Monopolistic Competition and Oligopoly

12

In the last two chapters, we saw how firms with monopoly power can choose prices and output levels to maximize profit. We also saw that monopoly power does not require a firm to be a pure monopolist. In many industries, even though several firms compete with each other, each firm has at least some monopoly power: It has control over price and can profitably charge a price that exceeds marginal cost.

In this chapter, we examine market structures other than pure monopoly that can give rise to monopoly power. We begin with what might seem like an oxymoron: **monopolistic competition**. A monopolistically competitive market is similar to a perfectly competitive market in two key respects: There are many firms and entry by new firms is not restricted. But it differs from perfect competition in that the product is *differentiated*: Each firm sells a brand or version of the product that differs in quality, appearance, or reputation, and each firm is the sole producer of its own brand. The amount of monopoly power wielded by a firm depends on its success in differentiating its product from those of other firms. Examples of monopolistically competitive industries abound: Toothpaste, laundry detergent, and packaged coffee are a few.

The second form of market structure we will examine is **oligopoly**: a market in which only a few firms compete with one another, and entry by new firms is impeded. The product that the firms produce might be differentiated, as with automobiles, or it might not be, as with steel. Monopoly power and profitability in oligopolistic industries depend in part on how the firms interact. For example, if the interaction is more cooperative than competitive, firms could charge prices well above marginal cost and earn large profits.

In some oligopolistic industries, firms do cooperate, but in others, they compete aggressively, even though this means lower profits. To see why, we need to consider how oligopolistic firms decide on output and prices. These decisions are complicated because each firm must operate *strategically*—when making a decision, it must weigh the probable reactions of its competitors. To understand oligopolistic markets, we must therefore introduce some basic concepts of gaming and strategy. We develop these concepts more fully in Chapter 13.

The third form of market structure that we examine is a **cartel**. In a cartelized market, some or all firms explicitly *collude*: They coordinate prices and output levels to maximize *joint* profits. Cartels can arise in markets that would otherwise be competitive, as with the OPEC oil cartel, or oligopolistic, as with the international bauxite cartel.

CHAPTER OUTLINE

LIST OF EXAMPLES

• **monopolistic competition** Market in which firms can enter freely, each producing its own brand or version of a differentiated product.

• **oligopoly** Market in which only a few firms compete with one another, and entry by new firms is impeded.

• **cartel** Market in which some or all firms explicitly collude, coordinating prices and output levels to maximize joint profits.

At first glance, a cartel may seem like a pure monopoly. After all, the firms in a cartel appear to operate as though they were parts of one big company. But a cartel differs from a monopoly in two important respects. First, because cartels rarely control the entire market, they must consider how their pricing decisions will affect noncartel production levels. Second, because the members of a cartel are *not* part of one big company, they may be tempted to "cheat" their partners by undercutting prices and grabbing bigger shares of the market. As a result, many cartels tend to be unstable and short-lived.

12.1 MONOPOLISTIC COMPETITION

In many industries, the products are differentiated. For one reason or another, consumers view each firm's brand as different from other brands. Crest toothpaste, for example, is perceived to be different from Colgate, Aim, and other toothpastes. The difference is partly flavor, partly consistency, and partly reputation—the consumer's image (correct or incorrect) of the relative decay-preventing efficacy of Crest. As a result, some consumers (but not all) will pay more for Crest.

Because Procter & Gamble is the sole producer of Crest, it has monopoly power. But its monopoly power is limited because consumers can easily substitute other brands if the price of Crest rises. Although consumers who prefer Crest will pay more for it, most of them will not pay much more. The typical Crest user might pay 25 or 50 cents a tube more, but probably not one or two dollars more. For most consumers, toothpaste is toothpaste, and the differences among brands are small. Therefore, the demand curve for Crest toothpaste, though downward sloping, is fairly elastic. (A reasonable estimate of the elasticity of demand for Crest is –5.) Because of its limited monopoly power, Procter & Gamble will charge a price that is higher, but not much higher, than marginal cost. The situation is similar for Tide detergent or Scott paper towels.

In §10.2, we explain that a seller of a product has some monopoly power if it can profitably charge a price greater than marginal cost.

The Makings of Monopolistic Competition

A monopolistically competitive market has two key characteristics:

1. Firms compete by selling differentiated products that are highly substitutable for one another but not perfect substitutes. In other words, the cross-price elasticities of demand are large but not infinite.
2. There is *free entry and exit:* it is relatively easy for new firms to enter the market with their own brands and for existing firms to leave if their products become unprofitable.

To see why free entry is an important requirement, let's compare the markets for toothpaste and automobiles. The toothpaste market is monopolistically competitive, but the automobile market is better characterized as an oligopoly. It is relatively easy for other firms to introduce new brands of toothpaste, and this limits the profitability of producing Crest or Colgate. If the profits were large, other firms would spend the necessary money (for development, production, advertising, and promotion) to introduce new brands of their own, which would reduce the market shares and profitability of Crest and Colgate.

The automobile market is also characterized by product differentiation. However, the large scale economies involved in production make entry by new firms difficult. Thus, until the mid-1970s, when Japanese producers became important competitors, the three major U.S. automakers had the market largely to themselves.

There are many other examples of monopolistic competition besides toothpaste. Soap, shampoo, deodorants, shaving cream, cold remedies, and many other items found in a drugstore are sold in monopolistically competitive markets. The markets for bicycles and other sporting goods are likewise monopolistically competitive. So is most retail trade, because goods are sold in many different stores that compete with one another by differentiating their services according to location, availability and expertise of salespeople, credit terms, etc. Entry is relatively easy, so if profits are high in a neighborhood because there are only a few stores, new stores will enter.

Equilibrium in the Short Run and the Long Run

As with monopoly, in monopolistic competition firms face downward-sloping demand curves. Therefore, they have some monopoly power. But this does not mean that monopolistically competitive firms are likely to earn large profits. Monopolistic competition is also similar to perfect competition: Because there is free entry, the potential to earn profits will attract new firms with competing brands, driving economic profits down to zero.

To make this clear, let's examine the equilibrium price and output level for a monopolistically competitive firm in the short and long run. Figure 12.1(a) shows the short-run equilibrium. Because the firm's product differs from its competitors', its demand curve D_{SR} is downward sloping. (This is the *firm's* demand curve, not the market demand curve, which is more steeply sloped.) The profit-maximizing

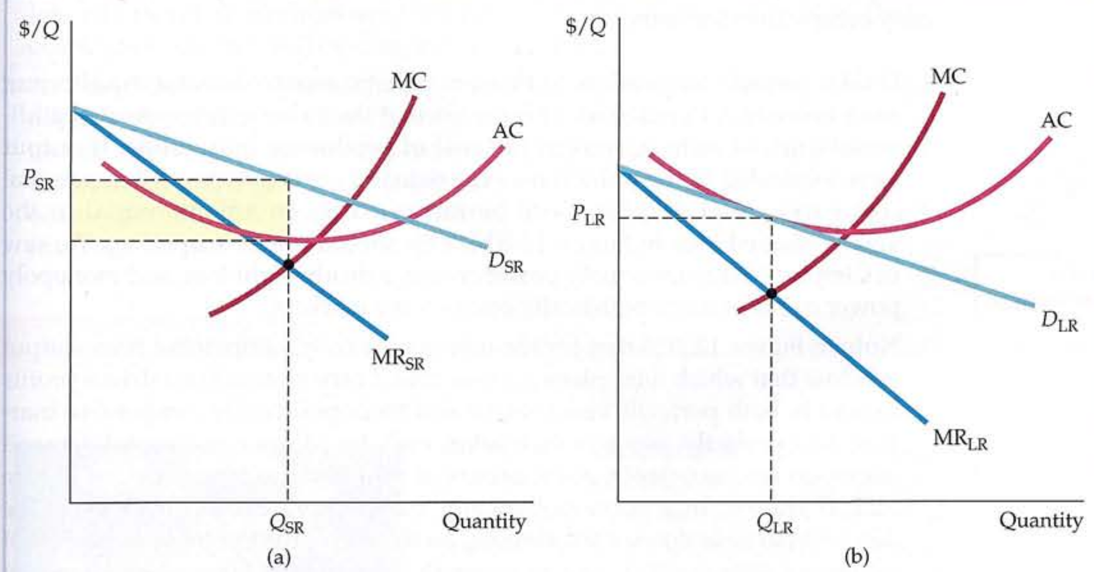

FIGURE 12.1 A Monopolistically Competitive Firm in the Short and Long Run

Because the firm is the only producer of its brand, it faces a downward-sloping demand curve. Price exceeds marginal cost and the firm has monopoly power. In the short run, described in part **(a)**, price also exceeds average cost, and the firm earns profits shown by the yellow-shaded rectangle. In the long run, these profits attract new firms with competing brands. The firm's market share falls, and its demand curve shifts downward. In long-run equilibrium, described in part **(b)**, price equals average cost, so the firm earns zero profit even though it has monopoly power.

In §10.1, we explain that a monopolist maximizes profit by choosing an output at which marginal revenue is equal to marginal cost.

quantity Q_{SR} is found at the intersection of the marginal revenue and marginal cost curves. Because the corresponding price P_{SR} exceeds average cost, the firm earns a profit, as shown by the shaded rectangle in the figure.

In the long run, this profit will induce entry by other firms. As they introduce competing brands, our firm will lose market share and sales; its demand curve will shift down, as in Figure 12.1(b). (In the long run, the average and marginal cost curves may also shift. We have assumed for simplicity that costs do not change.) The long-run demand curve D_{LR} will be just tangent to the firm's average cost curve. Here, profit maximization implies the quantity Q_{LR} and the price P_{LR}. It also implies *zero profit* because price is equal to average cost. Our firm still has monopoly power: Its long-run demand curve is downward sloping because its particular brand is still unique. But the entry and competition of other firms have driven its profit to zero.

Recall from §8.7 that with the possibility of entry and exit, firms will earn zero economic profit in long-run equilibrium.

More generally, firms may have different costs, and some brands will be more distinctive than others. In this case, firms may charge slightly different prices, and some will earn small profits.

Monopolistic Competition and Economic Efficiency

In §9.2, we explain that competitive markets are efficient because they maximize the sum of consumers' and producers' surplus.

Perfectly competitive markets are desirable because they are economically efficient: As long as there are no externalities and nothing impedes the workings of the market, the total surplus of consumers and producers is as large as possible. Monopolistic competition is similar to competition in some respects, but is it an efficient market structure? To answer this question, let's compare the long-run equilibrium of a monopolistically competitive industry to the long-run equilibrium of a perfectly competitive industry.

Figure 12.2 shows that there are two sources of inefficiency in a monopolistically competitive industry:

1. Unlike perfect competition, with monopolistic competition the equilibrium price exceeds marginal cost. This means that the value to consumers of additional units of output exceeds the cost of producing those units. If output were expanded to the point where the demand curve intersects the marginal cost curve, total surplus could be increased by an amount equal to the yellow-shaded area in Figure 12.2(b). This should not be surprising. We saw in Chapter 10 that monopoly power creates a deadweight loss, and monopoly power exists in monopolistically competitive markets.

In §10.4, we discuss the deadweight loss from monopoly power.

2. Note in Figure 12.2(b) that for the monopolistically competitive firm, output is below that which minimizes average cost. Entry of new firms drives profits to zero in both perfectly competitive and monopolistically competitive markets. In a perfectly competitive market, each firm faces a horizontal demand curve, so the zero-profit point occurs at minimum average cost, as Figure 12.2(a) shows. In a monopolistically competitive market, however, the demand curve is downward sloping, so the zero-profit point is to the left of minimum average cost. Excess capacity is inefficient because average cost would be lower with fewer firms.

These inefficiencies make consumers worse off. Is monopolistic competition then a socially undesirable market structure that should be regulated? The answer—for two reasons—is probably no:

1. In most monopolistically competitive markets, monopoly power is small. Usually enough firms compete, with brands that are sufficiently substitutable,

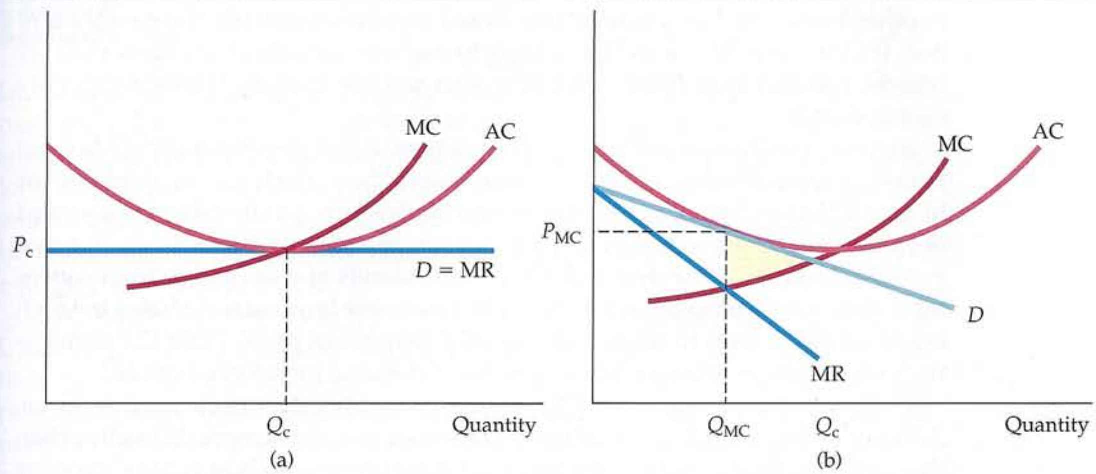

FIGURE 12.2 Comparison of Monopolistically Competitive Equilibrium and Perfectly Competitive Equilibrium

Under perfect competition, as in **(a)**, price equals marginal cost, but under monopolistic competition, price exceeds marginal cost. Thus there is a deadweight loss, as shown by the yellow-shaded area in **(b)**. In both types of markets, entry occurs until profits are driven to zero. Under perfect competition, the demand curve facing the firm is horizontal, so the zero-profit point occurs at the point of minimum average cost. Under monopolistic competition the demand curve is downward-sloping, so the zero-profit point is to the left of the point of minimum average cost. In evaluating monopolistic competition, these inefficiencies must be balanced against the gains to consumers from product diversity.

so that no single firm has much monopoly power. Any resulting deadweight loss will therefore be small. And because firms' demand curves will be fairly elastic, average cost will be close to the minimum.

2. Any inefficiency must be balanced against an important benefit from monopolistic competition: *product diversity*. Most consumers value the ability to choose among a wide variety of competing products and brands that differ in various ways. The gains from product diversity can be large and may easily outweigh the inefficiency costs resulting from downward-sloping demand curves.

EXAMPLE 12.1 Monopolistic Competition in the Markets for Colas and Coffee

The markets for soft drinks and coffee illustrate the characteristics of monopolistic competition. Each market has a variety of brands that differ slightly but are close substitutes for one another. Each brand of cola, for example, tastes a little different from the next. (Can you tell the difference between Coke and Pepsi? Between Coke and Royal Crown Cola?) And each brand of ground coffee has a slightly different flavor, fragrance, and caffeine content. Most consumers develop their own preferences; you might prefer Maxwell House coffee to other brands and buy it regularly. Brand loyalties, however, are usually limited. If the price of Maxwell House were to rise substantially above those of other brands, you and most other consumers who had been buying it would probably switch brands.

Just how much monopoly power does General Foods, the producer of Maxwell House, have with this brand? In other words, how elastic is the demand for Maxwell House? Most large companies carefully study product demands as part of their market research. Company estimates are usually proprietary, but two published studies of the demands for various brands of colas and ground coffees used simulated shopping experiments to determine how market shares for each brand would change in response to specific changes in price. Table 12.1 summarizes the results by showing the elasticities of demand for several brands.[1]

First, note that among colas, Royal Crown is much less price elastic than Coke. Although it has a small share of the cola market, its taste is more distinctive than that of Coke, Pepsi, and other brands, so consumers who buy it have stronger brand loyalty. But even though Royal Crown has more monopoly power than Coke, it is not necessarily more profitable. Profits depend on fixed costs and volume, as well as price. Even if its average profit is smaller, Coke will generate more profit because it has a much larger share of the market.

TABLE 12.1 Elasticities of Demand for Brands of Colas and Coffee

	Brand	Elasticity of Demand
Colas	Royal Crown	−2.4
	Coke	−5.2 to −5.7
Ground coffee	Folgers	−6.4
	Maxwell House	−8.2
	Chock Full o'Nuts	−3.6

Second, note that coffees as a group are more price elastic than colas. There is less brand loyalty among coffee buyers than among cola buyers because the differences among coffees are less perceptible than the differences among colas. Note that the demand for Chock Full o' Nuts is less price elastic than its competitors. Why? Because Chock Full o' Nuts, like Royal Crown Cola, has a more distinctive taste than Folgers or Maxwell House, and so consumers who buy it tend to remain loyal. Fewer consumers notice or care about the taste differences between Folgers and Maxwell House.

With the exception of Royal Crown and Chock Full o' Nuts, all the colas and coffees are quite price elastic. With elasticities on the order of −4 to −8, each brand has only limited monopoly power. This is typical of monopolistic competition.

[1]The elasticity estimates in Table 12.1 are from John R. Nevin, "Laboratory Experiments for Estimating Consumer Demand: A Validation Study," *Journal of Marketing Research* 11 (August 1974): 261–68; and Lakshman Krishnamurthi and S. P. Raj, "A Model of Brand Choice and Purchase Quantity Price Sensitivities," *Marketing Science* (1991). In typical simulated shopping experiments, consumers are asked to choose the brands that they prefer from a variety of prepriced brands. This trial is repeated several times, with different prices each time.

12.2 OLIGOPOLY

In oligopolistic markets, the products may or may not be differentiated. What matters is that only a few firms account for most or all of total production. In some oligopolistic markets, some or all firms earn substantial profits over the long run because *barriers to entry* make it difficult or impossible for new firms to enter. Oligopoly is a prevalent form of market structure. Examples of oligopolistic industries include automobiles, steel, aluminum, petrochemicals, electrical equipment, and computers.

Why might barriers to entry arise? We discussed some of the reasons in Chapter 10. Scale economies may make it unprofitable for more than a few firms to coexist in the market; patents or access to a technology may exclude potential competitors; and the need to spend money for name recognition and market reputation may discourage entry by new firms. These are "natural" entry barriers—they are basic to the structure of the particular market. In addition, incumbent firms may take *strategic actions* to deter entry. For example, they might threaten to flood the market and drive prices down if entry occurs, and to make the threat credible, they can construct excess production capacity.

Managing an oligopolistic firm is complicated because pricing, output, advertising, and investment decisions involve important strategic considerations. Because only a few firms are competing, each firm must carefully consider how its actions will affect its rivals, and how its rivals are likely to react.

Suppose that because of sluggish car sales, Ford is considering a 10-percent price cut to stimulate demand. It must think carefully about how competing auto companies will react. They might not react at all, or they might cut their prices only slightly, in which case Ford could enjoy a substantial increase in sales, largely at the expense of its competitors. Or they might match Ford's price cut, in which case all of the firms will sell more cars, but might make much lower profits because of the lower prices. Another possibility is that some firms will cut their prices by *even more* than Ford to punish Ford for rocking the boat, and this in turn might lead to a price war and to a drastic fall in profits for the entire industry. Ford must carefully weigh all these possibilities. In fact, for almost any major economic decision that a firm makes—setting price, determining production levels, undertaking a major promotion campaign, or investing in new production capacity—it must try to determine the most likely response of its competitors.

These strategic considerations can be complex. When making decisions, each firm must weigh its competitors' reactions, knowing that these competitors will also weigh *its* reactions to *their* decisions. Furthermore, decisions, reactions, reactions to reactions, and so forth are dynamic, evolving over time. When the managers of a firm evaluate the potential consequences of their decisions, they must assume that their competitors are as rational and intelligent as they are. Then, they must put themselves in their competitors' place and consider how they would react.

Equilibrium in an Oligopolistic Market

When we study a market, we usually want to determine the price and quantity that will prevail in equilibrium. For example, we saw that in a perfectly competitive market, the equilibrium price equates the quantity supplied with the quantity demanded. Then we saw that for a monopoly, an equilibrium occurs when marginal revenue equals marginal cost. Finally, when we studied monopolistic competition, we saw how a long-run equilibrium results as the entry of new firms drives profits to zero.

In these markets, each firm could take price or market demand as given and largely ignore its competitors. In an oligopolistic market, however, a firm sets price or output based partly on strategic considerations regarding the behavior of its competitors. At the same time, competitors' decisions depend on the first firm's decision. How, then, can we figure out what the market price and output will be in equilibrium—or whether there will even be an equilibrium? To answer these questions, we need an underlying principle to describe an equilibrium when firms make decisions that explicitly take each other's behavior into account.

Remember how we described an equilibrium in competitive and monopolistic markets: *When a market is in equilibrium, firms are doing the best they can and have no reason to change their price or output.* Thus a competitive market is in equilibrium when the quantity supplied equals the quantity demanded: Each firm is doing the best it can—it is selling all that it produces and is maximizing its profit. Likewise, a monopolist is in equilibrium when marginal revenue equals marginal cost because it, too, is doing the best it can and is maximizing its profit.

In §8.7, we explain that in a competitive market, long-run equilibrium occurs when no firm has an incentive to enter or exit because firms are earning zero economic profit and the quantity demanded is equal to the quantity supplied.

Nash Equilibrium With some modification, we can apply this same principle to an oligopolistic market. Now, however, each firm will want to do the best it can *given what its competitors are doing*. And what should the firm assume that its competitors are doing? Because the firm will do the best it can given what its competitors are doing, *it is natural to assume that these competitors will do the best they can given what that firm is doing*. Each firm, then, takes its competitors into account, and assumes that its competitors are doing likewise.

This may seem a bit abstract at first, but it is logical, and as we will see, it gives us a basis for determining an equilibrium in an oligopolistic market. The concept was first explained clearly by the mathematician John Nash in 1951, so we call the equilibrium it describes a **Nash equilibrium**. It is an important concept that we will use repeatedly:

• **Nash equilibrium** Set of strategies or actions in which each firm does the best it can given its competitors' actions.

Nash Equilibrium: Each firm is doing the best it can given what its competitors are doing.

We discuss this equilibrium concept in more detail in Chapter 13, where we show how it can be applied to a broad range of strategic problems. In this chapter, we will apply it to the analysis of oligopolistic markets.

To keep things as uncomplicated as possible, this chapter will focus largely on markets in which two firms are competing with each other. We call such a market a **duopoly**. Thus each firm has just one competitor to take into account in making its decisions. Although we focus on duopolies, our basic results will also apply to markets with more than two firms.

• **duopoly** Market in which two firms compete with each other.

The Cournot Model

We will begin with a simple model of duopoly first introduced by the French economist Augustin Cournot in 1838. Suppose the firms produce a homogeneous good and know the market demand curve. *Each firm must decide how much to produce, and the two firms make their decisions at the same time.* When making its production decision, each firm takes its competitor into account. It knows that its competitor is *also* deciding how much to produce, and the market price will depend on the *total output* of both firms.

Recall from §8.8 that when firms produce homogeneous or identical goods, consumers consider only price when making their purchasing decisions.

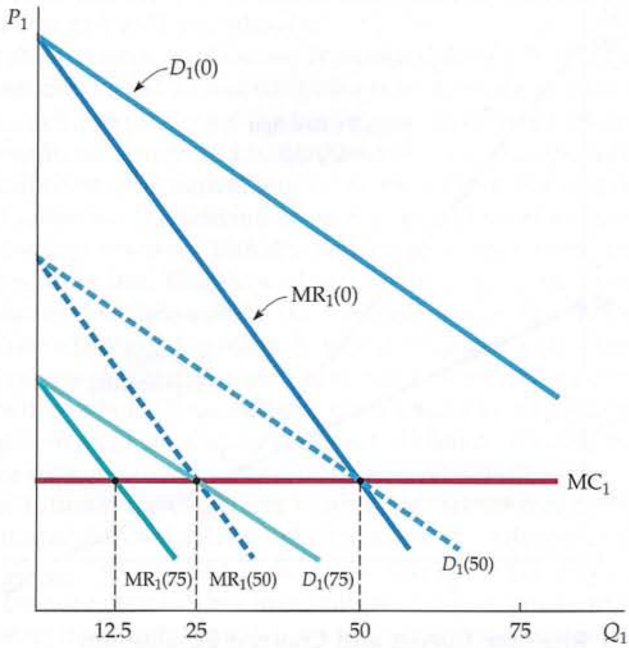

FIGURE 12.3 Firm 1's Output Decision

Firm 1's profit-maximizing output depends on how much it thinks that Firm 2 will produce. If it thinks Firm 2 will produce nothing, its demand curve, labeled $D_1(0)$, is the market demand curve. The corresponding marginal revenue curve, labeled $MR_1(0)$, intersects Firm 1's marginal cost curve MC_1 at an output of 50 units. If Firm 1 thinks that Firm 2 will produce 50 units, its demand curve, $D_1(50)$, is shifted to the left by this amount. Profit maximization now implies an output of 25 units. Finally, if Firm 1 thinks that Firm 2 will produce 75 units, Firm 1 will produce only 12.5 units.

The essence of the **Cournot model** is that *each firm treats the output level of its competitor as fixed when deciding how much to produce.* To see how this works, let's consider the output decision of Firm 1. Suppose Firm 1 thinks that Firm 2 will produce nothing. In that case, Firm 1's demand curve is the market demand curve. In Figure 12.3 this is shown as $D_1(0)$, which means the demand curve for Firm 1, assuming Firm 2 produces zero. Figure 12.3 also shows the corresponding marginal revenue curve $MR_1(0)$. We have assumed that Firm 1's marginal cost MC_1 is constant. As shown in the figure, Firm 1's profit-maximizing output is 50 units, the point where $MR_1(0)$ intersects MC_1. So if Firm 2 produces zero, Firm 1 should produce 50.

• **Cournot model** Oligopoly model in which firms produce a homogeneous good, each firm treats the output of its competitors as fixed, and all firms decide simultaneously how much to produce.

Suppose, instead, that Firm 1 thinks Firm 2 will produce 50 units. Then Firm 1's demand curve is the market demand curve shifted to the left by 50. In Figure 12.3, this curve is labeled $D_1(50)$, and the corresponding marginal revenue curve is labeled $MR_1(50)$. Firm 1's profit-maximizing output is now 25 units, the point where $MR_1(50) = MC_1$. Now, suppose Firm 1 thinks that Firm 2 will produce 75 units. Then Firm 1's demand curve is the market demand curve shifted to the left by 75. It is labeled $D_1(75)$ in Figure 12.3, and the corresponding marginal revenue curve is labeled $MR_1(75)$. Firm 1's profit-maximizing output is now 12.5 units, the point where $MR_1(75) = MC_1$. Finally, suppose Firm 1 thinks that Firm 2 will produce 100 units. Then Firm 1's demand and marginal revenue curves (which are not shown in the figure) would intersect its marginal cost

If competitor output is fixed, there can really be now adjustment at all, making the assumption of the model to never result in equilibrium.

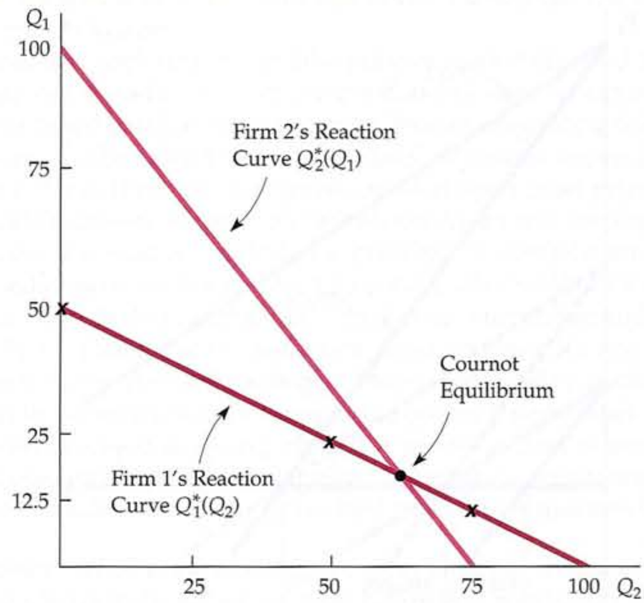

FIGURE 12.4 Reaction Curves and Cournot Equilibrium

Firm 1's reaction curve shows how much it will produce as a function of how much it thinks Firm 2 will produce. (The xs at $Q_2 = 0$, 50, and 75 correspond to the examples shown in Figure 12.3.) Firm 2's reaction curve shows its output as a function of how much it thinks Firm 1 will produce. In Cournot equilibrium, each firm correctly assumes the amount that its competitor will produce and thereby maximizes its own profits. Therefore, neither firm will move from this equilibrium.

curve on the vertical axis; if Firm 1 thinks that Firm 2 will produce 100 units or more, it should produce nothing.

Reaction Curves To summarize: If Firm 1 thinks that Firm 2 will produce nothing, it will produce 50; if it thinks Firm 2 will produce 50, it will produce 25; if it thinks Firm 2 will produce 75, it will produce 12.5; and if it thinks Firm 2 will produce 100, then it will produce nothing. *Firm 1's profit-maximizing output is thus a decreasing schedule of how much it thinks Firm 2 will produce.* We call this schedule Firm 1's **reaction curve** and denote it by $Q_1^*(Q_2)$. This curve is plotted in Figure 12.4, where each of the four output combinations that we found above is shown as an x.

• **reaction curve** Relationship between a firm's profit-maximizing output and the amount it thinks its competitor will produce.

We can go through the same kind of analysis for Firm 2; that is, we can determine Firm 2's profit-maximizing quantity given various assumptions about how much Firm 1 will produce. The result will be a reaction curve for Firm 2—i.e., a schedule $Q_2^*(Q_1)$ that relates its output to the output that it thinks Firm 1 will produce. If Firm 2's marginal revenue or marginal cost curve is different from that of Firm 1, its reaction curve will also differ in form. For example, Firm 2's reaction curve might look like the one drawn in Figure 12.4.

• **Cournot equilibrium** Equilibrium in the Cournot model in which each firm correctly assumes how much its competitor will produce and sets its own production level accordingly.

Cournot Equilibrium How much will each firm produce? Each firm's reaction curve tells it how much to produce, given the output of its competitor. In equilibrium, each firm sets output according to its own reaction curve; the equilibrium output levels are therefore found at the *intersection* of the two reaction curves. We call the resulting set of output levels a **Cournot equilibrium**. In this equilibrium, each firm correctly assumes how much its competitor will produce, and it maximizes its profit accordingly.

Note that this Cournot equilibrium is an example of a Nash equilibrium (and thus it is sometimes called a *Cournot-Nash equilibrium*). Remember that in a Nash equilibrium, each firm is doing the best it can given what its competitors are doing. As a result, no firm would individually want to change its behavior. In the Cournot equilibrium, each firm is producing an amount that maximizes its profit *given what its competitor is producing*, so neither would want to change its output.

Suppose the two firms are initially producing output levels that differ from the Cournot equilibrium. Will they adjust their outputs until the Cournot equilibrium is reached? Unfortunately, the Cournot model says nothing about the dynamics of the adjustment process. In fact, during any adjustment process, the model's central assumption that each firm can assume that its competitor's output is fixed will not hold. Because both firms would be adjusting their outputs, neither output would be fixed. We need different models to understand dynamic adjustment, and we will examine some in Chapter 13.

When is it rational for each firm to assume that its competitor's output is fixed? It is rational if the two firms are choosing their outputs only once because then their outputs cannot change. It is also rational once they are in Cournot equilibrium because then neither firm will have any incentive to change its output. When using the Cournot model, we must therefore confine ourselves to the behavior of firms in equilibrium.

The Linear Demand Curve—An Example

Let's work through an example—two identical firms facing a linear market demand curve. This will help clarify the meaning of a Cournot equilibrium and let us compare it with the competitive equilibrium and the equilibrium that results if the firms collude and choose their output levels cooperatively.

Suppose our duopolists face the following market demand curve:

$$P = 30 - Q$$

where Q is the *total* production of both firms (i.e., $Q = Q_1 + Q_2$). Also, suppose that both firms have zero marginal cost:

$$\mathrm{MC}_1 = \mathrm{MC}_2 = 0$$

We can determine the reaction curve for Firm 1 as follows. To maximize profit, it sets marginal revenue equal to marginal cost. Its total revenue R_1 is given by

$$\begin{aligned} R_1 = PQ_1 &= (30 - Q)Q_1 \\ &= 30Q_1 - (Q_1 + Q_2)Q_1 \\ &= 30Q_1 - Q_1^2 - Q_2Q_1 \end{aligned}$$

Its marginal revenue MR_1 is just the incremental revenue ΔR_1 resulting from an incremental change in output ΔQ_1:

$$\mathrm{MR}_1 = \Delta R_1/\Delta Q_1 = 30 - 2Q_1 - Q_2$$

Now, setting MR_1 equal to zero (the firm's marginal cost) and solving for Q_1, we find

$$\textit{Firm 1's reaction curve:} \quad Q_1 = 15 - \frac{1}{2}Q_2 \qquad \textbf{(12.1)}$$

The same calculation applies to Firm 2:

$$\textit{Firm 2's reaction curve:} \quad Q_2 = 15 - \frac{1}{2}Q_1 \qquad \textbf{(12.2)}$$

The equilibrium output levels are the values for Q_1 and Q_2 at the intersection of the two reaction curves—i.e., the levels that solve equations (12.1) and (12.2). By replacing Q_2 in equation (12.1) with the expression on the righthand side of (12.2), you can verify that the equilibrium output levels are

$$\textit{Cournot equilibrium:} \quad Q_1 = Q_2 = 10$$

The total quantity produced is therefore $Q = Q_1 + Q_2 = 20$, so the equilibrium market price is $P = 30 - Q = 10$, and each firm earns a profit of 100.

Figure 12.5 shows the firms' reaction curves and this Cournot equilibrium. Note that Firm 1's reaction curve shows its output Q_1 in terms of Firm 2's output Q_2. Likewise, Firm 2's reaction curve shows Q_2 in terms of Q_1. (Because the firms are identical, the two reaction curves have the same form. They look different because one gives Q_1 in terms of Q_2 and the other gives Q_2 in terms of Q_1.)

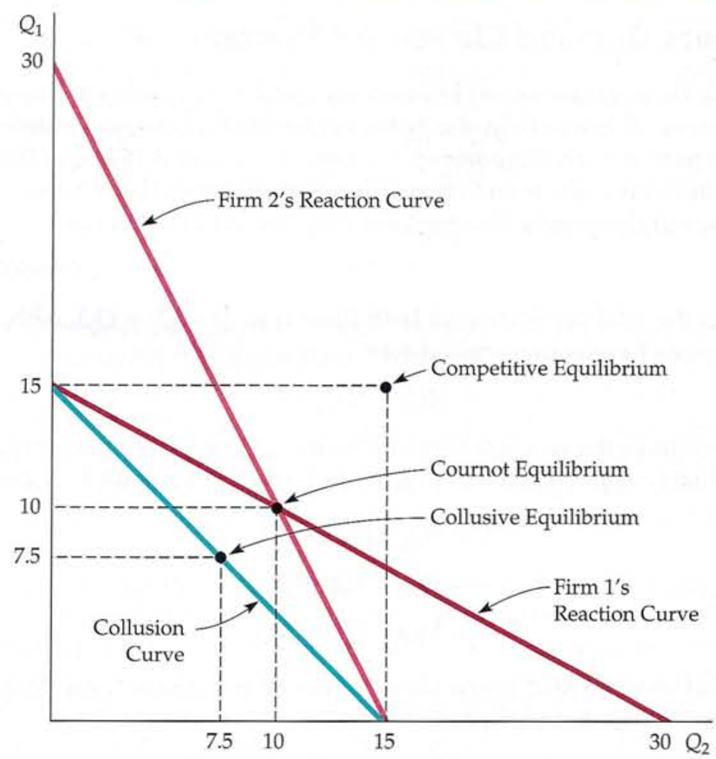

FIGURE 12.5 Duopoly Example

The demand curve is $P = 30 - Q$, and both firms have zero marginal cost. In Cournot equilibrium, each firm produces 10. The collusion curve shows combinations of Q_1 and Q_2 that maximize *total* profits. If the firms collude and share profits equally, each will produce 7.5. Also shown is the competitive equilibrium, in which price equals marginal cost and profit is zero.

The Cournot equilibrium is at the intersection of the two curves. At this point, each firm is maximizing its own profit, given its competitor's output.

We have assumed that the two firms compete with each other. Suppose, instead, that the antitrust laws were relaxed and the two firms could collude. They would set their outputs to maximize *total profit*, and presumably they would split that profit evenly. Total profit is maximized by choosing total output Q so that marginal revenue equals marginal cost, which in this example is zero. Total revenue for the two firms is

$$R = PQ = (30 - Q)Q = 30Q - Q^2$$

Marginal revenue is therefore

$$\text{MR} = \Delta R/\Delta Q = 30 - 2Q$$

Setting MR equal to zero, we see that total profit is maximized when $Q = 15$.

Any combination of outputs Q_1 and Q_2 that add up to 15 maximizes total profit. The curve $Q_1 + Q_2 = 15$, called the *collusion curve*, therefore gives all pairs of outputs Q_1 and Q_2 that maximize total profit. This curve is also shown in Figure 12.5. If the firms agree to share profits equally, each will produce half of the total output:

$$Q_1 = Q_2 = 7.5$$

As you would expect, both firms now produce less—and earn higher profits (112.50)—than in the Cournot equilibrium. Figure 12.5 shows this collusive equilibrium and the *competitive* output levels found by setting price equal to marginal cost. (You can verify that they are $Q_1 = Q_2 = 15$, which implies that each firm makes zero profit.) Note that the Cournot outcome is much better (for the firms) than perfect competition, but not as good as the outcome from collusion.

First Mover Advantage—The Stackelberg Model

We have assumed that our two duopolists make their output decisions at the same time. Now let's see what happens if one of the firms can set its output first. There are two questions of interest. First, is it advantageous to go first? Second, how much will each firm produce?

Continuing with our example, we assume that both firms have zero marginal cost, and that market demand is given by $P = 30 - Q$, where Q is total output. *Suppose Firm 1 sets its output first and then Firm 2, after observing Firm 1's output, makes its output decision.* In setting output, *Firm 1 must therefore consider how Firm 2 will react.* This **Stackelberg model** of duopoly is different from the Cournot model, in which neither firm has any opportunity to react.

• **Stackelberg model** Oligopoly model in which one firm sets its output before other firms do.

Let's begin with Firm 2. Because it makes its output decision *after* Firm 1, it takes Firm 1's output as fixed. Therefore, Firm 2's profit-maximizing output is given by its Cournot reaction curve, which we derived above as equation (12.2):

$$\textit{Firm 2's reaction curve:} \quad Q_2 = 15 - \frac{1}{2}Q_1 \qquad \textbf{(12.2)}$$

What about Firm 1? To maximize profit, it chooses Q_1 so that its marginal revenue equals its marginal cost of zero. Recall that Firm 1's revenue is

$$R_1 = PQ_1 = 30Q_1 - Q_1^2 - Q_2Q_1 \qquad \textbf{(12.3)}$$

Because R_1 depends on Q_2, Firm 1 must anticipate how much Firm 2 will produce. Firm 1 knows, however, that Firm 2 will choose Q_2 according to the reaction curve (12.2). Substituting equation (12.2) for Q_2 into equation (12.3), we find that Firm 1's revenue is

$$R_1 = 30Q_1 - Q_1^2 - Q_1\left(15 - \frac{1}{2}Q_1\right)$$
$$= 15Q_1 - \frac{1}{2}Q_1^2$$

Its marginal revenue is therefore

$$\text{MR}_1 = \Delta R_1/\Delta Q_1 = 15 - Q_1 \quad \textbf{(12.4)}$$

Setting $\text{MR}_1 = 0$ gives $Q_1 = 15$. And from Firm 2's reaction curve (12.2), we find that $Q_2 = 7.5$. Firm 1 produces twice as much as Firm 2 and makes twice as much profit. *Going first gives Firm 1 an advantage.* This may appear counterintuitive: It seems disadvantageous to announce your output first. Why, then, is going first a strategic advantage?

The reason is that announcing first creates a *fait accompli*: No matter what your competitor does, your output will be large. To maximize profit, your competitor must take your large output level as given and set a low level of output for itself. If your competitor produced a large level of output, it would drive price down and you would both lose money. So unless your competitor views "getting even" as more important than making money, it would be irrational for it to produce a large amount. As we will see in Chapter 13, this kind of "first-mover advantage" occurs in many strategic situations.

The Cournot and Stackelberg models are alternative representations of oligopolistic behavior. Which model is the more appropriate depends on the industry. For an industry composed of roughly similar firms, none of which has a strong operating advantage or leadership position, the Cournot model is probably the more appropriate. On the other hand, some industries are dominated by a large firm that usually takes the lead in introducing new products or setting price; the mainframe computer market is an example, with IBM the leader. Then the Stackelberg model may be more realistic.

12.3 PRICE COMPETITION

We have assumed that our oligopolistic firms compete by setting quantities. In many oligopolistic industries, however, competition occurs along price dimensions. For example, automobile companies view price as a key strategic variable, and each one chooses its price with its competitors in mind. In this section, we use the Nash equilibrium concept to study price competition, first in an industry that produces a homogeneous good and then in an industry with some degree of product differentiation.

Price Competition with Homogeneous Products—The Bertrand Model

• **Bertrand model** Oligopoly model in which firms produce a homogeneous good, each firm treats the price of its competitors as fixed, and all firms decide simultaneously what price to charge.

The **Bertrand model** was developed in 1883 by another French economist, Joseph Bertrand. Like the Cournot model, it applies to firms that produce the same homogeneous good and make their decisions at the same time. In this case, however, the firms choose *prices* instead of quantities. As we will see, this change can dramatically affect the market outcome.

Let's return to the duopoly example of the last section, in which the market demand curve is

$$P = 30 - Q$$

where $Q = Q_1 + Q_2$ is again total production of a homogeneous good. This time, however, we will assume that both firms have a marginal cost of \$3:

$$MC_1 = MC_2 = \$3$$

As an exercise, you can show that the Cournot equilibrium for this duopoly, which results when both firms choose *output* simultaneously, is $Q_1 = Q_2 = 9$. You can also check that in this Cournot equilibrium, the market price is \$12, so that each firm makes a profit of \$81.

Now suppose that these two duopolists compete by simultaneously choosing a *price* instead of a quantity. What price will each firm choose, and how much profit will each earn? To answer these questions, note that because the good is homogeneous, consumers will purchase only from the lowest-price seller. Thus, if the two firms charge different prices, the lower-price firm will supply the entire market and the higher-price firm will sell nothing. If both firms charge the same price, consumers will be indifferent as to which firm they buy from and each firm will supply half the market.

What is the Nash equilibrium in this case? If you think about this problem a little, you will see that because of the incentive to cut prices, the Nash equilibrium is the competitive outcome—i.e., both firms set price equal to marginal cost: $P_1 = P_2 = \$3$. Then industry output is 27 units, of which each firm produces 13.5 units. And because price equals marginal cost, both firms earn zero profit. To check that this outcome is a Nash equilibrium, ask whether either firm would have any incentive to change its price. Suppose Firm 1 raised its price. It would then lose all of its sales to Firm 2 and therefore be no better off. If, instead, it lowered its price, it would capture the entire market but would lose money on every unit it produced; again, it would be worse off. Therefore, Firm 1 (and likewise Firm 2) has no incentive to deviate: It is doing the best it can to maximize profit, given what its competitor is doing.

Why couldn't there be a Nash equilibrium in which the firms charged the same price, but a higher one (say, \$5), so that each made some profit? Because if either firm lowered its price just a little, it could capture the entire market and nearly double its profit. Thus each firm would want to undercut its competitor. Such undercutting would continue until the price dropped to \$3.

By changing the strategic choice variable from output to price, we get a dramatically different outcome. In the Cournot model, because each firm produces only 9 units, the market price is \$12. Now the market price is \$3. In the Cournot model, each firm made a profit; in the Bertrand model, the firms price at marginal cost and make no profit.

The Bertrand model has been criticized on several counts. First, when firms produce a homogeneous good, it is more natural to compete by setting quantities rather than prices. Second, even if firms do set prices *and* choose the same price (as the model predicts), what share of total sales will go to each one? We *assumed* that sales would be divided equally among the firms, but there is no reason why this must be the case. Despite these shortcomings, the Bertrand model is useful because it shows how the equilibrium outcome in an oligopoly can depend crucially on the firms' choice of strategic variable.[2]

Price Competition with Differentiated Products

Oligopolistic markets often have at least some degree of product differentiation.[3] Market shares are determined not just by prices, but also by differences in the design, performance, and durability of each firm's product. In such cases, it is natural for firms to compete by choosing prices rather than quantities.

To see how price competition with differentiated products can work, let's go through the following simple example. Suppose each of two duopolists has fixed costs of $20 but zero variable costs, and that they face the same demand curves:

$$\textit{Firm 1's demand:} \quad Q_1 = 12 - 2P_1 + P_2 \qquad \textbf{(12.5a)}$$

$$\textit{Firm 2's demand:} \quad Q_2 = 12 - 2P_2 + P_1 \qquad \textbf{(12.5b)}$$

where P_1 and P_2 are the prices that Firms 1 and 2 charge, respectively, and Q_1 and Q_2 are the resulting quantities that they sell. Note that the quantity that each firm can sell decreases when it raises its own price but increases when its competitor charges a higher price.

Choosing Prices We will assume that both firms set their prices at the same time and that each firm takes its competitor's price as fixed. We can therefore use the Nash equilibrium concept to determine the resulting prices. Let's begin with Firm 1. Its profit π_1 is its revenue P_1Q_1 less its fixed cost of $20. Substituting for Q_1 from the demand curve of equation (12.5a), we have

$$\pi_1 = P_1Q_1 - 20 = 12P_1 - 2P_1^2 + P_1P_2 - 20$$

At what price P_1 is this profit maximized? The answer depends on P_2, which Firm 1 assumes to be fixed. However, whatever price Firm 2 is charging, Firm 1's profit is maximized when the incremental profit from a very small increase in its own price is just zero. Taking P_2 as fixed, Firm 1's profit-maximizing price is therefore given by

$$\Delta\pi_1/\Delta P_1 = 12 - 4P_1 + P_2 = 0$$

This equation can be rewritten to give the following pricing rule, or *reaction curve*, for Firm 1:

$$\textit{Firm 1's reaction curve:} \quad P_1 = 3 + \frac{1}{4}P_2$$

This equation tells Firm 1 what price to set, given the price P_2 that Firm 2 is setting. We can similarly find the following pricing rule for Firm 2:

$$\textit{Firm 2's reaction curve:} \quad P_2 = 3 + \frac{1}{4}P_1$$

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[2]Also, it has been shown that if firms produce a homogeneous good and compete by first setting output *capacities* and then setting price, the Cournot equilibrium in quantities again results. See David Kreps and Jose Scheinkman, "Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes," *Bell Journal of Economics* 14 (1983): 326–38.

[3]Product differentiation can exist even for a seemingly homogeneous product. Consider gasoline, for example. Although gasoline itself is a homogeneous good, service stations differ in terms of location and services provided. As a result, gasoline prices may differ from one service station to another.

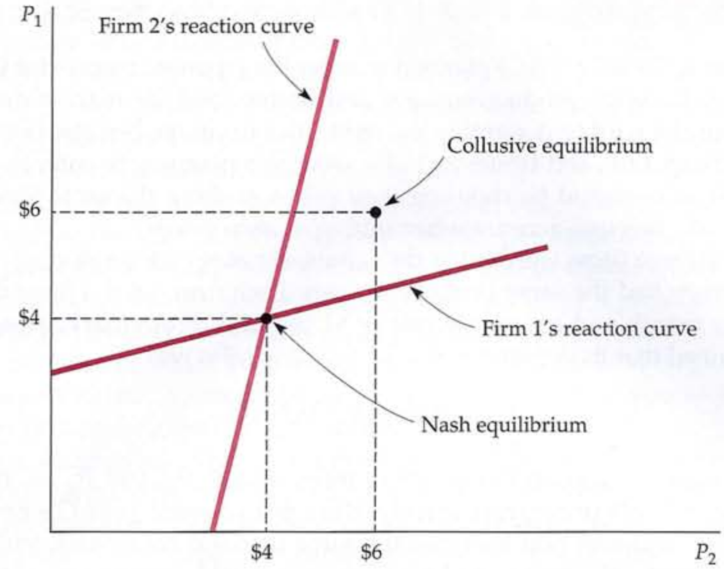

FIGURE 12.6 Nash Equilibrium in Prices

Here two firms sell a differentiated product, and each firm's demand depends both on its own price and on its competitor's price. The two firms choose their prices at the same time, each taking its competitor's price as given. Firm 1's reaction curve gives its profit-maximizing price as a function of the price that Firm 2 sets, and similarly for Firm 2. The Nash equilibrium is at the intersection of the two reaction curves: When each firm charges a price of $4, it is doing the best it can given its competitor's price and has no incentive to change price. Also shown is the collusive equilibrium: If the firms cooperatively set price, they will choose $6.

These reaction curves are drawn in Figure 12.6. The Nash equilibrium is at the point where the two reaction curves cross; you can verify that each firm is then charging a price of $4 and earning a profit of $12. *At this point, because each firm is doing the best it can given the price its competitor has set, neither firm has an incentive to change its price.*

Now suppose the two firms collude: Instead of choosing their prices independently, they both decide to charge the same price—namely, the price that maximizes both of their profits. You can verify that the firms would then charge $6, and that they would be better off colluding because each would now earn a profit of $16.[4] Figure 12.6 shows this collusive equilibrium.

Finally, suppose Firm 1 sets its price first and that, after observing Firm 1's decision, Firm 2 makes its pricing decision. Unlike the Stackelberg model in which the firms set their quantities, in this case Firm 1 would be at a distinct *disadvantage* by moving first. (To see this, calculate Firm 1's profit-maximizing price, *taking Firm 2's reaction curve into account.*) Why is moving first now a disadvantage? Because it gives the firm that moves second an opportunity to undercut slightly and thereby capture a larger market share. (See Exercise 11 at the end of the chapter.)

[4]The firms have the same costs, so they will charge the same price P. Total profit is given by

$$\pi_T = \pi_1 + \pi_2 = 24P - 4P^2 + 2P^2 - 40 = 24P - 2P^2 - 40.$$

This is maximized when $\Delta\pi_T/\Delta P = 0$. $\Delta\pi_T/\Delta P = 24 - 4P$, so the joint profit-maximizing price is $P = \$6$. Each firm's profit is therefore

$$\pi_1 = \pi_2 = 12P - P^2 - 20 = 72 - 36 - 20 = \$16$$

EXAMPLE 12.2 A Pricing Problem for Procter & Gamble

When Procter & Gamble (P&G) planned to enter the Japanese market for Gypsy Moth Tape, it knew its production costs and understood the market demand curve but found it hard to determine the right price to charge because two other firms—Kao Soap, Ltd., and Unilever, Ltd.—were also planning to enter the market. All three firms would be choosing their prices at about the same time, and P&G had to take this into account when setting its own price.[5]

Because all three firms were using the same technology for producing Gypsy Moth Tape, they had the same production costs. Each firm faced a fixed cost of $480,000 per month and a variable cost of $1 per unit. From market research, P&G ascertained that its demand curve for monthly sales was

$$Q = 3375P^{-3.5}(P_U)^{.25}(P_K)^{.25}$$

where Q is monthly sales in thousands of units, and P, P_U, and P_K are P&G's, Unilever's, and Kao's prices, respectively. Now, put yourself in P&G's position. Assuming that Unilever and Kao face the same demand conditions, *with what price should you enter the market, and how much profit should you expect to earn?*

You might begin by calculating the profit you would earn as a function of the price you charge, under alternative assumptions about the prices that Unilever and Kao will charge. Using the demand curve and cost numbers given above, we have done these calculations and tabulated the results in Table 12.2. Each entry shows your profit, in thousands of dollars per month, for a particular combination of prices (while assuming in each case that Unilever and Kao set the same price). For example, if you charge $1.30 and Unilever and Kao both charge $1.50, you will earn a profit of $15,000 per month.

But remember that in all likelihood, the managers of Unilever and Kao are making the same calculations that you are and probably have their own versions of Table 12.2. Now suppose your competitors charge $1.50 or more. As the table

TABLE 12.2 P&G's Profit (in thousands of dollars per month)

P&G's	Competitor's (Equal) Prices ($)							
Price ($)	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80
1.10	−226	−215	−204	−194	−183	−174	−165	−155
1.20	−106	−89	−73	−58	−43	−28	−15	−2
1.30	−56	−37	−19	2	15	31	47	62
1.40	−44	−25	−6	12	29	46	62	78
1.50	−52	−32	−15	3	20	36	52	68
1.60	−70	−51	−34	−18	−1	14	30	44
1.70	−93	−76	−59	−44	−28	−13	1	15
1.80	−118	−102	−87	−72	−57	−44	−30	−17

[5]This example is based on classroom material developed by Professor John Hauser of MIT. To protect P&G's proprietary interests, some of the facts about the product and the market have been altered. The fundamental description of P&G's problem, however, is accurate.

shows, you would want to charge only \$1.40, because that price gives you the highest profit. (For example, if they charged \$1.50, you would make \$29,000 per month by charging \$1.40 but only \$20,000 by charging \$1.50, and \$15,000 by charging \$1.30.) Consequently, you would not want to charge \$1.50 (or more). Assuming that your competitors have followed the same reasoning, you should not expect them to charge \$1.50 (or more) either.

What if your competitors charge \$1.30? In that case, you will lose money, but you will lose the least amount of money (\$6000 per month) by charging \$1.40. Your competitors would therefore not expect you to charge \$1.30, and by the same reasoning, you should not expect them to charge a price this low. What price lets you do the best you can, given your competitors' prices? It is \$1.40. This is also the price at which your competitors are doing the best *they* can, so it is a Nash equilibrium.[6] As the table shows, in this equilibrium you and your competitors each make a profit of \$12,000 per month.

If you could *collude* with your competitors, you could make a larger profit. You would all agree to charge \$1.50, and each of you would earn \$20,000. But this collusive agreement might be hard to enforce: You could increase your profit further at your competitor's expense by dropping your price below theirs, and of course your competitors could do the same thing to you.

12.4 COMPETITION VERSUS COLLUSION: THE PRISONERS' DILEMMA

A Nash equilibrium is a *noncooperative* equilibrium: Each firm makes the decisions that give it the highest possible profit, given the actions of its competitors. As we have seen, the resulting profit earned by each firm is higher than it would be under perfect competition but lower than if the firms colluded.

Collusion, however, is illegal, and most managers prefer to stay out of jail. But if cooperation can lead to higher profits, why don't firms cooperate *without* explicitly colluding? In particular, if you and your competitor can both figure out the profit-maximizing price you would agree to charge *if* you were to collude, *why not just set that price and hope your competitor will do the same*? If your competitor *does* do the same, you will both make more money.

The problem is that your competitor *probably won't* choose to set price at the collusive level. Why not? *Because your competitor would do better by choosing a lower price, even if it knew that you were going to set price at the collusive level.*

To understand this, let's go back to our example of price competition from the last section. The firms in that example each have a fixed cost of \$20, have zero variable cost, and face the following demand curves:

$$\textit{Firm 1's demand:} \quad Q_1 = 12 - 2P_1 + P_2$$

$$\textit{Firm 2's demand:} \quad Q_2 = 12 - 2P_2 + P_1$$

We found that in the Nash equilibrium each firm will charge a price of \$4 and earn a profit of \$12, whereas if the firms collude, they will charge a price of \$6 and earn a profit of \$16. Now suppose that the firms do not collude, but that

[6]This Nash equilibrium can also be derived algebraically from the demand curve and cost data above. We leave this to you as an exercise.

Firm 1 charges the \$6 collusive price, hoping that Firm 2 will do the same. If Firm 2 *does* do the same, it will earn a profit of \$16. But what if it charges the \$4 price instead? In that case, Firm 2 would earn a profit of

$$\pi_2 = P_2Q_2 - 20 = (4)[12 - (2)(4) + 6] - 20 = \$20$$

Firm 1, on the other hand, will earn a profit of only

$$\pi_1 = P_1Q_1 - 20 = (6)[12 - (2)(6) + 4] - 20 = \$4$$

So if Firm 1 charges \$6 but Firm 2 charges only \$4, Firm 2's profit will increase to \$20. And it will do so at the expense of Firm 1's profit, which will fall to \$4. Clearly, Firm 2 does best by charging only \$4. Similarly, Firm 1 does best by charging only \$4. If Firm 2 charges \$6 and Firm 1 charges \$4, Firm 1 will earn a \$20 profit and Firm 2 only \$4.

• **noncooperative game** Game in which negotiation and enforcement of binding contracts are not possible.

• **payoff matrix** Table showing profit (or payoff) to each firm given its decision and the decision of its competitor.

Payoff Matrix Table 12.3 summarizes the results of these different possibilities. In deciding what price to set, the two firms are playing a **noncooperative game**: Each firm independently does the best it can, taking its competitor into account. Table 12.3 is called the **payoff matrix** for this game because it shows the profit (or payoff) to each firm given its decision and the decision of its competitor. For example, the upper left-hand corner of the payoff matrix tells us that if both firms charge \$4, each will make a \$12 profit. The upper right-hand corner tells us that if Firm 1 charges \$4 and Firm 2 charges \$6, Firm 1 will make \$20 and Firm 2 \$4.

This payoff matrix can clarify the answer to our original question: Why don't firms behave cooperatively, and thereby earn higher profits, even if they can't collude? In this case, cooperating means *both* firms charging \$6 instead of \$4 and thereby earning \$16 instead of \$12. The problem is that each firm always makes more money by charging \$4, *no matter what its competitor does*. As the payoff matrix shows, if Firm 2 charges \$4, Firm 1 does best by charging \$4. And if Firm 2 charges \$6, Firm 1 still does best by charging \$4. Similarly, Firm 2 always does best by charging \$4, no matter what Firm 1 does. As a result, unless the two firms can sign an enforceable agreement to charge \$6, neither firm can expect its competitor to charge \$6, and both will charge \$4.

• **prisoners' dilemma** Game theory example in which two prisoners must decide separately whether to confess to a crime; if a prisoner confesses, he will receive a lighter sentence and his accomplice will receive a heavier one, but if neither confesses, sentences will be lighter than if both confess.

The Prisoners' Dilemma A classic example in game theory, called the **prisoners' dilemma**, illustrates the problem faced by oligopolistic firms. It goes as follows: Two prisoners have been accused of collaborating in a crime. They are in separate jail cells and cannot communicate with each other. Each has been asked to confess. If both prisoners confess, each will receive a prison term of five years. If neither confesses, the prosecution's case will be difficult to make, so the prisoners can expect to plea bargain and receive terms of two years. On the other hand, if one prisoner confesses and the other does not, the one who confesses will receive a term of only one year, while the other will go to prison for 10 years. If you were one of these prisoners, what would you do—confess or not confess?

TABLE 12.3 Payoff Matrix for Pricing Game

		Firm 2	
		Charge \$4	**Charge \$6**
Firm 1	Charge \$4	\$12, \$12	\$20, \$4
	Charge \$6	\$4, \$20	\$16, \$16

TABLE 12.4 Payoff Matrix for Prisoners' Dilemma

		Prisoner B: Confess	Prisoner B: Don't confess
Prisoner A	Confess	−5, −5	−1, −10
	Don't confess	−10, −1	−2, −2

The payoff matrix in Table 12.4 summarizes the possible outcomes. (Note that the "payoffs" are negative; the entry in the lower right-hand corner means a two-year sentence for each prisoner.) As the table shows, our prisoners face a dilemma. If they could both agree not to confess (in a way that would be binding), then each would go to jail for only two years. But they can't talk to each other, and even if they could, can they trust each other? If Prisoner *A* does not confess, he risks being taken advantage of by his former accomplice. After all, *no matter what Prisoner* A *does, Prisoner* B *comes out ahead by confessing*. Likewise, Prisoner *A* always comes out ahead by confessing, so Prisoner *B* must worry that by not confessing, she will be taken advantage of. Therefore, both prisoners will probably confess and go to jail for five years.

Oligopolistic firms often find themselves in a prisoners' dilemma. They must decide whether to compete aggressively, attempting to capture a larger share of the market at their competitor's expense, or to "cooperate" and compete more passively, coexisting with their competitors and settling for their current market share, and perhaps even implicitly colluding. If the firms compete passively, setting high prices and limiting output, they will make higher profits than if they compete aggressively.

Like our prisoners, however, each firm has an incentive to "fink" and undercut its competitors, and each knows that its competitors have the same incentive. As desirable as cooperation is, each firm worries—with good reason—that if it competes passively, its competitor might decide to compete aggressively and seize the lion's share of the market. In the pricing problem illustrated in Table 12.3, both firms do better by "cooperating" and charging a high price. But the firms are in a prisoners' dilemma, where neither can trust its competitor to set a high price.

EXAMPLE 12.3 Procter & Gamble in a Prisoners' Dilemma

In Example 12.2, we examined the problem that arose when P&G, Unilever, and Kao Soap all planned to enter the Japanese market for Gypsy Moth Tape at the same time. They all faced the same cost and demand conditions, and each firm had to decide on a price that took its competitors into account. In Table 12.2, (page 460) we tabulated the profits to P&G corresponding to alternative prices that the firm and its competitors might charge. We argued that P&G should expect its competitors to charge a price of $1.40 and should do the same.[7]

[7]As in Example 12.2, some of the facts about the product and the market have been altered to protect P&G's proprietary interests.

P&G would be better off if it *and its competitors* all charged a price of $1.50. This is clear from the payoff matrix in Table 12.5. This payoff matrix is the portion of Table 12.2 corresponding to prices of $1.40 and $1.50, with the payoffs to P&G's competitors also tabulated.[8] If all the firms charge $1.50, each will make a profit of $20,000 per month, instead of the $12,000 per month they make by charging $1.40. So why don't they charge $1.50?

Because these firms are in a prisoners' dilemma. No matter what Unilever and Kao do, P&G makes more money by charging $1.40. For example, if Unilever and Kao charge $1.50, P&G can make $29,000 per month by charging $1.40, versus $20,000 by charging $1.50. Unilever and Kao are in the same boat. For example, if P&G charges $1.50 and Unilever and Kao both charge $1.40, P&G's competitors will each make $21,000, instead of $20,000.[9] As a result, P&G knows that if it sets a price of $1.50, its competitors will have a strong incentive to undercut and charge $1.40. P&G will then have only a small share of the market and make only $3000 per month profit. Should P&G make a leap of faith and charge $1.50? If you were faced with this dilemma, what would you do?

TABLE 12.5 Payoff Matrix for Pricing Problem

		Unilever and KAO	
		Charge $1.40	Charge $1.50
P&G	Charge $1.40	$12, $12	$29, $11
	Charge $1.50	$3, $21	$20, $20

12.5 IMPLICATIONS OF THE PRISONERS' DILEMMA FOR OLIGOPOLISTIC PRICING

Does the prisoners' dilemma doom oligopolistic firms to aggressive competition and low profits? Not necessarily. Although our imaginary prisoners have only one opportunity to confess, most firms set output and price over and over again, continually observing their competitors' behavior and adjusting their own accordingly. This allows firms to develop reputations from which trust can arise. As a result, oligopolistic coordination and cooperation can sometimes prevail.

Take, for example, an industry made up of three or four firms that have coexisted for a long time. Over the years, the managers of those firms might grow tired of losing money because of price wars, and an implicit understanding might arise by which all the firms maintain high prices and no firm tries to take market share from its competitors. Although each firm might be tempted to undercut its competitors, its managers know that the resulting gains will be short lived: Competitors will retaliate, and the result will be renewed warfare and lower profits over the long run.

[8]This payoff matrix assumes that Unilever and Kao both charge the same price. Entries represent profits in thousands of dollars per month.

[9]If P&G and Kao both charged $1.50 and *only* Unilever undercut and charged $1.40, Unilever would make $29,000 per month. It is especially profitable to be the only firm charging the low price.

This resolution of the prisoners' dilemma occurs in some industries, but not in others. Sometimes managers are not content with the moderately high profits resulting from implicit collusion and prefer to compete aggressively in order to increase market share. Sometimes implicit understandings are difficult to reach. For example, firms with different costs and different assessments of market demand might disagree about the "correct" collusive price. Firm *A* might think the "correct" price is \$10, while Firm *B* thinks it is \$9. When it sets a \$9 price, Firm *A* might view this as an attempt to undercut and retaliate by lowering its price to \$8. The result is a price war.

In many industries, therefore, implicit collusion is short lived. There is often a fundamental layer of mistrust, so warfare erupts as soon as one firm is perceived by its competitors to be "rocking the boat" by changing its price or increasing advertising.

Price Rigidity

Because implicit collusion tends to be fragile, oligopolistic firms often have a strong desire for price stability. This is why **price rigidity** can be a characteristic of oligopolistic industries. Even if costs or demand change, firms are reluctant to change price. If costs fall or market demand declines, they fear that lower prices might send the wrong message to their competitors and set off a price war. And if costs or demand rises, they are reluctant to raise prices because they are afraid that their competitors may not raise theirs.

• **price rigidity** Characteristic of oligopolistic markets by which firms are reluctant to change prices even if costs or demands change.

Price rigidity is the basis of the **kinked demand curve model** of oligopoly. According to this model, each firm faces a demand curve kinked at the currently prevailing price P^*. (See Figure 12.7.) At prices above P^*, the demand curve is very elastic. The reason is that the firm believes that if it raises its price above P^*, other firms will not follow suit, and it will therefore lose sales and much of its market share. On the other hand, the firm believes that if it lowers its price below P^*, other firms will follow suit because they will not want to lose *their* shares of the market. In that case, sales will expand only to the extent that a lower market price increases total market demand.

• **kinked demand curve model** Oligopoly model in which each firm faces a demand curve kinked at the currently prevailing price: at higher prices demand is very elastic, whereas at lower prices it is inelastic.

Because the firm's demand curve is kinked, its marginal revenue curve is discontinuous. (The bottom part of the marginal revenue curve corresponds to the less elastic part of the demand curve, as shown by the solid portions of each curve.) As a result, the firm's costs can change without resulting in a change in price. As shown in Figure 12.7, marginal cost could increase but still equal marginal revenue at the same output level, so that price stays the same.

Although the kinked demand curve model is attractively simple, it does not really explain oligopolistic pricing. It says nothing about how firms arrived at price P^* in the first place, and why they didn't arrive at some different price. It is useful mainly as a *description* of price rigidity rather than as an *explanation* of it. The explanation for price rigidity comes from the prisoners' dilemma and from firms' desires to avoid mutually destructive price competition.

Price Signaling and Price Leadership

A big impediment to implicitly collusive pricing is the fact that it is difficult for firms to agree (without talking to each other) on what the price should be. Coordination is particularly difficult when cost and demand conditions—and thus the "correct" price—are changing. **Price signaling** is a form of implicit collusion that sometimes gets around this problem. For example, a firm might announce that it has raised its price (perhaps through a press release) and hope

• **price signaling** Form of implicit collusion in which a firm announces a price increase in the hope that other firms will follow suit.

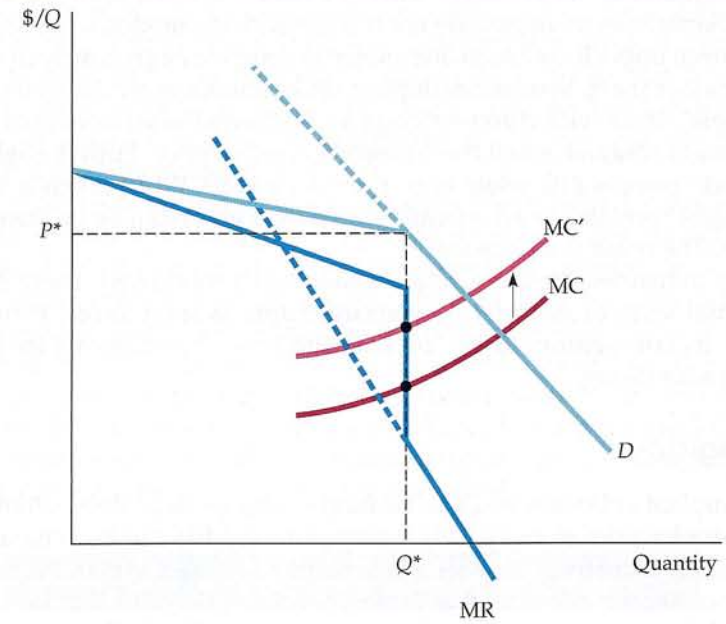

FIGURE 12.7 The Kinked Demand Curve

Each firm believes that if it raises its price above the current price P^*, none of its competitors will follow suit, so it will lose most of its sales. Each firm also believes that if it lowers price, everyone will follow suit, and its sales will increase only to the extent that market demand increases. As a result, the firm's demand curve D is kinked at price P^*, and its marginal revenue curve MR is discontinuous at that point. If marginal cost increases from MC to MC′, the firm will still produce the same output level Q^* and charge the same price P^*.

that its competitors will take this announcement as a signal that they should also raise prices. If competitors follow suit, all of the firms will earn higher profits.

• **price leadership** Pattern of pricing in which one firm regularly announces price changes that other firms then match.

Sometimes a pattern is established whereby one firm regularly announces price changes and other firms in the industry follow suit. This pattern is called **price leadership**: One firm is implicitly recognized as the "leader," while the other firms, the "price followers," match its prices. This behavior solves the problem of coordinating price: Everyone charges what the leader is charging.

Suppose, for example, that three oligopolistic firms are currently charging \$10 for their product. (If they all know the market demand curve, this might be the Nash equilibrium price.) Suppose that by colluding, they could all set a price of \$20 and greatly increase their profits. Meeting and agreeing to set a price of \$20 is illegal. But suppose instead that Firm *A* raises its price to \$15, and announces to the business press that it is doing so because higher prices are needed to restore economic vitality to the industry. Firms *B* and *C* might view this as a clear message—namely, that Firm *A* is seeking their cooperation in raising prices. They might then raise their own prices to \$15. Firm *A* might then increase price further—say, to \$18—and Firms *B* and *C* might raise their prices as well. Whether or not the profit-maximizing price of \$20 is reached (or surpassed), a pattern of coordination has been established that, from the firm's point of view, may be nearly as effective as meeting and formally agreeing on a price.[10]

This example of signaling and price leadership is extreme and might lead to an antitrust lawsuit. But in some industries, a large firm might naturally emerge as a leader, with the other firms deciding that they are best off just matching the leader's prices, rather than trying to undercut the leader or each other. An example is the U.S. automobile industry, where General Motors has traditionally been the price leader.

Price leadership can also serve as a way for oligopolistic firms to deal with the reluctance to change prices, a reluctance that arises out of the fear of being undercut or "rocking the boat." As cost and demand conditions change, firms may find it increasingly necessary to change prices that have remained rigid for some time. In that case, they might look to a price leader to signal when and by how much price should change. Sometimes a large firm will naturally act as leader; sometimes different firms will act as leader from time to time. The example that follows illustrates this.

EXAMPLE 12.4 Price Leadership and Price Rigidity in Commercial Banking

Commercial banks borrow money from individuals and companies who deposit funds in checking accounts, savings accounts, and certificates of deposit. They then use this money to make loans to household and corporate borrowers. By lending at an interest rate higher than the rate that they pay on their deposits, they earn a profit.

The largest commercial banks in the United States compete with each other to make loans to large corporate clients. The main form of competition is over price—in this case, the interest rates they charge. If competition becomes aggressive, the interest rates fall, and so do profits. The incentive to avoid aggressive competition leads to price rigidity, and to a form of price leadership.

The interest rate that banks charge large corporate clients is called the *prime rate*. Because it is widely known, it is a convenient focal point for price leadership. Most large banks charge the same or nearly the same prime rate; they avoid making frequent changes in the rate that might be destabilizing and lead to competitive warfare. The prime rate changes only when money market conditions cause other interest rates to rise or fall substantially. When that happens, one of the major banks announces a change in its rate and other banks quickly follow suit. Different banks act as leader from time to time, but when one bank announces a change, the others follow within two or three days.

Figure 12.8 compares the prime rate with the interest rate on high-grade (AAA) corporate bonds. Observe that although the corporate bond rate fluctuated continuously, there were extended periods during which the prime rate did the change. This is an example of price rigidity—banks are reluctant to change their lending rate for fear of being undercut and losing business to their competitors.

[10]For a formal model of how such price leadership can facilitate collusion, see Julio J. Rotemberg and Garth Saloner, "Collusive Price Leadership," *Journal of Industrial Economics*, 1990.

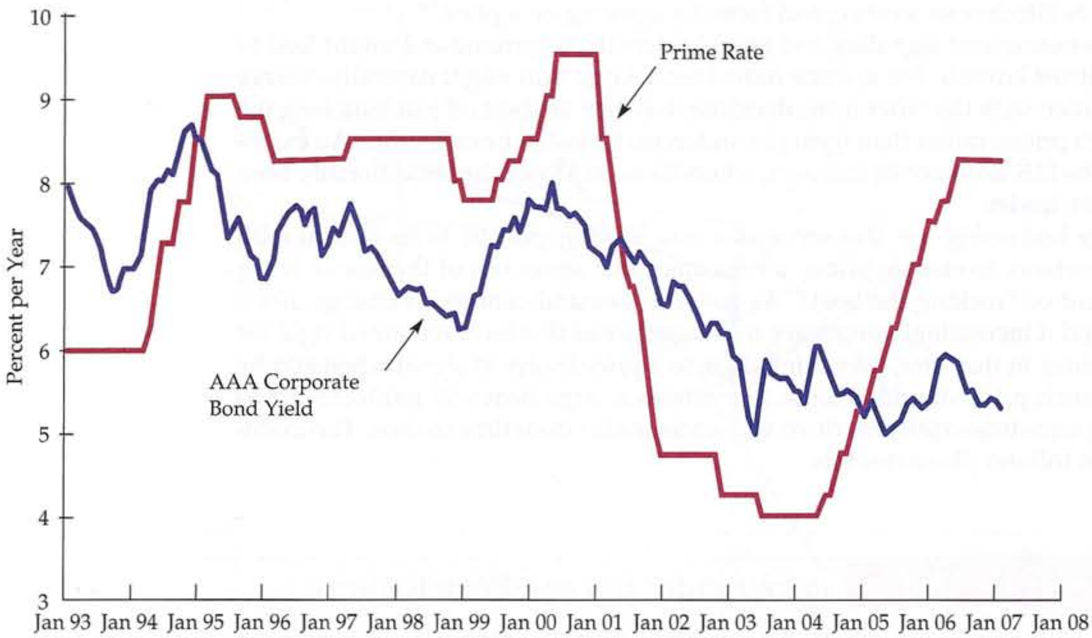

FIGURE 12.8 Prime Rate versus Corporate Bond Rate

The prime rate is the rate that major banks charge large corporate customers for short-term loans. It changes only infrequently because banks are reluctant to undercut one another. When a change does occur, it begins with one bank, and other banks quickly follow suit. The corporate bond rate is the return on long-term corporate bonds. Because these bonds are widely traded, this rate fluctuates with market conditions.

The Dominant Firm Model

• **dominant firm** Firm with a large share of total sales that sets price to maximize profits, taking into account the supply response of smaller firms.

In some oligopolistic markets, one large firm has a major share of total sales while a group of smaller firms supplies the remainder of the market. The large firm might then act as a **dominant firm**, setting a price that maximizes its own profits. The other firms, which individually could have little influence over price, would then act as perfect competitors: They take the price set by the dominant firm as given and produce accordingly. But what price should the dominant firm set? To maximize profit, it must take into account how the output of the other firms depends on the price it sets.

Figure 12.9 shows how a dominant firm sets its price. Here, D is the market demand curve, and S_F is the supply curve (i.e., the aggregate marginal cost curve) of the smaller fringe firms. The dominant firm must determine *its* demand curve D_D. As the figure shows, this curve is just the difference between market demand and the supply of fringe firms. For example, at price P_1, the supply of fringe firms is just equal to market demand; thus the dominant firm can sell nothing at this price. At a price P_2 or less, fringe firms will not supply any of the good, so the dominant firm faces the market demand curve. At prices between P_1 and P_2, the dominant firm faces the demand curve D_D.

Corresponding to D_D is the dominant firm's marginal revenue curve MR_D. MC_D is the dominant firm's marginal cost curve. To maximize its profit, the

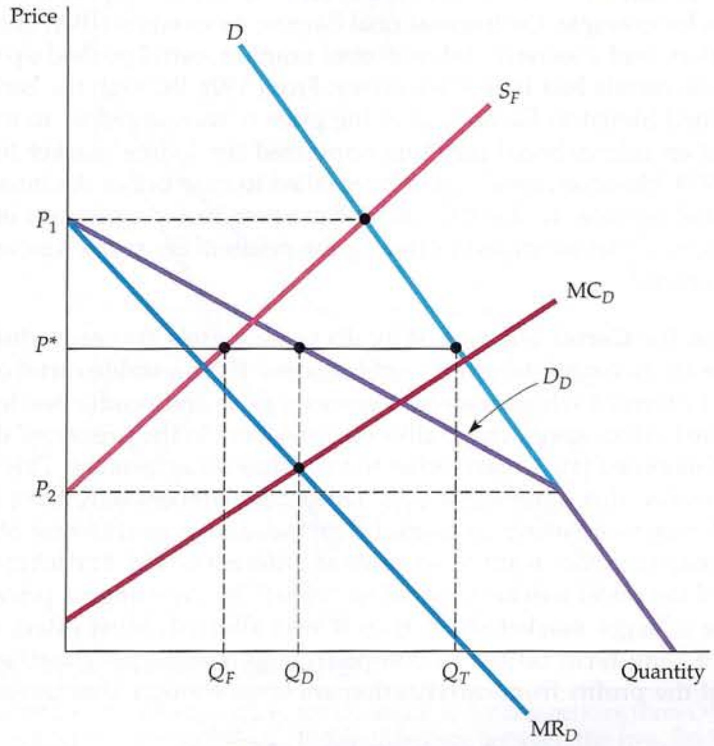

FIGURE 12.9 Price Setting by a Dominant Firm

The dominant firm sets price, and the other firms sell all they want at that price. The dominant firm's demand curve, D_D, is the difference between market demand D and the supply of fringe firms S_F. The dominant firm produces a quantity Q_D at the point where its marginal revenue MR_D is equal to its marginal cost MC_D. The corresponding price is P^*. At this price, fringe firms sell Q_F, so that total sales equal Q_T.

dominant firm produces quantity Q_D at the intersection of MR_D and MC_D. From the demand curve D_D, we find price P^*. At this price, fringe firms sell a quantity Q_F; thus the total quantity sold is $Q_T = Q_D + Q_F$.

12.6 CARTELS

Producers in a *cartel* explicitly agree to cooperate in setting prices and output levels. Not all the producers in an industry need to join the cartel, and most cartels involve only a subset of producers. But if enough producers adhere to the cartel's agreements, and if market demand is sufficiently inelastic, the cartel may drive prices well above competitive levels.

Cartels are often international. While U.S. antitrust laws prohibit American companies from colluding, those of other countries are much weaker and are sometimes poorly enforced. Furthermore, nothing prevents countries, or companies owned or controlled by foreign governments, from forming cartels. For example, the OPEC cartel is an international agreement among oil-producing countries which has succeeded in raising world oil prices above competitive levels.

Other international cartels have also succeeded in raising prices. During the mid-1970s, for example, the International Bauxite Association (IBA) quadrupled bauxite prices, and a secretive international uranium cartel pushed up uranium prices. Some cartels had longer successes: From 1928 through the early 1970s, a cartel called Mercurio Europeo kept the price of mercury close to monopoly levels, and an international cartel monopolized the iodine market from 1878 through 1939. However, most cartels have failed to raise prices. An international copper cartel operates to this day, but it has never had a significant impact on copper prices. Cartel attempts to drive up the prices of tin, coffee, tea, and cocoa have also failed.[11]

Conditions for Cartel Success Why do some cartels succeed while others fail? There are two conditions for cartel success. First, a stable cartel organization must be formed whose members agree on price and production levels and then adhere to that agreement. Unlike our prisoners in the prisoners' dilemma, cartel members can talk to each other to formalize an agreement. This does not mean, however, that agreeing is easy. Different members may have different costs, different assessments of market demand, and even different objectives, and they may therefore want to set price at different levels. Furthermore, each member of the cartel will be tempted to "cheat" by lowering its price slightly to capture a larger market share than it was allotted. Most often, only the threat of a long-term return to competitive prices deters cheating of this sort. But if the profits from cartelization are large enough, that threat may be sufficient.

Recall from §10.2 that monopoly power refers to market power on the part of a seller—the ability of a firm to price its product above its marginal cost of production.

The second condition is the potential for monopoly power. Even if a cartel can solve its organizational problems, there will be little room to raise price if it faces a highly elastic demand curve. Potential monopoly power may be the most important condition for success; if the potential gains from cooperation are large, cartel members will have more incentive to solve their organizational problems.

Analysis of Cartel Pricing

Only rarely do *all* the producers of a good combine to form a cartel. A cartel usually accounts for only a portion of total production and must take into account the supply response of competitive (noncartel) producers when it sets price. Cartel pricing can thus be analyzed by using the dominant firm model discussed earlier. We will apply this model to two cartels, the OPEC oil cartel and the CIPEC copper cartel.[12] This will help us understand why OPEC was successful in raising price while CIPEC was not.

Analyzing OPEC Figure 12.10 illustrates the case of OPEC. Total demand TD is the total world demand curve for crude oil, and S_c is the competitive (non-OPEC) supply curve. The demand for OPEC oil D_{OPEC} is the difference between total demand and competitive supply, and MR_{OPEC} is the corresponding marginal revenue curve. MC_{OPEC} is OPEC's marginal cost curve; as you can see, OPEC has

[11]See Jeffrey K. MacKie-Mason and Robert S. Pindyck, "Cartel Theory and Cartel Experience in International Minerals Markets," in *Energy: Markets and Regulation* (Cambridge, MA: MIT Press, 1986).

[12]CIPEC is the French acronym for International Council of Copper Exporting Countries.

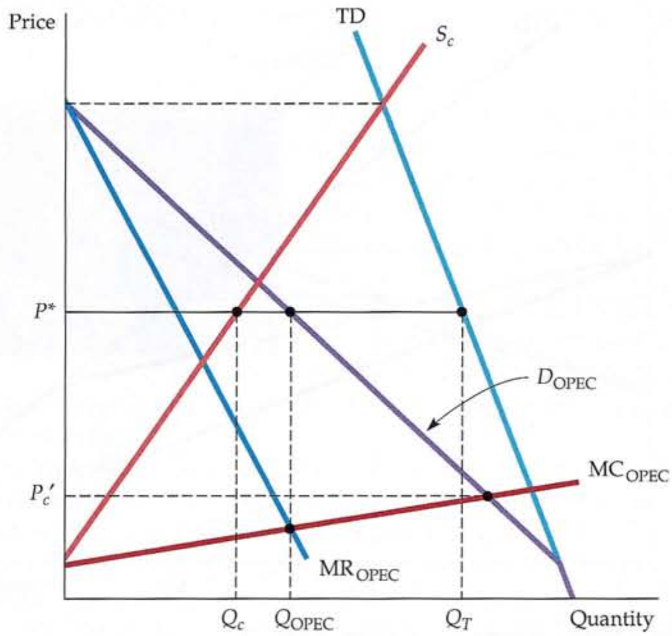

FIGURE 12.10 The OPEC Oil Cartel

TD is the total world demand curve for oil, and S_c is the competitive (non-OPEC) supply curve. OPEC's demand D_{OPEC} is the difference between the two. Because both total demand and competitive supply are inelastic, OPEC's demand is inelastic. OPEC's profit-maximizing quantity Q_{OPEC} is found at the intersection of its marginal revenue and marginal cost curves; at this quantity, OPEC charges price P^*. If OPEC producers had not cartelized, price would be P_c, where OPEC's demand and marginal cost curves intersect.

much lower production costs than do non-OPEC producers. OPEC's marginal revenue and marginal cost are equal at quantity Q_{OPEC}, which is the quantity that OPEC will produce. We see from OPEC's demand curve that the price will be P^*, at which competitive supply is Q_c.

Suppose petroleum-exporting countries had not formed a cartel but had instead produced competitively. Price would then have equaled marginal cost. We can therefore determine the competitive price from the point where OPEC's demand curve intersects its marginal cost curve. That price, labeled P_c, is much lower than the cartel price P^*. Because both total demand and non-OPEC supply are inelastic, the demand for OPEC oil is also fairly inelastic. Thus the cartel has substantial monopoly power, and it has used that power to drive prices well above competitive levels.

In Chapter 2, we stressed the importance of distinguishing between short-run and long-run supply and demand. That distinction is important here. The total demand and non-OPEC supply curves in Figure 12.10 apply to a short- or intermediate-run analysis. In the long run, both demand and supply will be much more elastic, which means that OPEC's demand curve will also be much more elastic. We would thus expect that in the long run OPEC would be unable to maintain a price that is so much above the competitive level. Indeed, during 1982–1989, oil prices fell in real terms, largely because of the long-run adjustment of demand and non-OPEC supply.

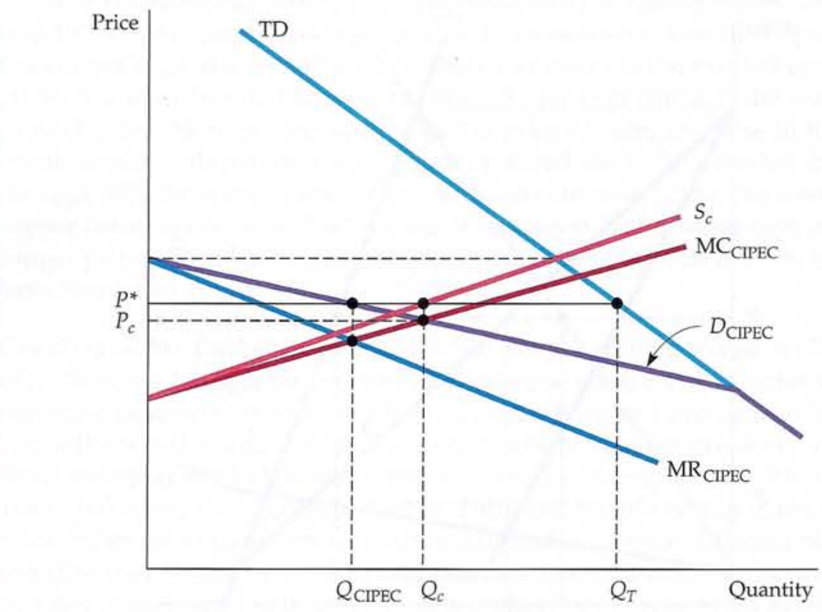

FIGURE 12.11 The CIPEC Copper Cartel

TD is the total demand for copper and S_c is the competitive (non-CIPEC) supply. CIPEC's demand D_{CIPEC} is the difference between the two. Both total demand and competitive supply are relatively elastic, so CIPEC's demand curve is elastic, and CIPEC has very little monopoly power. Note that CIPEC's optimal price P^* is close to the competitive price P_c.

Analyzing CIPEC Figure 12.11 provides a similar analysis of CIPEC, which consists of four copper-producing countries: Chile, Peru, Zambia, and Congo (formerly Zaire), that collectively account for less than half of world copper production. In these countries, production costs are lower than those of non-CIPEC producers, but except for Chile, not much lower. In Figure 12.11, CIPEC's marginal cost curve is therefore drawn only a little below the non-CIPEC supply curve. CIPEC's demand curve D_{CIPEC} is the difference between total demand TD and non-CIPEC supply S_c. CIPEC's marginal cost and marginal revenue curves intersect at quantity Q_{CIPEC}, with the corresponding price P^*. Again, the competitive price P_c is found at the point where CIPEC's demand curve intersects its marginal cost curve. Note that this price is very close to the cartel price P^*.

Why can't CIPEC increase copper prices much? As Figure 12.11 shows, the total demand for copper is more elastic than that for oil. (Other materials, such as aluminum, can easily be substituted for copper.) Also, competitive supply is much more elastic. Even in the short run, non-CIPEC producers can easily expand supply if prices should rise (in part because of the availability of supply from scrap metal). Thus CIPEC's potential monopoly power is small.

As the examples of OPEC and CIPEC illustrate, successful cartelization requires two things. First, the total demand for the good must not be very price elastic. Second, either the cartel must control nearly all the world's supply or, if it does not, the supply of noncartel producers must not be price elastic. Most international commodity cartels have failed because few world markets meet both conditions.

EXAMPLE 12.5 The Cartelization of Intercollegiate Athletics

Many people think of intercollegiate athletics as an extracurricular activity for college students and a diversion for fans. They assume that universities support athletics because it not only gives amateur athletes a chance to develop their skills and play football or basketball before large audiences but also provides entertainment and promotes school spirit and alumni support. Although it does these things, intercollegiate athletics is also a big—and an extremely profitable—industry.

Like any industry, intercollegiate athletics has firms and consumers. The "firms" are the universities that support and finance teams. The inputs to production are the coaches, student athletes, and capital in the form of stadiums and playing fields. The consumers, many of whom are current or former college students, are the fans who buy tickets to games and the TV and radio networks that pay to broadcast them. There are many firms and consumers, which suggests that the industry is competitive. But the persistently high level of profits in this industry is inconsistent with competition—a large state university can regularly earn more than $6 million a year in profits from football games alone.[13] This profitability is the result of monopoly power, obtained via cartelization.

The cartel organization is the National Collegiate Athletic Association (NCAA). The NCAA restricts competition in a number of important ways. To reduce bargaining power by student athletes, the NCAA creates and enforces rules regarding eligibility and terms of compensation. To reduce competition by universities, it limits the number of games that can be played each season and the number of teams that can participate in each division. And to limit price competition, the NCAA has, until 1984, been the sole negotiator for all football television contracts, thereby monopolizing one of the main sources of industry revenues.

Has the NCAA been a successful cartel? Like most cartels, its members have occasionally broken its rules and regulations. But until 1984, it had increased the monopoly power of this industry well above what it would have been otherwise. In 1984, however, the Supreme Court ruled that the NCAA's monopolization of football television contracts was illegal and that individual universities could negotiate their own contracts. The ensuing competition led to a drop in contract fees. As a result, more college football is shown on television but, because of the lower fees, the revenues to the schools have dropped somewhat. All in all, although the Supreme Court's ruling reduced the NCAA's monopoly power, it did not eliminate it. Despite no longer retaining exclusive rights to negotiate college football television contracts, the NCAA still negotiates fees for other televised collegiate sports. In 2001, CBS signed a $6 billion deal with the NCAA to cover the men's Division I basketball tournament for 11 years, and ESPN agreed

[13]See "In Big-Time College Athletics, the Real Score Is in Dollars," *New York Times*, March 1, 1987.

to pay the NCAA $200 million over 11 years for coverage of 11 nonrevenue sports (such as soccer, men's ice hockey, and the College World Series).[14]

Since then, the NCAA's anticompetitive practices have come under numerous attacks. In 2005, the National Invitation Tournament (NIT), a college basketball tournament operated by the Metropolitan Intercollegiate Basketball Committee, challenged the NCAA's rule that effectively forced schools invited to its tournament to boycott the NIT. The NIT claimed that this practice was anticompetitive and an illegal use of the NCAA's powers. The parties ultimately settled the lawsuit for nearly $60 million. In 2007, the NCAA was sued by 11,500 Division I football and basketball players claiming that it illegally fixed the price of an athletic scholarship below the cost of a college education. According to the players, the NCAA shortchanged them, on average, $2,500 a year because of its arbitrary limit on scholarships.

EXAMPLE 12.6 The Milk Cartel

The U.S. government has supported the price of milk since the Great Depression and continues to do so today. The government, however, scaled back price supports during the 1990s, and as a result, wholesale prices of milk have fluctuated more widely. Not surprisingly, farmers have been complaining.

In response to these complaints, in 1996 the federal government allowed milk producers in the six New England states to cartelize. The cartel—called the Northeast Interstate Dairy Compact—set minimum wholesale prices for milk, and was exempt from the antitrust laws. The result was that consumers in New England paid more for a gallon of milk than consumers elsewhere in the nation.

In 1999, Congress responded to the lobbying efforts of farmers in other states by attempting to expand the milk cartel. Legislation was introduced that would have allowed dairy farmers in New York, New Jersey, Maryland, Delaware, and Pennsylvania to join the New England states and thereby form a cartel covering most of the northeast United States.[15] Not wanting to be left out, dairy farmers in the South also lobbied Congress for higher milk prices. As a result, the 1999 legislation also authorized 16 southern states, including Texas, Florida, and Georgia, to create their own regional cartel.

Studies have suggested that the original cartel (covering only the New England states) has caused retail prices of milk to rise by only a few cents a gallon. Why so little? The reason is that the New England cartel is surrounded by a fringe of noncartel producers—namely, dairy farmers in New York, New Jersey, and other states. Expanding the cartel, however, would have shrunk the competitive fringe, thereby giving the cartel a greater influence over milk prices.

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[14] "Sweeping Changes Suggested for NCAA; Graduation Rates, Commercialism Cited," *The Washington Post*, June 27, 2001; "NCAA Panel Trying to Turn Back Clock; Big Bucks Make the Knight Commission's Recent Call for Academic Integrity Obsolete," *San Antonio Express-News*, July 20, 2001.

[15] "Congress Weighs an Expanded Milk Cartel That Would Aid Farmers by Raising Prices," *New York Times*, May 2, 1999. For an update, go to the following Web site: **www.dairycompact.org**.

Recognizing the political headaches and regional conflict caused by these attempts at cartelization, Congress ended the Northeast Interstate Dairy Compact in October 2001. Although proponents of the Compact attempted to revive the cartel, opposition in Congress has been strong and, as of 2007, has not been re-authorized. Nonetheless, milk production continues to benefit from federal price supports.

SUMMARY

1. In a monopolistically competitive market, firms compete by selling differentiated products, which are highly substitutable. New firms can enter or exit easily. Firms have only a small amount of monopoly power. In the long run, entry will occur until profits are driven to zero. Firms then produce with excess capacity (i.e., at output levels below those that minimize average cost).
2. In an oligopolistic market, only a few firms account for most or all of production. Barriers to entry allow some firms to earn substantial profits, even over the long run. Economic decisions involve strategic considerations—each firm must consider how its actions will affect its rivals, and how they are likely to react.
3. In the Cournot model of oligopoly, firms make their output decisions at the same time, each taking the other's output as fixed. In equilibrium, each firm is maximizing its profit, given the output of its competitor, so no firm has an incentive to change its output. The firms are therefore in a Nash equilibrium. Each firm's profit is higher than it would be under perfect competition but less than what it would earn by colluding.
4. In the Stackelberg model, one firm sets its output first. That firm has a strategic advantage and earns a higher profit. It knows that it can choose a large output and that its competitors will have to choose smaller outputs if they want to maximize profits.
5. The Nash equilibrium concept can also be applied to markets in which firms produce substitute goods and compete by setting price. In equilibrium, each firm maximizes its profit, given the prices of its competitors, and so has no incentive to change price.
6. Firms would earn higher profits by collusively agreeing to raise prices, but the antitrust laws usually prohibit this. They might all set high prices without colluding, each hoping its competitors will do the same, but they are in a prisoners' dilemma, which makes this unlikely. Each firm has an incentive to cheat by lowering its price and capturing sales from competitors.
7. The prisoners' dilemma creates price rigidity in oligopolistic markets. Firms are reluctant to change prices for fear of setting off price warfare.
8. Price leadership is a form of implicit collusion that sometimes gets around the prisoners' dilemma. One firm sets price and other firms follow suit.
9. In a cartel, producers explicitly collude in setting prices and output levels. Successful cartelization requires that the total demand not be very price elastic, and that either the cartel control most supply or else the supply of noncartel producers be inelastic.

QUESTIONS FOR REVIEW

1. What are the characteristics of a monopolistically competitive market? What happens to the equilibrium price and quantity in such a market if one firm introduces a new, improved product?
2. Why is the firm's demand curve flatter than the total market demand curve in monopolistic competition? Suppose a monopolistically competitive firm is making a profit in the short run. What will happen to its demand curve in the long run?
3. Some experts have argued that too many brands of breakfast cereal are on the market. Give an argument to support this view. Give an argument against it.
4. Why is the Cournot equilibrium stable? (i.e., Why don't firms have any incentive to change their output levels once in equilibrium?) Even if they can't collude, why don't firms set their outputs at the joint profit-maximizing levels (i.e., the levels they would have chosen had they colluded)?
5. In the Stackelberg model, the firm that sets output first has an advantage. Explain why.
6. What do the Cournot and Bertrand models have in common? What is different about the two models?
7. Explain the meaning of a Nash equilibrium when firms are competing with respect to price. Why is the equilibrium stable? Why don't the firms raise prices to the level that maximizes joint profits?
8. The kinked demand curve describes price rigidity. Explain how the model works. What are its limitations? Why does price rigidity occur in oligopolistic markets?

9. Why does price leadership sometimes evolve in oligopolistic markets? Explain how the price leader determines a profit-maximizing price.
10. Why has the OPEC oil cartel succeeded in raising prices substantially while the CIPEC copper cartel has not? What conditions are necessary for successful cartelization? What organizational problems must a cartel overcome?

EXERCISES

1. Suppose all firms in a monopolistically competitive industry were merged into one large firm. Would that new firm produce as many different brands? Would it produce only a single brand? Explain.
2. Consider two firms facing the demand curve $P = 50 - 5Q$, where $Q = Q_1 + Q_2$. The firms' cost functions are $C_1(Q_1) = 20 + 10Q_1$ and $C_2(Q_2) = 10 + 12Q_2$.
   a. Suppose both firms have entered the industry. What is the joint profit-maximizing level of output? How much will each firm produce? How would your answer change if the firms have not yet entered the industry?
   b. What is each firm's equilibrium output and profit if they behave noncooperatively? Use the Cournot model. Draw the firms' reaction curves and show the equilibrium.
   c. How much should Firm 1 be willing to pay to purchase Firm 2 if collusion is illegal but a takeover is not?
3. A monopolist can produce at a constant average (and marginal) cost of AC = MC = \$5. It faces a market demand curve given by $Q = 53 - P$.
   a. Calculate the profit-maximizing price and quantity for this monopolist. Also calculate its profits.
   b. Suppose a second firm enters the market. Let Q_1 be the output of the first firm and Q_2 be the output of the second. Market demand is now given by
   $$Q_1 + Q_2 = 53 - P$$
   Assuming that this second firm has the same costs as the first, write the profits of each firm as functions of Q_1 and Q_2.
   c. Suppose (as in the Cournot model) that each firm chooses its profit-maximizing level of output on the assumption that its competitor's output is fixed. Find each firm's "reaction curve" (i.e., the rule that gives its desired output in terms of its competitor's output).
   d. Calculate the Cournot equilibrium (i.e., the values of Q_1 and Q_2 for which each firm is doing as well as it can given its competitor's output). What are the resulting market price and profits of each firm?
   *e. Suppose there are N firms in the industry, all with the same constant marginal cost, MC = \$5. Find the Cournot equilibrium. How much will each firm produce, what will be the market price, and how much profit will each firm earn? Also, show that as N becomes large, the market price approaches the price that would prevail under perfect competition.
4. This exercise is a continuation of Exercise 3. We return to two firms with the same constant average and marginal cost, AC = MC = 5, facing the market demand curve $Q_1 + Q_2 = 53 - P$. Now we will use the Stackelberg model to analyze what will happen if one of the firms makes its output decision before the other.
   a. Suppose Firm 1 is the Stackelberg leader (i.e., makes its output decisions before Firm 2). Find the reaction curves that tell each firm how much to produce in terms of the output of its competitor.
   b. How much will each firm produce, and what will its profit be?
5. Two firms compete in selling identical widgets. They choose their output levels Q_1 and Q_2 simultaneously and face the demand curve
   $$P = 30 - Q$$
   where $Q = Q_1 + Q_2$. Until recently, both firms had *zero marginal costs*. Recent environmental regulations have increased Firm 2's marginal cost to \$15. Firm 1's marginal cost remains constant at zero. True or false: As a result, the market price will rise to the *monopoly* level.
6. Suppose that two identical firms produce widgets and that they are the only firms in the market. Their costs are given by $C_1 = 60Q_1$ and $C_2 = 60Q_2$, where Q_1 is the output of Firm 1 and Q_2 the output of Firm 2. Price is determined by the following demand curve:
   $$P = 300 - Q$$
   where $Q = Q_1 + Q_2$.
   a. Find the Cournot-Nash equilibrium. Calculate the profit of each firm at this equilibrium.
   b. Suppose the two firms form a cartel to maximize joint profits. How many widgets will be produced? Calculate each firm's profit.
   c. Suppose Firm 1 were the only firm in the industry. How would market output and Firm 1's profit differ from that found in part (b) above?
   d. Returning to the duopoly of part (b), suppose Firm 1 abides by the agreement but Firm 2 cheats by increasing production. How many widgets will Firm 2 produce? What will be each firm's profits?
7. Suppose that two competing firms, A and B, produce a homogeneous good. Both firms have a marginal cost of MC = \$50. Describe what would happen to output and price in each of the following situations if the firms are at (i) Cournot equilibrium, (ii) collusive equilibrium, and (iii) Bertrand equilibrium.

a. Because Firm A must increase wages, its MC increases to \$80.
b. The marginal cost of both firms increases.
c. The demand curve shifts to the right.

8. Suppose the airline industry consisted of only two firms: American and Texas Air Corp. Let the two firms have identical cost functions, $C(q) = 40q$. Assume that the demand curve for the industry is given by $P = 100 - Q$ and that each firm expects the other to behave as a Cournot competitor.
a. Calculate the Cournot-Nash equilibrium for each firm, assuming that each chooses the output level that maximizes its profits when taking its rival's output as given. What are the profits of each firm?
b. What would be the equilibrium quantity if Texas Air had constant marginal and average costs of \$25 and American had constant marginal and average costs of \$40?
c. Assuming that both firms have the original cost function, $C(q) = 40q$, how much should Texas Air be willing to invest to lower its marginal cost from 40 to 25, assuming that American will not follow suit? How much should American be willing to spend to reduce its marginal cost to 25, assuming that Texas Air will have marginal costs of 25 regardless of American's actions?

***9.** Demand for light bulbs can be characterized by $Q = 100 - P$, where Q is in millions of boxes of lights sold and P is the price per box. There are two producers of lights, Everglow and Dimlit. They have identical cost functions:

$$C_i = 10Q_i + \tfrac{1}{2}Q_i^2 \, (i = E, D)$$
$$Q = Q_E + Q_D$$

a. Unable to recognize the potential for collusion, the two firms act as short-run perfect competitors. What are the equilibrium values of Q_E, Q_D, and P? What are each firm's profits?
b. Top management in both firms is replaced. Each new manager independently recognizes the oligopolistic nature of the light bulb industry and plays Cournot. What are the equilibrium values of Q_E, Q_D, and P? What are each firm's profits?
c. Suppose the Everglow manager guesses correctly that Dimlit is playing Cournot, so Everglow plays Stackelberg. What are the equilibrium values of Q_E, Q_D, and P? What are each firm's profits?
d. If the managers of the two companies collude, what are the equilibrium values of Q_E, Q_D, and P? What are each firm's profits?

10. Two firms produce luxury sheepskin auto seat covers: Western Where (WW) and B.B.B. Sheep (BBBS). Each firm has a cost function given by

$$C(q) = 30q + 1.5q^2$$

The market demand for these seat covers is represented by the inverse demand equation

$$P = 300 - 3Q$$

where $Q = q_1 + q_2$, total output.
a. If each firm acts to maximize its profits, taking its rival's output as given (i.e., the firms behave as Cournot oligopolists), what will be the equilibrium quantities selected by each firm? What is total output, and what is the market price? What are the profits for each firm?
b. It occurs to the managers of WW and BBBS that they could do a lot better by colluding. If the two firms collude, what will be the profit-maximizing choice of output? The industry price? The output and the profit for each firm in this case?
c. The managers of these firms realize that explicit agreements to collude are illegal. Each firm must decide on its own whether to produce the Cournot quantity or the cartel quantity. To aid in making the decision, the manager of WW constructs a payoff matrix like the one below. Fill in each box with the profit of WW and the profit of BBBS. Given this payoff matrix, what output strategy is each firm likely to pursue?

Profit Payoff Matrix

(WW Profit, BBBS Profit)		BBBS: Produce Cournot q	BBBS: Produce Cartel q
WW	Produce Cournot q		
WW	Produce Cartel q		

d. Suppose WW can set its output level *before* BBBS does. How much will WW choose to produce in this case? How much will BBBS produce? What is the market price, and what is the profit for each firm? Is WW better off by choosing its output first? Explain why or why not.

***11.** Two firms compete by choosing price. Their demand functions are

$$Q_1 = 20 - P_1 + P_2$$

and

$$Q_2 = 20 + P_1 - P_2$$

where P_1 and P_2 are the prices charged by each firm, respectively, and Q_1 and Q_2 are the resulting demands. Note that the demand for each good depends only on the difference in prices; if the two firms colluded and set the same price, they could make that price as high as they wanted, and earn infinite profits. Marginal costs are zero.
a. Suppose the two firms set their prices at the *same time*. Find the resulting Nash equilibrium. What price will each firm charge, how much will it sell, and what will its profit be? (*Hint:* Maximize the profit of each firm with respect to its price.)

b. Suppose Firm 1 sets its price *first* and then Firm 2 sets its price. What price will each firm charge, how much will it sell, and what will its profit be?

c. Suppose you are one of these firms and that there are three ways you could play the game: (i) Both firms set price at the same time; (ii) You set price first; or (iii) Your competitor sets price first. If you could choose among these options, which would you prefer? Explain why.

*12. The dominant firm model can help us understand the behavior of some cartels. Let's apply this model to the OPEC oil cartel. We will use isoelastic curves to describe world demand W and noncartel (competitive) supply S. Reasonable numbers for the price elasticities of world demand and noncartel supply are $-1/2$ and $1/2$, respectively. Then, expressing W and S in millions of barrels per day (mb/d), we could write

$$W = 160P^{-1/2}$$

and

$$S = (3\tfrac{1}{3})P^{1/2}$$

Note that OPEC's net demand is $D = W - S$.

a. Draw the world demand curve W, the non-OPEC supply curve S, OPEC's net demand curve D, and OPEC's marginal revenue curve. For purposes of approximation, assume OPEC's production cost is zero. Indicate OPEC's optimal price, OPEC's optimal production, and non-OPEC production on the diagram. Now, show on the diagram how the various curves will shift and how OPEC's optimal price will change if non-OPEC supply becomes more expensive because reserves of oil start running out.

b. Calculate OPEC's optimal (profit-maximizing) price. (*Hint*: Because OPEC's cost is zero, just write the expression for OPEC revenue and find the price that maximizes it.)

c. Suppose the oil-consuming countries were to unite and form a "buyers' cartel" to gain monopsony power. What can we say, and what can't we say, about the impact this action would have on price?

13. Suppose the market for tennis shoes has one dominant firm and five fringe firms. The market demand is $Q = 400 - 2P$. The dominant firm has a constant marginal cost of 20. The fringe firms each have a marginal cost of $MC = 20 + 5q$.

a. Verify that the total supply curve for the five fringe firms is $Q_f = P - 20$.

b. Find the dominant firm's demand curve.

c. Find the profit-maximizing quantity produced and price charged by the dominant firm, and the quantity produced and price charged by each of the fringe firms.

d. Suppose there are 10 fringe firms instead of five. How does this change your results?

e. Suppose there continue to be five fringe firms but that each manages to reduce its marginal cost to $MC = 20 + 2q$. How does this change your results?

*14. A lemon-growing cartel consists of four orchards. Their total cost functions are

$$TC_1 = 20 + 5Q_1^2$$

$$TC_2 = 25 + 3Q_2^2$$

$$TC_3 = 15 + 4Q_3^2$$

$$TC_4 = 20 + 6Q_4^2$$

TC is in hundreds of dollars, and Q is in cartons per month picked and shipped.

a. Tabulate total, average, and marginal costs for each firm for output levels between 1 and 5 cartons per month (i.e., for 1, 2, 3, 4, and 5 cartons).

b. If the cartel decided to ship 10 cartons per month and set a price of \$25 per carton, how should output be allocated among the firms?

c. At this shipping level, which firm has the most incentive to cheat? Does any firm *not* have an incentive to cheat?