CHAPTER 11

Pricing with Market Power

As we explained in Chapter 10, market power is quite common. Many industries have only a few producers, so that each producer has some monopoly power. And many firms, as buyers of raw materials, labor, or specialized capital goods, have some monopsony power in the markets for these factor inputs. The problem the managers of these firms face is how to use their market power most effectively; They must decide how to set prices, choose quantities of factor inputs, and determine output in both the short and long run to maximize the firm's profit.

Managers of firms with market power have a harder job than those who manage perfectly competitive firms. A firm that is perfectly competitive in output markets has no influence over market price. As a result, its managers need only worry about the cost side of the firm's operations, choosing output so that price is equal to marginal cost. But the managers of a firm with monopoly power must also worry about the characteristics o.f demand. Even if they set a single price for the firm's output, they must obtain at least a rough estimate of the elasticity of demand to .determine what that price (and corresponding output level) should be. Furthermore, one can often do much better by using a more complicated pricing strategy, for example, charging different prices to different customers. To design such pricing strategies, managers need ingenuity and even more information about demand.

This chapter explains how firms with market power set prices. We begin with the basic objective of every pricing strategy-capturing consumer surplus and converting it into additional profit for the firm. Then we discuss how this can be done using *price discrimination.* Here different prices are charged to different customers, sometimes for the same product, and sometimes for small variations in the product. Because price discrimination is widely practiced in one form or another, it is important to understand how it works.

Next, we discuss the *two-part tariff.* Here customers must pay in advance for the right to purchase units of the good at a later time (and at additional cost). The classic example of this is an amusement park, where customers pay a fee to enter, and then an additional fee for each ride they go on. Although amusement parks may seem like a rather specialized market, there are many other examples of two-part tariffs: the price of a Gillette razor, which gives the owner the opportunity to purchase Gillette razor blades; the price of a Polaroid camera, which gives the owner the opportunity to purchase Polaroid film; or the monthly subscription cost of a mobile telephone, which gives users the opportunity to make phone calls from their automobiles, paying by the message unit as they do so.

We will also discuss *bundling*. This pricing strategy simply involves tying products together and selling them as a package. For example: a personal computer that comes bundled with several software packages; a one-week vacation in Hawaii in which the airfare, rental car, and hotel are bundled and sold at a single package price; or a luxury car, in which the air conditioning, power windows, and stereo are "standard" features.

Finally, we will examine the use of *advertising* by firms with market power. As we will see, deciding how much money to spend on advertising requires information about demand, and is closely related to the firm's pricing decision. We will derive a simple rule of thumb for determining the profit-maximizing advertising-to-sales ratio.

11.1 *Capturing Consumer Surplus*

All the pricing strategies that we will examine have one thing in common—they are ways of capturing consumer surplus and transferring it to the producer. You can see this more clearly in Figure 11.1. Suppose the firm sold all its output at a single price. To maximize profit, it would pick a price P^* and corresponding output Q^* at the intersection of its marginal cost and marginal revenue curves. The firm would then be profitable, but its managers might wonder if they could make it even more profitable.

They know that some customers (in region A of the demand curve) would pay more than P^*. But raising price would mean losing some customers, selling less,and earning smaller profits. Similarly, other potential customers are not buying the firm's product because they will not pay a price as high as P^*. Many of them, however, would pay prices higher than the firm's marginal cost. (These customers are in region B of the demand curve.) By lowering its price, the firm could sell to some of these customers, but it would then earn less revenue from its existing customers, and again profits would shrink.

How can the firm capture the consumer surplus (or at least part of it) from its customers in region A, and perhaps also sell profitably to some of its potential customers in region B? Charging a single price clearly will not do the

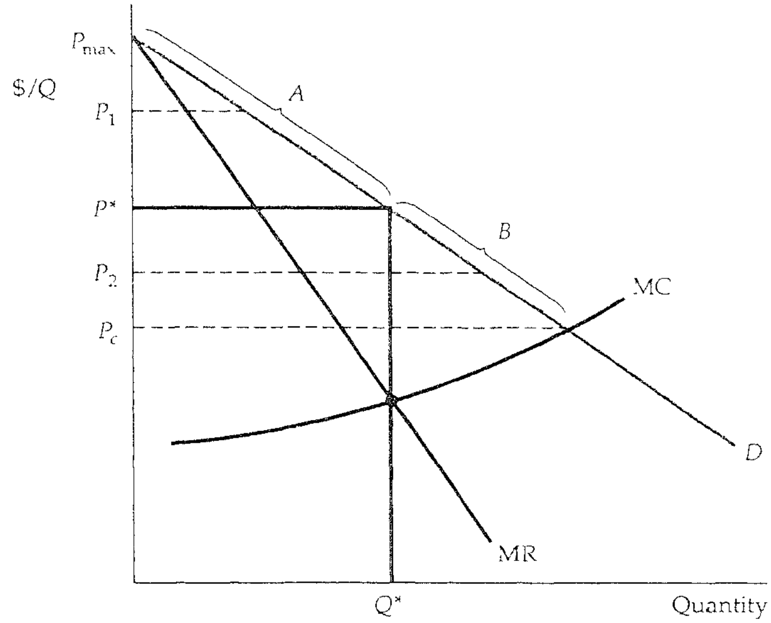


FIGURE 11.1 Capturing Consumer Surplus. If a firm can charge only one price for all its customers, that price will be P^* and the quantity produced will be Q^*. Ideally, the firm would like to charge a higher price to consumers willing to pay more than P^*, thereby capturing some of the consumer surplus under region A of the demand curve. The firm would also like to sell to consumers willing to pay prices lower than P^* but only if that does not entail lowering the price to other consumers. In that "way the firm could also capture some of the surplus under region B of the demand curve.

trick. However, the firm might charge different prices to different customers, according to where the customers are along the demand curve. For example, some customers in the upper end of region A would be charged the higher price P_1, some in region B would be charged the lower price P_2, and some in between would be charged P^*. This is the basis of *price discrimination*-charging different prices to different customers. The problem, of course, is to identify the different customers, and to get them to pay different prices. We will see how this can be done in the next section.

The other pricing techniques that we will discuss in this chapter-two-part tariffs and bundling-also expand the range of the firm's market to include more customers and to capture more consumer surplus. In each case we will examine the amount by which the firm's profit can be increased, as well as the effect on consumer welfare. (As we will see, when there is a high degree of monopoly power these pricing techniques can sometimes make both consumers and the producer better off.) We turn first to price discrimination.

11.2 *Price Discrimination*

Price discrimination can take three broad forms, which we call first, second- and third-degree price discrimination. We will examine them in turn.

First-Degree Price Discrimination

Ideally, a firm would like to charge a different price to each of its customers. If it could, it would charge each customer the maximum price that customer is willing to pay for each unit bought. We call this maximum price the customer's *reservation price.* The practice of charging each customer his or her reservation price is called *perfect first-degree price discrimination.*[1] Let's see how it affects the firm's profit.

First, we need to know the profit the firm earns when it charges only the single price P^* in Figure 11.2. To find out, we can add the profit on each incremental unit produced and sold, up to the total quantity Q^*. This incremental profit is the marginal revenue less the marginal cost for each unit. In Figure 11.2, this marginal revenue is highest and marginal cost lowest for the first unit. For each additional unit, marginal revenue falls and marginal cost rises, so the firm produces the total output Q^*, where marginal revenue and marginal cost are equal. Total variable profit is simply the sum of the profits on each incremental unit produced, and therefore, it is given by the tan shaded area in Figure 11.2, between the marginal revenue and marginal cost curves.[2] Consumer surplus, which is the area between the average revenue curve and the price P^* that customers pay, is outlined as a dark triangle.

Now, what happens if the firm can perfectly price discriminate? Since each consumer is charged exactly what he or she is willing to pay, the marginal revenue curve is no longer relevant to the firm's output decision. Instead, the incremental revenue earned from each additional unit sold is simply the price paid for that unit, and is therefore given by the demand curve.

Since price discrimination does not affect the firm's cost structure, the cost of each additional unit is again given by the firm's marginal cost curve. Therefore, *the profit from producing and selling each incremental unit is now the difference between demand and marginal cost.* As long as demand exceeds marginal cost, the firm can increase its profit by expanding production, and it will do so until it produces a total output Q^{**}. At Q^{**} demand is equal to marginal cost, and producing more reduces profit.

[1] We are assuming that each customer buys one unit of the good. If a customer bought more than one unit, the firm would have to charge different prices for each of the units.

[2] Recall that total profit π is the difference between total revenue R and total cost C, so incremental profit is just $\Delta\pi = \Delta R - \Delta C = MR - MC$. Total variable profit is found by summing all the $\Delta\pi$s, and thus it is the area between the MR and MC curves. This ignores fixed costs, which are independent of the firm's output and pricing decisions.

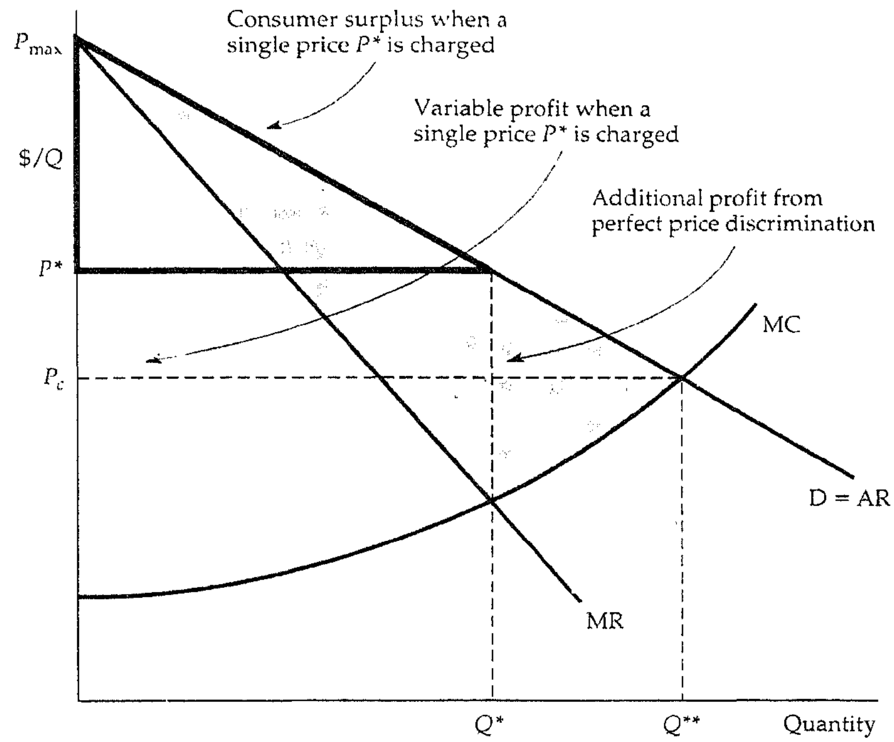


FIGURE 11.2 Additional Profit from Perfect First-Degree Price Discrimination. The firm charges each consumer his or her reservation price, so it is profitable to expand output to Q^{**}. When only a single price, P^* is charged, the firm's variable profit is the area between the marginal revenue and marginal cost curves. With perfect price discrimination, this profit expands to the area between the demand curve and the marginal cost curve.

Total profit is now given by the area between the demand and marginal cost curves.[3] Note from Figure 11.2 that total profit is now much larger. (The additional profit resulting from price discrimination is shown by the red shaded area.) Note also that since every customer is being charged the maximum amount that he or she is willing to pay, all consumer surplus has been captured by the firm.

In practice, perfect first-degree price discrimination is almost never possible. First, it is usually impractical to charge each and every customer a different price (unless there are only a few customers).[4] Second, a firm usually does

[3] Incremental profitis againis $\Delta\pi = \Delta R - \Delta C$, but ΔR given by the price to each customer (i.e.,the average revenue curve), so $\Delta\pi$ = AR − MC. Total profit is the sum of these $\Delta\pi$s and is given by the area between the AR and ML curves.

[4] And recall that even if it could be done, it might violate the antitrust laws if it is deemed to be anticompetitive.

not know the reservation price of each customer. Even if the firm could ask how much each customer would be willing to pay, it probably would not receive honest answers. After all, it is in the customers' interest to claim that they would pay very little (because then they would be charged a low price).

Sometimes, however, firms can discriminate imperfectly by charging a few different prices based on estimates of customers' reservation prices. This happens frequently when professionals, such as doctors, lawyers, accountants, or architects,who know their clients reasonably well, are the "firms." Then the client's willingness to pay can be assessed, and fees set accordingly. For example, a doctor may offer a reduced fee to a low-income patient whose willingness to pay or insurance coverage is low, but charge higher fees to upper-income or better-insured patients. And an accountant, having just completed a client's tax returns, is in an excellent position to estimate how much the client is willing to pay for the service.

Another example is a car salesperson, who typically works with a 15 percent profit margin. The salesperson can give part of this away to the customer by making a "deal," or can insist that the customer pay the sticker price for the car. A good salesperson knows how to size up customers and determine whether they will look elsewhere for a car if they don't receive a sizable discount. The customer who is likely to leave and shop around receives a big discount (from the salesperson's point of view, a small profit is better than no sale and no profit), but the customer in a hurry is offered little or no discount. In other words, a successful car salesperson knows how to price discriminate!

Still another example is how colleges and universities charge tuition. Colleges don't charge different tuition rates to different students in the same degree program. Instead, they offer financial aid, in the form of a scholarship or subsidized loan, which reduces the *net* tuition that the student must pay. By requiring those who seek aid to disclose information about family income and wealth, colleges can link the amount of aid to the student's ability (and hence willingness) to pay. Thus, students who are financially well off pay more for their education, but students who are less well off pay less.

Figure 11.3 illustrates this kind of imperfect first-degree price discrimination. Here, if only a single price were charged, it would be P4. Instead, six different prices are charged, the lowest of which, P_6 *is* just above the point where marginal cost intersects the demand curve. Note that those customers who would not have been willing to pay a price of P_4 or greater are actually better off in this situation-they are now in the market and may be enjoying at least some consumer surplus. In fact, if price discrimination brings enough new customers into the market, consumer welfare can increase, so that both the producer and consumers are better off.

Second-Degree Price Discrimination

In some markets, each consumer purchases many units of the good over any given period, and the consumer's demand declines with the number of units

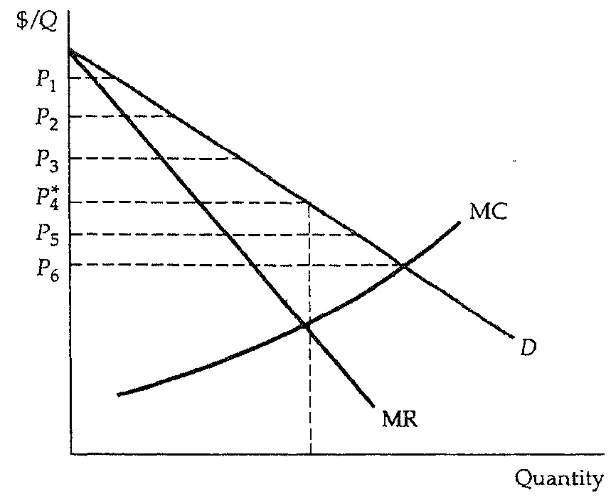


FIGURE 11.3 First-Degree Price Discrimination in Practice. Firms usually don't know the reservation price of every consumer. But sometimes reservation prices can be roughly identified. Here, six different prices are charged. The firm earns higher profits, but some consumers may also benefit. With a single price P^*_4 there are fewer consumers. The consumers who now pay P_5 or P_6 may have a surplus.

purchased. Examples include water, heating fuel, and electricity. Consumers may each purchase a few hundred kilowatt-hours of electricity a month, but their willingness to pay declines with increasing consumption. (The first hundred kilowatt-hours may be worth a lot to the consumer-operating a refrigerator and providing for minimal lighting. Conservation becomes easier with the additional units, and may be worthwhile if the price is high.) In this situation, a firm can discriminate according to the quantity consumed. This is called *second-degree price discrimination,* and it works by charging different prices for different quantities or "blocks" of the same good or service.

An example of second-degree price discrimination is block pricing by electric power companies. If there are scale economies so that average and marginal costs are declining, the state agency that controls the company's rates may encourage block pricing. By expanding output and achieving greater scale economies, consumer welfare can be increased, even allowing for greater profit to the company. The reason is that prices are reduced overall, while the savings from the lower unit costs still permit the power company to make a reasonable profit.

Figure 11.4 illustrates second-degree price discrimination for a firm with declining average and marginal costs. If a single price were charged, it would be P_0, and the quantity produced would be Q_0. Instead, three different prices are charged, based on the quantities purchased. The first block of sales is priced at P_1, the second at P_2, and the third at P_3.

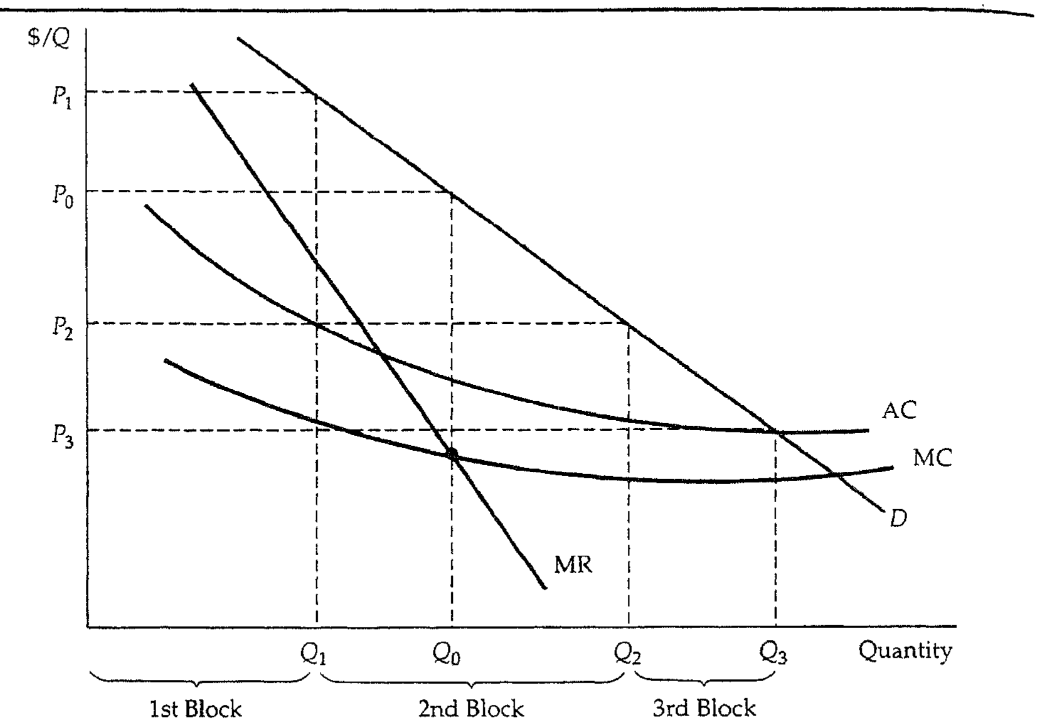


FIGURE 11.4 Second-Degree Price Discrimination. Different prices are charged for different quantities, or "blocks,"of the same good. Here, there are three blocks, with corresponding prices P_1, P_2, and P_3. There are also economies of scale, and average and marginal costs are declining. Second-degree price discrimination can then make consumers better off by expanding output and lowering cost.

Third-Degree Price Discrimination

A well-known liquor company has what seems to be a strange pricing practice. The company produces a vodka that it advertises as one of the smoothest and best-tasting available. This vodka is called "Three Star Golden Crown," and it is sold for about $16 a bottle.[5] However, the company also takes some of this same vodka and bottles it under the name "Old Sloshbucket," which is sold for about $8 a bottle. Why does it do this? Has the president of the company been spending too much time near the vats?

Perhaps, but this liquor company is also practicing *third-degree price discrimination,* and it does it because the practice is profitable. This form of price discrimination divides consumers into two or more groups with separate demand

[5] We have changed the names to protect the innocent.

curves for each group. This is the most prevalent form of price discrimination, and examples abound: regular versus "special" airline fares; the premium versus nonpremium brand of liquor, canned food or frozen vegetables; discounts to students and senior citizens; and so on.

In each case, some characteristic is used to divide consumers into distinct groups. For example, for many goods, students and senior citizens are usually willing to pay less on average than the rest of the population (because their incomes are lower), and identity can be readily established (via college ID or a driver's license). Likewise, to separate vacationers from business travelers (whose companies are usually willing to pay much higher fares), airlines can put restrictions on special low-fare tickets, such as requiring advance purchase. With the liquor company, or the premium versus nonpremium (e.g., supermarket label) brand of food, the label itself divides consumers; many consumers are willing to pay more for a name brand, even though the nonpremium brand is identical or nearly identical (and in fact is sometimes manufactured by the same company that produced the premium brand).

If third-degree price discrimination is feasible, how should the firm decide what price to charge each group of consumers? Let's think about this in two steps. First, we know that however much is produced, total output should be divided between the groups of customers, so that the marginal revenues for each group are equal. Otherwise, the firm would not be maximizing profit. For example, if there are two groups of customers and the marginal revenue for the first group, MR_1, exceeds the marginal revenue for the second group, MR_2, the firm could clearly do better byshifting output from the second group to the first. It would do this by lowering the price to the first group and raising the price to the second group. So whatever the two prices are, they must be such that the marginal revenues for the different groups are equal.

Second, we know that *total* output must be such that the marginal revenue for each group of consumers is equal to the marginal cost of production. Again, if this were not the case, the firm could increase its profit by raising or lowering total output (and lowering or raising its prices to both groups). For example, suppose the marginal revenues were the same for each group of consumers, but marginal revenue exceeded the marginal.cost of production.The firm could then make a greater profit by increasing its total output. It would lower its prices to both groups of consumers, sp that the marginal revenues for each group fell (but were still equal to each other), and approached marginal cost (which would increase as total output increased).

Let's look at this algebraically. Let P_1 be the price charged to the first group of consumers, P_2 the price charged to the second group, and $C(Q_T)$ the total cost of producing output $Q_T = Q_1 + Q_2$. Then total profit is given by

$$\pi = P_1Q_1 + P_2Q_2 - C(Q_T)$$

The firm should increase its sales to each group of consumers, Q_1 and Q_2, until the incremental profit from the last unit sold is zero. First, we set incremental profit for sales to the first group of consumers equal to zero:

$$\frac{\Delta\pi}{\Delta Q_1} = \frac{\Delta(P_1Q_1)}{\Delta Q_1} - \frac{\Delta C}{\Delta Q_1} = 0$$

Here $\Delta(P_1Q_1)/\Delta Q_1$ is the incremental revenue from an extra unit of sales to the first group of consumers (i.e., MR_1). The next term, $\Delta C/\Delta Q_1$, is the incremental cost of producing this extra unit, i.e., marginal cost, MC. We thus have

$$MR_1 = MC$$

Similarly, for the second group of consumers, we must have

$$MR_2 = MC$$

Putting these relations together, we see that prices and output must be set so that

$$\boxed{MR_1 = MR_2 = MC} \qquad (11.1)$$

Again, marginal revenue must be equal across groups of consumers and must equal marginal cost.

Managers may find it easier to think in terms of the relative prices that should be charged to each group of consumers, and to relate these prices to the elasticities of demand. Recall that we can write marginal revenue in terms of the elasticity of demand:

$$MR = P(1 + 1/E_d)$$

Then $MR_1 = P_1(1 + 1/E_1)$ and $MR_2 = P_2(1 + 1/E_2)$, where E_1 and E_2 are the elasticities of demand for the *firm's* sales in the first and second markets, respectively. Now equating MR_1 and MR_2 gives the following relationship that must hold for the prices:

$$\boxed{\frac{P_1}{P_2} = \frac{(1 + 1/E_2)}{(1 + 1/E_1)}}$$

As you would expect, the higher price will be charged to consumers with the lower demand elasticity. For example, if the elasticity of demand for consumers in group 1 is -2, and the elasticity for consumers in group 2 is -4, we will have $P_1/P_2 = (1 - \frac{1}{4})/(1 - \frac{1}{2}) = (\frac{3}{4})/(\frac{1}{2}) = 1.5$. In other words, the price charged to the first group of consumers should be 1.5 times as high as the price charged to the second group.

Figure 11.5 illustrates third-degree price discrimination. Note that the demand curve D_1 for the first group of consumers is less elastic than the curve

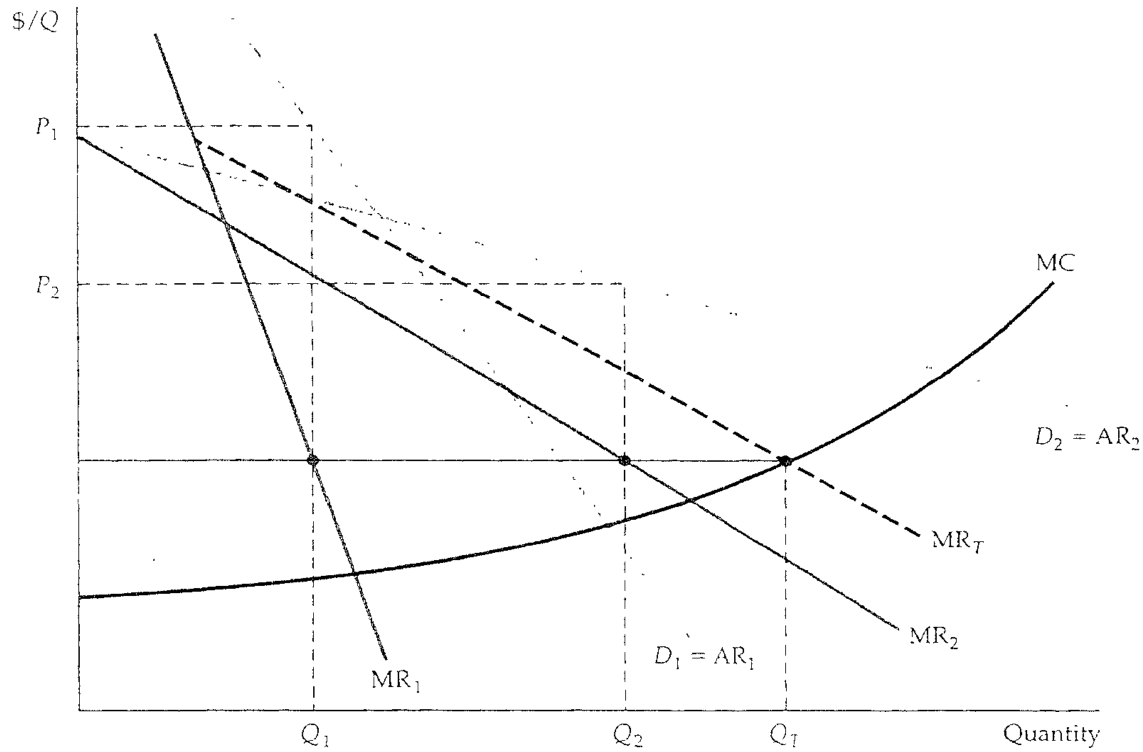


FIGURE 11.5 Third-Degree Price Discrimination. Consumers are divided into two groups, with separate demand curves for each group. The optimal prices and quantities are such that the marginal revenue from each group is the same and equal to marginal cost. Here group 1, with demand curve D_1, is charged P_1, and group 2, with the more elastic demand curve D_2 is charged the lower price P_2. Marginal cost depends on the total quantity produced Q_T. Note that Q_1 and Q_2 are chosen so that $MR_1 = MR_2 = MC$.

for the second group, and the price charged to the first group is likewise higher. The total quantity produced, $Q_T = Q_1 + Q_2$, is found by summing the marginal revenue curves MR_1 and MR_2 horizontally, which yields the dashed curve MR_T, and finding its intersection with the marginal cost curve. Since MC must equal MR_1 and MR_2 we can draw a horizontal line leftwards from this intersection to find the quantities Q_1 and Q_2.

It may not always be worthwhile for the firm to try to sell to more than one group of consumers. In particular, if demand is small for the other group of consumers and marginal cost is rising steeply, the increased cost of producing and selling to this other group may outweigh the increase in revenue. Thus, in Figure 11.6, the firm is better off charging a single price P^* and selling only to the larger group of consumers because the additional cost of serving the smaller market would outweigh the additional revenue.

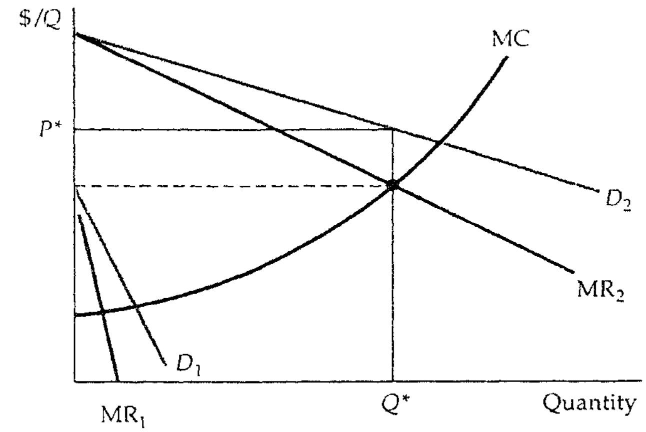


FIGURE 11.6 No Sales to Smaller Market. Even if third-degree price discrimination is feasible, it doesn't always pay to sell to both groups of consumers if marginal cost is rising. Here, the first group of consumers, with demand D_1, are not willing to pay much for the good. It is unprofitable to sell to them because the price would have to be too low to compensate for the resulting, increase in marginal cost.

EXAMPLE 11.1 THE ECONOMICS OF COUPONS AND REBATES

The producers of processed foods and related consumer goods often issue coupons that let one buy the product at a discount. These coupons are usually distributed as part of an advertisement for the product, and they may appear in a newspaper or magazine, or as part of a promotional mailing. For example, a coupon for a particular breakfast cereal might be worth 25 cents toward the purchase of a box of the cereal. Why do firms issue these coupons? Why not just lower the price of the product, and thereby save the costs of printing and collecting the coupons?

Coupons provide a means of price discrimination. Studies show that only about 20 to 30 percent of all consumers regularly bother to clip, save, and use coupons when they go shopping. These consumers tend to be more sensitive to price than those who ignore coupons. They generally have more price-elastic demands and lower reservation prices. So by issuing coupons, a cereal company can separate its customers into two groups, and in effect charge the more price-sensitive customers a lower price than the other customers.

Rebate programs work the same way. For example, Kodak ran a program in which a consumer could mail in a form together with the proof of purchase of three rolls of film, and receive a rebate of $1.50. Why not just lower the price of film by 50 cents a roll? Because only those consumers with relatively price-sensitive demands bother to send in the material and request a rebate. Again, the program is a means of price discrimination.

TABLE 11.1 Price Elasticities of Demand for Users Versus Nonusers of Coupons

	Price Elasticity	
Product	Nonusers	Users
Toilet tissue	-0.60	-0.66
Stuffing/dressing	"0.71	-0.96
Shampoo	-0.84	-1.04
Cooking/salad oil	-1.22	-1.32
Dry mix dinners	-0.88	-1.09
Cake mix	-0.21	-0.43
Cat food	-0.49	-1.13
Frozen entrees	-0.60	-0.95
Gelatin	-0.97	-1.25
Spaghetti sauces	-1.65	-1.81
Creme rinse/conditioner	-0.82	-1.12
Soups	-1.05	-1.22
Hot dogs	-0.59	-0.77

Can consumers really be divided into distinct groups in this way? Table 11.1 shows the results of a statistical study in which, for a variety of products, price elasticities of demand were estimated for users and nonusers of coupons.[6] This study confirms that users of coupons tend to have more price-sensitive demands. It also shows the extent to which the elasticities differ for the two groups of consumers, and how the difference varies from one product to another.

These elasticity estimates by themselves do not tell a firm what price to set and how large a discount to offer through its coupons because they pertain to *market demand,* not the demand for the firm's particular brand. For example, Table 11.1 indicates that the elasticity of demand for cake mix is -0.21 for nonusers of coupons and -0.43 for users. But the elasticity of demand for any of the eight or ten major brands of cake mix on the market will be far larger than either of these numbers-about eight or ten times as large; as a rule of thumb.[7] So for any one brand of cake mix, say, Pillsbury, the elasticity of demand for users of coupons might be about -4, versus about -2 for nonusers. From equation. (11.2) we can therefore determine that the price to nonusers of coupons should be about 1.5 times the price to users. In other words, if a box of cake mix sells for $1.50, the company should offer coupons that give a 50 cent discount.

[6] The study is by Chakravarthi Narasimhan, "A Price Discrimination Theory of Coupons," *Marketing Science* (Spring 1984).

[7] This rule of thumb follows if interfirm competition can be described by the Cournot model, which we discuss in Chapter 12.

EXAMPLE 11.2 HOW TO SET AIRLINE FARES

Travelers are often amazed at the variety of fares available for a round-trip flight from New York to Los Angeles. For example, the first-class fare was recently almost $2,000; the regular (unrestricted) economy fare was about $1,200; and special discount fares (often requiring the purchase of a ticket two weeks in advance and/or a Saturday night stayover) could be bought for as little as $500. Although first-class service is not the same as economy service with a minimum stay requirement, the difference would not seem to warrant a price that is four times as high. Why, then, do airlines set fares this way?

The reason is that these fares provide a profitable form of price discrimination for airlines. The gains from discriminating are large, because different types of customers, with very different elasticities of demand, purchase these different types of tickets. Table 11.2 shows price (and income) elasticities of demand for three categories of service within the United States: first-class, unrestricted coach, and discount tickets. (A discounted ticket often has restrictions and may be partly nonrefundable.)

Note that the demand for discounted fares is about two or three times as price elastic as first-class or unrestricted coach service. The reason is that discounted tickets are usually used by families and other leisure travelers, while first-class and unrestricted coach tickets are more often bought by business travelers, who have little choice about when they travel, and whose companies pick up the tab. Of course, these elasticities pertain to market demand, and with several airlines competing for customers, the elasticities of demand for each airline will be larger. But the *relative* sizes of elasticities across the three categories of service should be about the same. When elasticities of demand differ so widely, it should not be surprising that airlines set such different fares for different categories of service.

Price discrimination has become increasingly sophisticated in the United States. A wide variety of fares is available, depending on how far in advance the ticket is bought, the percentage of the fare that is refundable if the trip is

TABLE 11.2 Elasticities of Demand for Air Travel

	Fare Category		
Elasticity	First-Class	Unrestricted Coach	Discount
Price	-0.3	-0.4	-0.9
Income	1.2	1.2	1.8

changed or cancelled, and whether the trip includes a weekend stay.[8] The objective of the airlines has been to discriminate more finely among travelers with different reservation prices. As American Airlines, vice-president of pricing and product planning explained it, "You don't want to sell a seat to a guy for $69 when he is willing to pay $400"[9] At the same time, an airline would rather sell a seat for $69 than leave it empty.

11.3 *Intertemporal Price Discrimination and Peak-Load Pricing*

Intertemporal price discrimination is an important and widely practiced pricing strategy closely related to third-degree price discrimination. Here consumers are separated into different groups with different demand functions by being charged different prices at different points in time.

To see how intertemporal price discrimination works, think about how an electronics company might price new, technologically advanced equipment, such as videocassette recorders during the 1970s, compact disc players in the early 1980s, and most recently, digital tape players. In Figure 11.7, D_1 is the (inelastic) demand curve for a small group of consumers who value the product highly and do not want to wait to buy it (e.g., stereo buffs who value high-quality sound and want the latest equipment). D_2 is the demand curve for the broader group of consumers who are more willing to forgo the product if the price is too high. The strategy, then, is to initially offer the product at the high price P_1, selling mostly to consumers on demand curve D_1. Later, after this first group of consumers has bought the product, the price is lowered to P_2, and sales are made to the larger group of consumers on demand curve D_2.[10]

There are other examples of intertemporal price discrimination. One involves charging a high price for a first-run movie, then lowering the price after the movie has been out a year. Another, practiced almost universally by publishers, is to charge a high price for the hardcover edition of a book, and then to release the paperback version at a much lower price about a year later.

[8] Airlines also allocate the number of seats on each flight that will be available for each fare category. This is based on the total demand and mix of passengers expected for each flight. Methods for doing this are discussed in Peter R Belobaba,"Airline Yield Management: An Overview of Seat Inventory Control," *Transportation Science* 21 (May 1987): 63-73.

[9] "The Art of Devising Air Fares," *New York Times,* March 4, 1987.

[10] "The prices of new electronic products also come down over time because costs fall as producers start to achieve greater scale economies and move down the learning curve. But even if costs did not fall, producers can make more money by first setting a high price and then reducing it over time, thereby discriminating and capturing consumer surplus.

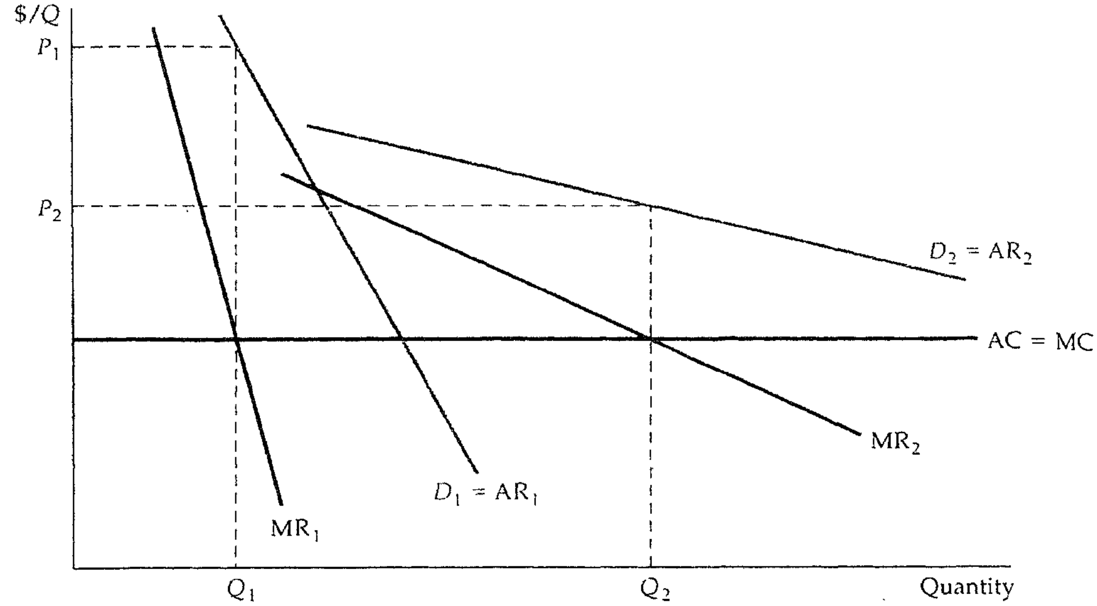


FIGURE 11.7 Intertemporal Price Discrimination. Here, consumers are divided into groups by changing the price over time. Initially, the price is high, and the firm captures surplus from consumers who have a high demand for the good and are unwilling to wait to buy it. Later,the price is reduced to appeal to the mass market.

Many people think that the lower price of the paperback is due to a much lower cost of production, but this is not true. Once a book has been edited and typeset, the marginal cost of printing an additional copy, whether hard-cover or paperback, is quite low, perhaps a dollar or so. The paperback version is sold for much less not because it is much cheaper to print, but because high-demand consumers have already purchased the hardbound edition, and the remaining consumers generally have more elastic demands.

Peak-load pricing is another form of intertemporal price discrimination. For some goods and services, demand peaks at particular times-for roads and tunnels during commuter rush hours, for electricity during late summer afternoons, and for ski resorts and amusement parks on weekends. Marginal cost is also high during these peak periods because of capacity constraints. Prices should thus be higher during peak periods.

This is illustrated in Figure 11.8, where D_1 is the demand curve for the peak period, and D_2 is the demand curve for the nonpeak period. The firm sets marginal revenue equal to marginal cost for each period, obtaining the high price PI for the peak period, and the lower price P_2 for the nonpeak period, with corresponding quantities Q_1 and Q_2. This increases the firm's profit above what it would be if it charged one price for all periods. It is also more efficient-the

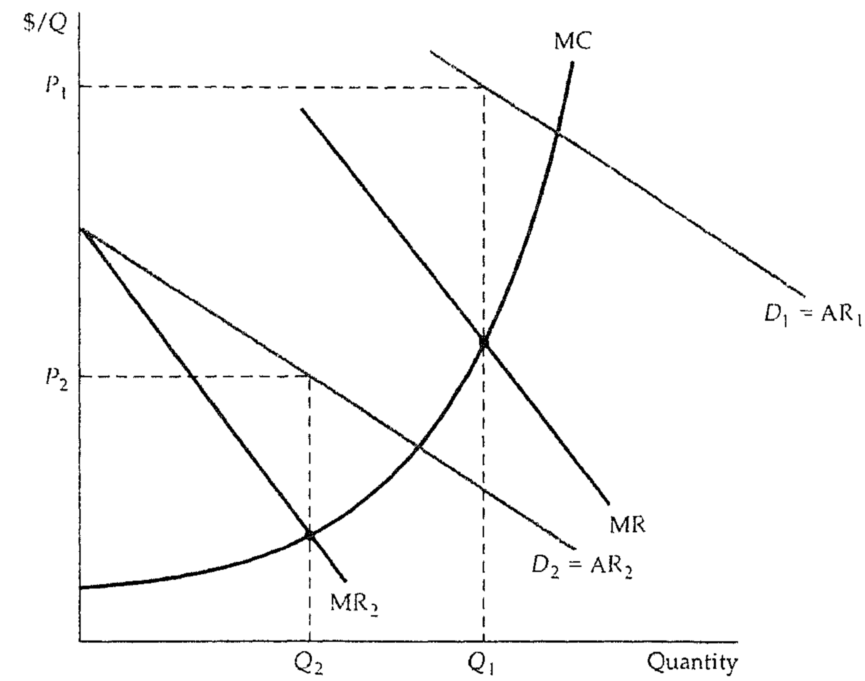


FIGURE 11.8 Peak-Load Pricing. Demands for some goods and services increase sharply during particular times of the day or year. Charging a higher price P_1 during the peak periods is more profitable for the firm than charging a single price at all times. It is also more efficient because marginal cost is higher during peak periods.

sum of producer and consumer surplus is greater because prices are closer to marginal cost.[11]

Note that peak-load pricing is different from third-degree price discrimination. With third-degree price discrimination, marginal revenue has to be equal for each group of consumers and equal to marginal cost. The reason is that the costs of serving the different groups are not independent. For example, with unrestricted versus discounted air fares, increasing the number of seats sold at discounted fares affects the cost of selling unrestricted tickets-marginal cost rises rapidly as the airplane fills up. But this is not so with peak-load pricing (and for that matter, with most instances of intertemporal price discrimination). Selling more tickets for the ski lifts or amusement park on a weekday does not significantly raise the cost of selling tickets on the weekend. Similarly, selling more electricity during the off-peak period will not sig-

[11] The efficiency gain from peak-load pricing is important. If the firm were a regulated monopolist (e.g., an electric utility), the regulatory agency should set the prices P_1 and P_2 at the points where the *demand* curves, D_1 and D_2, intersect the marginal cost curve, rather than where the marginal revenue curves intersect marginal cost. Consumers then realize the entire efficiency gain.

nificantly increase the cost of selling electricity during the peak period. As a result, price and sales in each period can be determined independently by setting marginal cost equal to marginal revenue for each period.

Movie theaters, which charge more for the evening show than for the matinee, are another example of this. For most movie theaters the marginal cost of serving customers during the matinee is independent of the marginal cost during the evening. The owner of a movie theater can determine the optimal prices for the evening and matinee shows independently, using estimates of demand in each period along with estimates of marginal cost.

EXAMPLE 11.3 HOW TO PRICE A BEST-SELLING NOVEL

Publishing both hardbound and paperback editions of a book allows publishers to price discriminate. As they do with most goods, consumers differ considerably in their willingness to pay for books. For example, some consumers want to buy a new best seller as soon as it is released, even if the price is $25. Other consumers, however, will wait a year until the book is available in paperback for $6. But how should a publishing company decide that $25 is the right price for the new hardbound edition and $6 is the right price for the paperback edition? And how long should it wait before bringing out the paperback edition?

The key is to divide consumers into two groups, so that those who are willing to pay a high price do so, and only those unwilling to pay a high price wait and buy the paperback. This means that significant time must be allowed to pass before the paperback is released. If consumers know that the paperback will be available within a few months, they will have little incentive to buy the hardbound edition.[12] On the other hand, the publisher cannot wait too long to bring out the paperback edition, or else interest in the book will wane,and the market will dry up. As a result,publishers typically wait twelve to eighteen months before releasing the paperback edition.

What about price? Setting the price of the hardbound edition is difficult because, except for a few authors whose books always seem to sell, a publisher has little data with which to estimate demand for a book that is about to be published, other than the sales of similar books in the past. But usually only aggregate data are available for each category of book. So most new novels, for example, are released at similar prices. It is clear, however, that those consumers willing to wait for the paperback edition have demands that are far

[12] Some consumers will buy the hardbound edition even if the paperback is already available because it is more durable and more attractive on a bookshelf. This must be taken into account when setting prices, but it is of secondary importance compared with intertemporal price discrimination.

more elastic than those of bibliophiles. It is not surprising, then, that paperback editions sell for so much less than hardbound ones.[13]

11.4 *The Two-Part Tariff*

The two-part tariff is related to price discrimination and provides another means of extracting consumer surplus. It requires consumers to pay a fee up front for the right to buy a product. Consumers then pay an additional fee for each unit of the product they wish to consume. The classic example of this is an amusement park.[14] You pay an admission fee to enter, and you also pay a certain amount for each ride you go on. The owner of the park has to decide whether to charge a high entrance fee and a low price for the rides, or alternatively, to admit people for free but charge high prices for the rides.

The two-part tariff has been applied in many settings: tennis and golf clubs (you pay an annual membership fee, plus a fee for each use of a court or round of golf); the rental of large mainframe computers (you pay a flat monthly fee plus a fee for each unit of processing time consumed); telephone service (you pay a monthly hook-up fee plus a fee for message units); a Polaroid camera (you pay for the camera, which lets you productively consume the film, which you pay for by the package); and safety razors (you pay for the razor, which lets you consume the blades that fit only that brand of razor).

The problem for the firm is how to set the entry fee (which we denote by T) versus the usage fee (which we denote by P). Assuming that the firm has some market power, should it set a high entry fee and low usage fee, or vice versa? To see how a firm can solve this problem, we need to understand the basic principles involved.

Let us begin with an artificial but simple case. Suppose only one consumer is in the market (or many consumers with identical demand curves). Suppose also that the firm knows this consumer's demand curve. Now, remember that the firm wants to capture as much consumer surplus as possible. In this case, the solution is straightforward: Set the usage fee P equal to marginal cost, and the entry fee T equal to the total consumer surplus for each consumer. Thus, in Figure 11.9, the consumer pays T^* (or a bit less) to use the product, and

[13] The hardbound and paperback editions are often published by different companies. The author's agent auctions the rights to the two editions, but the contract for the paperback specifies a delay to protect the sales of the hardbound edition. The principle still applies, however. The length of the delay and the prices of the two editions are chosen to intertemporally price discriminate.

[14] See Walter Oi, "A Disneyland Dilemma: Two-Fart Tariffs for a Mickey Mouse Monopoly," *Quarterly Journal of Economics* (Feb. 1971): 77-96.

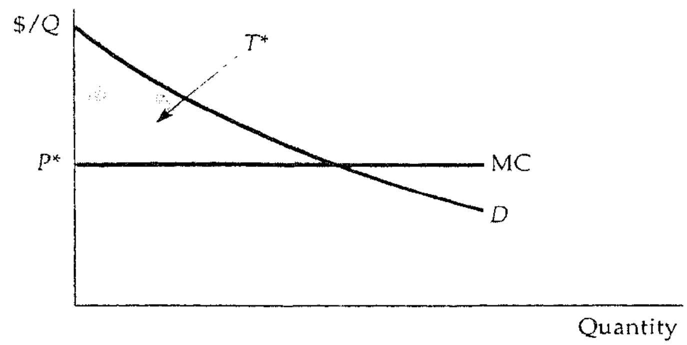


FIGURE 11.9 Two-Part Tariff with a Single Consumer. The consumer has demand curve D. The firm maximizes profit by setting usage fee P equal to marginal cost and entry fee T equal to the entire surplus of the consumer.

P^* = MC per unit consumed. With the fees set this way, the firm captures *all* the consumer surplus as its profit.

Now, suppose there are two different consumers (or two groups of identical consumers). The firm, however, can set only *one* entry fee and one usage fee. The firm would thus no longer want to set the usage fee equal to marginal cost. If it did, it could make the entry fee no larger than the consumer surplus of the consumer with the smaller demand (or else it would lose that consumer), and this would not give a maximum profit. Instead, the firm should set the usage fee *above* marginal cost, and then set the entry fee equal to the remaining consumer surplus of the consumer with the smaller demand.

Figure 11.10 illustrates this. With the optimal usage fee at P^* greater than MC, the firm's profit is $2T^* + (P^* - \text{MC})(Q_1 + Q_2)$. (There are two consumers, and each pays T^*.) You can verify that this profit is more than twice the area of triangle *ABC*, the consumer surplus of the consumer with the smaller demand when P = MC. To determine the exact values of P^* and T^*, the firm would need to know (in addition to its marginal cost) the demand curves D_1 and D_2. It would then write down its profit as a function of P and T, and choose the two prices that maximize this function. (See Exercise 10 for an example of how to do this.)

Most firms, however, face a variety of consumers with different demands. Unfortunately, there is no simple formula to calculate the optimal two-part tariff in this case, and some trial and error might be required. But there is always a trade-off: A lower entry fee means more entrants and thus more profit from sales of the item. However, as the entry fee becomes smaller and the number of entrants larger, the profit derived from the entry fee will fall. The problem, then, is to pick an entry fee that results in the optimum number of entrants,that is, the fee that allows for maximum profit. In principle, one can do this by starting with a price for sales of the item. P, finding the optimum

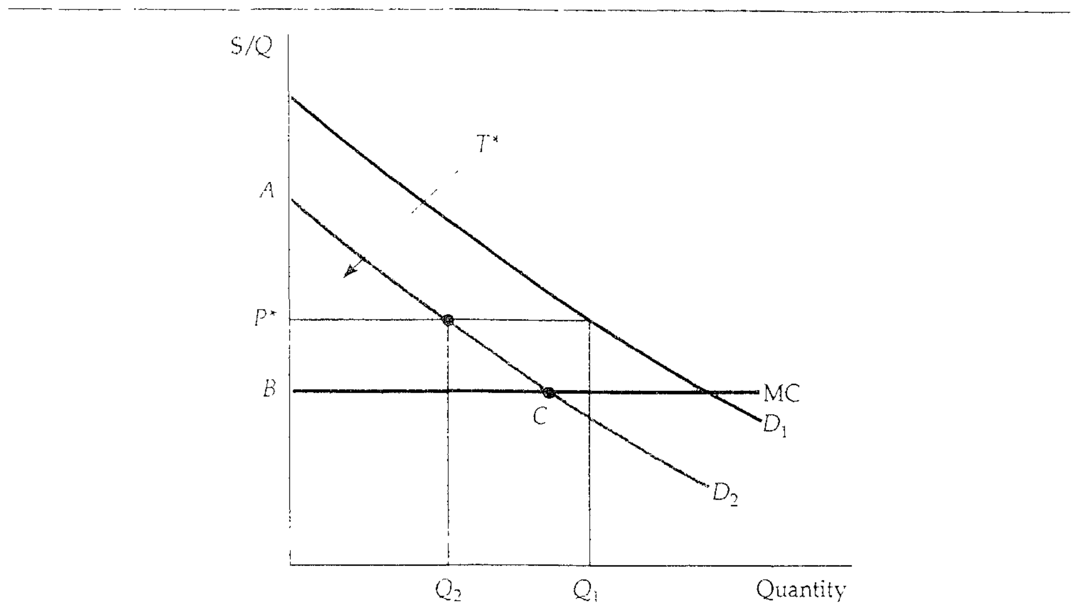


FIGURE 11.10 Two-Part Tariff with Two Consumers. The profit-maximizing usage fee P^* will exceed marginal cost. The entry fee T^* *is* equal to the surplus of the consumer with the smaller demand. The resulting profit is $2T^* + (P^* - MC) \times (Q_1 + Q_2)$. Note that this profit is larger than twice the area of triangle *ABC*.

entry fee T, and then estimating the resulting profit. The price *P* is then changed, and the corresponding entry fee calculated, along with the new profit level. By iterating this way, one can approach the optimal two-part tariff.

Figure 11.11 illustrates this. Here, the firm's profit π is divided into two components, each of which is plotted as a function of the entry fee *T*, assuming a fixed sales price P. The first component π_a is the profit from the entry fee, and is equal to the revenue $n(T)T$, where $n(T)$ is the number or entrants. (Note that a high T implies a small *n*.) Initially, as T is increased from zero", the revenue $n(T)T$ rises. Eventually, however, further increases in *T* will make *n* so small that $n(T)T$ falls. The second component, π_s, is the profit from sales of the item itself at price *P*, and is equal to $(P - MC)Q$, where *Q* is the rate at which entrants purchase the item. *Q* will be larger the larger the number of entrants *n*. Thus π_s falls when *T* is increased because a higher *1* reduces *n*.

Starting with a number for *P*, we determine the optimal (profit-maximizing) T^*. We then change *P*, find a new T^*, and determine whether profit is now higher or lower. This is repeated until profit has been maximized-

Obviously, more data are needed to design an optimal two-part tariff than to choose a single price. Knowing marginal cost and the aggregate demand curve is not enough. It is impossible (in most cases) to determine the demand curve of every consumer, but one would at least like to know by how much

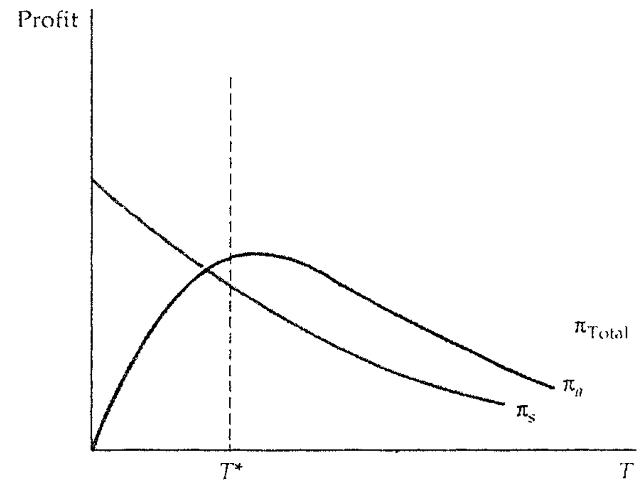


FIGURE 11.11 Two-Part Tariff with Many Different Consumers. Total profitπ is the sum of the profit from the entry fee π_a and the profit from sales π_s. Both π_a and π_s depend on T, the entry fee:

$$\pi = \pi_a + \pi_s = n(T)T + (P - MC)Q(n)$$

where n is the number of entrants, which depends on the entry fee T, and Q is the.rate of sales, which is greater the larger is n. Here T^* is the profit-maximizing entry fee, given P. To calculate optimum values for P and T one can start with a number for P, find the optimum T, and then estimate the resulting profit. P is then charged and the corresponding T is recalculated, along with the new profit level.

individual demands differ from one another. If consumers' demands for your product are fairly similar, you would want to charge a price *P* that is close to marginal cost, and -make the entry fee *T* large. This is the ideal situation from the firm's point of view because most of the consumer surplus could then be captured. On the other hand, if consumers have different demands for your product, you would probably want to set *P* substantially above marginal cost, and charge a lower entry fee *T*. But then the two-part tariff is a much less effective means of capturing consumer surplus; setting a single price may do almost as well.

Firms are perpetually searching for innovative pricing strategies, and a few have devised and introduced a two-part tariff with a "twist"-the entry fee T entitles the customer to a certain number of free units. For example, if you buy a Gillette razor, several blades are usually included in the package. And the monthly lease fee for a large mainframe computer usually includes some free usage before usage is charged. This twist lets the firm set a higher entry fee T without losing as many small consumers. These small consumers might pay little or nothing for usage under this scheme, so the higher entry fee will capture their surplus without driving them out of the market, while also capturing more of the surplus of the large consumers.

EXAMPLE 11.4 POLAROID CAMERAS

In 1971 Polaroid introduced its new SX-70 camera. This camera was sold, not leased, to individual consumers. Nevertheless, because it sold its film separately, Polaroid could apply a two-part tariff to the pricing of the SX-70. Let us examine how this pricing device gave Polaroid greater profits than would have' been possible if its camera had used ordinary roll film, and how Polaroid might have determined the optimal prices for each part of its two-part tariff. Some time later, Kodak entered the market with a competing self-developing film and camera.[15] We will also consider the effect of Kodak's entry into the market on Polaroid's prices and profits.

First, let's make it clear why the pricing of the SX-70 (and Polaroid's other cameras and film as well) involved a two-part tariff. Polaroid had a monopoly on both its camera and the film. (Only Polaroid film could be used in the camera.) Consumers bought the camera and film to take instant pictures: The camera was the "entry fee" that provided access to the consumption of instant pictures, which was what consumers ultimately demanded.[16] In this sense, the price of the camera was like the entry fee at an amusement park. However, while the marginal cost of allowing someone entry into the park is close to zero, the marginal cost of producing a camera was significantly above zero, and thus had to be taken into account when designing the two-part tariff.

It was important that Polaroid have a monopoly on the film as well as the camera. If the camera had used ordinary roll film, competitive forces would have pushed the price of film close to its marginal cost. If all consumers had identical demands, Polaroid could still have captured all the consumer surplus by setting a high price for the camera (equal to the surplus of each consumer). But in practice, consumers were heterogeneous, and the optimal two-part tariff required a price for the film well above marginal cost. (In fact Polaroid got-and still gets-most of its profits from film rather than cameras.) Polaroid needed .its monopoly on the film to maintain this high price.

How should Polaroid have selected its prices for the camera and film? It could have begun with some analytical spadework. Its profit is given by

$$\pi = PQ + nT - C_1(Q) - C_2(n)$$

where P is the price of the film, T is the price of the camera, Q is the quantity of film sold, n is the number of cameras sold, and $C_1(Q)$ and $C_2(n)$ are the costs of producing film and cameras, respectively.

Polaroid wanted to maximize its profit π, taking into account that Q and n depend on P and T. Given a heterogeneous base of potential consumers, this

[15] In 1984 the courts ruled that Kodak's camera and film involved a patent infringement, and Kodak was forced to withdraw from the instant picture market in 1985. However, it played an important role in this market for nearly a decade.

[16] We are simplifying here. In fact some consumers obtain utility just from owning the camera, even if they take few or no pictures. Adults, like children, enjoy new toys, and can obtain pleasure from the mere possession of a technologically innovative good.

dependence on *P* and *T* might only have been guessed at initially, drawing on knowledge of related products. Later, a better understanding of demand and of how *Q* and *n* depend on *P* and *T* might have been possible as the firm accumulated data from its sales experience. Knowledge of C_1 and C_2 may have been easier to come by, perhaps from engineering and statistical studies (as discussed in Chapter 7).

Given some initial guesses or estimates for $Q(P)$, $n(T)$, $C_1(Q)$, and $C_2(n)$, Polaroid could have calculated the profit-maximizing prices P and T. It could also have determined how sensitive these prices were to uncertainty over demand and cost. This could have provided a guideline for trial-and-error pricing experiments. Over time these experiments would also have told Polaroid more about demand and cost, so that it could refine its two-part tariff.[17]

Did the entry of Kodak with a competing instant camera and film mean that Polaroid lost its ability to use a two-part tariff to extract consumer surplus? No-only Polaroid film could be used in Polaroid cameras, and Polaroid still had some monopoly power to exploit However, its monopoly power was reduced, the amount of consumer surplus that could potentially be extracted was smaller, and prices had to be changed. With demand now more elastic, Polaroid would have wanted to reduce the price of its cameras significantly (and indeed it did). Assuming that consumers remained as heterogeneous as before, Polaroid might also have wanted to reduce the price of its film.

*11.5 *Bundling*

You. have probably seen the 1939 film. *Gone with the Wind.* It is a classic that is nearly as popular now as it was then. Yet we would guess that you have not seen *Getting Gertie's Garter,* a flop that the same film company (Loews) also produced in 1939. And we would also guess that you didn't know that these two films were priced in what was then an unusual and innovative way.[18]

Movie theaters that leased *Gone with the Wind* also had to lease *Getting Gertie's Garter,* (Movie theaters pay the film companies or their distributors a daily or weekly fee for the films they lease.) In other words, these two films were *bundled,* i.e., sold as a package. Why would the film company do this?

You might think that the answer is obvious: *Gone with the Wind* was a great film and *Gertie* was a lousy film, so bundling the two forced movie theaters to lease *Gertie,* But this answer doesn't make economic sense. Suppose a theater's

[17] Setting prices for a product such as a Polaroid camera is clearly not a simple matter. We have ignored the *dynamic* behavior of cost and demand: how production costs fall as the firm moves down its learning curve,and how demand changes over time as the market begins to saturate.

[18] For those readers who claim to know all this, our final trivia question is: Who played the role of Gertie in *Getting Gertie's Carter?*

reservation price (the maximum price it will pay) for *Gone with the Wind* is $12,000 per week, and its reservation price for *Gertie is* $3000 per week. Then the most it would pay for *both* films is $15,000, whether it takes the films individually or as a package.

Bundling makes sense when *customers have heterogeneous demands,* and when the firm cannot price discriminate. With films, different movie theaters serve different groups of patrons and therefore may well have different demands for films. For example, the theater might appeal to different age groups, who have different'relative film preferences.

To see how a film company can use this heterogeneity to its advantage, suppose there are *two* movie theaters, and their reservation prices for our two films are as follows:

	Gone with the Wind	*Getting Gertie's Garter*
Theater A	$12/000	$3,000
Theater *B*	$10/000	$4,000

If the films are rented separately, the maximum price that could be charged for *Wind* is $10,000 because charging more than this would exclude Theater B. Similarly, the maximum price that could be charged for *Gertie* is $3000. Charging these two prices would yield $13,000 from each theater, for a total of $26,000 in revenue. But suppose the films are *bundled.* Theater A values the *pair* of films at $15,000 ($12,000 + $3000), and Theater B values the pair at $14,000 ($10,000 + $4000). So we can charge each theater $14,000 for the pair of films, and earn a total revenue of $28,000. Clearly, we can earn more revenue ($2000 more) by bundling the films.

Why is bundling more profitable than selling the films separately? Because (in this example) the *relative* valuations of the two films are reversed. In other words, although both theaters would pay much more for *Wind* than for *Gertie,* Theater *A* would pay more than Theater *B* for *Wind* ($12,000 vs. $10,000), while Theater *B* would pay more than Theater *A* for *Gertie* ($4000 vs. $3000). In technical terms, we say that the demands are *negatively correlated*-the customer willing to pay the most for *Wind* is willing to pay the least for *Gertie.* To see why this is critical, suppose demands were *positively correlated,* that is. Theater *A* would pay more for *both* films:

	Gone with the Wind	*Getting Gertie's Garter*
Theater A	$12,000	$4,000
Theater *B*	$10/000	$3,000

The most that Theater *A* would pay for the pair of films is now $16,000, but the most that Theater *B* would pay for the pair is only $13,000. So if the films were bundled, the maximum price that could be charged for the package is $13,000, yielding a total revenue of $26,000, the same as by selling the films separately.

Now, suppose a firm is selling two different goods to many consumers. To analyze the possible advantages of bundling, we will use a simple diagram to describe the preferences of the consumers in terms of their reservation prices and their consumption decisions given the prices charged. In Figure 11.12 the horizontal axis is r_1, which is the reservation price of a consumer for good 1, and the vertical axis is r_2 which is the reservation price for good 2. The figure shows the reservation prices for three consumers. Consumer *A* is willing to pay up to \$3.25 for good 1 and up to \$6 for good 2; consumer *B* is willing to pay \$8.25 for good 1 and up to \$3.25 for good 2; and consumer *C* is willing to pay up to \$10 for each of the goods. In general, the reservation prices for any number of consumers can be plotted this way.

Suppose there are many consumers, and the products are sold separately, at prices P_1 and P_2, respectively. Figure 11.13 shows how consumers can be divided into groups. Consumers in region I of the graph have reservation prices that are above the prices being charged for each of the goods, and so will buy both goods. Consumers in region II have a reservation price for good 2 that is above P_2, but a reservation price for good 1 that is below P_1; they will buy only good 2. Similarly, consumers in region IV will buy only good 1. Finally, consumers in region III have reservation prices below the prices charged for each of the goods, and so will buy neither good.

Now suppose the goods are sold as a bundle, for a total price of P_B.. We can then divide the graph into two regions, as in Figure 11.14. Any given consumer will buy the bundle only if its price is less than or equal to the sum of that consumer's reservation prices for the two goods. The dividing line is therefore the equation $P_B = r_1 + r_2$, or equivalently, $r_2 = P_B - r_1$. Consumers in region I have reservation prices that add up to more than Py, so they will buy

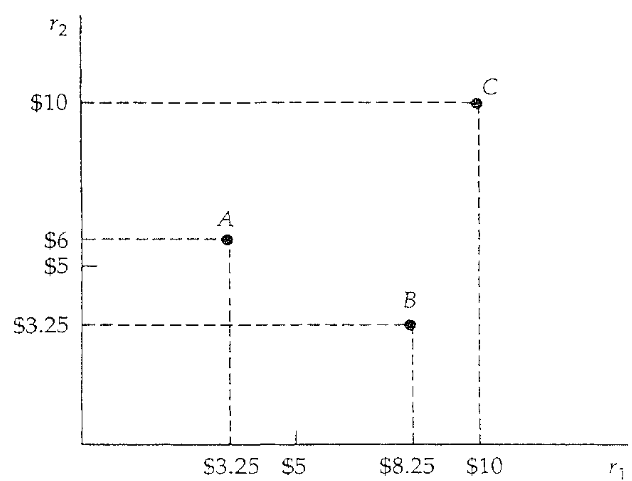
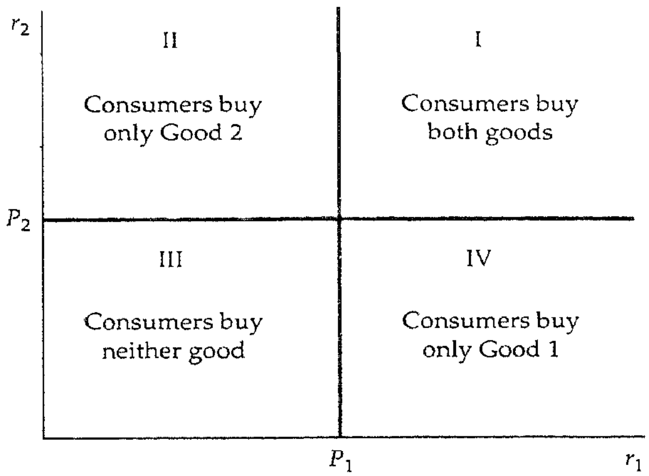


FIGURE 11.12 Reservation Prices. Reservation prices r_1 and r_2 for two goods are shown for three consumers, labeled *A*, *B*, and *C*. Consumer *A* is willing to pay up to \$3.25 for good 1 and up to \$6 for good 2.



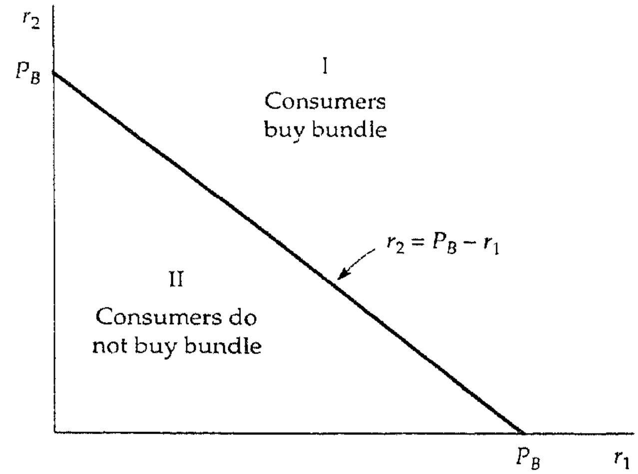


FIGURE 11.13 (left) Consumption Decisions When Products Are Sold Separately. The reservation prices of consumers in region I exceed the prices P_1 and P_2 for the two goods, so these consumers buy both goods. Consumers in regions II and IV buy only one of the goods, and consumers in region III buy neither good.
FIGURE 11.14 (right) Consumption Decisions When Products Are Bundled. Consumers compare the *sum* of their reservation prices, $r_1 + r_2$ with the price of the bundle P_B. They buy the bundle only if $r_1 + r_2$ is at least as large as P_B.

the bundle. Consumers in region II have reservation prices that add up to less than P_B, so they will not buy the bundle.

Depending on the prices charged, some of the consumers in region II of Figure 11.14 might have bought one of the goods if they had been sold separately. These consumers are lost to the firm, however, when it sells the goods as a bundle. The firm, then, has to determine whether it can do better by bundling.

In general, the effectiveness of bundling depends on how negatively correlated demands are. In other words, it works best when consumers who have a high reservation price for good 1 have a low reservation price for good 2, and vice versa. Figures 11.15a and b show two extremes. In Figure 11.15a each point represents the two reservation prices of a consumer. Note that the demands for the two goods are perfectly positively correlated-consumers with a high reservation price for good 1 also have a high reservation price for good 2. If the firm bundles and charges a price $P_B = P_1 + P_2$ it will make the same profit it would if it sold the goods separately at prices P_1 and P_2. In Figure 11.15b, on the other hand, demands are perfectly negatively correlated-a higher reservation price for good 2 implies a proportionately lower one for good 1. In this case, bundling is the ideal strategy. By charging the price P_B shown in the figure, the firm can capture *all* the consumer surplus.

Figure 11.16, which shows the movie example that we introduced at the beginning of this section, illustrates how the demands of the two movie theaters are negatively correlated- (Theater *A* will pay relatively more for *Gone with the*

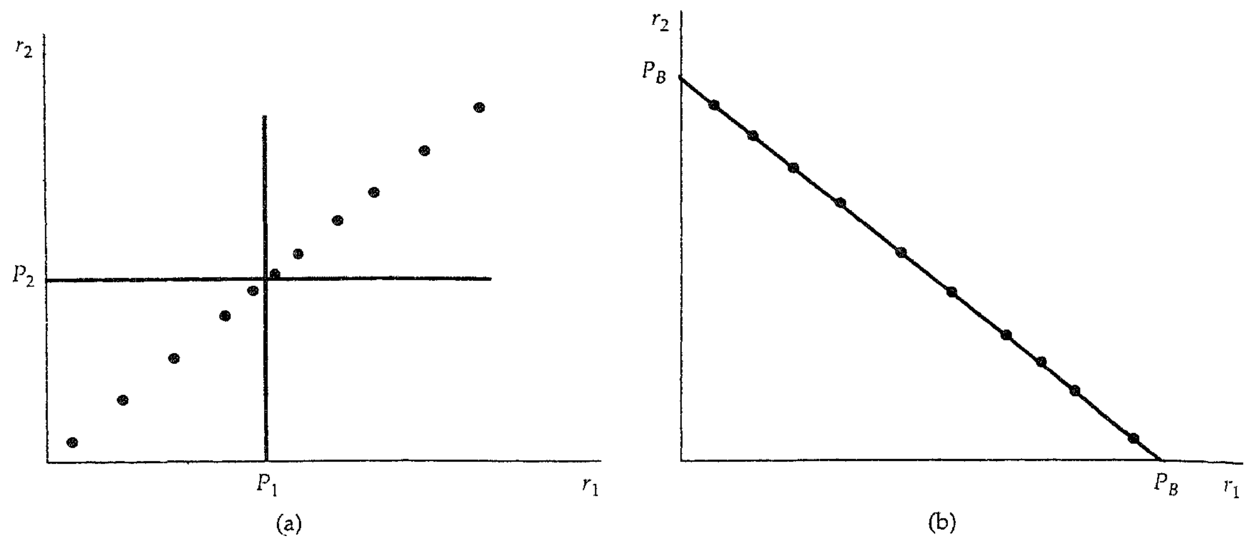


FIGURE 11.15 Reservation Prices. In (a), demands are perfectly positively correlated, so the firm does not gain by bundling. It would earn the same profit as by selling the goods separately. In (b), demands are perfectly negatively correlated. Bundling is the ideal strategy-all the consumer surplus can be extracted.

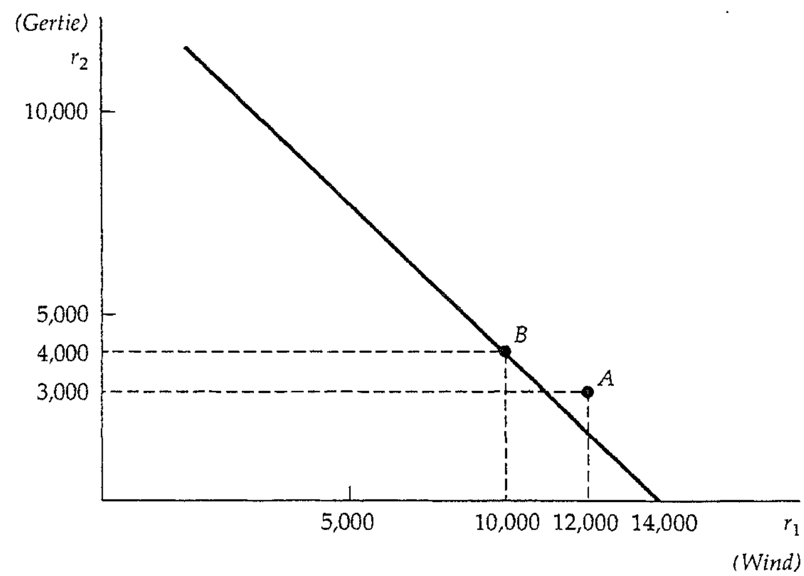


FIGURE 11.16 Movie Example. Consumers *A* and *B* are two movie theaters. The diagram shows their reservation prices for the films *Gone with the Wind* and *Getting Gertie's Garter.* Since the demands are negatively correlated, bundling pays.

Wind, but Theater *B* will pay relatively more for *Getting Gertie's Garter)* This makes it more profitable to rent the films as a bundle, priced at $14,000.

Mixed Bundling

So far, we have assumed that the firm has two options-either to sell the goods separately or as a bundle. But there is a third option, called *mixed bundling.* As the name suggests, the firm offers its products both separately and as a bundle, with a package price below the sum of the individual prices. Mixed bundling is often the ideal strategy when demands are only somewhat negatively correlated, and/or when marginal production costs are significant. (Thus far, we have assumed that marginal production costs are zero.)

In Figure 11.17, mixed bundling is the most profitable strategy. Here, demands are perfectly negatively correlated, but there are significant marginal

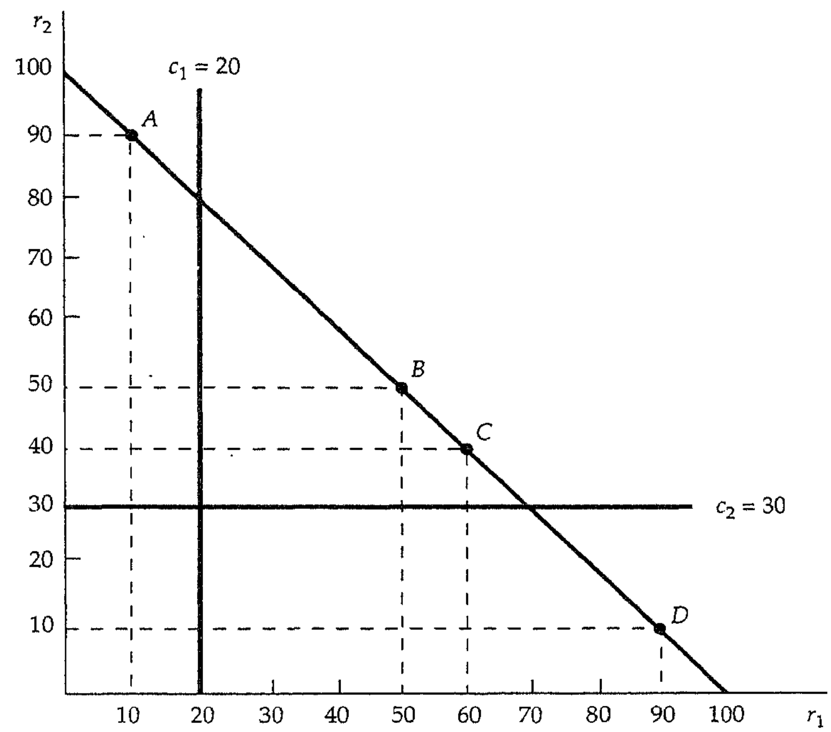


FIGURE 11.17 Mixed Versus Pure Bundling. With positive marginal costs, mixed bundling may be more profitable than pure bundling,as in this example. Consumer *A* has a reservation price for good 1 that is below marginal cost C_1, and consumer *D* has a reservation price for good 2 that is below marginal cost C_2. With mixed bundling, consumer *A* is induced to buy only good 2, and consumer *D* is induced to buy only good 1, reducing the firm's cost

costs. (The marginal cost of producing good 1 is $20, and the marginal cost of producing good 2 is $30.) Four consumers are shown, labeled *A* through *D*. Now, let's compare three strategies-selling the goods separately at prices P_1 = $50 and P_2 = $90; selling the goods only as a bundle (a strategy that we will refer to as "pure bundling") at a price of $100; or mixed bundling, where the goods are sold separately at prices $P_1 = P_2$ = $89.95, or as a bundle at a price of $100.

Table 11.3 shows these three strategies and the resulting profits. (You can try other prices for P_1, P_2 and P_B to verify that those given in the table maximize profit for each strategy.) When the goods are sold separately, only consumers *B*, *C*, and *D* buy good 1, and only consumer *A* buys good 2, so that the total profit is 3($50 - $20) + 1($90 - $30) = $150. With pure bundling, all four consumers buy the bundle for $100, so that total profit is 4($100 - $20 - $30) = $200. As we should expect, pure bundling is better than selling the goods separately because consumers' demands are negatively correlated. But what about mixed bundling? Now consumer *D* buys only good 1 for $89.95, consumer *A* buys only good 2 for $89.95, and consumers *B* and *C* buy the bundle for $100. Total profit is now ($89.95 - $20) + ($89.95 - $30) + 2($100 - $20 - $30) = $229.90.

Here, mixed bundling is the most profitable strategy, even though demands are perfectly negatively correlated (i.e., all four consumers have reservation prices on the line $r_2 = 100 - r_1$). The reason is that for each good, marginal production cost exceeds the reservation price of one consumer. For example, consumer *A* has a reservation price of $90 for good 2, but a reservation price of only $10 for good 1. Since the cost of producing a unit of good 1 is $20, the firm would prefer that consumer *A* buy only good 2, and not the bundle. It can achieve this by offering good 2 separately for a price just below consumer *A*'s reservation price, while also offering the bundle at a price acceptable to consumers *B* and *C*.

Mixed bundling would *not* be the preferred strategy in this example if marginal costs were zero, because then there would be no benefit in excluding consumer *A* from buying good 1 and consumer *D* from buying good 2. We leave it to you to demonstrate this (see Exercise 12).[19]

TABLE 11.3

	P_1	P_2	P_B	Profit
Sell separately	$50	$90		$150
Pure bundling			$100	$200
Mixed bundling	$89.95	$89.95	$100	$229.90

[19] For further discussion of bundling, see William J. Adams and Janet L. Yellin, "Commodity Bundling and the Burden of Monopoly,"*Quarterly Journal of Economics* 90 (Aug. 1976): 475-498. Sometimes a firm with monopoly power will find it profitable to bundle its product with the product of another

EXAMPLE 11.5 THE COMPLETE DINNER VS. À LA CARTE: A RESTAURANT'S PRICING PROBLEM

Many restaurants offer complete dinners as well as an a la carte menu. Why? Most customers go out to eat knowing roughly how much they are willing to spend for dinner (and choose the restaurant accordingly). However the customers that enter a restaurant have different preferences. For example, some value an appetizer highly, but could happily skip the dessert. Other customers have just the opposite preferences-they attach little value to the appetizer, but dessert is essential. And finally,some customers attach moderate values to both the appetizer and dessert. What pricing strategy lets the restaurant capture as much consumer surplus as possible from these heterogeneous customers? The answer, of course, is mixed bundling.

For a restaurant, mixed bundling means offering both complete dinners (the appetizer, main course, and dessert come as a package) and an a la carte menu (the customer buys the appetizer, main course, and dessert separately). This allows the a la carte menu to be priced to capture consumer surplus from customers who value some dishes much more highly than other dishes. (Such customers would correspond to consumers *A* and *D* in Figure 11.17.) At the same time, the complete dinner retains those customers who have lower variations in their reservation prices for different dishes (e.g., customers who attach a moderate value to both the appetizer and dessert).

For example, if the restaurant expects to attract customers willing to spend about $20 for dinner, it might charge about $5 for the appetizers, about $14 for a typical main dish, and about $4 for dessert. It could also offer a complete dinner, which includes an appetizer, main course, and dessert, for $20. Then, the customer who loves dessert but couldn't care less about an appetizer will order only the main dish and dessert, and spend $18 (and the restaurant will save the cost of preparing an appetizer). At the same time, another customer who attaches a moderate value (say, $3 or $3.50) to both the appetizer and dessert will buy the complete dinner.

Unfortunately for consumers, perhaps, creative pricing can be more important than creative cooking for the financial success of a restaurant. Successful restaurateurs know their customers' demand characteristics and use that knowledge to design a pricing strategy that extracts as much consumer surplus as possible.

firm; see Richard L. Schmalensee, "Commodity Bundling by Single-Product Monopolies," *Journal of Law and Economics* 25 (April 1982): 67-71. Bundling can also be. profitable when the products are substitutes or complements. See Arthur Lewbel, "Bundling of Substitutes or Complements," *International Journal of Industrial Organization* 3 (1985): 101-107.

Tying

Tying is a general term that refers to any requirement that products be bought or sold in some combination. Bundling is a common form of tying, but tying can also take other forms. For example, suppose a firm sells a product (such as a copying machine), the use of which requires the consumption of a secondary product (such as paper). The consumer who buys the first product is also required to buy the secondary product from the same company. This requirement is usually imposed through a contract. Note that this is different from the examples of bundling discussed earlier. In those examples, the consumer might have been happy to buy just one of the products. In this case, however, the first product is useless without access to the secondary product.

Why might firms use this kind of pricing practice? One of the main benefits of tying is that it often allows a firm to *meter demand,* and thus to practice price discrimination more effectively. For example, during the 1950s, when Xerox had a monopoly on copying machines but not on paper, customers who leased a Xerox copier also had to buy Xerox paper. This allowed Xerox to meter consumption (customers who used a machine intensively bought more paper), and thereby apply a two-part tariff to the pricing of its machines. Also during the 1950s, IBM required customers who leased its mainframe computers to use paper computer cards made only by IBM. By pricing these cards well above marginal cost, IBM was effectively charging higher prices for computer usage to customers with larger demands.[20]

Tying can also have other uses. An important one is to protect customer goodwill connected with a brand name. This is why franchises are often required to purchase inputs from the franchiser. For example, Mobil Oil requires its service stations to sell only Mobil motor oil, Mobil batteries, and so on. Similarly,until recently, a McDonald's franchisee had to purchase all materials and supplies-from the hamburgers to the paper cups-from McDonald's, thus ensuring product uniformity and protecting the brand name.[21]

*11.6 *Advertising*

We have seen how firms can utilize their market power when making pricing decisions. Pricing is important for a firm, but most firms with market power have another important decision to make: how much to advertise. In this sec-

[20] However, antitrust actions forced, IBM to discontinue this pricing practice.

[21] In some cases, the courts ruled that tying is not necessary to protect customer goodwill and is anticompetitive, so now a McDonald's franchisee can buy supplies from any McDonald's approved source. For a discussion of some of the antitrust issues involved in franchise tying, see Benjamin Klein and Lester R Saft,"The Law and Economics of Franchise Tying Contracts," *Journal of Law and Economics* 28 (May 1985): 345-361-

tion we will see how firms with market power can make profit-maximizing advertising decisions,and how those decisions depend on the characteristics of demand for the firm's product.[22]

For simplicity, we will assume that the firm sets only one price for its product. We will also assume that having done sufficient market research, it knows how its quantity demanded depends on both its price P *and* its advertising expenditures in dollars A; that is, it knows $Q(P,A)$. Figure 11.18 shows the firm's demand and cost curves with and without advertising. AR and MR are the firm's

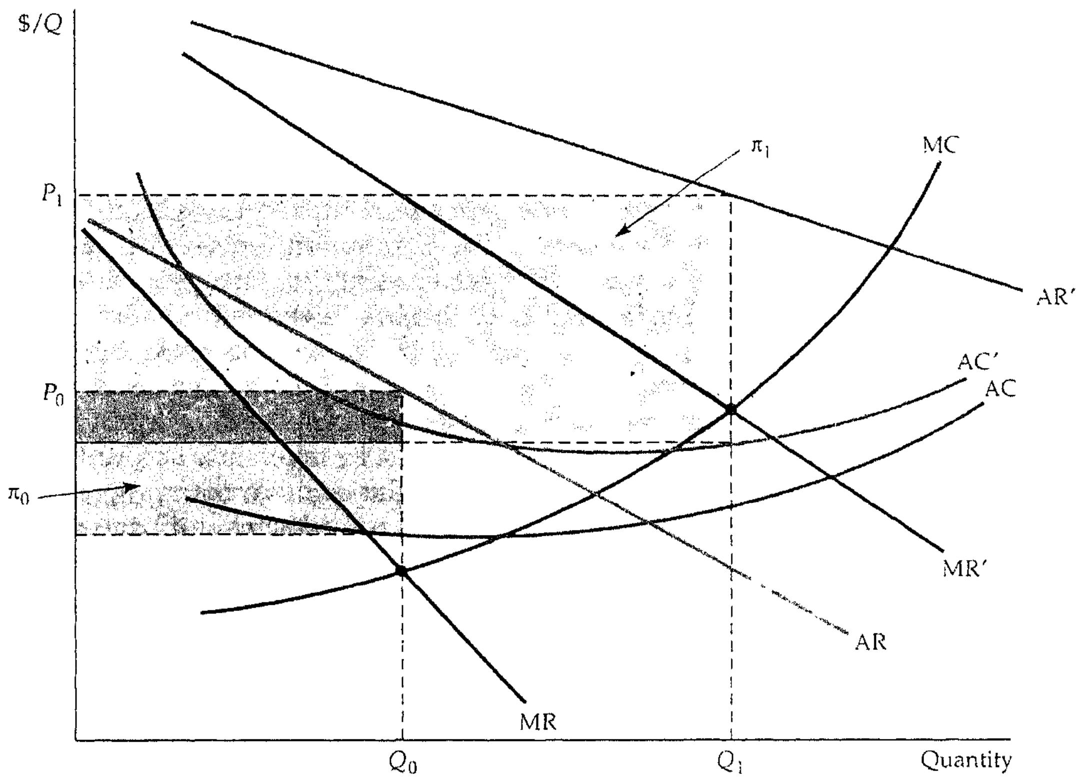


FIGURE 11.18 Effects of Advertising. AR and MR are average and marginal revenue when the firm doesn't advertise, and AC and MC are average and marginal cost. The firm produces Q_0 and receives a ricc P_0. Its total profit $\pi_0$is given by the gray-shaded rectangle. If the firm advertises, its average and marginal revenue curves shift to the right. Average cost rises (to AC'), but marginal cost remains the same. The firm now produces Q_1 (where MR' = MC), and receives a price P_1. Its total profit, π_1, is now larger.

[22] A perfectly competitive firm has little reason to advertise, since by definition it can sell as much as it produces at a market price that it takes as given. That is why itWould be unusual to see a producer of corn or soybeans advertise.

average and marginal revenue curves when it doesn't advertise, and AC and MC are its average and marginal cost curves. It produces a quantity Q_0, where MR = MC, and receives a price P_0. Its profit per unit is the difference between P_0 and average cost, so its total profit π_0 is given by the gray-shaded rectangle.

Now suppose the firm advertises. This causes its demand curve to shift out and to the right; the new average and marginal revenue curves are given by AR' and MR'. Advertising is a fixed cost, so the firm's average cost curve rises (to AC'). Marginal cost, however, remains the same. With advertising the firm produces Q_1 (where MR' = MC), and receives a price P_1. Its total profit π_1, given by the red-shaded rectangle, is now much larger.

While the firm in Figure 11.18 is clearly better off advertising, the figure does not help us determine *how much* advertising the firm should do. Our firm must choose its price P and advertising expenditure A to maximize profit, which is now given by:

$$\pi = PQ(P,A) - C(Q) - A$$

Given a price, more advertising will result in more sales, and hence more revenue. But what is the firm's profit-maximizing advertising expenditure? You might be tempted to say that the firm should increase its advertising expenditures until the last dollar of advertising just brings forth an additional dollar of revenue, that is, until the marginal revenue from advertising, $\Delta(PQ)/\Delta A$, is just equal to 1. But as Figure 11.18 shows, this reasoning omits an important element. Remember that advertising leads to increased output (in the figure, output increased from Q_0 to Q_1). But increased output in turn means increased production costs, and this must be taken into account when comparing the costs and benefits of an extra dollar of advertising.

The correct decision is to increase advertising until the marginal revenue from an additional dollar of advertising, MR_{Ads}, Just equals *the full* marginal cost of that advertising. That full marginal cost is the sum of the dollar spent directly on the advertising and the marginal production cost that results from the increased sales that advertising brings about. Thus the firm should advertise up to the point that[23]

$$MR_{Ads} = P\frac{\Delta Q}{\Delta A} = 1 + MC\frac{\Delta Q}{\Delta A} \tag{11.3}$$

$$= \textit{full} \text{ marginal cost of advertising}$$

This rule is often ignored by managers, who justify advertising budgets by comparing the expected benefits (i.e., added sales) only with the cost of the advertising. But additional sales mean increased production costs, which must also be taken into account.

[23] "To derive this using calculus, differentiate $\pi(Q,A)$ with respect to A, and set the derivative equal to zero:

$$\partial\pi/\partial A = P(\partial Q/\partial A) - MC(\partial Q/\partial A) - 1 = 0$$

Rearranging gives equation (11.3).

A Rule of Thumb for Advertising

Like the rule MR = MC, equation (11.3) is sometimes difficult to apply in practice. In Chapter 10 we saw that MR = MC implies the following rule of thumb for pricing: $(P - \text{MC})/P = -1/E_P$, where E_P is the firm's price elasticity of demand. We can combine this rule of thumb for pricing with equation (11.3) to obtain a rule of thumb for advertising.

First, rewrite equation (11.3) as follows:

$$(P - \text{MC})\frac{\Delta Q}{\Delta A} = 1$$

Now multiply both sides of this equation by A/PQ, the *advertising-to-sales ratio:*

$$\frac{P - \text{MC}}{P}\left[\frac{A}{Q}\frac{\Delta Q}{\Delta A}\right] = \frac{A}{PQ}$$

The term in brackets, $(A/Q)(\Delta Q/\Delta A)$, is the *advertising elasticity of demand,* i.e., the percentage change in the quantity demanded that results from a 1 percent increase in advertising expenditures. We will denote this elasticity by E_A. Since $(P - \text{MC})/P$ must equal $-1/E_P$, we can rewrite this equation as follows:

$$\boxed{A/PQ = -(E_A/E_P)} \qquad (11.4)$$

Equation (11.4) is a rule of thumb for advertising. It says that to maximize profit, the firm's advertising-to-sales ratio should be equal to minus the ratio of the advertising and price elasticities of demand. Given information (from, say, market research studies) on these two elasticities, the firm can use this rule to check that its advertising budget is not too small or too large.

To put this rule into perspective, assume that a firm is generating sales revenue of $1,000,000 per year while allocating only $10,000 (1% of its revenues) to advertising. The firm knows that its advertising elasticity of demand is .2, so that a doubling of its advertising budget from $10,000 to $20,000 should increase sales by 20%. The firm also knows that the price elasticity of demand for its product is -4. Should the firm increase its advertising budget, knowing that with a price elasticity of demand of –4, its markup of price over marginal cost is substantial? The answer is yes; equation (11.4) tells us that the firm's advertising-to-sales ratio should be -(.2/-4) = 5%, so the firm should increase its advertising budget from $10,000 to $50,000.

This rule makes intuitive sense. It says firms should advertise a lot if (i) demand is very sensitive to advertising (E_A is large), or (ii) demand is not very price elastic (E_P is small). While (i) is obvious, why should firms advertise more when the price elasticity of demand is small? The reason is that a small elasticity of demand implies a large markup of price over marginal cost, so that the marginal profit from each extra unit sold is high. In this case, if advertising can help sell a few more units, it will be worth its cost.[24]

EXAMPLE 11.6 ADVERTISING: SUPERMARKETS TO DESIGNER JEANS

In Example 10.1 we looked at the use of markup pricing by supermarkets, convenience stores, and makers of designer jeans, and saw how in each case the markup of price over marginal cost depended on the firm's price elasticity of demand. Now lets see why these firms, and also producers of laundry detergent, advertise as much (or as little) as they do.

First, supermarkets. We said that the price elasticity of demand for a typical supermarket is around -10. To determine the advertising-to-sales ratio, we also need to know the advertising elasticity of demand. This number can vary considerably depending on what part of the country the supermarket is in, and whether it is in a city, suburb, or rural area, but 0.1 to 0.3 would be a reasonable range. Substituting these numbers into equation (11.4), we find that the manager of a typical supermarket should have an advertising budget that is around 1 to 3 percent of sales-which is indeed what many supermarkets spend on advertising.

Convenience stores have lower price elasticities of demand (around -5), but their advertising-to-sales ratios are usually less than those for supermarkets (and are often zero). Why? Because convenience stores mostly serve customers who live nearby,. and might need a few items late at night, or don't want to drive to the supermarket. These customers already know about the convenience store and are unlikely to change their buying habits if the store advertises. Hence E_A is very small, and advertising is not worthwhile.

Advertising is quite important for makers of designer jeans, who will have advertising-to-sales ratios as high as 10 or 20 percent. We said that price elasticities of demand in the range of -3 to -4 are typical for the major labels, and advertising elasticities of demand can range from .3 to as high as 1. (Advertising is important in making consumers aware of the label and giving it an aura and image.) So, these levels of advertising would seem to make sense.

Laundry detergents have among the very highest advertising-to-sales ratios, sometimes exceeding 30 percent, even though demand for any one brand is at least as price elastic as it is for designer jeans. What justifies all the advertising? The answer is a very large advertising elasticity. The demand for

[24]Advertising often affects the price elasticity of demand, and this must be taken into account by the firm. For some products, advertising broadens the market by attracting a large range of customers, or creating a bandwagon effect. This is likely to make demand more price elastic than it would have been otherwise. (But E_A is likely to be large, so that advertising will still be worthwhile.) Sometimes advertising is used to differentiate a product from others (by creating an image, allure, or brand identification), so that its demand is less price elastic than it would otherwise be.

any one brand of laundry detergent depends crucially on advertising; without it, consumers would have little basis for selecting any one brand.[25]

Summary

1. Firms with market power are in an enviable position because they have the potential to earn large profits, but realizing that potential may depend critically on the firm's pricing strategy. Even if the firm sets a single price, it needs an estimate of the elasticity of demand for its output. More complicated strategies, which can involve setting several different prices, require even more information about demand.
2. A pricing strategy aims to enlarge the customer base that the firm can sell to, and capture as much consumer surplus as possible. There are a number of ways to do this, and they usually involve setting more than a single price.
3. Ideally, the firm would like to perfectly price discriminate, i.e., charge each customer his or her reservation price. In practice this is almost always impossible. On the other hand, various forms of imperfect price discrimination are often used to increase profits.
4. The two-part tariff is another means of capturing consumer surplus. Customers must pay an "entry" fee, which allows them to buy the good at a per-unit price. The two-part tariff is most effective when customer demands are relatively homogeneous.
5. When demands are heterogeneous and negatively correlated, bundling can increase profits. With pure bundling, two or more different goods are sold only as a package. With mixed bundling, the customer can buy the goods individually or as a package.
6. Bundling is a special case of tying, a requirement that products be bought or sold in some combination. Tying can be used to meter demand or to protect customer goodwill associated with a brand name.
7. Advertising can further increase profits. The profit-maximizing advertising-to-sales ratio is equal in magnitude to the ratio of the advertising and price elasticities of demand.

Questions for Review

1. Suppose a firm can practice perfect,first-degree price discrimination. What is the lowest price it will charge, and what will its total output be?

2. How does a car salesperson practice price discrimination? How does the ability to discriminate correctly affect his or her earnings?

[25] For an overview of statistical approaches to estimating the advertising elasticity of demand, see Ernst R. Berndt, *The Practice of Econometrics* (Reading, Mass: Addison-Wesley 1990), Chapter 8.

3. Electric utilities often practice second-degree price discrimination. Why might this improve consumer welfare?

4. Give some examples of third-degree price discrimination. Can third-degree price discrimination be effective if the different groups of consumers have different levels of demand but the same price elasticities?

5. Show why optimal, third-degree price discrimination requires that marginal revenue for each group of consumers equals marginal cost. Use this condition to explain how a firm should change its prices and total output if the demand curve for one group of consumers shifted outward, so that marginal revenue for that group increased.

6. How is peak-load pricing a form of price discrimination? Can it make consumers better off? Give an example.

7. How can a firm determine an optimal two-part tariff if it has two customers with different demand curves? (Assume that it knows the demand curves.)

8. Why is the pricing of a Gillette safety razor a form of a two-part tariff? Must Gillette be a monopoly producer of its blades as well as its razors? Suppose you were advising Gillette on how to determine the two parts of the tariff. What procedure would you suggest?

9. Why did Loews bundle *Gone with the Wind* and *Getting Gertie's Garter*? What characteristic of demands is needed for bundling to increase profits?

10. How does mixed bundling differ from pure bundling? Under what conditions is mixed bundling preferred to pure bundling? Why do many restaurants practice mixed bundling (by offering a complete dinner as well as an a la carte menu), instead of pure bundling?

11. How does tying differ from bundling? Why might a firm want to practice tying?

12. Why is it incorrect to advertise up to the point that the last dollar of advertising expenditures generates another dollar of sales? What is the correct rule for the marginal advertising dollar?

13. How can a firm check that its advertising-to-sales ratio is not too high or too low? What information would it need?

Exercises

1. Price discrimination requires the ability to sort customers and the ability to prevent arbitrage. Explain how the following can function as price discrimination schemes and discuss both sorting and arbitrage:

a. requiring airline travelers to spend at least one Saturday night away from home to qualify for a low fare.

b. insisting on delivering cement to buyers, and basing prices on buyers' locations.

c. selling food processors along with coupons that can be sent to the manufacturer to obtain a $10 rebate.

d. offering temporary price cuts on bathroom tissue.

e. charging high-income patients more than low-income patients for plastic surgery.

2. If the demand for drive-in movies is more elastic for couples than for single individuals, it will be optimal for theaters to charge one admission fee for the driver of the car and an extra fee for passengers. True or False? Explain.

3. When pricing automobiles for wholesale delivery to dealers, American car companies typically charge a much higher percentage markup over cost for "luxury option" items (such as vinyl roof, carpeting, decorative trim, etc.) than for the car itself or for more "basic" options such as power steering and automatic transmission. Explain why

4. Suppose that BMW can produce any quantity of cars at a constant marginal cost equal to $15/000 and a fixed cost of $20 million. You are asked to advise the CEO as to what prices and quantities BMW should set for sales in Europe and in the U.S. The demand for BMWs in each market is given by:

$$Q_E = 18{,}000 - 400P_E \text{ and } Q_U = 5500 - 100P_U$$

where the subscript E denotes Europe, the subscript u denotes the United States, and all prices and costs are in thousands of dollars. Assume that BMW can restrict U.S. sales to authorized BMW dealers only.

a. What quantity of BMWs should the firm sell in each market and what will the price be in each market? What is the total profit?

b. If BMW were forced to charge the same price in each market, what would be the quantity sold in each market, the equilibrium price, and the company's profit?

5. A monopolist is deciding how to allocate output between two markets. The two markets are separated geographically (East Coast and Midwest). Demand and marginal revenue for the two markets are:

$$P_1 = 15 - Q_1 \qquad MR_1 = 15 - 2Q_1$$
$$P_2 = 25 - 2Q_2 \qquad MR_2 = 25 - 4Q_2$$

The monopolist's total cost is $C = 5 + 3(Q_1 + Q_2)$. What are price, output, profits, marginal revenues, and d(\d\ jight loss (i) if the monopolist can price discriminate? (ii) if the law prohibits charging different prices in the two regions?

* **6.** Elizabeth Airlines (EA) flies only one route: Chicago-Honolulu. The demand for each flight on this route is $Q = 500 - P$. Elizabeth's cost of running each flight is \$30,000 plus \$100 per passenger.

a. What is the profit-maximizing price EA will charge? How many people will be on each flight? What is EAs profit for each flight?

b. Elizabeth learns that the fixed costs per flight are in fact \$41,000 instead of \$30,000. Will she stay in this business long? Illustrate your answer using a graph of the demand curve that EA faces, EA's average cost curve when fixed costs are \$30/000, and EAs average cost curve when fixed costs are \$41,000.

c. Wait! Elizabeth finds out that two different types of people fly to Honolulu. Type A is business people with a demand of $Q_A = 260 - 0.4P$. Type B is students whose total demand is $Q_B = 240 - 0.6P$. The students are easy to spot, so Elizabeth decides to charge them different prices. Graph each of these demand curves and the horizontal sum of them. What price does Elizabeth charge the students? What price does she charge the other customers? How many of each type are on each flight?

d. What would EAs profit be for each flight? Would she stay in business? Calculate the consumer surplus of each consumer group. What is the total consumer surplus?

e. Before EA started price discriminating, how much consumer surplus was the Type A demand getting from air travel to Honolulu? Type B? Why did the total surplus decline with price discrimination,even though the total quantity sold was unchanged?

7. Many retail video stores offer two alternative plans for renting films:

a. A two-part tariff: Pay an annual membership fee (e.g., \$40), and then pay a small fee for the daily rental of each film (e.g., \$2 per film per day).

b. A straight rental fee: Pay no membership fee, but pay a higher daily rental fee (e.g., \$4 per film per day).

What is the logic behind the two-part tariff in this case? Why offer the customer a choice of two plans, rather than simply a two-part tariff?

8. Sal's satellite company broadcasts TV to subscribers in Los Angeles and New York. The demand functions for each of these two groups are

$$Q_{NY} = 50 - (1/3)P_{NY}$$
$$Q_{LA} = 80 - (2/3)P_{LA}$$

where Q is in thousands of subscriptions per year, and P is the subscription price per year. The cost of providing Q units of service is given by

$$C = 1000 + 30Q$$

where $Q = Q_{NY} + Q_{LA}$.

a. What are the profit-maximizing prices and quantities for the N.Y and L.A. markets?

b. As a consequence of a new satellite that the Pentagon recently deployed, people in Los Angeles receive Sal's New York broadcasts, and people in New York receive Sal's Los Angeles broadcasts. As a result, anyone in New York or Los Angeles can receive Sal's broadcasts by subscribing in either city. Hence Sal can only charge a single price. What price should he charge, and what quantities will he sell in N.Y and L.A.?

c. In which of the above situations, (a) or (b), is Sal better off? In terms of consumer surplus, which situation do people in New York prefer and which do people in Los Angeles prefer? Why?

* **9.** You are an executive for Super Computer, Inc. (SC), which rents out super computers. SC receives a fixed rental payment per time period in exchange for the right to unlimited computing at a rate of P cents per second. SC has two types of potential customers of equal number-ten businesses and ten academic institutions. Each business customer has the demand function $Q = 10 - P$, where Q is in millions of seconds per month; each academic institution has the demand $Q = 8 - P$. The marginal cost to SC of additional computing is two cents per second, no matter what the volume.

a. Suppose that you could separate business and academic customers. What rental fee and usage fee would you charge each group? What are your profits?

b. Suppose you were unable to keep the two types of customers separate, and you charged a zero rental fee. What usage fee maximizes your profits? What are your profits?

c. Suppose you set up one two-part tariff; that is, you set one rental and one usage fee that both business and academic customers face. What usage and rental fees will you set? What are your profits? Explain why price is not equal to marginal cost.

10. As the owner of the only tennis club in an isolated wealthy community, you must decide on membership dues and fees for court time. There are two types of tennis players. "Serious" players have demand

$$Q_1 = 6 - P$$

where Q_1 is court hours per week and P is the fee per hour for each individual player. There are also "occasional" players with demand

$$Q_2 = 3 - (1/2)P$$

Assume that there are 1000 players of each type. You have plenty of courts, so that the marginal cost of court time is zero. You have fixed costs of $5000 per week. Serious and occasional players look alike, so you must charge them the same prices.

a. Suppose that to maintain a "professional" atmosphere, you want to limit membership to serious players. How should you set the *annual* membership dues and court fees (assume 52 weeks per year) to maximize profits, keeping in mind the constraint that only serious players choose to join? What are profits (per week)?

b. A friend tells you that you could make greater profits by encouraging both types of players to join. Is the friend right? What annual dues and court fees would maximize weekly profits? What would these profits be?

c. Suppose that over the years young, upwardly mobile professionals move to your community, all of whom are serious players. You believe there are now 3000 serious players and 1000 occasional players. Is it still profitable to cater to the occasional player? What are the profit-maximizing annual dues and court fees? What are profits per week?

11. Figure 11.12 shows the reservation prices of three consumers for two goods. Assuming that marginal production cost is zero for both goods, can the producer make the most money by selling the goods separately, by bundling, or by "mixed" bundling (i.e., offering the goods separately or as a bundle)? What prices should be charged?

12. Go back to the example in Figure 11.17. Suppose the marginal costs C_1 and C_2 were zero. Show that in this case pure bundling is the most profitable pricing strategy, and not mixed bundling. What price should be charged for the bundle, and what will the firm's profit be?

13. On October 22,1982, an article appeared in the *New York Times* about IBM's pricing policy. The previous day IBM had announced major price cuts on most of its small and medium-sized computers. The article said:

> "IBM probably has no choice but to cut prices periodically to get its customers to purchase more and lease less. If they succeed, this could make life more difficult for IBM's major competitors. Outright purchases of computers are needed for ever larger IBM revenues and profits, says Morgan Stanley's Ulric Well in his new book. *Information Systems in the '80*'s. Mr. Weil declares that IBM cannot revert to an emphasis on leasing."

a. Provide a brief but clear argument *in support* of the claim that IBM should try "to get its customers to purchase more and lease less."

b. Provide a brief but clear argument *against* this claim.
c. What factors determine whether leasing or selling is preferable for a company like IBM? Explain briefly.

14. You are selling two goods, 1 and 2, to a market consisting of three consumers with reservation prices as follows:

	Reservation Price ($)	
Consumer	for 1	for 2
A	10	70
B	40	40
C	70	10

The unit cost of each product is $20.
a. Compute the optimal prices and profits for (i) selling the goods separately, (ii) pure bundling, and (iii) mixed bundling.
b. Which strategy is most profitable? Why?

15. Your firm produces two products, the demands for which are independent. Both products are produced at zero marginal cost. You face four consumers (or groups of consumers) with the following reservation prices:

Consumer	Good 1 ($)	Good 2 ($)
A	30	90
B	40	60
C	60	40
D	90	30

a. Consider three alternative pricing strategies: (i) selling the goods separately; (ii) pure bundling; (iii) mixed bundling. For *each strategy,* determine the optimal prices to be charged and the resulting profits. Which strategy is best?
b. Now suppose the production of each good entails a marginal cost of $35. How does this change your answers to (a)? Why is the optimal strategy now different?

***16.** Consider a firm with monopoly power that faces the demand curve

$$P = 100 - 3Q + 4A^{1/2}$$

and has the total cost function

$$C = 4Q^2 + 10Q + A$$

where A is the level of advertising expenditures, and P and Q are price and output.
a. Find the values of A, Q, and P that maximize this firm's profit.
b. Calculate the Lerner index of monopoly power, $L = (P - MC)/P$, for this firm at its profit-maximizing levels of A, Q, and P.

APPENDIX TO CHAPTER 11

Transfer Pricing in the Integrated Firm

So far we have studied the firm's pricing decision assuming that it sells its output in an *outside market,* i.e., to consumers or to other firms. Many firms, however, are *vertically integrated*-they contain several divisions, with some divisions producing parts and components that other divisions use to produce the finished product.[1] For example, each of the major U.S. automobile companies has "upstream" divisions that produce engines, brakes, radiators, and other components that the "downstream" divisions use to produce the finished products. *Transfer pricing* refers to the valuation of these parts and components within the firm. *Transfer prices* are internal prices at which the parts and components front upstream divisions are "sold" to downstream divisions. Transfer prices must be chosen correctly because they are the signals that divisional managers use to determine output levels.

This appendix shows how a profit-maximizing firm chooses its transfer prices and divisional output levels. We will also examine other issues raised by vertical integration. For example, suppose a computer firm's upstream division produces memory chips that are used by a downstream division to produce the final product. If other firms also produce these chips, should our firm obtain all its chips from the upstream division, or should it also buy some on the outside market? Should the upstream division produce more chips than are needed by the downstream division, selling the excess in the market? And how should the firm coordinate the upstream and downstream divisions? In particular, can we design incentives for the divisions, so that the firm's profit is maximized?

We begin with the simplest case-there is no outside market for the output of the upstream division, i.e., the upstream division produces a good that is neither produced nor used by any other firm. Next we consider what happens when there is an outside market for the upstream division's output.

Transfer Pricing When There Is No Outside Market

Consider a firm that has three divisions: Two upstream divisions produce inputs to a downstream processing division. The two upstream divisions pro-

[1] A firm is *horizontally integrated* when it has several divisions that produce the same product or closely related products. Many firms are both vertically and horizontally integrated.

duce quantities Q_1 and Q_2 and have total costs $C_1(Q_1)$ and $C_2(Q_2)$. The downstream division produces a quantity Q using the production function

$$Q=f(K,L,Q_1,Q_2)$$

where K and L are capital and labor inputs, and Q_1 and Q_2 are the intermediate inputs from the upstream divisions. Excluding the costs of the inputs Q_1 and Q_2, the downstream division has a total production cost $C_d(Q)$. The total revenue from sales of the final product is $R(Q)$.

We assume there are *no outside markets* for the intermediate inputs Q_1 and Q_2. (They can be used only by the downstream division.) Then the firm has two problems. First, what quantities Q_1, Q_2, and Q maximize its profit? Second, is there an incentive scheme that will decentralize the firm's management? In particular, is there a set of transfer prices P_1 and P_2, so that *if each division maximizes its own divisional profit, the profit of the overall firm will also be maximized*?

To solve these problems, note that the firm's total profit is

$$\pi(Q) = R(Q) - C_d(Q) - C_1(Q_1) - C_2(Q_2) \qquad \text{(A11.1)}$$

Now, what is the level of Q_1 that maximizes this profit? It is the level at which *the cost of the last unit of Q_1 is just equal to the additional revenue it brings to the firm.* The cost of producing one extra unit of Q_1 is the marginal cost $\Delta C_1/\Delta Q_1 = MC_1$. How much extra revenue results from the unit? An extra unit of Q_1 allows the firm to produce more final output Q of an amount $\Delta Q/\Delta Q_1 = MP_1$, the marginal product of Q_1. An extra unit of final output results in additional revenue $\Delta R/\Delta Q = MR$,but it also results in additional cost to the downstream division, of an amount $\Delta C_d/\Delta Q = MC_d$. Thus, the *net marginal revenue* NMR_1 that the firm earns from an extra unit of Q_1 is $(MR - MC_d)MP_1$. Setting this equal to the marginal cost of the unit, we obtain the following rule for profit maximization:[2]

$$\boxed{NMR_1 = (MR - MC_d)MP_1 = MC_1} \qquad \text{(A11.2)}$$

Going through the same steps for the second intermediate input gives

$$\boxed{NMR_2 = (MR - MC_d)MP_2 = MC_2} \qquad \text{(A11.3)}$$

Note from equations (A11.2) and (A11.3) that it is *incorrect* to determine the firm's final output level Q by setting marginal revenue equal to marginal cost for the downstream division, i.e., by setting $MR = MC_d$. Doing so ignores the cost of producing the intermediate input. (MR exceeds MC_d because this cost

[2] Using calculus,we can obtain this by differentiating equation (A11.1) with respect to Q_1:

$$\begin{aligned} d\pi/dQ_1 &= (dR/dQ)(\partial Q/\partial Q_1) - (dC_d/dQ)(\partial Q/\partial Q_1) - dC_1/dQ_1 \\ &= (MR - MC_d)MP_1 - MC_1 \end{aligned}$$

Setting $d\pi/dQ = 0$ maximize profit gives equation (A11.2).

is positive.) Also, note that equations (All.2) and (All.3) are standard conditions of marginal analysis-the output of each upstream division should be such that its marginal cost is equal to its marginal contribution to the profit of the overall firm.

Now, what transfer prices P_1 and P_2 should be "charged" to the downstream division for its use of the intermediate inputs? Remember that if each of the three divisions uses these transfer prices to maximize its own divisional profit, the profit of the overall firm should be maximized. The two upstream divisions will maximize their divisional profits, π_1 and π_2, which are given by

$$\pi_1 = P_1Q_1 - C_1(Q_1)$$

and

$$\pi_2 = P_2Q_2 - C_2(Q_2)$$

Since the upstream divisions take P_1 and P_2 as given, they will choose Q_1 and Q_2 so that $P_1 = MC_1$ and $P_2 = MC_2$. Similarly, the downstream division will maximize

$$\pi(Q) = R(Q) - C_d(Q) - P_1Q_1 - P_2Q_2$$

Since the downstream division also takes P_1 and P_2 as given, it will choose Q_1 and Q_2 so that

$$(MR - MC_d)MP_1 = NMR_1 = P_1 \qquad \text{(A11.4)}$$

and

$$(MR - MC_d)MP_2 = NMR_2 = P_2 \qquad \text{(All-5)}$$

Note that by setting the transfer prices equal to the respective marginal costs ($P_1 = MC_1$ and $P_2 = MC_2$), the profit-maximizing conditions given by equations (All.2) and (All.3) will be satisfied. We therefore have a simple solution to the transfer pricing problem: *Set each transfer price equal to the marginal cost of the respective upstream division.* Then when each division is told to maximize its own profit, the, quantities Q_1 and Q_2 that the upstream divisions will want to produce will be the same quantities that the downstream division will want to "buy," and they will maximize the total profit of the firm.

We can illustrate this graphically with the following example. Race Car Motors, Inc., has two divisions. The upstream Engine Division produces engines, and the downstream Assembly Division puts together automobiles, using one engine (and a few other parts) in each car. In Figure All.1, the average revenue curve AR is Race Car Motors' demand curve for cars. (Note that the firm has monopoly power in the automobile market) MC_A is the marginal cost of assembling automobiles, *given the engines* (i.e., it does not include the cost of the engines). Since the car requires one engine, the marginal product of the engines is one, so that the curve labeled MR - MC_A is also the net marginal revenue curve for engines: $NMR_E = (MR_E - MC_A)MP_E = MR - MC_A$.

The profit-maximizing number of engines (and number of cars) is given by the intersection of the net marginal revenue curve NMR_E with the marginal

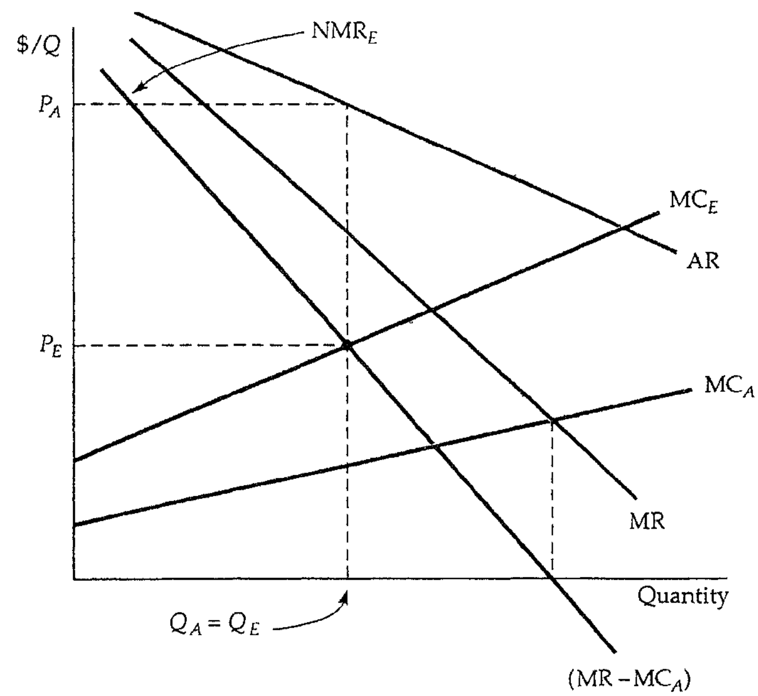


FIGURE A11.1 Race Car Motors, Inc. The firm's upstream division should produce a quantity of engines Q_E that equates its marginal cost of engine production MC_E with the downstream division's net marginal revenue of engines NMR_E. Since the firm uses one engine in every car, NMR_E is the difference between the marginal revenue from selling cars and the marginal cost of assembling them, i.e., MR - MC_A. The optimal transfer price for engines P_E equals the marginal cost of producing them. Finished cars are sold at price P_A.

cost curve for engines MC_E. Having determined the number of cars it will produce, and knowing its divisional cost functions, the management of Race Car Motors can now set the transfer price P_E that correctly values the engines used to produce its cars. It is this transfer price that should be used to calculate divisional profit (and year-end bonuses for the divisional managers).

Transfer Pricing with a Competitive Outside Market

Now suppose there is a *competitive* outside market for the intermediate good produced by an upstream division. Since the outside market is competitive, there is a single market price at which one can buy or sell the good. Therefore, *the marginal cost of the intermediate good is simply the market price.* Since the optimal transfer price must equal marginal cost, it must also equal the competitive market price.

To see this, suppose there is a competitive market for the engines that Race Car Motors produces. If the market price is low. Race Car Motors may want to buy some or all of its engines in the market; if it is high, it may want to sell engines in the market. Figure All.2 illustrates the first case. For quantities below $Q_{E,1}$, the upstream division's marginal cost of producing engines MC_E is below the market price $P_{E,M}$, and for quantities above $Q_{E,1}$ it is above the market price. The firm should obtain engines at least cost, so the marginal cost of engines MC^*_E is the upstream division's marginal cost for quantities up to $Q_{E,1}$ and the market price for quantities above $Q_{E,1}$. Note that Race Car Motors uses more engines and produces more cars than it would have had there not been an outside engine market. The downstream division now buys $Q_{E,2}$ engines and produces an equal number of automobiles. However, it "buys" only $Q_{E,1}$ of these engines from the upstream division, and buys the rest on the open market.

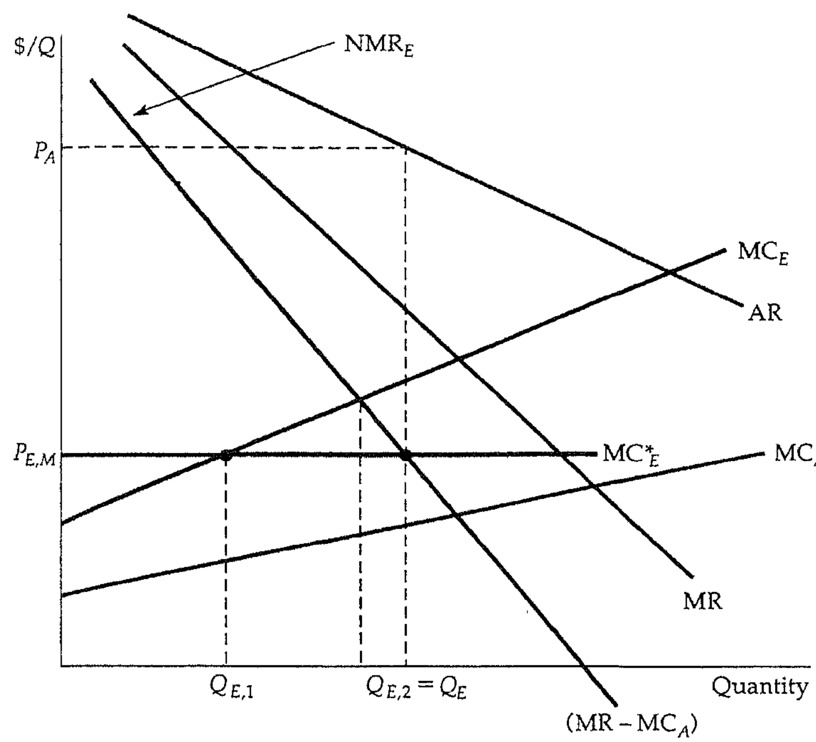


FIGURE A11.2 .Race Car Motors Buys Engines in a Competitive Outside Market. The firm's marginal cost of engines MC^*_E is the upstream division's marginal cost for quantities up to $Q_{E,1}$ and the market price PE,M for quantities above $Q_{E,1}$. The downstream division should use a total of $Q_{E,2}$ engines to produce an equal number of cars; then the marginal cost of engines equals net marginal revenue. $Q_{E,2}$- $Q_{E,1}$ of these engines are bought in the outside market. The upstream division "pays" the downstream division the transfer price $P_{E,M}$ for the remaining $Q_{E,1}$ engines.

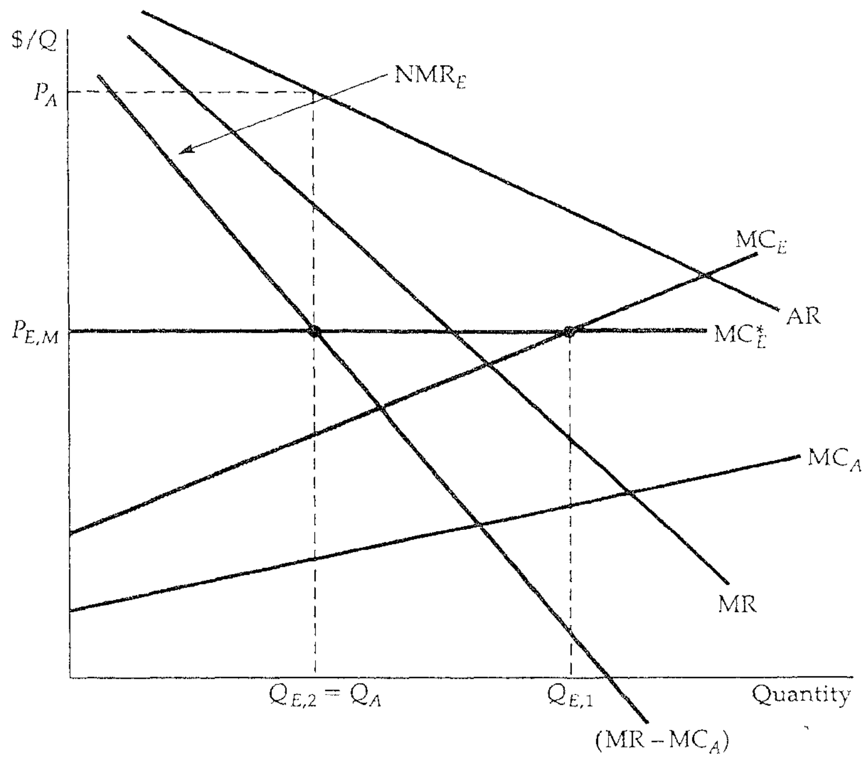


FIGURE A11.3 Race Car Motors Sells Engines in a Competitive Outside Market. The optimal transfer price is again, the market price $P_{E,M}$. This price is above the point at which MC_E intersects NMR_E so the upstream division sells some of its engines in the outside market. The upstream division produces $Q_{E,1}$ engines, the quantity at which MC_E equals $P_{E,M}$. The downstream division uses only $Q_{E,2}$ of these, the quantity at which NMR_E equals $P_{E,M}$. Compared with Figure A11.1, in which there is no outside market, more engines but fewer cars are produced.

It might appear strange that Race Car Motors should have to go into the open market to buy engines, when it can make those engines itself. If it made all its own engines, however, its marginal cost of producing engines would exceed the competitive market price, and although the profit of the upstream division would be higher, *the total profit of the firm would be lower.*

Figure A11.3 shows the case where Race Car Motors *sells* engines in the outside market. Now the competitive market price $P_{E,M}$ is above the transfer price that the firm would have set had there not been an outside market. In this case the upstream Engine Division produces $Q_{E,1}$ engines, but only $Q_{E,2}$ engines are used by the downstream division to produce automobiles. The rest are sold in the outside market at the price $P_{E,M}$.

Note that compared with a situation in which there is no outside engine market. Race Car Motors is producing more engines but fewer cars. Why not produce this larger number of engines, but use all of them to produce more cars? Because the engines are too valuable. On the margin, the net revenue that can be earned from selling them in the outside market is higher than the net revenue from using them to build additional cars.

Transfer Pricing with a Noncompetitive Outside Market

Now suppose there is an outside market for the output of the upstream division, but that market is not competitive-the firm has monopoly power. The same principles apply, but we must be careful when measuring net marginal revenue.

Suppose the engine produced by the upstream Engine Division is a special one that only Race Car Motors can make. There is an outside market for this engine, however, so Race Car Motors can be a monopoly supplier to that market and can also produce engines for its own use. What is the optimal transfer price for use of the engines by the downstream division, and at what price (if any) should engines be sold in the outside market?

We must find the firm's net marginal revenue from the sale of engines. In Figure A11.4, $D_{E,M}$ is the outside market demand curve for engines, and $MR_{E,M}$ is the corresponding marginal revenue curve. Race Car Motors therefore has two sources of marginal revenue from the production and sale of an additional engine-the marginal revenue $MR_{E,M}$ from sales in the outside market and the net marginal revenue ($MR - MC_A$) from the use of the engines by the downstream division. By summing these two curves horizontally, we obtain the *total net marginal revenue curve for engines',* it is the gray line labeled NMR_E.

The intersection of the marginal cost and total net marginal revenue curves gives the quantity of engines $Q_{E,1}$ that the upstream division should produce and the optimal transfer price P^*_E (Again, the optimal transfer price is equal to marginal cost.) But note that only $Q_{E,2}$ of these engines are used by the downstream division to make cars. (This is the quantity at which the downstream division's net marginal revenue, $MR - MC_A$, is equal to the transfer price P^*_E) The remaining engines $Q_{E,3}$ are sold in the outside market. However, they are not sold at the transfer price P^*_E., Instead the firm exercises its monopoly power and sells them at the higher price $P_{E,M}$.

Why pay the upstream division only P^*_E per engine when the firm is selling engines in the outside market at the higher price $P_{E,M}$? Because if the upstream division is paid more than P^*_E(and thereby encouraged to produce more engines), the marginal cost of engines will rise and exceed the net marginal revenue from their use by the downstream division. And if the price charged in the outside market were lowered, the marginal revenue from sales in that market would fall below marginal cost. At the prices P^*_E and $P_{E,M}$, marginal revenues and marginal cost are equal: $MR_{E,M} = (MR - MC_A) = MC_E$.

A Numerical Example

Suppose Race Car Motors has the following demand for its automobiles:

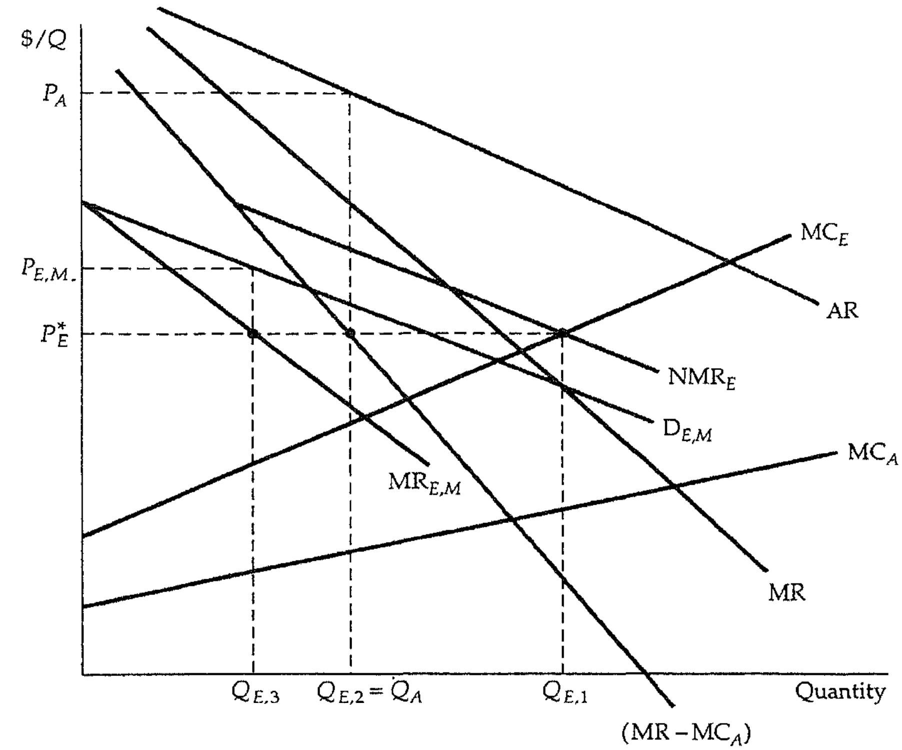


FIGURE A11.4 Race Car Motors Is a Monopoly Supplier of Engines to an Outside Market. $D_{E,M}$ is the outside market demand curve for engines, $MR_{E,M}$ is the corresponding marginal revenue curve, and (MR - MC_A) is the net marginal revenue from the use of engines by the downstream division. The *total net marginal revenue curve for engines* NMR_E is the horizontal sum of these two marginal revenues. The optimal transfer price P^*_E and the quantity of engines that the upstream division produces $Q_{E,1}$ are found where $MC_E = NMR_E$. $Q_{E,2}$ of these engines are used by the downstream division, the quantity at which the downstream division's net marginal revenue, MR - MC_A, is equal to the transfer price PI. The remaining engines $Q_{E,3}$ are sold in the outside market at the price $P_{E,M}$.

$$P = 20{,}000 - Q$$

so that its marginal revenue is

$$MR == 20{,}000 - 2Q$$

The downstream division's cost of assembling cars is

$$C_A(Q) = 8{,}000Q$$

so that the division's marginal cost is $MC_A = 8{,}000$. The upstream division's cost of producing engines is

$$C_E(Q_E) = 2Q_E^2$$

so that the division's marginal cost is $MC_E(Q_E) = 4Q_E$.

(a) First, suppose there is *no outside market* for the engines. How many engines and cars should the firm produce, and what should the transfer price for engines be? To solve this problem, we set the net marginal revenue for engines equal to the marginal cost of producing engines. Since each car has one engine, $Q_E = Q$, and the net marginal revenue of engines is

$$NMR_E = MR - MC_A = 12{,}000 - 2Q_S$$

Now set NMR_E equal to MC_E:

$$12{,}000 - 2Q_E = 4Q_E$$

so that $6Q_E = 12{,}000$, and $Q_E = 2{,}000$. The firm should therefore produce 2,000 engines and 2,000 cars. The optimal transfer price is the marginal cost of these 2,000 engines: $P_E = 4Q_E = \$8{,}000$.

(b) Now suppose that engines can be bought or sold for \$6,000 in an *outside competitive market.* This is below the \$8,000 transfer price that is optimal when there is no outside market, so the firm should buy some engines outside. Its marginal cost of engines, and the optimal transfer price, is now \$6,000. Set this \$6,000 marginal cost equal to the net marginal revenue of engines:

$$6{,}000 = NMR_E = 12{,}000 - 2Q_E$$

Thus the total quantity of engines and cars is now 3,000. The company now produces more cars (and sells them at a lower price) because its cost of engines is lower. Also, since the transfer price for the engines is now \$6,000, the upstream Engine Division supplies only 1,500 engines (because $MC_E(1{,}500) = \$6{,}000$). The remaining 1,500 engines are bought in the outside market.

(c) Now suppose Race Car Motors is the only producer of these engines, but can sell them in an outside market. Demand in the outside market is:

$$P_{E,M} = 10{,}000 - Q_E$$

so that the marginal revenue from sales in the market is:

$$MR_{E,M} = 10{,}000 - 2Q_E$$

To determine the optimal transfer price, we find the *total* net marginal revenue by horizontally summing $MR_{E,M}$ with the net marginal revenue from "sales" to the downstream division, $12{,}000 - 2Q_E$, as in Figure 11A.4. For outputs Q_E greater than 1,000, this is:

$$NMR_{E,Total} = 11{,}000 - Q_E$$

Now set this equal to the marginal cost of producing engines:

$$11{,}000 - Q_E = 4Q_E$$

Therefore, the total quantity of engines produced should be $Q_E = 2{,}200$.

How many of these engines should go to the downstream division, and how many to the outside market? Note that the marginal cost of producing these 2,200 engines, and therefore the optimal transfer price, is $4Q_E$ = \$8,800. Set this equal to the marginal revenue from sales in the outside market:

$$8{,}800 = 10{,}000 - 2Q_E$$

or Q_E = 600. Therefore 600 engines should be sold in the outside market. Finally, set this \$8,800 transfer price equal to the net marginal revenue from "sales" to the downstream division:

$$8{,}800 = 12{,}000 - 2Q_E$$

or Q_E = 1,600. So 1,600 engines should be supplied to the downstream division for use in the production of 1,600 cars.

Exercises

1. Review the numerical example about Race Car Motors. Calculate the profit earned by the upstream division, the downstream division, and the firm as a whole in each of the three cases examined: (a) no outside market for engines; (b) a competitive market for engines in which the market price is \$6000; and (c) the firm is a monopoly supplier of engines to an outside market. In which case does Race Car Motors earn the most profit? In which case does the upstream division earn the most? the downstream division?

2. Ajax Computer makes a computer for climate control in office buildings. The company uses a microprocessor produced by its upstream division, along with other parts bought in outside competitive markets. The microprocessor **is** produced at a constant marginal cost of \$500, and the marginal cost of assembling the computer (including the cost of the other parts) by the downstream division is a constant \$700. The firm has been selling the computer for \$2000, and until now there has been no outside market for the microprocessor.

a. Suppose an outside market for the microprocessor develops and Ajax has monopoly power in that market, selling microprocessors for \$1000 each. Assuming that demand for the microprocessor is unrelated to the demand for the Ajax computer, what transfer price should Ajax apply to the microprocessor for its use by the downstream division? Should its production of computers be increased, decreased, or left unchanged? Explain briefly

b. How would your answer to (a) change if the demands for the computer and the microprocessors were competitive; i.e., some of the people who buy the microprocessors use them to make climate control systems of their own?

3. Reebok produces and sells running shoes. It faces a market demand schedule $P = 11 - 1.5Q_S$, where Q_S is the number of pairs of shoes sold (in thousands) and P is the price in dollars per thousand pairs of shoes. Production of each pair of shoes requires 1 square yard of leather. The leather is shaped and cut by the Form Division of Reebok. The cost function for leather is

$$TC_L = 1 + Q_L + 0.5Q_L^2$$

where Q_L is the quantity of leather (in thousands of square yards) produced. The cost function for running shoes is (excluding the leather)

$$TC_S = 2Q_S$$

a. What is the optimal transfer price?

b. Leather can be bought and sold in a competitive market at the price of P_F = 1.5. In this case, how much leather should the Form Division supply internally? How much should it supply to the outside market? Will Reebok buy any leather in the outside market? Find the optimal transfer price.

c. Now suppose the leather is unique and of extremely high quality. Therefore, the Form Division may act as a monopoly supplier to the outside market as well as a supplier to the downstream division. Suppose the outside demand for leather is given by $P = 32 - Q_L$. What is the optimal transfer price for the use of leather by the downstream division? At what price, if any, should leather be sold to the outside market? What quantity, if any, will be sold to the outside market?