shows that Wise, too, will develop the drink.

1c. There is a chance of cooperation in this research and development game if the game is played repeatedly and cheating on the agreement is punished using a tit for tat strategy.
1a. Figure 16.1 shows the average total cost curve and demand curve in 1901, when cars were made by hand. At the time the average total cost was high but reached its minimum after only a few cars were produced, so the market had many automobile producers.

1b. With the introduction of the assembly line, the average total cost rose a bit when a small number of cars is produced and fell otherwise. It reached its minimum after a larger number of cars were produced. Figure 16.2 illustrates this situation. The market was becoming a natural oligopoly.

1c. The introduction of robots raised the average total cost at low levels of production and lowered the average cost at higher levels of production. The number of cars before the average total cost reached its minimum increased. Figure 16.3 shows this situation. The market is a natural oligopoly.
1d. Initially the cost and demand allowed many firms to be in the market. But then the evolving cost curves lead the market to become a natural oligopoly. The barrier to entry is the very high average total cost when only a few cars are produced. If a firm wants to enter the market, it is necessary for it to have a large scale of production, which is difficult to achieve.

2a. In perfect competition in the long run, price equals minimum average total cost. So if Ann and Zack produce as perfect competitors, the total quantity of rides is 30 a day, the price is $5 a ride, and both make zero economic profit.

2b. A monopoly produces where marginal revenue equals marginal cost. The marginal revenue curve happens to intersect the average total cost curve at its minimum point. And, at minimum average total cost, the marginal cost curve intersects the average total cost curve. So the marginal revenue curve intersects the marginal cost at a quantity of 15 taxi rides a day. The demand curve shows that when the quantity demanded is 10 taxi rides a day, the price is $10 a taxi ride. Average total cost is $5. The monopoly makes an economic profit per ride equal to the price, $10 a ride, minus average total cost, $5 a ride, which is $5 a ride. The monopoly sells 15 rides a day, so the total economic profit is $5 a ride × 15 rides a day, which is $75 a day. Ann and Zack divide the profit, so each makes an economic profit of $37.50.

2c. Ann and Zack both have an incentive to break the cartel agreement by cutting their price below $10 a ride. For each, the marginal revenue of an additional tax ride exceeds the marginal cost, so each knows that if it, and it alone cheated, its profit would increase.

3a. A payoff matrix is to the right. Calculating the profits when either Ann or Zack break the collusive cartel agreement is difficult and the answer to the question depends on these profits. Probably the most reasonable assumptions are that the “cheater,” that is the player who does not collude, has a larger economic profit and that the “victim,” that is the player who does colludes, has an economic loss because no one uses his or her higher-price rides. So, the cheater has

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### Payoff Matrix

<table>
<thead>
<tr>
<th>Ann’s strategies</th>
<th>Collude</th>
<th>Not collude</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Zack’s strategies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collude</td>
<td>$37.50</td>
<td>$60.00</td>
</tr>
<tr>
<td>Not collude</td>
<td>$-10.00</td>
<td>$0.00</td>
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<tr>
<td><strong>Ann’s strategies</strong></td>
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<tr>
<td>Collude</td>
<td>$37.50</td>
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<td>Not collude</td>
<td>$-10.00</td>
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an economic profit that exceeds $37.50, the victim has an economic loss, $-10 in the payoff matrix, and the sum of the profit plus the loss is less than $75, the total profit when both Ann and Zack comply with their agreement. In the payoff matrix, the entries are dollars of economic profit.

3b. The Nash equilibrium is for Ann and Zack to produce the same quantity of rides as would be produced in perfect competition. Both earn $0 economic profit.

3c. The efficient quantity of taxi rides is produced.

3d. If the game is played repeatedly and a tit-for-tat strategy is used, the Nash equilibrium is for Ann and Zack to produce the same quantity of rides as would be produced in monopoly. Both earn an economic profit of $37.50.

3e. An inefficient quantity of taxi rides is produced.

4a. The payoff matrix is to the right. If Jenny and Joe both go to a movie, Jenny gets $100 + 100 = 200 and Joe gets $-100 (from the movie) + 100 (from being with Jenny) = 0. If they both go to a game, Jenny has the payoff of 0 and Joe has the payoff of 200. If Jenny goes to a game and Joe to a movie, each has a payoff of $-100. And if Jenny goes to a movie and Joe to a game, each has a payoff of 100.

4b. The game is different from a prisoners’ dilemma. The equilibrium will not be the worst outcome. Take Jenny’s decision. If Joe is going to a movie, Jenny definitely wants to go to a movie. If Joe is going to a game, Jenny again goes to the movie. Jenny will go to a movie regardless of Joe’s choice. Joe will always go to a game. So, the Nash equilibrium has Jenny going to the movie and Joe going to the game, so that each receives 100 as their payoff.

4c. The Nash equilibrium was explained in part (b) and has Jenny going to a movie and Joe to a game. If the game is played repeatedly, the Nash equilibrium is one possible outcome. Another possible outcome is that they might be able to settle upon alternating a movie and a game in some fashion. But if they alternate 50/50, there is no net gain in payoff to either.

4d. Jenny and Joe do not get the best outcome for each. Jenny’s best outcome is to go with a movie to Joe and she does not get this outcome in the Nash
equilibrium and only gets it one half of the time if they alternate where they go in a repeated game. Similarly, Joe does not get his best outcome of going to a game with Jenny.

5a. The United States’ best strategy is to impose a tariff because regardless of whether Canada exports or does not export, the payoff to the United States is greater with a tariff than without.

5b. Canada’s best strategy is to export because regardless of whether the United States imposes a tariff or does not impose a tariff, the payoff to Canada is greater by exporting than by not exporting.

5c. The outcome of the game is for the United States to impose a tariff and for Canada to export. This equilibrium occurs because both the United States and Canada are using their best strategies.

5d. The equilibrium is a Nash equilibrium but it differs from the Nash equilibrium in the prisoners’ dilemma game because the equilibrium in this trade game is not a bad outcome for both players. In particular, in the Nash equilibrium for the trade game, the United States has its best possible outcome and receives its highest payoff of 125. Any other outcome would give the United States a lower payoff. In the Nash equilibrium for the prisoners’ dilemma game, neither player achieves his or her best outcome.

5e. A free trade agreement would prevent the United States from imposing a tariff. The outcome in this case is for the United States to not impose a tariff and for Canada to export. Compared to the outcome in which the United States imposes a tariff and Canada exports, the free trade agreement lowers the payoff to the United States (from 125 to 100) but raises it for Canada (from 50 to 100). So Canada would benefit more from a free trade agreement.

6a. Wanabe does not believe Agile’s assertion. If Wanabe does not enter, Agile’s best strategy is to set a high price. And, even if Wanabe enters the market, Agile’s best strategy is to set a high price because Agile has a larger payoff from setting a high price, 7, than by setting a low price, 1. So Wanabe has no reason to believe Agile’s assertion.

6b. Wanabe enters the market. If Wanabe does not enter, Wanabe receives a payoff of 0. If Wanabe enters, Agile sets a high price and so Wanabe receives a payoff of 5.
7a. The CFOs believe that the other company will cheat on the agreement by advertising and by so doing will steal market share and profit.

7b. A payoff matrix that supports the CFOs is to the right. The payoffs are millions of dollars of economic profit. The strategies are to “comply” with the agreement to curtail advertising and “cheat” on the agreement to limit advertising. The crucial feature of the payoff matrix is that if one firm cheats and the other complies, even though the cheater spends $100 million on advertising, the advertising is sufficiently effective that the cheater’s profit rises compared to complying with the agreement.

7c. Coke’s best strategy is to cheat on the agreement by advertising, regardless of whether or not Pepsi complies with the agreement because Coke’s payoff is always greater by cheating. For instance, if Pepsi cheats, Coke’s profit is greater by cheating (zero) than by complying (−$30 million). And if Pepsi complies, Coke’s profit is still greater by cheating ($120 million) than by complying ($100 million). Similarly, Pepsi’s best strategy is to cheat. So the Nash equilibrium is for both firms to cheat on the agreement by advertising.

7d. A payoff matrix that supports the sales managers is to the right. The payoffs are millions of dollars of economic profit. The strategies are to “comply” with the agreement to curtail advertising and “cheat” on the agreement to limit advertising. One crucial feature of the payoff matrix is that if one firm cheats and the other complies, the cheater spends $100 million on advertising but the advertising is so ineffective that that the cheater’s profit falls compared to complying with the agreement. The other crucial feature
is that if one firm cheats and the other complies, the complier’s profit is greater than its profit if it also cheated.

7e. Coke’s best strategy is to comply with the agreement to limit advertising, regardless of whether or not Pepsi complies with the agreement because Coke’s payoff is always greater by complying. For instance, if Pepsi cheats, Coke’s profit is greater by complying ($30 million) than by cheating (zero). And if Pepsi complies, Coke’s profit is still greater by complying ($100 million) than by cheating ($80 million). Similarly, Pepsi’s best strategy is to comply. So the Nash equilibrium is for both firms to comply with the agreement to limit advertising.
Critical Thinking

8. Firms “conspire against the public” when they are interdependent. Adam Smith implicitly asserted that the market structure was oligopoly.

9. Procter & Gamble, Colgate, and Glaxo Smith Kline make a vast number of dental care products. Take toothpaste for an example. Procter & Gamble makes over 15 different types of toothpastes, ranging from “Advanced Cleaning” to “Dual Action Whitening” to “Extra Whitening” to “Sensitivity Protection” to “Kid’s Cavity Protection” to “Rejuvenating Effects.” Meanwhile Colgate makes as many toothpastes, ranging from “Colgate Simply White” to “Colgate Sparking White Mint Zing” to “Colgate Sensitive Maximum Strength Plus Whitening” to “Colgate Cavity Protection” to “Colgate 2 in 1 Kids.” Finally, Glaxo makes “Aquafresh Extreme Clean,” “Aquafresh Ultimate White,” “Aquafresh Extra Fresh,” and “Aquafresh Kids” among others. Some of each company’s products might differ from other products. For instance, the whitening toothpastes might be different than the cavity preventing toothpastes. To the extent they are different and needed to be developed, Procter & Gamble, Colgate, and Glaxo Smith Kline are engaged in an R&D game. However, many of the products seem to be quite similar. For example, the difference between “Dual Action Whitening” and “Extra Whitening” or the difference between “Simply White” and “Sparkling White” is probably negligible. And, the difference between Procter and Gamble’s many whitening toothpastes, Colgate’s myriad brands of whitening toothpastes, and Glaxo’s many brands is probably slight. So it is likely that the three companies also are involved in an advertising game.

10. The market for word processing software is an example of oligopoly because there are only a few, interdependent producers of word processing software.

10a. Consumers would be harmed if word processing software companies agreed to form a cartel and create only one type of word processing software because the price of the software would rise. In addition, to the extent that different consumers like the different features of different programs, the lack of variety from having only one type of word processing software is a further loss. There does not appear to be much gained from standardization because different programs already read files created by competing programs.

10b. Consumers gain the benefit of lower prices from the competition. They also gain the benefit of having variety in what particular programs can do.

10c. Each software firm knows collusion will result in a larger economic profit for the entire industry. But each software firm also knows that it will indi-
vidually earn a larger economic profit if it can cheat on the agreement while the other firms continue to collude. The agreement would eventually break down as each firm continues to produce more output so that each firm is making only a normal profit.

11a. The more people use a particular browser, the more advertisers are willing to pay. And charging for a browser also generates profit. If the browser is given away and the competitor charges, likely the one given away gains market share and that company makes a large economic profit. The other company incurs an economic loss. If both browsers are given away, both companies probably earn a comparable economic profit. And if both browsers are sold, both companies probably earn the largest economic profit because they collect from both advertisers and consumers.

11b. A payoff matrix is to the right that reflects the analysis of the profit in the previous part of this question. The joint profit is the largest when the browser is given away and is the smallest when the browser is sold. The numbers in the matrix are the economic profit in millions of dollars. Your students’ profit figures will be different.

11c. With the profits in the payoff matrix, the Nash equilibrium is to give the browsers away for free. Your students’ answers might differ according to the profits they have in their payoff matrices.
**Web Exercises**

12a. OPEC is a cartel because it is a group of countries trying to jointly control the price and quantity of oil.

12b. As a single entity, OPEC’s main objective is to gain the maximum profit for its member nations.

12c. OPEC sets targets for its member nations’ production of oil.

12d. The obstacles that OPEC must overcome are twofold. First, its member nations each have the incentive to cheat on their assigned quotas by pumping more oil than their quota. Each nation knows that if it and it alone pumps more oil, then its profit increases. However, if each nation pumps more oil, the price of oil falls and all nations lose. OPEC also faces the problem that non-OPEC nations produce oil. So if OPEC decreases its production and raises the price of oil, non-OPEC nations might increase their production and lower the price.

12e. OPEC faces a classic prisoners’ dilemma. Taken together, all member nations are better off if each nation adheres to its quota. But each nation knows that if it and it alone pumps more oil, then its profit increases. However, if each nation pumps more oil, the price of oil falls and all nations lose. So each member nation following its own self interest can create an equilibrium which is not the best for the OPEC nations.

12f. The non-OPEC nations also face a prisoners’ dilemma. If OPEC successfully decreases its production and raises the price of oil, each non-OPEC nation is better off. But each non-OPEC nation realizes that if it and it alone increases its production, its profits rise. However, if all non-OPEC nations produce more oil, they drive the price of oil down and are worse off. Each non-OPEC nation following its own self interest can create an equilibrium which is not the best for itself.

12g. To the extent that OPEC can successfully raise the price of oil by restricting the production of oil, the oil market is inefficient. A competitive oil market is efficient.

13a. The market for ethanol is probably an oligopoly with Archer Daniels Midland the largest producer, having a market share that exceeds 40 percent.

13b. The price of ethanol is being kept high by actions of Archer Daniels Midland by submitting bids that were rigged to other producers’ prices.

13c. Archer Daniels Midland and other ethanol producers benefit if the price of ethanol is kept high. So they might enter into a collusive agreement to fix the price so it remains high. Once the agreement is reached, taken together all the producers benefit from the high price. But it is in each producer’s individual self interest to cheat a bit on the agreement by lowering the
price slightly and producing more ethanol. If all the producers cheat, the price of ethanol tumbles and all producers’ profits fall.

13d. The market for ethanol is inefficient if the producers are engaged in keeping the price high. The market is dominated by one firm and this firm, by its actions, might well be aimed at keeping the price above the competitive level.
**ADDITIONAL EXERCISES FOR ASSIGNMENT**

- **Questions**

  - **CHECKPOINT 16.3 Game Theory**

    1. The equilibrium of a duopolist’s game can have both firms acting as competitors, so that they get the “worst” outcome possible. From the social standpoint of efficiency, how does this outcome compare to their best outcome, when they jointly act as a monopoly?

    2. OPEC, the Organization of Petroleum Exporting Countries, was formed in Baghdad in 1960. Since its formation, this cartel has suffered from a major problem with respect to the quota (limit) of output it assigns each member nation. What is OPEC’s goal and what sort of quota do you think the cartel assigns? How and why do nations cheat on their quota? What happens when a nation cheats on its quota?

    3. Both AMD and Intel spend billions of dollars a year on research and development. Why can’t they get together to decide to decrease their spending?

- **Answers**

  - **CHECKPOINT 16.3 Game Theory**

    1. The outcome where both act as competitors is more efficient than the outcome when they act as monopolists. If they act as monopolists, they create a deadweight loss. If they act as perfect competitors, they will produce the efficient quantity and there will be no deadweight loss.

    2. To keep the price of oil high, as has been the case since 1999, OPEC creates a target level of output designed to achieve a particular high price. OPEC’s goal is to set a price high enough so that its member nations earn the maximum economic profit. Once the target output is set, OPEC assigns a production quota to each member. As long as each member adheres to its quota the price remains high. However, from time to time, individual nations cheat on the agreement by producing more oil than allowed. Nations cheat because if they alone cheat, the impact on oil prices will be slight but the impact on their profit will be large. The supply of oil increases and the price falls. Then, once prices begin to fall other members panic and start selling more oil to get the highest price they can before a collapse takes place. If every nation cheats, the supply will increase more than if just a few do and the collapse in price becomes a self-realizing prophecy.

    3. The problem faced by AMD and Intel is similar to any prisoners’ dilemma game: Neither can trust the other to actually cut back on their research and development spending. And, if one firm did cut back and the other did not, the one cutting back would run the risk of being driven from business.
USING EYE ON THE U.S. ECONOMY

Examples of Oligopoly
You can list several of the industries given in the figure on the board. Before you add the Herfindahl-Hirschman Index to your list, ask your students to list the industries in order of competitiveness. Based on what they already know about the industries, ask them if they think they are an example of oligopoly or monopolistic competition. You might get a difference of opinion, say in breakfast cereals where some students believe the large number of cereals equates to a large number of producers.

USING EYE ON THE GLOBAL ECONOMY

The OPEC Global Oil Cartel
In 2004 and 2005, oil prices were in the headlines seemingly every day. When oil prices surged over these two years and when hurricanes struck, causing further oil price spikes, students talked persistently about the price of gasoline. Even if oil prices have retreated when you study this chapter, nonetheless students will be sensitive to the price of gasoline. You can use the data in this eye to show the students the tension that always exists within a cartel: Each individual producer (in OPEC’s case, each individual nation) realizes that if it, and it alone increases its production, its profits will rise dramatically. So each producer has an incentive to boost its production. Of course, if all or many producers do so, then the price falls and all are worse off. This situation is what played out in OPEC in the 1980s. From 1980, when oil prices were at then record highs, each nation in OPEC attempted to “cheat” by producing more oil than its quota and, simultaneously, many non-OPEC oil sources came on line. As a result the price of tumbled and then stayed low for virtually 15 years. Ask your students to predict what they foresee for oil prices over the next decade. Although there is no way to determine whose prediction will be right, quite likely you will get a range of views, from “We’ll run out of oil,” to “More production and more energy efficiency will drive the price lower.” Clearly a wide-ranging set of opinions can make for a very interesting classroom discussion.

Duopoly in Computer CPUs
This story provides a good example of how firms face a duopolists’ dilemma and how the competitive result is often the outcome. It also can springboard to a discussion of how firms decide to advertise and innovate. In particular, for years until 2006 Intel advertised “Intel inside,” and so frequently consumers have come to prefer an Intel chip powering their computer. On the other hand, AMD is probably more advanced in making dual-core chips because at the beginning
of 2006, AMD dual core chips were faster at completing more tasks than Intel’s dual core chips. Yet AMD still faces the handicap of consumers’ preference for “Intel inside.” You can highlight this competition on price and quality and let students speculate on how the firms will continue to compete.