CHAPTER 15

Using Noncompetitive Market Models

Noncompetitive models provide analytical frameworks for understanding the functioning of a variety of markets and certain pressing social problems.

Chapter Outline

Learning Objectives

- Determine the relative magnitude of the deadweight loss of monopoly.
- Ascertain the extent to which, if any, monopolies suppress innovations.
- Explore whether government intervention can promote efficiency in the case of natural monopoly.
- Analyze the deadweight loss associated with a government-established cartel such as the British Columbia Egg Marketing Board.
- Explore the concepts of iterated dominance and commitment in the context of game theory models.

In Chapters 11 through 14, we examined a number of models in which firms have varying degrees of market power. We found that prices tend to be higher and output lower than under competitive conditions. These models also provide analytical frameworks that can be used to examine other issues relevant to the functioning of noncompetitive markets and to understand certain pressing social problems. In this chapter we look at several examples, including the magnitude of the deadweight loss associated with monopoly and the effect of monopoly on innovation. We also examine how best to regulate monopolies that arise because economies of scale characterize the production of a good over the relevant range of market output. In such *natural monopoly* cases, average production cost is minimized if a single firm supplies the entire market.

15.1 THE SIZE OF THE DEADWEIGHT LOSS OF MONOPOLY

In Chapter 11, we explained how monopoly, at least from a static perspective, results in a deadweight loss. Figure 15.1 illustrates this analysis for a market that would be a constant-cost industry under competitive conditions. The competitive outcome is an output of Q (1,000) and a price of P (\$1.00). If the industry becomes a pure monopoly and the monopoly can produce under the same cost conditions (so the competitive supply curve becomes the monopolist's marginal cost and average cost curves), the monopoly outcome is an output of Q_M (500) and a price of P_M (\$2.00). The deadweight loss of monopoly is shown as the triangular area *BCA*.

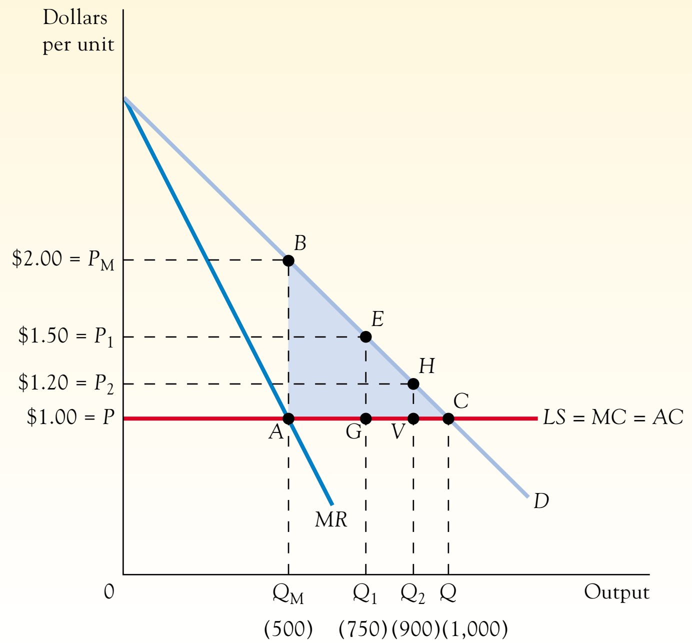
Determining the magnitude of this deadweight loss is important for public policy reasons. This is so because, as we saw in Chapter 11, the deadweight loss indicates how much lower total (consumer plus producer) surplus is in a market on account of monopoly. Public policies promoting greater competition in such a market hence offer the potential for increasing total surplus and attaining efficiency in output.

Note that the deadweight loss is given by the area of the triangle *BCA* (at least when we assume linear demand and supply curves), and the area of a triangle equals one-half its base times its height. Thus, if we can determine the base and the height of the deadweight loss triangle, we can calculate the magnitude. The height of the triangle, distance *BA* in Figure 15.1, is the excess of the monopoly price over marginal cost of production ($P_M - MC$). The base of the triangle, distance *AC*, is the restriction in output due to the monopoly ($Q - Q_M$). This restriction in output can be calculated if we know price and marginal cost at the monopoly outcome and the price elasticity of demand (assuming marginal cost is constant). For example, the demand curve in Figure 15.1 has an arc elasticity of one between Q_M and Q, and because the monopoly price is 100 percent above the competitive price, we know the competitive output is 100 percent above the monopoly output (the ratio of the percentage change in output and percentage change in price equals the elasticity). Therefore, for the figures given in the graph, we can calculate the deadweight loss as ($\frac{1}{2}$)

FIGURE 15.1

The Deadweight Loss of Noncompetitive Output

When price is P_M and output Q_M, the deadweight loss due to the monopolistic restriction of output is triangular area *BCA.* If the product is produced by an oligopoly, output is likely to be higher (say, Q_2) and the deadweight loss smaller (area *HCV*).



$(BA)(AC)$, or $(\frac{1}{2})(\$1)(500)$, or \$250. This is equal to one-fourth of the total consumer outlay on the product in our example.

Several economists have estimated the magnitude of the deadweight loss due to monopolistic restrictions in output in the real world. The first was Arnold Harberger, whose 1954 study concluded that the deadweight loss of monopoly in U.S. manufacturing corporations equaled a scant 0.1 percent (or one-thousandth) of gross national product (GNP).[1] (Manufacturing, however, accounted for only about one-fourth of GNP, so if monopoly is as important in other sectors as in manufacturing, the economy-wide deadweight loss would have been 0.4 percent.) A number of more recent studies, using different data and methodologies, have tended to support Harberger's conclusion that the deadweight loss is not large relative to GNP. A comprehensive survey of the research concludes that the deadweight loss of monopoly in the United States lies somewhere between 0.5 and 2 percent of GNP.[2]

There are several reasons why estimates of the deadweight loss of monopoly in relation to GNP are not large. One is that we are comparing the deadweight loss not to the size of the monopolized sector, but to the size of the whole economy (GNP). In our example in Figure 15.1, the deadweight loss is 25 percent of the total outlay in this market, but if only 20 percent of the economy is monopolized (to this degree), then the total deadweight loss relative to GNP would be one-fifth of 25 percent, or 5 percent.

An even more important factor is that there are few, if any, instances of pure monopoly in the United States. Most examples of noncompetitive markets involve markets dominated by several large firms (that is, oligopolies) rather than pure monopolies. Studies of the deadweight loss of monopoly are really examining monopoly power in industries such as soft drink manufacturing, as opposed to sole-producer industries.

Although we do not have a single satisfactory theory of oligopoly, recall that in most oligopoly models, the output is greater than the pure monopoly output. To see the importance of this point, suppose that output is actually three-fourths the competitive output in Figure 15.1—because the industry is an oligopoly. Then output is Q_1 (750) and the price is P_1, or \$1.50, because the demand curve is linear. The deadweight loss is then equal to area ECG, or $(\frac{1}{2})(\$0.50)(250)$, which equals \$62.50. Note that although the output restriction in this case (250) is half as large as the output restriction under pure monopoly (500), the deadweight loss is only one-fourth as large.

Of course, we cannot directly measure the restriction in output in any industry; we can observe only actual output. What we can try to measure directly is the excess of price over marginal cost—that is, the height of the deadweight loss triangle. This is what is done in practice, and the $P - MC$ estimates, along with estimated or assumed demand elasticities, allow us to infer the restriction in output. Unfortunately, it is far from straightforward to estimate how much the actual price exceeds marginal cost. If we assume that average cost and marginal cost are equal, as in our diagram, then the excess of price over marginal cost is also the economic profit per unit of output. Thus, data on profits may tell us how much higher than cost price is. But profit data always report accounting profits, and these typically exceed the pure economic profits we wish to measure. Nonetheless, looking at accounting profits data and making adjustments to try to estimate economic profits provide interesting clues to the excess of price over marginal cost in different industries.

Considering all U.S. corporations, how much accounting profit do you think businesses on average make per dollar of sales? The typical response from college students in a Gallup

[1]Arnold Harberger, "Monopoly and Resource Allocation," *American Economic Review*, 44 No. 2 (May 1954), pp. 77–87.

[2]Frederic M. Scherer and David Ross, *Industrial Market Structure and Economic Performance*, 3rd ed. (Boston, Mass.: Houghton Mifflin, 1990), p. 667.

opinion survey was 45 cents.[3] The correct answer is actually 5 cents of after-tax profit per dollar of sales. (In the same survey students also indicated that they thought a "fair" profit for corporations would be 25 cents per dollar of sales.) The 5 percent profit margin is based on the accounting definition of profit; the economic profit margin tends to be smaller. Of course, we are considering the average for all corporations, and for those with market power the profit margin can be much greater. But it turns out to be very rare for any industry to have a profit margin, even based on accounting data, as large as 20 percent. That is not really so surprising given that a 20 percent profit margin would be four times the average, and would constitute a powerful incentive for entry to occur in the market.

So, instead of basing our deadweight loss estimate on the output restriction, as we did in assuming output was three-fourths the competitive level, let's assume that in the industries with market power, price is 20 percent above marginal cost. This situation is shown in Figure 15.1 by an output of Q_2 and a price of P_2, or an output of 900 and price of \$1.20. The deadweight loss is area *HCV*, which equals ($\frac{1}{2}$)(\$0.20)(100), or \$10. This is about 1 percent of the industry's total revenue. However, the arc elasticity of demand between points *H* and *C* on the demand curve is only 0.58, and if we used the more commonly assumed value of 1 for our exercise, the deadweight loss would be nearly \$20, or about 2 percent of the industry's total revenue. If one in five industries exercise this degree of monopoly power, the economy-wide deadweight loss from monopoly would be 0.4 percent of GNP.

These considerations have convinced many economists that the deadweight loss of monopolistic restrictions in output in the United States economy is almost certain to be less than 1 percent of GNP. Presumably, this is because most of the economy is reasonably competitive, with a relatively small number of exceptions. But there may be other types of deadweight loss associated with noncompetitive markets, as we will see next.

Other Possible Deadweight Losses of Monopoly

We have emphasized two consequences of monopoly widely viewed as undesirable: the restriction of output and the redistribution of income in favor of the owners of the monopoly. Only the restriction of output involves a net loss in total surplus, and both theory and the available evidence suggest it is not very large compared with GNP. Other potential effects of monopoly, however, should also be mentioned.

When comparing monopoly and competition, we assumed that the costs of production under monopoly would be the same as under competition. If the monopoly maximizes profit, this assumption is correct. For example, the monopoly would produce the 500 units of output in Figure 15.1 at a cost of \$500. If profit is to be maximized, whatever output the firm produces must be produced at the lowest possible cost. The pressure on a monopoly to minimize production cost, however, is not as strong as the pressure on a competitive firm. If cost should increase because of slack cost controls in a competitive firm, the firm will start losing money and eventually close operations. For the monopolist, though, higher-than-necessary cost may just mean a smaller profit, not a loss. In the absence of competition with other firms, the monopolist is under less pressure to minimize cost. As Adam Smith observed, "monopoly . . . is a great enemy to good management."[4]

If production cost is unnecessarily high under monopoly, this is another deadweight loss. For instance, if in Figure 15.1 the monopoly produces 500 units at a cost of \$1.50 per unit, the total cost of producing 500 units is therefore \$250 higher under monopoly than it would be under competition. Part of the potential monopoly profit of \$500 would be dissipated through the cost increase. Some of the \$500 profit rectangle, $P_M BAP$, no longer would be a

[3] *Gallup Opinion Index*, Report No. 123 (Princeton, N.J., September 1975).

[4] Adam Smith, *The Wealth of Nations* (New York: Modern Library, 1937), p. 147.

transfer of income from consumers to the monopolist; instead, the money is absorbed by higher-than-necessary cost and is a net loss.

A similar outcome results if the monopoly incurs costs in acquiring or maintaining its market position. Our analysis implicitly assumed that production cost is the only cost of the monopoly. But a monopoly may have to expend resources to ensure continuation of its monopoly power. A lobbying effort may be necessary to secure favorable government policies to block competition by other firms. Management may spend more time worrying about protecting its market from encroachers than making business decisions regarding output and cost. Legal and accounting staffs may be required to fend off antitrust suits by the Justice Department. Because an average of seven years is needed to see an antitrust suit through to conclusion, litigation can be quite costly for both the government and the firm. For instance, in 1974 the Justice Department brought an antitrust suit against American Telephone and Telegraph (AT&T). By 1981, AT&T estimated that it had spent $250 million on the case—$25 million in direct legal costs, such as lawyers' fees and briefs, and another $225 million on supporting paperwork—and that pretrial proceedings had involved more than 40 million pages.[5] In January 1982, as the trial was nearing its conclusion, AT&T and the Justice Department settled the case out of court.

Due either to the absence of competitive pressures or to the expenses associated with securing monopoly power, cost may be higher than necessary under monopoly. Consequently, measures of the deadweight loss of monopoly based on the welfare triangle, which considers only the output restriction, may underestimate monopoly's true deadweight loss. We must emphasize that the analysis does not imply that cost *will* be higher under monopoly, only that it *may* be. There is little current evidence to suggest how quantitatively important this other deadweight loss really is. Moreover, as discussed in Chapter 11, it is important not to overlook the dynamic perspective on monopoly. While a monopolist may face less pressure to minimize cost than a competitive firm, monopoly power may have been acquired in the first place through discovering a way to build a better mousetrap or an existing mousetrap at lower cost. From a dynamic perspective, therefore, monopolies may be associated with a lower, rather than higher, production cost.

15.2 Do Monopolies Suppress Inventions?

A bit of folklore is that firms sometimes suppress inventions that would benefit consumers. One version of this idea is the belief that manufacturers design products to wear out quickly (planned obsolescence) so that consumers periodically will have to replace them.

An economist would assess these beliefs by looking first at the internal consistency of the argument. The basic premise is that a firm will make a larger profit by suppressing a worthwhile invention than by marketing it. Under what conditions will this be true?

To avoid ambiguity, we'll define a "worthwhile" invention as one that allows a firm to produce a higher-quality product at an unchanged cost or to produce the same-quality product at a lower cost. Suppression of such an invention would be unambiguously harmful.

Under competitive conditions a firm would never suppress a worthwhile invention. Suppose that the invention permits the production of the same-quality product at a lower cost. The first firm to introduce the process will have a lower production cost than its rivals, and this guarantees a profit. Even if the invention cannot be patented, the firm can earn a profit until other firms have had time to copy it.

What about the monopoly case? Let's look at an example and see whether it's likely a monopoly will suppress a worthwhile invention. Suppose that the market for light bulbs is monopolized

[5] "Out of the Quagmire," *Wall Street Journal*, January 30, 1981, p. 1.

and that the monopoly sells light bulbs that last for 1,000 hours. Then the monopolist acquires an invention that permits production of bulbs that last for 10,000 hours at the same unit cost as the 1,000-hour bulbs. Obviously, consumers would purchase many fewer light bulbs per year if each one lasted 10 times as long. Does this mean that the monopoly will make more money if it continues to sell the 1,000-hour light bulb and withholds the superior product?

The answer is no. To see why, suppose that consumers want 10,000 hours of light per year. Initially, they purchase 10 1,000-hour bulbs at $1.00 each, involving a total outlay of $10.00. If it costs the monopolist $0.50 to make each bulb, the firm makes a profit of $5.00 per consumer. Each consumer will be willing to pay at least $10.00 (more if convenience counts) for one 10,000-hour bulb, because a 10,000-hour bulb yields the same light as 10 1,000-hour bulbs that together cost $10.00. The monopolist, however, can produce each 10,000-hour bulb for $0.50, so profit is $9.50 on the sale of one 10,000-hour bulb but only $5.00 on the sale of 10 1,000-hour bulbs.

The foregoing example assumes that customers continue to purchase just enough light bulbs for 10,000 hours of light in both cases. While such an assumption may not be valid, the result that the monopolist will make more money by selling the superior light bulb continues to hold even when the assumption does not.[6] A graphical analysis shows why. There are two ways to proceed. One is to consider the demand curve for light bulbs but to recognize that the demand curve for 10,000-hour light bulbs differs from the curve for 1,000-hour bulbs. A simpler approach is to recognize that what consumers are really purchasing is the services of light bulbs—that is, hours of lighting—and the demand curve defined in this way does not shift. What changes when we switch from 1,000- to 10,000-hour bulbs is the cost and price per hour of lighting, not the demand curve itself.

Figure 15.2 illustrates this latter approach. On the horizontal axis we measure kilohours of lighting; each kilohour equals 1,000 hours, the service provided by each of the first type of bulbs. For simplicity, average and marginal cost are assumed to be constant at $0.50 per 1,000-hour bulb (per kilohour).

The initial pre-invention equilibrium at Q_1 involves 100 kilohours (100 1,000-hour bulbs) sold for $1.00 each. Each 1,000-hour bulb costs $0.50 to produce, so total profit is $50. The invention of the 10,000-hour bulb, which the firm can produce at the same unit cost ($0.50), means that the cost per kilohour falls to $0.05. Thus, the average cost curve if the new light bulb is produced is AC'. Operating with this lower-cost curve, the monopolist can make more profit, and the new profit-maximizing output of kilohours (not bulbs) is Q_2. Price falls to $0.75 per kilohour. Profit rises from $50 to $105: the cost per kilohour is $0.05, and the price is $0.75, so the profit per kilohour is $0.70; $0.70 times 150 kilohours yields a total profit of $105. Note that the new equilibrium corresponds to the sale of 15 10,000-hour bulbs at $7.50 each; fewer bulbs are sold.

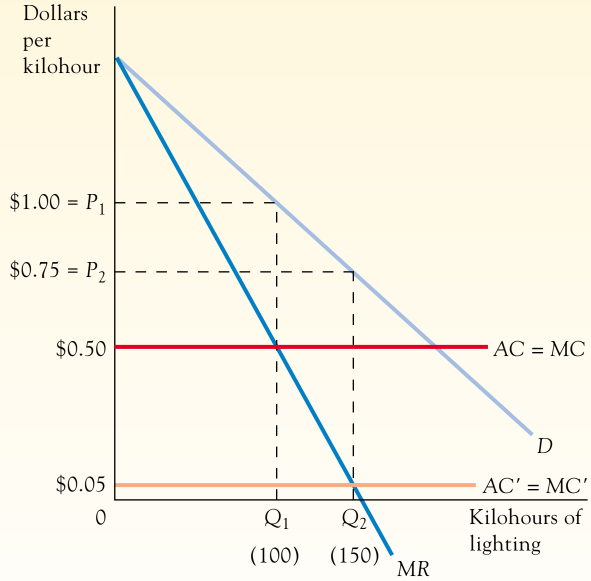
This analysis suggests that a monopolist has no reason to suppress a worthwhile invention—the reverse, in fact, is true. We have examined the more difficult case of a higher-quality product to show how we can analyze quality changes by focusing on product services (hours of lighting) rather than the product itself. We reach the same conclusion for an invention that lowers the cost of producing a product of unchanged quality. In that case the cost curves for an unchanged-quality product shift downward due to the invention, implying more profit for a monopolist.

Because a monopolist can increase profit by marketing a worthwhile invention, economists tend to be skeptical of allegations that businesses suppress them. As with many generalizations

[6]Our analysis, of course, ignores the subtle complication that a consumer may want some amount of hours of light per year (such as 15,000) that is not a whole-number multiple of 10,000, while light from the superior bulbs must be purchased in 10,000-hour increments. Such a complication can still be addressed, however, to the extent that a consumer wants light in more than one year. That is, any excess light from a superior bulb not used in one year can be employed in the next year. A consumer who wants 5,000 hours of light in each of two years thus could use one of the 10,000-hour bulbs over the course of those two years rather than five of the 1,000-hour bulbs in each of the two years.

FIGURE 15.2

Monopoly and Inventions
If a monopoly can produce a 10,000-hour light bulb at the same cost as a 1,000-hour bulb, the invention effectively reduces the cost per kilohour of light from \$0.50 to \$0.05. The monopoly will make a larger profit by producing and selling the superior bulb.



in economics, though, we can conceive of an exception, a case where a monopoly would find it profitable to suppress an invention. For instance, suppose the firm would lose its monopoly position by introducing the invention. Once the invention of the 10,000-hour light bulb becomes public knowledge, other firms could produce and sell it for \$0.50. The monopoly would then find itself in a competitive market. If the firm can patent the invention, however, the monopoly may be able to retain its monopoly position and market the invention.[7]

There are many instances of worthwhile inventions being marketed, both by competitive firms and by firms with various degrees of monopoly power. Thus, the generalization that profit incentives will lead to the introduction of worthwhile inventions seems reliable. While there may be other deadweight losses associated with monopoly, widespread suppression of inventions does not appear to be one of them.

APPLICATION 15.1 HOLLYWOOD AND HOME ENTERTAINMENT

It is commonly assumed that major Hollywood motion picture producers should be opposed to the development of a market for home videos and DVDs.[8] After all, buying or renting a video/DVD is a substitute for going to see the same movie at a theater. However, motion picture producers now make twice as much from home video/DVD sales and rentals (\$30 billion in 2002) as from traditional theatrical exhibitions. And the explosive growth in ancillary markets such as home video/DVD, cable, and foreign television markets hasn't

[8]This application is based on: Carl Shapiro and Hal R. Varian, *Information Rules* (Boston: Harvard Business School Press, 1999); and James R. Jaeger II, "The Movie Industry," *www.mec.films.com/moviein.html.*

[7]This is a long-run analysis. In the short run, firms, whether they are monopolistic or competitive, may not introduce an invention immediately. When the time comes to replace worn-out equipment, however (and that time will come more quickly when a lower-cost process is available), the firm will introduce the invention.

diminished overall theater revenues. Indeed, annual revenues from theatrical exhibitions grew from $2.8 billion in 1980 to $15 billion in 2002.

In much the same way that the advent of rental libraries in eighteenth century England spurred the demand for books, so has the development of the home video/DVD market helped increase demand for motion pictures. Although Hollywood was initially petrified by the invention of videotape recorders, and the television industry filed lawsuits to prevent home copying of broadcast programs, prerecorded videotapes and DVDs have proven to be Hollywood's boon rather than the source of its demise. Most movie producers eventually realized that videotapes and DVDs lowered distribution costs (as depicted in Figure 15.2) and thereby represented an opportunity to dramatically expand the markets for their products. According to economists Carl Shapiro and Hal Varian of the University of California, Berkeley, these prescient producers "succeeded beyond their wildest dreams, while those who stuck with the old model were consigned to the dustbins of history."[9]

[9]Ibid., pp. 96–97.

15.3 NATURAL MONOPOLY

In some cases monopoly results because one large firm can produce at a lower per-unit cost than several smaller firms together accounting for the same total output. If the production technology is such that economies of scale (declining average cost per unit of output) extend to very high output levels, a large firm can undersell small firms, and one or a few large firms will eventually dominate the industry. The extreme case is one in which the average cost of a single enterprise declines over the entire range of market demand. As mentioned earlier, this is called a **natural monopoly**.

NATURAL MONOPOLY
the case in which the average cost of a single enterprise declines over the entire range of market demand

Natural monopoly presents a challenging public policy dilemma. On the one hand, it implies that efficiency in production will be better served if a single firm supplies the entire market. On the other hand, natural monopoly results in the absence of any firms that actively compete with the monopolist. The monopolist thus will be tempted to exploit its natural monopoly power and to restrict output and raise price. And inefficiency in output (a deadweight loss) will occur if the monopolist takes these actions to increase its profit.

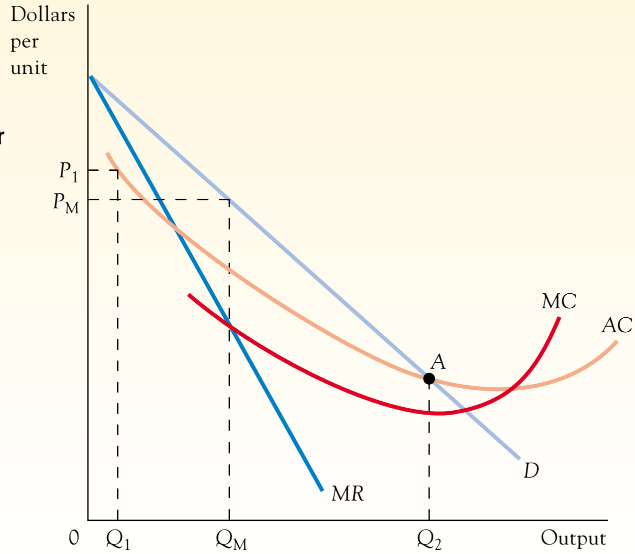
Figure 15.3 illustrates the natural monopoly case. Graphically, a natural monopoly exists when the long-run average cost curve of a single firm is still declining at the point where it intersects the total market demand curve for the product—at point A in the diagram. One firm can produce an output of Q_2 at an average cost of AQ_2. In this situation, the market, if unregulated, will be dominated by a single firm. If, instead, there are several small firms, each producing Q_1, for example, price will have to be at least P_1. Yet any one firm could expand output, sell at a lower price, and ultimately drive the smaller firms out. Monopoly is the "natural" result. Moreover, forcing a competitive structure on this market is undesirable in terms of attaining efficiency in production. The real cost of serving the market will be higher than necessary if there are several, small, high-cost firms.

Drawing cost curves that imply a natural monopoly is easy, but the key question is whether natural monopoly is prevalent in the real world. In fact, natural monopoly conditions are not common, but they do exist for several products. Economists believe, for example, that natural monopoly characterizes the provision of electricity, water, natural gas, telephone services, and possibly cable television to specific geographic localities. Consider electricity. Providing it requires that homes be physically connected to the generating facility through underground or overhead lines. If several separate firms served homes in a given community, each firm would have to run its own connecting power lines. The cost of duplicating connecting lines (implying higher average costs) could be avoided by using just one set of lines. This situation is depicted in Figure 15.3. Unit costs are higher when sev-

FIGURE 15.3

Natural Monopoly

When the average cost of producing a good declines over the entire range of market demand, a natural monopoly exists. It is less expensive for one firm to produce the entire market output than for several small firms to share the market. One firm can produce Q_2 at a unit cost of AQ_2, which is less than the cost when several firms each produce Q_1 at a unit cost of P_1. However, if the firm is allowed to produce monopolistically, output will be Q_M and price P_M.



eral firms supply a few homes (Q_1) than when one operation provides electricity to all homes (Q_2).

When natural monopoly conditions exist, there are four ways public policymakers can deal with the situation. One is to leave the market alone. In this case a monopoly will result, and the monopoly will not choose to supply Q_2 at a cost of AQ_2 per unit (in Figure 15.3). Instead, it will choose the profit-maximizing output of Q_M with a price of P_M. The second option is to permit a monopoly to operate but to regulate its activities. The third option is to have government ownership and operation of the facility (the U.S. Postal Service, for example). A fourth option involves a government-sponsored competition for the right to operate a natural monopoly. Ideally, the operating right is awarded to the bidder promising to charge the lowest price. Competition for the right to be the sole supplier can serve to promote efficiency in output even though once the award is made, there is only one supplier.

In the United States the regulatory option has generally been pursued. A privately owned firm is given the legal right to be the monopoly provider, but a public agency is created to regulate the firm's behavior. How can such a natural monopoly be regulated?

Regulation of Natural Monopoly

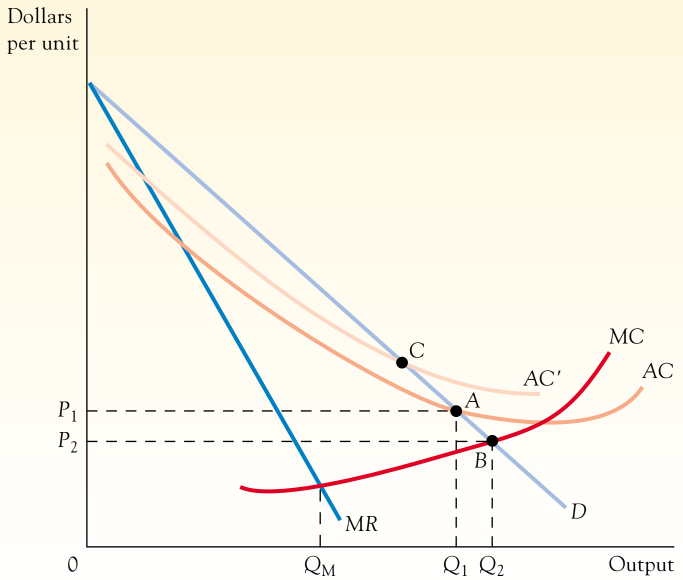
The public agencies charged with regulating natural monopolies, usually called public utilities, generally set the prices that may be charged. Before investigating how this is accomplished, let's examine the economic principles behind the price-setting approach.

In Figure 15.4, the natural monopoly's average and marginal cost curves are AC and MC (ignore AC′ for the moment). If we have complete knowledge of cost and demand conditions, two logical prices can be set. One is the price at the level where the average cost curve intersects the demand curve, a price of P_1. This solution is called *average-cost pricing*. If the monopoly produces Q_1, the price of P_1 just covers its average cost, implying zero economic profit. Moreover, the monopoly has an incentive to produce Q_1 if a maximum price of P_1 can be charged. As explained in Chapter 11, in the case of a price ceiling the demand curve facing the monopoly becomes P_1AD, so marginal revenue (equal to P_1 up to an output of Q_1) exceeds marginal cost as output expands to Q_1, but MR drops below MC at higher

FIGURE 15.4

Regulation of Natural Monopoly

If price is set equal to *MC* at P_2, the monopoly cannot cover its production cost. If price is set equal to *AC* at P_1, output will be inefficient, the monopoly may have little incentive to minimize cost, and the average cost curve could rise to *AC′*.



output levels. Indeed, when a price of P_1 is set, any output other than Q_1 yields a loss, because average cost is above P_1 at lower rates of output.

At an output of Q_1, price exceeds marginal cost (because average cost is falling at point *A*, marginal cost must be below it). Thus, consumers value additional units of output at more than they cost to produce, which suggests a second option—to set price at the level where the marginal cost curve intersects the demand curve (point *B*). This option is called *marginal-cost pricing*. There is, however, a major obstacle to marginal-cost pricing: if we set price at P_2, the monopoly incurs a loss. Because marginal cost is below average cost at Q_2, setting price equal to marginal cost will put the firm out of business. A subsidy can be used to enable the firm to produce Q_2 at a price of P_2, but the cost of implementing and financing the subsidy generally makes this solution impractical.

Thus, the most practical alternative seems to be average-cost pricing. Output is greater than the unregulated monopoly output of Q_M, and because expansion of output from Q_M to Q_1 provides more benefits to consumers than the additional production costs, there is an efficiency gain. (Said another way, part of the deadweight loss arising from restricted output by an unregulated monopoly is eliminated.) The price to consumers is lower than under unregulated monopoly, and the monopoly's owners receive no profit.

Regulation of Natural Monopoly in Practice

In practice, regulators do not have complete knowledge of cost and demand conditions. They generally attempt to attain the average-cost-pricing outcome by focusing on the rate of return on invested capital (accounting profit) earned by a monopoly. It works this way: If the realized rate of return is higher than what is thought to be a normal return (suggesting economic profit), then the current price must be above average cost, and the result signals regulators to reduce the price. Conversely, if the realized rate of return is lower than normal (suggesting economic losses), regulators raise the allowed price. Proceeding in this trial-and-error fashion, regulators locate the price at which profit is normal—that is, where price equals average cost.

There are several problems with this approach, but perhaps the most serious is that it diminishes the monopolist's incentive to minimize cost. If cost rises, regulators permit a higher price so that the monopoly still earns a normal rate of return. Thus, managers have an incentive to pad expense accounts, pay themselves and their colleagues higher-than-necessary wages, and incur numerous other costs that would normally be avoided because they cut into profit. Unnecessary costs will not reduce profit if the regulatory agency permits a price increase to cover the costs.

Figure 15.4 also illustrates the consequences of this behavior. The *AC* curve continues to show minimum unit production cost, but cost padding shifts the actual cost curve to *AC*′. Because losses would occur at a price of P_1, regulators grant a price increase to cover the higher costs (point C). Most regulatory agencies recognize the perverse incentive of the regulation, and to overcome it, they frequently become involved in monitoring the costs of the monopoly. However, to determine the need for a particular cost is not easy, so average cost probably drifts upward to some degree.

This form of regulation may also lead the monopoly to suppress or slow down the introduction of inventions, which would not occur in an unregulated environment. The slowness with which AT&T introduced automated switching equipment is a good example. Automatic panel switches to replace operators were invented in the 1920s, but not until 50 years later, in the mid-1970s, did AT&T replace the old switches—even though the automatic switches permitted a greater number of connections and more rapid switching between them at a much lower cost and with much simpler maintenance. Recent advances in switching equipment, primarily digital technology, have produced further speed and cost economies, permitting additional services such as call waiting, call forwarding, and international direct dialing. AT&T did not convert all exchanges to digital switching until the turn of the century, however, so even though the relevant technology existed, some customers were unable to purchase these services for many years.

The slowness with which regulated monopolies introduce new products and technology may be a natural response to a price ceiling. If a monopoly discovers a cost-saving technology, it is unable to keep the increased profit because regulators will in turn reduce its rates. Similarly, the monopoly has reduced incentive to engage in research and development activities designed to decrease costs. Further, it is under no competitive pressure to offer new services quickly because its customers are unlikely to have a better alternative.

For these reasons, economists have become increasingly critical of the regulation of natural monopolies. One famous study compared electric rates in regulated and unregulated states between 1912 and 1937—before all states regulated rates—and found no difference in the rates charged.[10] However, the alternatives to regulation when natural monopoly conditions prevail—alternatives such as unregulated monopoly and government ownership—may not be particularly attractive either. Thus, there may be no completely satisfactory solution to the natural monopoly problem.

APPLICATION 15.2 REGULATING NATURAL MONOPOLY THROUGH PUBLIC OWNERSHIP: THE CASE OF USPS

An alternative to rate regulation in the case of natural monopoly is public ownership. This is the approach adopted in the case of mail service in the United States. Namely, it is assumed that the average cost of service will be lower if there is a single designated producer—the United States Postal Service (USPS)—and that public ownership of production can be relied upon to ensure that price equals average cost.[11]

[11]This application is based on Mark A. Zupan, "Let the Market Deliver the Mail," *New York Times*, August 7, 1993, p. 11.

[10]George J. Stigler and Claire Friedland, "What Can Regulators Regulate?: The Case of Electricity," *Journal of Law and Economics*, 5 No. 2 (October 1962), pp. 1–16.

Public ownership, however, is associated with some notable drawbacks. For example, because one of the objectives of a public enterprise typically is to ensure that price equals average cost, the incentive to innovate and/or to minimize cost is attenuated. The managers of a public enterprise generally cannot benefit from the introduction of an innovative product and/or cost-saving technology since the profit of the enterprise is constrained to equal zero. This is in marked contrast to an unregulated, for-profit setting, where such improvements can translate into a healthier bottom line.

The absence of a profit motive likely explains why the USPS has been slow to allow for credit card payments, increase its hours of operation, and offer ancillary products (for example, the packaging services supplied by for-profit competitors such as Mail Boxes Etc.). The nonprofit constraint also suggests why USPS did not originate overnight package delivery service (an innovation introduced by for-profit Federal Express). Finally, while economies of scale may characterize mail service, enshrining one publicly owned firm to provide the service at cost may result in costs not being minimized. Indeed, the USPS's own internal Postal Inspection Service indicates that on the 10 percent of all rural routes that are contracted out to private companies, the quality of service is greater and the cost is significantly lower (by over 50 percent) than it would be if the USPS provided the service. The difference in the cost of service between contracted-out and non-contracted-out routes is primarily due to wages and fringe benefits.

15.4 Government-Established Cartels: The Case of the British Columbia Egg Marketing Board

As we saw in Chapter 13, a cartel has difficulty trying to maintain profits for its members, mostly due to the threat of entry and the incentive for cartel members to cheat. To be effective, a cartel must find some way to overcome these problems. One approach is to enlist the aid of government. That is, if government will help to organize the cartel and agree to punish cheaters, then cartel policy can be effectively enforced.

There are many instances in which generally competitive industries have been transformed into cartels with the aid of government. In Chapter 10, for example, we examined the effects of government regulation on the airline industry and taxicab markets. Although we treated both as competitive industries, we should recognize that government regulations produced higher prices and restricted output, just as a cartel would. Why, then, would government sanction a cartel? Usually, the reasons are well intentioned: to protect an industry from "ruinous competition," to guarantee consumer safety, to ensure product quality, and so on. The results, however, are often undesirable, as we saw in Chapter 10.

The Civil Aeronautics Board (CAB), for example, was created to protect the airline industry from "cutthroat competition," to guarantee passenger safety, and to develop standards for quality and service. To achieve these goals, the CAB was empowered to set air fares and to allocate routes among carriers. These regulations enabled the CAB to maintain identical air fares on the same routes and to deny entry to new carriers; in other words, the CAB effectively (and legally) set prices for the airline industry, established market-sharing route structures, and kept competitors from entering the industry, just as an effective cartel might do. Issuing medallions for taxicabs and regulating cab fares have similar effects and result in higher fares and restricted output.

Generally, government-established cartels have fewer problems than other cartels because they function within the law. Prices are set without fear of antitrust prosecution. Cheating is not as great a concern because cartel violations can be declared illegal and violators punished. Finally, entry can be limited by requiring licenses (taxis) or making entry conditional on government approval (airlines).

From this perspective, let's examine the operation of one such government-established cartel in Canada, the Egg Marketing Board of British Columbia. In Chapter 10, we examined the structural impact of regulation on the airline and cab markets; in this example, we want to focus on efficiency questions. The egg-marketing cartel is particularly well suited to this analysis because of the findings of a study by Thomas Borcherding, which estimates the deadweight loss of the egg-marketing policy.[12]

British Columbia's Egg Marketing Board (BCEMB) was established in 1967 and consists of four members elected from the egg producers in British Columbia. In coordination with the federal Canadian Egg Marketing Agency, the BCEMB establishes a quota for the province as a whole as well as for individual producers. The quotas are expressed in units of 30 dozen eggs per week; the total number of quotas is fixed, and so is the maximum number of quotas possessed by an individual producer. It is illegal for egg producers to produce and sell eggs in excess of their individual quotas, and the BCEMB assesses heavy penalties for violations. In addition, egg prices are established by a complicated formula.

Clearly, the BCEMB has the power to act as a cartel because it can legally control the quantity of eggs supplied to the market. The stated intent of the Board is, however, not to raise prices, but to stabilize them, so as to avoid the uncertainties created by price fluctuations. How can we determine what effect the BCEMB has on the price of eggs? Borcherding provides several pieces of evidence suggesting BCEMB quotas have raised egg prices above competitive levels. First, between 1965 (pre-BCEMB) and 1973, per capita egg consumption in Canada fell relative to the consumption in the United States, which indirectly suggests a jump in the relative price of eggs in Canada. Second, between 1961 and 1967, the average difference in egg prices between British Columbia and the adjacent State of Washington was only 1.4 cents per dozen, but over the 1973 to 1979 period the average price difference was 12.4 cents per dozen, a 20 percent differential.

A third piece of evidence is perhaps the most convincing. The quotas represent the legal right to produce eggs, and they have been transferable since 1976; that is, they can be bought and sold. If the operations of the BCEMB had led to a competitive environment for egg production, the market value of a quota would be zero. No one would actually pay for the right to earn a competitive return since that return could be realized in other industries without having to purchase quotas. In 1976, however, a unit of quota sold for \$550; by 2002 the average price for a quota was \$6,600. (Prices are in Canadian dollars throughout this section.) Explaining a positive market price for quotas is difficult except on the premise that a quota entitles a producer to sell eggs at a price above the cost of production. Therefore, the evidence suggests that the BCEMB policy has led to higher egg prices in British Columbia by restricting output through quotas.

Estimating the Deadweight Loss: The First Round

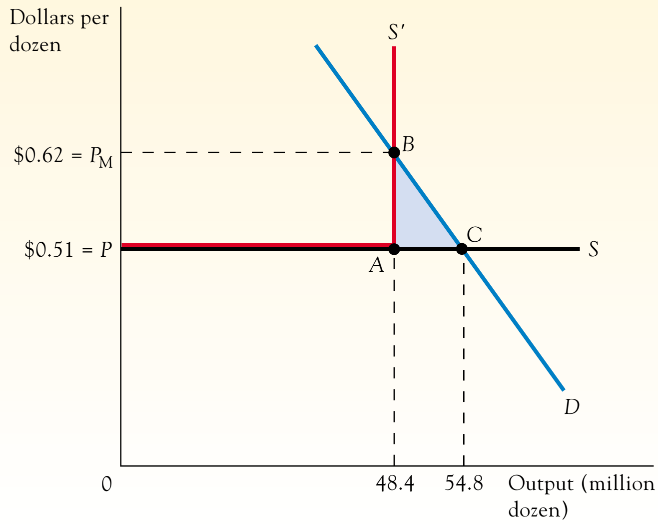
Figure 15.5 illustrates the consequences of the BCEMB policy on the (not unreasonable) assumption that the egg industry would be constant-cost under competitive conditions. In 1975, total egg output was 48.4 million dozen and output could not exceed that level because of the quotas, so the supply curve effectively becomes vertical at 48.4 million dozen, as shown by S'. The price of eggs, P_M, was \$0.62. Because that price is above the cost of production, P, producers realized a profit of $P_M BAP$.

As we saw in Chapter 10, the profit is not a net loss to society but is, instead, an income transfer from consumers to producers. Area BCA is, however, a net loss, or deadweight loss. To estimate the size of this deadweight loss, we require two pieces of information: the height (BA) of the triangular area and the width of the base (AC). The height BA represents the excess of market price over production cost, and the distance AC represents how much greater egg purchases would have been if eggs were sold at a price equal to production cost.

[12]Thomas Borcherding (with Gary W. Dorosh), *The Egg Marketing Board* (Vancouver, B.C.: The Fraser Institute, 1981).

FIGURE 15.5

Deadweight Loss of BCEMB Quota Restrictions
Quotas restrict output to 48.4 million dozen, so price rises to $0.62. The deadweight loss triangle, *BCA*, can be estimated from knowledge of the price increment and the demand elasticity for eggs at point *B.*



Borcherding infers the price differential, $P_M - P$, from the market value of a quota. Knowing the value of a quota makes it simple to calculate this price differential since the weekly value tends to equal the excess profit attained on the sale of 30 dozen eggs per week. Quotas, however, are not sold on a weekly basis; a quota gives a producer the right to produce eggs indefinitely. Therefore, the market value of a quota is the present value of all future profits. Calculating the price differential from this figure is still possible, however, by making appropriate assumptions about the interest rate used to discount future profits. Proceeding in this way, Borcherding estimates that P_M was 11 cents above the cost of production. Because the figure is similar to the difference in egg prices between British Columbia and the State of Washington, he has further support that the estimate falls in the correct range. An 11-cent price differential implies that the total annual producer profit is $5.3 million (48.4 million × $0.11).

The distance *AC* can be estimated if we know the elasticity of demand at point *B* and assume the demand curve is linear over the *BC* range. Based on several statistical studies, Borcherding assumes the elasticity of demand to be 0.75. To estimate *AC*, recall that the elasticity of demand equals $(\Delta Q/Q)/(\Delta P/P)$, so multiplying the percentage change in price ($\Delta P/P$, or 0.11/0.62) times elasticity yields the percentage change in quantity. Thus, we find that output would be 13.3 percent higher if price were 17.7 percent (0.11/0.62) lower, so the distance *AC* equals 6.4 million dozen per year.

With these two estimates for *AB* and *AC*, the deadweight loss triangle can be directly calculated as $\frac{1}{2}(AB \times AC)$, or $\frac{1}{2}(\$0.11 \times 6.4 \text{ million})$, about $350,000. This sum is about 1 percent as large as the total consumer outlay on eggs ($30 million), and about 6 percent as large as the total profit realized by egg producers, as a group.

Estimating the Deadweight Loss: The Second Round

As we emphasized in Section 15.1, the exercise of monopoly power may produce some other type of deadweight loss in addition to the output restriction we have just examined. What is notable about the Borcherding study is that it investigates this other type of deadweight loss and, in fact, is able to estimate its approximate magnitude. Moreover, it tends to be substantially larger than the deadweight loss due to reduced output.

First, let's consider in theory how the BCEMB could produce a deadweight loss by inducing a higher-than-necessary cost of production. Not only does the BCEMB limit the total number of units of quota, but it also limits the number of quotas that can be held by a single producer. Specifically, a farm generally is not permitted to use more than 280 units of quota, so this restriction directly limits the scale of operation. If the size of operation is below the most efficient scale, the result is a higher-than-necessary production cost.

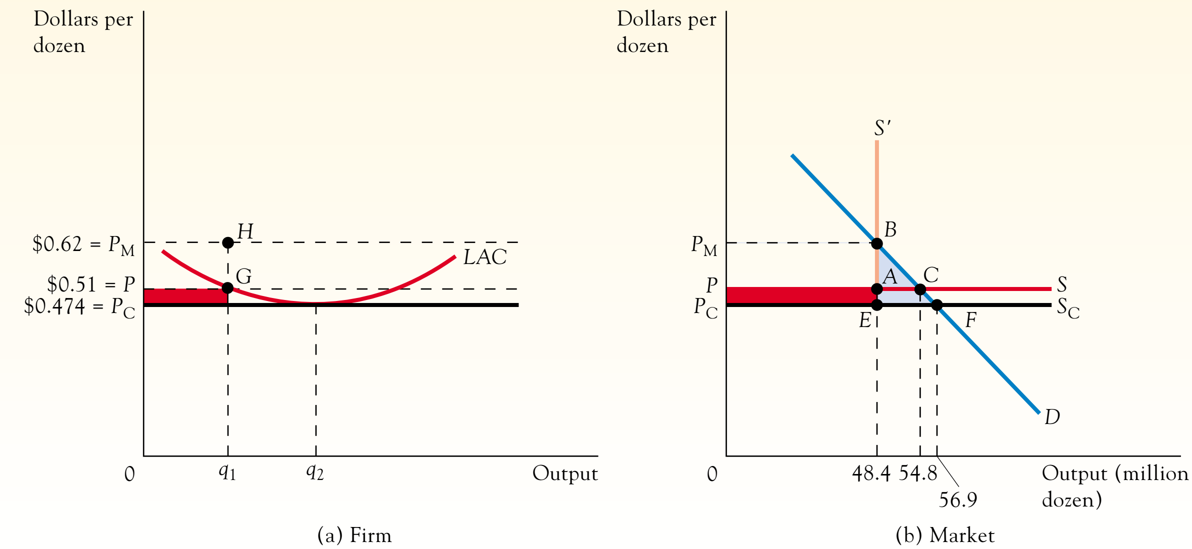
Figure 15.6 shows the results of such a restriction on individual farm size. In Figure 15.6a, the long-run average cost curve for a typical farm is shown as *LAC*. Without restrictions, the farm would produce an output of q_2 at the lowest point on *LAC*. The industry supply curve would be S_C in Figure 15.6b (recall that this is a constant-cost industry), and price would be P_C under competitive conditions. Now suppose that a maximum quota of q_1 per farm is established. The farm is constrained to operate at point G on *LAC*, and the unit cost of production is $P - P_C$ higher than necessary. If all farms have the same cost curves, the supply curve with this quota in place would be shown as *S* in Figure 15.6b, and horizontal at a price of *P*. Whatever output is supplied will now be produced at a higher cost than is necessary. More farms will operate, each at an inefficient scale of operation. In effect, the quotas make it impossible for the individual farm to take full advantage of economies of scale. If the total number of quotas is limited so that aggregate production can't exceed 48.4 million, the supply curve becomes vertical at that level of output. Price will then be P_M, and the individual farm makes a profit shown by area P_MHGP in Figure 15.6a.

Previously, we estimated the deadweight loss as area *BCA* in Figure 15.6b. Now we see that this area underestimates the total deadweight loss. For the 48.4 million dozen eggs that are produced, the production cost is higher than necessary by an amount equal to $PAEP_C$. In addition, output is *EF* less than under competitive conditions, so there is a deadweight loss equal to *BFE* due to the output restriction. The total deadweight loss is $PAEP_C$ plus *BFE*.

FIGURE 15.6

Effects of the BCEMB on Production Cost and Welfare

With firms restricted to a maximum output of q_1 by the BCEMB quotas, a firm is forced to operate at point *G* on its *LAC* curve, involving a higher-than-necessary unit cost. The result is an additional deadweight loss, shown as the red-shaded area in part (b).



Does the BCEMB limit quotas for individual farms at a level that entails higher unit costs, as in Figure 15.6? Some evidence suggesting it does comes from comparing individual farm sizes in British Columbia and the State of Washington. Washington has no restrictions on farm size, and about two-thirds of egg output is produced by farms with more than 50,000 birds; in British Columbia less than 5 percent of output is produced by farms of this size.[13] The average flock size is also much smaller in British Columbia than in Washington. If farm size in Washington is any indication of the efficient scale of operation for producing eggs, then British Columbian farms are typically too small.

Using the results of a statistical study showing how production cost varies with the size of farms, together with the different distributions of farm size in Washington and British Columbia, Borcherding estimates that average production cost is 3.6 cents per dozen higher in British Columbia than it would be under competitive conditions. From this estimate we can infer that area $PAEP_C$ equals $1.7 million. This amount is nearly five times as large as the deadweight loss we estimated in the previous subsection. In addition, using the same elasticity assumption as earlier, we can estimate the deadweight loss due to restricted output (the area *BFE*) to be $620,000. The total deadweight loss arising from egg-marketing quotas is therefore on the order of $2.3 million.

Does such a large deadweight loss estimate mean that the BCEMB should be abolished? Not necessarily—the deadweight loss indicates only the magnitude of inefficiency that is involved. Don't forget that egg producers gain about $5.3 million in annual combined profit, and some have argued that preservation of the small family farm is a desirable goal in itself. What Borcherding shows is that consumers pay a high cost for this result. To transfer $5.3 million in income to egg producers, the BCEMB imposes a cost of $5.3 million plus the deadweight loss of $2.3 million, or $7.6 million, on consumers. Moreover, since egg consumption does not vary much by income, low-income consumers bear a large part of this cost. Significantly, this cost to low-income consumers and the deadweight loss imposed by the BCEMB have grown since the time of Borcherding's analysis (this can be inferred from the price of a quota being $6,600 in 2002 versus only $550 in 1976—the year in which Borcherding examined the BCEMB).

APPLICATION 15.3 THE INTERNATIONAL AIR CARTEL

The International Air Transport Association (IATA) is another example of a government-sponsored cartel. The IATA comprises more than 135 international airlines, controls 73 percent of all international air traffic, and is adept at fixing prices and limiting capacity.[14] On international routes covered by IATA agreements, such as between European countries, air fares are double those in the more competitive U.S. market for routes of similar length. Governments support IATA by awarding landing rights in accordance with IATA agreements, typically only to carriers affiliated with the two countries involved on any given international route (Alitalia and Air France on the Paris–Rome route, for example).

Although IATA has all the makings of a cartel, its members have consistently earned meager profits. Where are the receipts from exorbitant fares going? For

[14]This application is based on Elden T. Chang and Mark A. Zupan, "International Fliers Could Use Takeoff on U.S. Deregulation," *Wall Street Journal*, October 8, 1985, p. 13; "French Delays 'Jeopardise Concorde'," *The Times*, October 12, 2000; and "Grounding the Highfliers," *Milwaukee Journal Sentinel*, August 17, 2000.

[13]A few farms are permitted to have outputs greater than the normal quota limit in British Columbia—namely, farms with over 50,000 birds, because 50,000 corresponds to about 700 units of quota. Only those farms that were already operating at that scale in 1967 are permitted these unusually large quotas.

one thing, price chiseling occurs. Some IATA members sell discount tickets, particularly for such heavily traveled routes as New York–London, through travel agencies known as "bucket shops." These bucket shops are often shut down in response to IATA member protests, only to reappear soon after. Estimates of consumer savings from the discounts at the expense of the cartel range from $200 million to $1.5 billion annually. (Even with these discounts, however, fares per mile exceed those on domestic routes in the United States.)

Besides price cheating, IATA members compete on nonprice services. Although attempts have been made to standardize passenger service levels, international airlines continue to lure passengers with attractive and solicitous flight attendants, fine food and drink, extra-wide seats, and on-ground hotels and saunas between connecting flights. Nonprice competition has a singular effect on airline costs: it makes them higher than necessary.

The IATA profits are also low because most international airlines are government-owned and/or subsidized. So there is little incentive to minimize cost—which results in a deadweight loss of the type discussed earlier in this chapter. Some cartel profits are dissipated through excessive spending on advertising, costly ticket offices like those on Fifth Avenue in New York and the Champs Elysées in Paris, overstaffing, and high employee salaries and fringe benefits.

Revenues from international passengers are used to cross-subsidize intranational passengers. Passengers flying between European cities in the same country pay half the price of flights in the U.S. market on similar-length routes. This makes international airlines look good to those citizens who travel only within their nation's borders. It also closely resembles a feature of the U.S. airline industry before it was deregulated: certain airlines were granted rights to operate profitable long-haul markets only if they provided service on certain unprofitable short-haul routes.

Because they tend to be publicly owned and/or subsidized, international airlines purchase aircraft for reasons other than rational economics. Political pressure to "buy local" sometimes persuades airlines to purchase domestically manufactured aircraft even if another aircraft better suits their needs. Due to pressures from their respective governments, for example, Air France and British Airways flew the Concorde extensively in the last quarter of the 20th century, despite annual operating losses of up to $10 million and $300 per passenger.

The Concorde has always held "prestige" value, however, and the airlines recognize its importance. On July 25, 2000, an Air France Concorde crashed just outside Charles De Gaulle airport, killing 113 people. British Airways promptly grounded its seven Concordes, but soon began complaining that French officials were slow to clear the jet's reputation, after it became known that debris from another airplane had caused the accident.

Both airlines had to weigh whether the costs of improving the safety of the quarter-century-old jet would be offset by its chief virtue—prestige.

15.5 More on Game Theory: Iterated Dominance and Commitment

In Chapter 14, we introduced the subject of game theory and showed how it related to the study of noncompetitive markets. In all of the applications we covered in Chapter 14, at least one of the two players had a dominant strategy. We were therefore able to easily determine the equilibrium—either a dominant-strategy equilibrium (as in the case of the prisoner's dilemma game where both players had a dominant strategy of cheating/confessing) or the Nash equilibrium of Table 14.2 where only one of the two players had a dominant strategy.

What if neither player has a dominant strategy? Can a Nash equilibrium still emerge? The answer is "yes." In this section, we will show one way in which this can happen through the concept of *iterated dominance*. We will also examine the possibility that a player can make a *commitment* that alters the relevant payoff matrix in such a manner that a different equilibrium will emerge—an equilibrium that is more favorable to the player making the commitment. We thus can see that the usefulness of game theory is not limited to situations where at least one of the two players has a dominant strategy and that a player may have the ability to take an action that affects the strategies selected by other players.

Iterated Dominance

Suppose that only two companies, Circuit City and Best Buy, compete in the consumer electronics market. The two firms each need to select one of three strategies regarding their products' prices: high, medium, or low. The relevant payoff matrix, representing each firm's profit based on the two firms' selected strategies, is depicted in Table 15.1.

What equilibrium will emerge given the Table 15.1 payoff matrix? Clearly, neither company has a dominant strategy. If Circuit City chooses a high price, Best Buy's best strategy is a medium price (with a profit of 105). If Circuit City chooses a low price, Best Buy's best strategy is a high price (a profit of 11 versus a profit of 7 associated with choosing a medium price). Thus, Best Buy does not have a best strategy irrespective of Circuit City's strategy.

Likewise, Circuit City does not have a best strategy irrespective of Best Buy's strategy. For example, if Best Buy chooses a high price, Circuit City's best strategy is a medium price (with a profit of 105). If Best Buy chooses a low price, Circuit City's best strategy is a high price (a profit of 11 versus a profit of 7 associated with choosing a medium price).

With neither player having a dominant strategy in Table 15.1, we cannot as readily derive the equilibrium as we did in the games examined in Chapter 14. It turns out, however, that there is a Nash equilibrium associated with the Table 15.1 payoff matrix. To determine this equilibrium we need to rely on the concept of **iterated dominance**: *ruling out any strategy that is inferior to, or dominated by, another strategy*. That is, if a certain strategy yields lower payoffs for Circuit City than another strategy irrespective of the strategy selected by Best Buy, Circuit City would never select such a strategy. The strategy that is dominated by another strategy thus can be effectively eliminated from Circuit City's menu of strategic possibilities and the dimensions of the relevant payoff matrix thereby reduced. Whenever Circuit City has a strategy that is dominated by another strategy, eliminating the dominated strategy effectively reduces the number of rows in the Table 15.1 payoff matrix. Analogously, when Best Buy faces a strategy that is dominated by another strategy, eliminating Best Buy's dominated strategy effectively reduces the number of columns in the Table 15.1 payoff matrix.

ITERATED DOMINANCE
the concept of eliminating any strategy that is inferior to or dominated by another strategy

Consider the low-price strategy for Circuit City. Irrespective of Best Buy's pricing strategy, a medium price consistently yields a higher payoff for Circuit City than does the low-price strategy. If Best Buy selects the high column, a medium price for Circuit City yields a payoff of 105 versus a payoff of 97 associated with a low price. If Best Buy opts for the medium column, a

TABLE 15.1 A MORE COMPLEX GAME

		Best Buy High Price	Best Buy Medium Price	Best Buy Low Price
Circuit City	High Price	90, 90	44, 105	11, 97
	Medium Price	105, 44	50, 50	7, 40
	Low Price	97, 11	40, 7	–10, –10

medium price for Circuit City yields a payoff of 50 versus a payoff of 40 associated with a low price. And, if Best Buy chooses the low price, a medium price remains a better choice for Circuit City than a low price (a payoff of 7 versus −10). Since Circuit City is never better off choosing the low price, the low row can effectively be eliminated from the Table 15.1 payoff matrix: It would never be selected by Circuit City in favor of the medium strategy.

Reasoning in a similar manner allows us to eliminate the low column for Best Buy. This strategy yields consistently lower payoffs than the medium option for Best Buy, regardless of Circuit City's pricing strategy. If Circuit City selects the high row, a medium price for Best Buy yields a payoff of 105 versus a payoff of 97 associated with a low price. If Circuit City opts for the medium row, the medium option for Best Buy yields a payoff of 50 versus a payoff of 40 associated with a low price. And, if Circuit City chooses a low price, the medium option remains a better choice for Best Buy than the low price (a payoff of 7 versus −10).

Once both the low row for Circuit City and the low column for Best Buy are eliminated from consideration, the three-by-three dimensional Table 15.1 matrix is reduced to the two-by-two Table 15.2 matrix: both players have only two strategies from which to choose.

In the two-by-two payoff matrix of Table 15.2, both players have a dominant strategy. Circuit City's payoffs associated with the medium price are always greater than those associated with the high price (105 versus 90 if Best Buy opts for the high-price strategy, 50 versus 44 if Best Buy selects the medium price). Best Buy's payoffs associated with a medium price are also always greater than those associated with a high price (105 versus 90 if Circuit City opts for the high row, 50 versus 44 if Circuit City selects the medium row). Consequently, once we take the steps—or iterations—of eliminating players' dominated strategies, we end up with the prediction that the equilibrium associated with the Table 15.1 game will be both players selecting the medium-price strategy and, as a result, receiving a payoff of 50.

The predicted equilibrium for the Table 15.1 game is a Nash equilibrium. That is, each player's choice is the best one given the strategy chosen by the other player. Specifically, if, through the concept of iterated dominance, Best Buy finds that a medium price is the best strategy, Circuit City's best choice is the medium option (it generates the highest payoff for Circuit City when Best Buy chooses the medium column). Likewise, if Circuit City opts for a medium price, the medium option is Best Buy's best choice (it generates the highest payoff for Best Buy when Circuit City chooses the medium row).

By eliminating dominated strategies, therefore, the concept of iterated dominance allows us to predict what equilibrium will emerge in more complex games, such as the one depicted in Table 15.1. Even though neither of the players in Table 15.1 has a dominant strategy, a Nash equilibrium still exists once clearly inferior strategies are eliminated from consideration.

Table 15.2 **Eliminating Dominated Strategies**

		Best Buy	
		High Price	Medium Price
Circuit City	High Price	90 / 90	44 / 105
	Medium Price	105 / 44	50 / 50

Commitment

The payoff matrix in Table 15.2 is another example of a prisoner's dilemma. Once the dominated low-price strategy of Table 15.1 is eliminated for both players, each player's dominant strategy is a medium price and results in a payoff of 50. The predicted outcome is one where both players are worse off than they would be if they both chose a high price and earned a payoff of 90. While choosing the medium option is in the self-interest of both players, the collective outcome of each player pursuing their self-interest is inferior for both.

Apart from the ways discussed in Chapter 14 by which players confronting a prisoner's dilemma game might overcome the problem and realize the best all-around outcome (through repeated games, altruism, and so on), there is another possible mechanism through which a player can ensure that acting on the basis of self-interest results in the maximum feasible payoff. Specifically, a player might find it desirable to make a **commitment** to a particular course of action and, by constraining one's choice of strategies, increase the player's equilibrium payoff.

COMMITMENT
the strategy of adopting a particular course of action, constraining one's choice of strategies, in order to increase your equilibrium payoff

It may seem paradoxical that constraining the set of strategic choices can generate a higher payoff. To see why this may be so, consider the case where both Circuit City and Best Buy vow that "they will not be undersold" in the context of Table 15.2. That is, if Circuit City chooses its medium row, Best Buy will not opt for a high-price strategy. Likewise if Best Buy chooses a medium price, Circuit City will not select a high-price strategy. The commitment to not be underpriced on the part of both players reduces the number of possible outcomes in this game from four to two: it effectively eliminates the northeast cell where Circuit City is underpriced by Best Buy and the southwest cell where Best Buy is underpriced by Circuit City. As depicted in Table 15.3, the only two possible outcomes that remain are if both players simultaneously opt for a high or low price. Thus, we can predict that both players will choose the high-price strategy and earn a profit of 90.

Note what the commitment to "not be undersold" on the part of Circuit City and Best Buy has accomplished. While appearing to promote competition in pricing, it allows the two players to overcome the prisoner's dilemma they previously confronted and results in consumers being charged the highest possible price to the benefit of the two sellers.

Of course, to be effective, a commitment must be credible. For example, Best Buy's vow not to be undersold implies that if Circuit City chooses a medium price in Table 15.3, Best Buy will not choose a high price, and vice versa for Circuit City if Best Buy chooses the medium option. To make their commitments credible, each player may promise to match

TABLE 15.3 THE ROLE OF COMMITMENT

Circuit City	Best Buy: High Price	Best Buy: Medium Price
High Price	90 (Circuit City), 90 (Best Buy)	
Medium Price		50 (Circuit City), 50 (Best Buy)

or even beat (by, say, $25) the best price a customer can obtain from the rival seller. In this manner, Best Buy and Circuit City effectively use customers to bind them to their commitments to not be undersold—customers who, in the course of enforcing Best Buy's and Circuit City's commitments, end up promoting a high-price equilibrium.

Commitments need not be limited to vows to not be undersold. In many game-theoretic situations, a player can take other actions to alter the relevant payoff matrix so that it will be in the player's interest to follow through on a particular strategy. For example, to deter a political rival from entering a race, a politician may build up a substantial war chest—a money reserve that effectively binds the politician to competing vigorously to retain his or her elected post. On overnight cross-country flights that are half-empty, after the airplane door is closed passengers usually scramble to sit in the middle seat of any empty row of three seats. Committing oneself to the middle seat diminishes the chances that a fellow passenger will choose either of the two empty seats next to you and increases the likelihood that you will have an empty row of seats in which to stretch out and sleep once the plane reaches a comfortable cruising altitude. As another example, Delco's shutting down of a production line that produces spark plugs specifically tailored for the Ford Motor Company may convince General Motors to divert more of its spark plug purchases to Delco because Delco can devote its attention to better satisfying General Motors' needs.

SUMMARY

- Several examples illustrate the functioning of noncompetitive markets, the deadweight loss associated with monopoly, and the effect of monopoly on innovation.
- Public policies promoting greater competition in a monopoly market offer the potential for increasing total surplus and attaining efficiency in output. Thus, it is important to determine the relative magnitude of the deadweight loss of monopoly.
- If the product is produced by an oligopoly, output is likely to be higher and the deadweight loss smaller than in the case of monopoly.
- In addition to restriction of output, other deadweight losses may occur in cases of monopoly. For instance, with the absence of competition with other firms, the monopolist may be under less pressure to minimize costs of production or may incur costs in acquiring or maintaining its market position.
- Suppression of inventions does not appear to be a result of monopoly because a monopolist can increase profit by marketing a worthwhile invention.
- Natural monopoly exists when the average cost of a single enterprise declines over the entire range of market demand. This situation implies that the monopolist can serve the entire market more efficiently than many small firms but leads to the possibility that the firm will be tempted to exploit its power and restrict output and raise price.
- There are four policy options in dealing with natural monopolies: leave the market alone; regulate the monopoly's activities, allow the government to own and operate the facility, or sponsor a competition for the right to operate a natural monopoly, which goes to the bidder promising to charge the lowest price. In the United States, the second option has generally been chosen.
- In principle, average-cost pricing offers the most practical alternative for public agencies that regulate the behavior of natural monopolies.
- In practice, regulators lack complete knowledge of cost and demand conditions and seek to promote average-cost pricing by focusing on the rate of return on invested capital. The problem with this approach is that it diminishes the firm's incentive to minimize cost and to innovate.
- Some cartels operate with the help of the government. These function within the law, and prices are set without fear of antitrust prosecution. Deadweight losses typically result both from the restriction in output promoted by the cartel and diminished incentives to minimize production cost and to innovate.
- In a game-theory setting, iterated dominance allows us to assume that a firm will rule out any strategy that is inferior to, or dominated by, another strategy.
- Commitment to a particular course of action is another strategy that can increase one's equilibrium payoff in a prisoner's dilemma situation.

REVIEW QUESTIONS AND PROBLEMS

Questions and problems marked with an asterisk have solutions given in Answers to Selected Problems at the back of the book (page 577).

15.1. Explain why a certain triangular area is a measure of the deadweight loss of monopoly. What information do you require in order to calculate the size of this triangle?

***15.2.** In an oligopolistic industry with constant marginal cost, output is 20 percent lower and price is 20 percent higher than competitive levels. How large is the deadweight loss as a percentage of the total consumer outlay on the product?

15.3. Studies have concluded that the deadweight loss of monopoly power in the United States is less than 0.5 percent of GNP. From your knowledge of the determinants of the deadweight loss, explain why such a small figure is plausible.

15.4. Suppose that the government levied a lump-sum tax on a monopolist. How would such a tax affect the monopolist's pricing and output decisions and profit?

15.5. Compare the effects of a $1-per-unit excise subsidy when applied to a monopoly and to a competitive industry with the same cost and demand conditions. In which case will price fall more? In which case will output increase more?

15.6. "If a business sells a product that wears out in a month, you will have to buy 12 a year, and the business will make 12 times as much money as it would selling a product that lasts a year." Evaluate this statement. Why don't businesses sell products that wear out in a day? In an hour?

15.7. Businesses frequently own patents on a number of products they do not produce and sell. This is sometimes cited as evidence that businesses suppress inventions. Is it?

15.8. Explain what natural monopoly is in terms of the relationship between cost curves and the demand curve. If the market is left to itself, what price and output will result?

15.9. Use a diagram to illustrate the "hoped for" result of natural monopoly regulation that attempts to set a price equal to average cost. What are the difficulties in achieving this outcome? Would an unregulated natural monopoly be preferable to a regulated natural monopoly?

***15.10.** From the data given, can we determine whether the BCEMB has set its quotas at a level that will maximize the combined profit of producers? Can you think of reasons why the BCEMB would not try to maximize aggregate producer profit?

15.11. Suppose that the 3.6-cent cost differential shown in Figure 15.6 is due not to operation at the wrong place on the *LAC* curves but rather payment of higher-than-competitive wages to farm workers (perhaps because they are unionized). How large will the deadweight loss be in Figure 15.6 in this case?

15.12. In Table 15.2, if only Best Buy commits to not being undersold, what will be the outcome?

15.13. The manufacturer of a drug that has had a monopoly, due to patent protection, commits to pricing at cost and ensuring that no firm in the market will make a profit should a rival manufacturer enter the market once the drug's patent wears off. Is such a commitment credible? Explain.

15.14. Two companies each own property (and mineral rights) in an oil field. Each firm therefore has the legal right to drill for oil on its land and take out as much oil as it can. The problem, of course, is that one company's actions affect how much oil the other can produce.

The following matrix represents how each of these companies views the situation. The terms outside the matrix represent oil output by each firm (either low, medium, or high) while the numbers in each cell show the present value of all oil to be extracted by each company, given the two extraction policies. The first number represents the value to Company A and the second number represents the value to Company B.

As an example, if Company A pumps at a "low" rate and Company B pumps at a "low" rate, then the value to Company A of all the oil it expects to take over the life of the field is $100 while the value to Company B of its oil is $8.

		Company B's Extraction Rate		
		Low	Medium	High
Company A's Extraction Rate	Low	100, 8	80, 15	50, 30
	Medium	125, 5	110, 10	55, 22
	High	120, 3	115, 8	60, 20

a. What extraction rates maximize the total value of the oil field?
b. Does the set of extraction rates of part (a) represent a stable situation? Explain.
c. Is there a dominant strategy (extraction rate) for either or both players? Explain.
d. Is there a Nash equilibrium set of extraction rates? If so, does it maximize the total value of the oil field?
e. Is there a mutually beneficial exchange inherent in this matrix—one that could solve the problem these two companies face? If Company A were to purchase Company B's oil rights, how much would it have to pay? Is this a feasible transaction?

15.15. If the latest computer chip produced by Intel has twice the storage capacity as the previous-generation chip, Intel would find it advantageous to market the new chip even though its sales of the old chip would plummet. True or false? Explain why. Would your answer change if Intel operated in a fully competitive market versus having monopoly power in the supply of computer chips?

15.16. Some have argued that the distribution of cable television service in a community is subject to economies of scale. Namely, it is cheaper to have just one company supply every household in the community with the service than to have several providers, each having to string separate cables throughout the community and each having to have their own satellite download facilities. On account of this apparent natural monopoly, communities employ franchise bidding to regulate local cable companies. Companies interested in supplying service to a community are required to bid *ex ante* for the right to be the sole supplier *ex post*. Explain why such franchise bidding competitions can serve to promote efficiency in markets characterized by natural monopoly.

15.17. When invading Mexico in the sixteenth century, Spanish explorer Cortes ordered the fleet of ships that had carried his army to the New World burned. Using the concept of commitment, explain why such a move to restrict the strategic choices available to them may have not been an act of madness but a means to enhance the odds that Cortes's army would successfully accomplish its objective of conquest.

15.18. Between 1997 and 2000, Microsoft spent more than $14 million supporting a wide variety of political candidates. To what extent does such spending reflect a deadweight loss? Explain.

15.19. Economist Bill Samuelson suggests a problem centering around three air carriers competing for passengers on a given city-pair route. Namely, the fare that can be charged on the route is fixed at $225, while the size of the market is fixed at 2,000 passengers per day. There are three competing airlines: A, B, and C. Each airline gets passengers in proportion to its share of total flights. For example, if all three airlines offered the same number of flights, then they would each get one-third of the passengers. If Airline A offered six flights and B and C each offered three, then A would get 50 percent of the market, while B and C would get 25 percent each. Each plane holds a maximum of 300 passengers. Each plane trip costs $20,000, whether the plane is full or not.

a. Confirm to yourself that firm A's profit equals $\$450{,}000(a/a + b + c) - \$20{,}000a$, where a, b, and c represent the number of flights by firms A, B, and C, respectively.

b. Confirm to yourself that the table below gives the profits to A as a function of its flights and its competitors' flights per day.

c. Consider a strategy for any one of the firms to be a policy of flying a certain number of flights per day. Is there a dominant strategy for A—that is, one number of flights that gives higher profits no matter what the competitors do?

d. Is there a Nash equilibrium in this game? That is, is there a set of strategies (numbers of flights a, b, and c) such that each airline's strategy is optimal given what the others are doing? Or, said another way, is there a set of strategies in which "unilateral defection" does not pay?

e. Are there any strategies of A's that are *dominated* by other strategies? That is, can you rule out one or more of A's strategies because they are always worth less than something else?

f. Follow the foregoing logic to its end: if you rule out some of A's strategies, can you also rule out some for B and C? And if you can do that, can you then go back and rule out more of A's strategies? Can you continue this process of "iterated dominance" to convince yourself of how many flights A should fly?

		(B and C) Total Number of Competitors' Flights													
		5	6	7	8	9	10	11	12	13	14	15	16	17	18
	2	88.6	72.5	60.0	50.0	41.8	35.0	29.2	24.3	20.0	16.3	12.9	10.0	7.4	5.0
A's	3	108.8	90.0	75.0	62.7	52.5	43.8	36.4	30.0	24.4	19.4	15.0	11.1	7.5	4.3
Own	4	120.0	100.0	83.6	70.0	58.5	48.6	40.0	32.5	25.9	20.0	14.7	10.0	5.7	1.8
Number	5	125.0	104.5	87.5	73.1	60.7	50.0	40.6	32.4	25.0	18.4	12.5	7.1	2.3	−2.2
of Flights	6	125.5	105.0	87.7	72.9	60.0	48.8	38.8	30.0	22.1	15.0	8.6	2.7	−2.6	−7.5
	7	122.6	102.3	85.0	70.0	56.9	45.3	35.0	25.8	17.5	10.0	3.2	−3.0	−8.8	−14.0
	8	116.9	97.1	80.0	65.0	51.8	40.0	29.5	20.0	11.4	3.6	−3.5	−10.0	−16.0	−21.5