8

Pricing Decisions in Practice

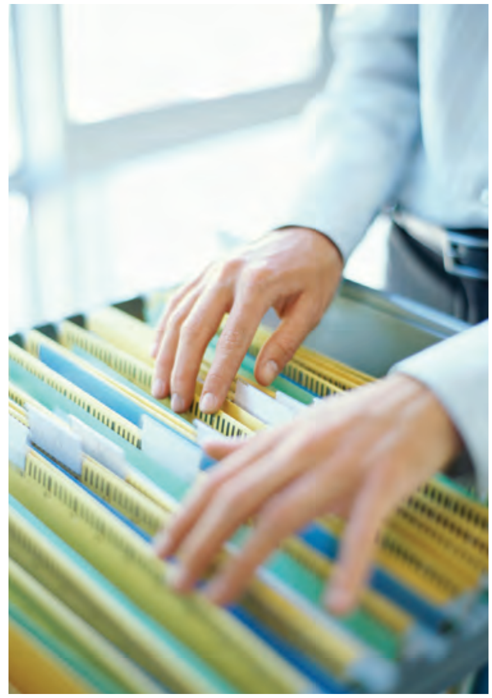
Learning Objectives

After reading this chapter, you should be able to:

- Explain how managers can utilize estimates of cost and revenue data, and estimates of price elasticity, to determine the profit-maximizing price.
- Explain how markup pricing can be the profit-maximizing means of price setting when search cost for data is significant.
- Reconcile markup pricing with marginal pricing, and understand that markup pricing can remain profit-maximizing despite shifts of the demand and cost curves.
- Identify ways that price discrimination can increase the profitability of the firm.
- Recognize when bundle pricing can increase the firm's profitability.

Introduction

In this chapter, we utilize the theoretical concepts introduced in prior chapters to help the manager make profit-maximizing decisions in the real world where cost and demand data is not available without incurring significant information search costs. Information search costs, defined previously as the costs of obtaining reasonably accurate data or knowledge pertaining to the issue at hand, are discretionary costs that may be avoided. In all cases, the profit-maximizing firm should incur search costs *only* if doing so would increase profit by enough to cover the cost of obtaining the data necessary to make the decision. In some cases, search costs will be relatively low, such as is possible by utilizing data that is internal to the firm and that has been routinely collected in past production periods. In other cases search costs to obtain data from customers or suppliers might be so large that the manager's educated guess will be profit-maximizing as long as it misses the mark by less than the search costs that were avoided.



Search costs are the costs associated with finding information. Profit-maximizing firms only incur these costs if doing so improves the profit of the decision.

Accordingly, this chapter is organized on the basis of the "search versus don't search" dichotomy. In the next section, we start with **marginalist pricing**—setting price using the *marginal cost equals marginal revenue* rule using estimated cost, revenue, and price elasticity data that can be obtained from information search activity by firms from prior production and market experience. We then turn to the use of simple (search-cost avoiding) pricing rules that allow a sufficiently accurate price and output decision such that the firm might maximize profits by avoiding expenditures on search costs and choosing a price that is "near enough" to that which would maximize profits with full information. We introduce **markup pricing**—whereby price is determined as a percentage markup over the firm's average costs—and examine the conditions under which it is likely to be, and to remain, profit maximizing despite shifts in the cost and demand conditions facing the firm. Finally, we examine two specific pricing topics, namely price discrimination and bundle pricing, which can allow the firm to make larger profit from the same number of customers.

8.1 Marginalist Pricing Using Estimated Revenue and Cost Data

First, a quick review of what we learned in Chapter 4 about estimating the demand function. We saw that a manager can estimate the firm's demand function by collecting data on both the firm's sales volume and the main variables that influence sales, and then using multiple regression analysis to estimate the coefficients in the demand function for each of those determinants of the firm's demand. The equation we used for the demand function in Chapter 4 was

$$Q_x = \alpha + \beta_1 P_x + \beta_2 P_y + \beta_3 A_x + \beta_4 A_y + \beta_5 GNI \qquad (8\text{-}1)$$

where Q_x represents quantity demanded of product X (in physical units); α (alpha) represents the influence of variables not included in the regression analysis; and the βs (betas) are the coefficients to the independent variables used in the regression equation, with each one showing the marginal impact on Q_x of a change in each of the independent variables, for example $\beta_1 = \delta Q_x/\delta P_x$. The independent variables included in this regression equation were the prices of product X and product Y; the advertising expenditures of product X and product Y; and the level of gross national income (GNI), the latter being a proxy variable representing the income of customers for product X. In Chapter 4 we found the constant term and the coefficients to the independent variables as follows:

$$Q_x = 5{,}030 - 3{,}806.2P_x + 1{,}458.5P_y + 256.6A_x - 32.3A_y + 0.18GNI \qquad (8\text{-}2)$$

The estimated demand function must be evaluated for its predictive reliability by considering the regression statistics that are provided by the regression analysis software. First, the **level of significance** of each of the independent variables is checked by observing whether its P-value is 0.05 or smaller for each variable—the P-values indicate the probability that the dependent variable (Q_x) really does *not* depend on each independent variable (e.g., A_y). For example, a P-value of 0.05 indicates that we can be confident at the 95% level of significance that the independent variable is indeed a significant determinant of demand.

Second, we consider the coefficient of determination (R^2), which indicates the proportion of the variance in the dependent variable that is explained by variations in the independent variables that were included in the regression equation. For example $R^2 = 0.65$ indicates that 65% of the variation in demand is explained by the independent variables on the right-hand side of the regression equation (and thus 35% of the variance in Q_x demanded must be explained by missing variables). The estimated demand function is the best measure of central tendency within the data, but predictions of sales (for any price level, for example) will be surrounded by a range of possible outcomes above and below the predicted value of sales, and as R^2 becomes smaller, this range of outcomes becomes larger. Note that the value of R^2 might range from a minimum of zero, indicating no correlation at all, to a maximum of 1.0, indicating perfect correlation.

The standard error of estimate (S_e) statistic provides a measure of the range of possible outcomes around the predicted value of sales. We can be confident at the 95% confidence level that the actual value of demand will lie within plus or minus $2S_e$ of the estimated value (for any level of price, for example). The standard error of the coefficient, S_β, (for each independent variable) provides a range of values around the estimated value of each β coefficient in the regression equation within which the true value might fall.[1] Again, we

1. The "true" value is the value we would find if the entire population of observations is used in the regression analysis. Typically, we select a sample that we expect to be representative of the population and thereby keep information search costs to a tolerable level. The standard errors of the coefficients indicate the extent to which sampling error might have occurred.

can be confident at the 95% level of confidence that the true value of the coefficient lies within a range that is plus or minus $2S_\beta$ from the estimated value of the β. Thus, managers can use these regression statistics to conduct sensitivity analysis on their predictions of sales for any level of price (or other independent variable) selected.

On the cost side, in Chapter 6, we considered several methods for the estimation of cost functions utilizing known data points. We demonstrated that we could estimate the location and shape of a particular cost curve (e.g., TVC) by interpolating between the known data points using gradient analysis, and then calculate the value of related cost measures (e.g., AVC and MC). With a greater number of known data points, we can achieve a more accurate estimation of the TVC function by fitting a "line of best fit" to the data using regression analysis and, subsequently, calculate the AVC and MC values for any output level. The line of best fit may be a linear, quadratic, or cubic function of output, the choice being made on the basis of which functional form best fits the data. This will be the form that exhibits the highest coefficient of determination (R^2) while maintaining 95% confidence levels of significance (P-values less than 0.05) for the independent variables included in the equation.

If your understanding of the terms and concepts in the above two paragraphs is a little rusty, you should go back and quickly review the relevant parts of Chapters 4 and 6 to refresh your memory.

Using Estimated Lines of Best Fit

Given the estimation of the demand and cost functions, we can find the profit-maximizing output level either by solving for Q using a pair of simultaneous equations, or by deriving and plotting the relevant curves (i.e., MC and MR) on a graph and observing the intersection point of these curves. The first method starts with deriving equations for the MR and MC curves. Considering first the MR curve, we know it has the same slope and twice the slope of the demand curve, so we need to first derive the demand curve from the demand function, as we did in Chapter 4. To do this we need to collapse equation 8-2 into the reduced form equation $Q_x = AOV + \beta P_x$ (where AOV represents the influence of all other variables except the price of X). In Chapter 4, using the values $P_y = \$6$; $A_x = 168$ (in thousands of dollars); $A_y = 182$ (in thousands of dollars); and GNI = 12,875 (in billions of dollars), we evaluated AOV to find the reduced form of the demand function shown as follows:

$$Q_x = 53{,}328.7 - 3{,}806.2P_x \qquad (8\text{-}3)$$

Next we inverted the demand function equation to find an expression for the firm's demand curve:

$$P_x = 14.011 - 0.00026273Q_x \qquad (8\text{-}4)$$

As we noted in Chapter 4, this very small coefficient to the variable Q_x is hard to comprehend, so we define Q_x in thousands of units and multiply the coefficient to Q_x by 1000, to express the demand curve equivalently as:

$$P_x = 14.011 - 0.26273Q_x \qquad (8\text{-}5)$$

Because the marginal revenue (MR) curve has the same intercept and twice the slope of the demand curve, it must be represented by:

$$MR = 14.011 - 0.52546Q_x \quad (8\text{-}6)$$

Now on the cost side, suppose (as we found in Chapter 6) that our most reliable estimate of the TVC function is a straight line of best fit in the form TVC = $\alpha + \beta Q$, namely:

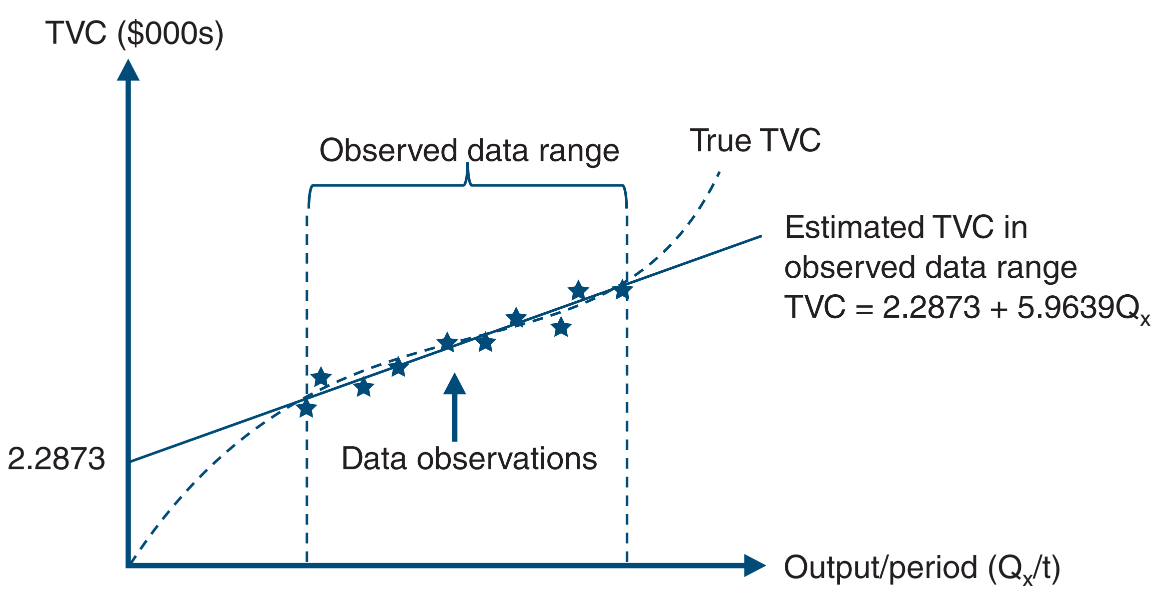
$$TVC = 2.2873 + 5.9639Q_x \quad (8\text{-}7)$$

where TVC is in thousands of dollars and Q_x is in thousands of units. We know from Chapter 6 that MC is the first derivative of TVC, so:

$$MC = 5.9639 \quad (8\text{-}8)$$

In this case, TVC was estimated as a linear function of output over the range of output levels represented by the sample data. Note that the first term (2.2873) on the right-hand side of equation 8-7 is the residual, or the amount of TVC that is not explained by the variation in Q_x. The first term serves as the vertical intercept value of the estimated TVC line and operates to raise the TVC line to the appropriate height to best represent the relationship between TVC and Q_x in the relevant range of the data observations. We illustrate this in Figure 8.1 where the dotted line indicates the unobserved TVC curve for *all* values of Q_x, and the straight line with intercept 2.2873 and slope 5.9639 for each thousand units of Q_x represents the estimated TVC that best fits the data in the range of data observations actually observed.[2]

Figure 8.1: Estimated TVC function that best fits the data in the observed range



2. As in Chapter 6, we choose the functional form of the line of best fit on the basis of which form (e.g., linear, quadratic, or cubic) that best fits the observed data points, and we judge "best fit" by the highest R^2 value when all of the independent variables that are included in the regression equation (e.g., Q, Q^2, and Q^3) are significant at the 95% confidence level.

Now, setting the expression for MR, which is equation (8-5), equal to the expression for MC, which is equation (8-7), we have:

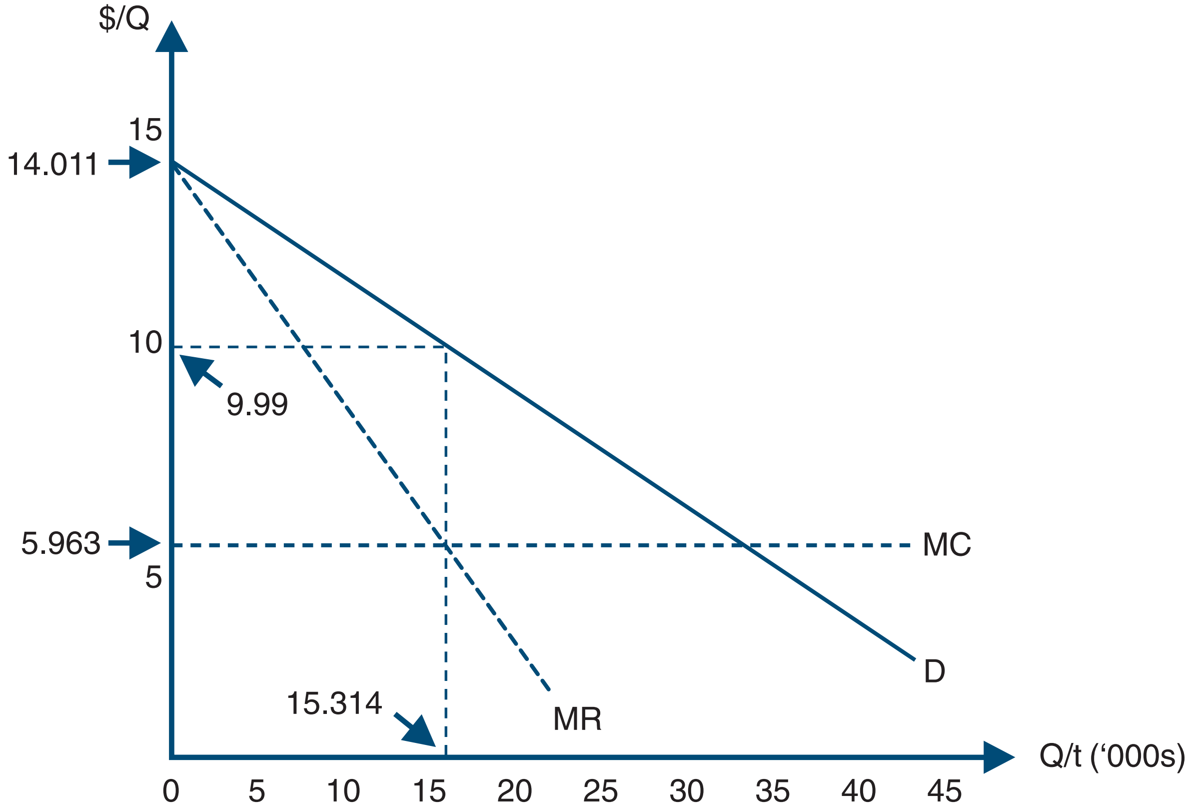
$$14.011 - 0.52546Q_x = 5.9639 \quad (8\text{-}9)$$

This is a single equation with one unknown variable, so we can solve[3] for the value of Q_x by subtracting 14.011 from both sides, and then dividing both sides by –0.52546, to find $Q_x = 15.314$. This is the profit-maximizing output (in thousands of units), so inserting this value of Q_x into the demand curve, equation 8-5, and solving for P_x we find the profit-maximizing price level to be \$9.99.[4] Total revenue (TR, in thousands of dollars) is calculated as $P_xQ_x = 152.9869$ and total variable cost (TVC, in thousands of dollars) can be calculated (from equation 8-6) as TVC = 2.2873 + 5.9639(15.314) = 93.6185. The contribution to total fixed cost and profit is equal to TR − TVC = 152.9869 − 93.61185 = 59.3684, or \$59,368.40. Thus, if total fixed cost is less than \$59,368.40 then the firm would be making a profit.

Now let's find the same result using graphical analysis. In Figure 8.2, we show the demand curve having an intercept value at 14.011, as per equation 8-5. To plot the demand curve we need to find a second point on the (straight line) demand curve. We do this by solving equation 8-5 to find a value for P_x at any particular value of Q_x, for example 15. When Q_x = 15, we solve for $P_x = 10.07$ from equation 8-5, which provides the coordinates for a second point on the demand curve. A straight line drawn from the intercept point (where P_x = 14.011 and $Q_x = 0$) that also passes through the point where $P_x = 10.07$ and $Q_x = 15$, thus represents the demand curve. To plot the MR curve we know the MR curve has the same intercept and twice the slope of the demand curve, so we know that the MR curve must also intercept the vertical axis at 14.011 and then slope down toward the horizontal axis at twice the rate that the demand curve does. Since we found that $P_x = 10.07$ when Q_x was 15, we can conclude that when MR = 10.7, the Q_x coordinate of the MR curve must be 7.5 (i.e., half of 15), so we can sketch in the MR curve as shown in Figure 8.2.[5]

3. To do this step by step, we start with $14.011 - 0.52546Q_x = 5.9639$. By subtracting 14.011 from both sides we have $-8.0471 = -0.52546Q_x$.Then, by dividing both sides of this equation by –0.52546 we find $Q_x = 15.314$. Substituting 15.314 for Q_x in the demand curve expression $P_x = 14.011 - 0.26273Q_x$ we have $P_x = 14.011 - 0.26273(15.314)$ which evaluates to be $P_x = \$9.99$.
4. When the profit-maximizing price turns out to be an odd number, such as \$9.52, it may require a cosmetic adjustment to let's say \$9.49, to be more suitable for marketing purposes.
5. Alternatively, we could find the horizontal-axis intercept of the demand curve by setting $P_x = 0$ and solving for Q_x in the demand curve, and then halve this Q_x value to find where the MR curve must cut the horizontal axis. We found earlier (see Figure 4.1 in Chapter 4) that this demand curve intercepts the horizontal axis at $Q_x = 53.328$, so the MR curve must intercept that axis at 26.664 (thousand units).

Figure 8.2: Graphical representation of the price and output decision



For the marginal cost curve, we know from the regression equation that TVC = 2.2873 + $5.9639Q_x$ and that MC = 5.9639, because marginal cost is the first derivative of the TVC function. Thus, MC is constant at \$5.96 per thousand units regardless of output level, in this particular case. Plotting MC as the horizontal line at \$5.96 we see that the MR curve crosses the MC curve at approximately Q_x = 15.314 units of output, and following that up vertically to the demand curve we find the profit-maximizing price level is \$9.99. These graphical results confirm the accuracy of our earlier algebraic results, or vice versa!

Using Estimates of Price Elasticity

Now, let's suppose that a manager knows the current price is \$7 and the output level is 25,000 units and has estimated the price elasticity of demand (ε) to be –2.5. As we saw in Chapter 4, price elasticity can be expressed as the percentage change in quantity demanded over the percentage change in the price level. For example, if ε = –2.5 this implies that the quantity demanded would increase by 2.5% if price was reduced by 1%. Since a 1% price change might not be noticed by consumers we would usually expect a more substantial price adjustment; for example, the manager would expect that a 10% price reduction would cause a 25% increase in quantity demanded (or conversely a 25% reduction in demand for a 10% price increase). Price elasticity of demand, as we saw in Chapter 4, can also be expressed as:

$$\varepsilon = \Delta Q/\Delta P \cdot P/Q \tag{8-10}$$

We can substitute the known or estimated values of ε, P, and Q from above into this equation to say $-2.5 = \Delta Q/\Delta P \cdot 7/25$ and solve this equation to find $\Delta Q/\Delta P = -8.9286$ (where Q is in thousands). Note that $\Delta Q/\Delta P$ is the reciprocal of the slope of the demand curve, so $1/-8.9286 = -0.112$ must be the slope of the demand curve. To find the intercept of the demand curve, we know that $P = \mathbf{a} - 0.112Q$, where **a** is the intercept term, and since we know $P = 7$ when $Q = 25$, we can substitute these values into the equation to solve for the intercept term $\mathbf{a} = 9.8$. Thus, the estimated expression for the demand curve is $P = 9.8 - 0.112Q$, and the marginal revenue curve must be $MR = 9.8 - 0.224Q$ (having the same intercept and twice the slope).

Now, supposing that the manager does regression analysis of TVC data and finds that the line of best fit is $TVC = 2Q + 0.2Q^2$, and (taking the first derivative) finds that $MC = 2 + 0.4Q$. Having an expression for both MC and MR we can now solve for the profit-maximizing output and price, either mathematically or graphically. The former will be faster, so let's set MC = MR and solve for Q as follows:

$$2 + 0.4Q = 9.8 - 0.224Q \qquad (8\text{-}11)$$

By adding $0.224Q$ to both sides and subtracting 2 from both sides we find $0.264Q = 7.8$. From this we find $Q = 7.8/0.264 = 29.545$ (thousands). Substituting this profit-maximizing output level into the demand curve expression we find $P = 9.8 - 0.112(29.545) = 6.49$. Thus, the profit-maximizing price is $6.49, so the manager should reduce price from the current level of $7 in order to maximize profit. Doing so would soon verify or disprove the initial estimate of price elasticity that formed the basis of the estimation of the demand curve, as quantity demanded should increase to about 29,545 units and profit should increase from the initial level. If profit does not increase as expected, then the resultant Q observation at the new price level ($6.49) provides a second known point on the demand curve, which allows the slope and intercept to be calculated (assuming no changes in the other determinants of demand) and, thus, the manager can proceed to find the profit-maximizing price and output level.

8.2 Markup (or Cost-Plus) Pricing

In practice, many firms use *markup pricing*, whereby average variable costs, AVC (also known as direct costs per unit), are marked up by a percentage of AVC to arrive at the price level. Thus:

$$P = AVC + X(AVC) \qquad (8\text{-}12)$$

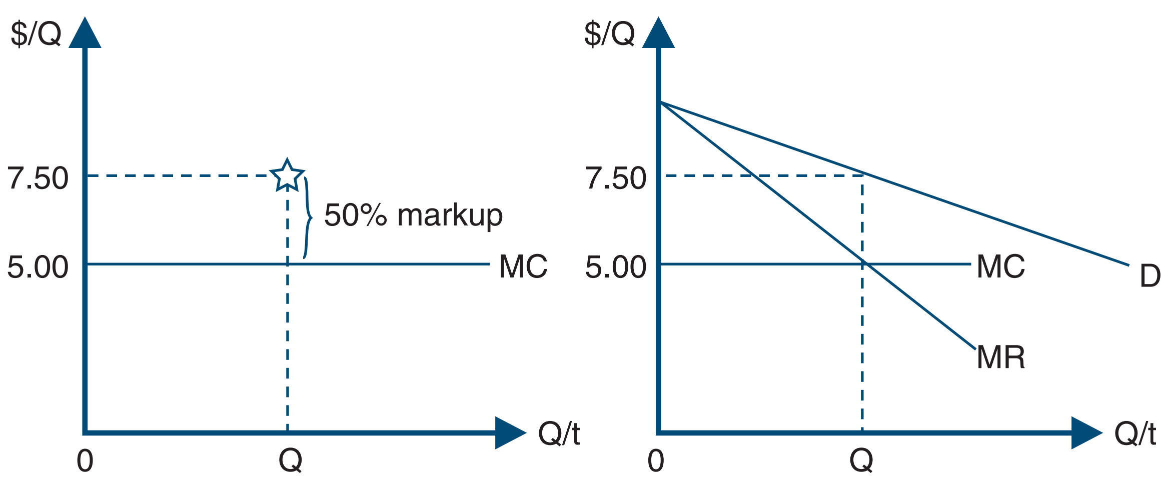
where X is the markup percentage and X(AVC) is the contribution margin, which as we saw previously is equal to P − AVC and represents the contribution that the price makes to the overhead costs and profit of the firm. Markup pricing is often called "cost-based pricing," but it is clear that the markup percentage must also take into account the price elasticity of demand, since higher markups mean higher prices and these will cause demand to be reduced by an amount that depends on the price elasticity of demand. In fact, markup pricing can be reconciled with the marginalist pricing rule (i.e., MC = MR) in the case where AVC is constant (and therefore AVC = MC), which we shall do in the next section.

When implementing markup pricing, firms must take into account the price elasticity of demand, since higher markups translate to higher prices which reduce demand by an amount that depends on the price elasticity of demand.

Reconciliation With Marginalist Pricing

In Figure 8.3, we show two graphs—on the left-hand side, we show the $7.50 price as determined by a 50% markup over direct costs of $5 per unit, and, subsequently, the firm's customers demand Q units, thus revealing one known point on the demand curve (depicted by the star). On the right-hand side of Figure 8.3, we show the complete demand and MR curves that are unknown to the firm. In this carefully drawn case, it is clear that the 50% markup is indeed profit-maximizing, since MC = MR at that price and output level.

Figure 8.3: Markup pricing and marginalist pricing reconciled



By observing the graph on the right-hand side, you can see that if the markup had been set instead at, say, 60% (for an $8 price with a $3 contribution margin), the consequent level of quantity demanded would be less than Q units and MC would be less than MR at that higher price and lower output combination, and thus that price and output combination would not be profit maximizing. Similarly, if the markup rate had been only 40% the price would be $7, quantity demanded would be more than Q, and, again, profit would not maximized because MC > MR at that price and quantity combination.

So, to be profit-maximizing the markup rate must reflect the height and slope of the demand curve, relative to the MC curve. As we have seen, the price elasticity of demand is related to the height and slope of the demand curve, and, indeed, there is a special relationship between price elasticity and the profit-maximizing markup rate over AVC, which is evident in the following expression:

$$P = AVC + \left[\frac{-1}{\varepsilon + 1}\right]AVC \qquad (8\text{-}13)$$

This expression shows that the profit-maximizing markup rate (the term in brackets in equation 8-13) is inversely related to the price elasticity of demand and is derived to include the requirement that MC = MR.[6] Note that this formula is only correct for the case where direct costs (AVC) are constant and, thus, AVC = MC in the relevant output range.

In Table 8.1 we show the profit-maximizing markup rates for a selection of price-elasticity values. It is evident that the higher (in absolute terms) is the price elasticity the lower the markup rate must be if the price is to be profit-maximizing. From Chapter 4, we know that price elasticity has an extremely high negative value near the vertical intercept with the price axis, with these values increasing as we move towards the midpoint of the demand curve, where $\varepsilon = -1$. We also know that MR falls to zero at the midpoint of the demand curve, and, therefore, any price below the midpoint cannot be profit-maximizing because we want MR = MC (and MC cannot be negative). Closer to the midpoint of the demand curve, where MR is quite low, MC must also be quite low if MR is to be equal to MC, and, hence, the higher will be the markup rate. Conversely, at points higher on the demand curve the MR is also higher, so for MR to be equal to MC, the MC must also be relatively high and, thus, the markup rate must be relatively low.

Table 8.1: Profit-maximizing markup rate (X) given price elasticity of demand (ε)

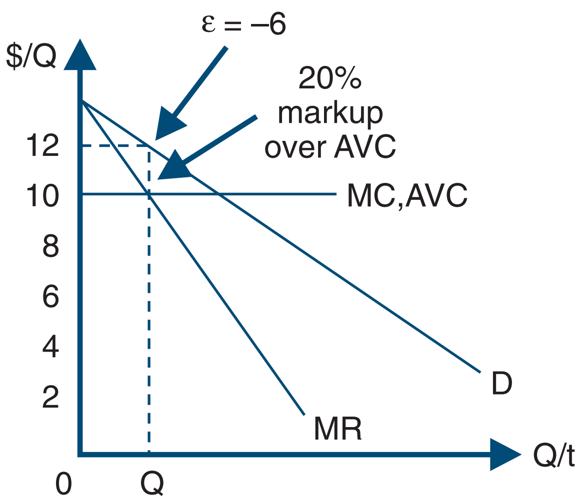
ε	–9	–8	–7	–6	–5	–4	–3	–2	–1.5
X	12.5%	14.3%	16.7%	20%	25%	33.3%	50%	100%	200%

This is illustrated by the examples in Figure 8.4, (where the same demand situation is depicted with two different cost situations), and in Figure 8.5 (where the cost situations are the same but the demand situations differ). Fundamentally, the markup percentages

6. To express X in terms of the MC = MR rule, we start by finding an alternative expression for MR. Since MR = dTR/dQ, and TR = P · Q, and since P also depends on Q, we use the chain rule of derivation to express marginal revenue as MR = P + Q(dP/dQ). Now multiply and divide the last term in equation 8-11 by P to find MR = P + QP/P · dP/dQ. Factoring out P we obtain MR = P {1 + Q/P · dP/dQ}. Now note that the term in the brackets is equivalent to one plus the reciprocal of the price elasticity of demand (since $\varepsilon = dQ/dP \cdot P/Q$). Hence, $MR = P(1 + 1/\varepsilon)$. Setting MC = MR and invoking the special case where MC = AVC we have $AVC = P(1 + 1/\varepsilon)$, which can be rewritten as $P = AVC + [-1/(\varepsilon + 1)]\,AVC$.

are different because the price elasticity of demand is different at the profit-maximizing-price levels, and these differ because of the differences in the cost levels (see Figure 8.4) or because of the differences in the demand situation (see Figure 8.5). Thus it is clearly important for managers to have in their minds an estimate of price elasticity before setting prices via markups over direct costs in situations where they do not know much about the height and slope of the demand curve.

Figure 8.4: Low markup rates versus high markup rates with different cost conditions



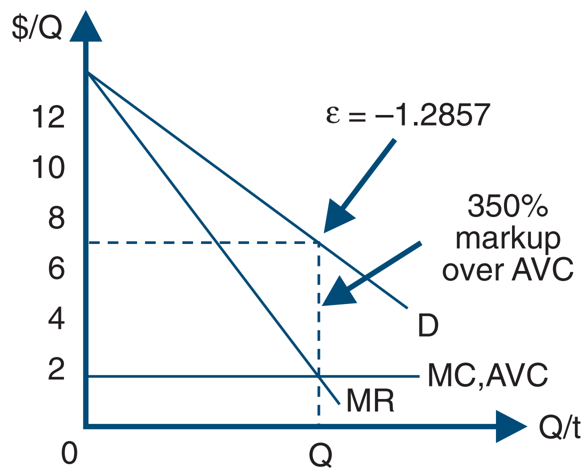
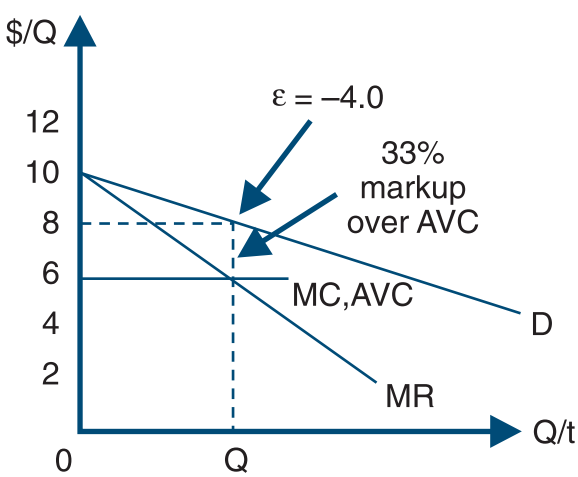
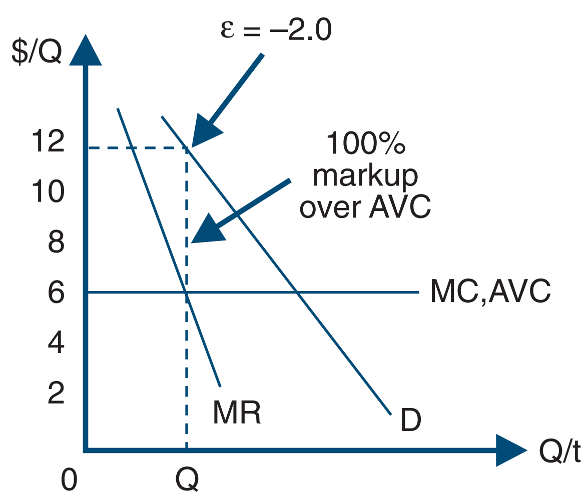


Figure 8.5: Low markup rates versus high markup rates with different demand conditions





As discussed in Chapter 4, managers should understand that price elasticity depends on two main drivers—namely, the substitution effect and the income effect.[7] The substitution effect is greater if the number and closeness of substitutes is greater; thus a 10% price increase, for example, might be expected to cause the loss of, say, 40% of sales when there are many close substitutes (as in monopolistic competition). Conversely, a 10% price increase would expect to cause the loss of only, say, 15% of sales if there are not many close substitutes (as in a highly-differentiated-products oligopoly) for example. The income effect is about affordability—if the price is relatively high compared to the customer's income, a price increase is more likely to cause the customer to stop purchasing that product, compared to a product where the price is small relative to customers' incomes. These are things that managers should know about their product and their customers, and so managers should be able to make a rough estimate of the value of price elasticity for that product.

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Managers must strategically set a markup rate. If the implied price elasticity seems too high, the markup rate is probably too high and should be reduced to increase profit.

How would managers use this information? They might either calculate (from equation 8-13) the profit-maximizing markup rate based on their best estimate of price elasticity, or conversely work from their preferred markup rate to find the implied price elasticity if that markup is to be profit-maximizing. Having arrived at an implied markup rate, managers must then ask themselves the question: Does that seem right? Is it congruent with what I know about the number and closeness of substitutes for my product and the general affordability of my product? For example, if a manager wants to maximize profit and intends to apply a 25% markup on direct costs to determine its price, this implies that the price elasticity of demand is –5, which infers that quantity demanded would drop by 50% if price were to be raised by 10%. The manager must ask the question "Does it seem reasonable that fully half the firm's demand would disappear if the firm raised price by 10%?" This implies either that the product has very close substitutes or that it is relatively expensive in relation to customers' incomes. If the implied price elasticity seems too high this means the chosen markup rate is probably too low and should be increased to increase profit. Oppositely, if the implied price elasticity seems too low, given the availability of substitutes and the ratio of price to customer incomes, the markup rate is probably too high and profits will increase if a lower markup (and price) is used. A simple test is possible, of course—the manager could go ahead and reduce the price slightly and see what happens to volume and profit, and then make a subsequent adjustment one way or the other.

7. Recall that the *substitution effect* is the change in quantity demanded due to a change in the price of a product relative to the unchanged prices of its substitute (rival) products, with a notional compensation for the change in real income (the purchasing power of money income) caused by the price change. The *income effect* is the change in the quantity demanded due to the change in real income due to the changed price of the focal product, holding relative prices constant.

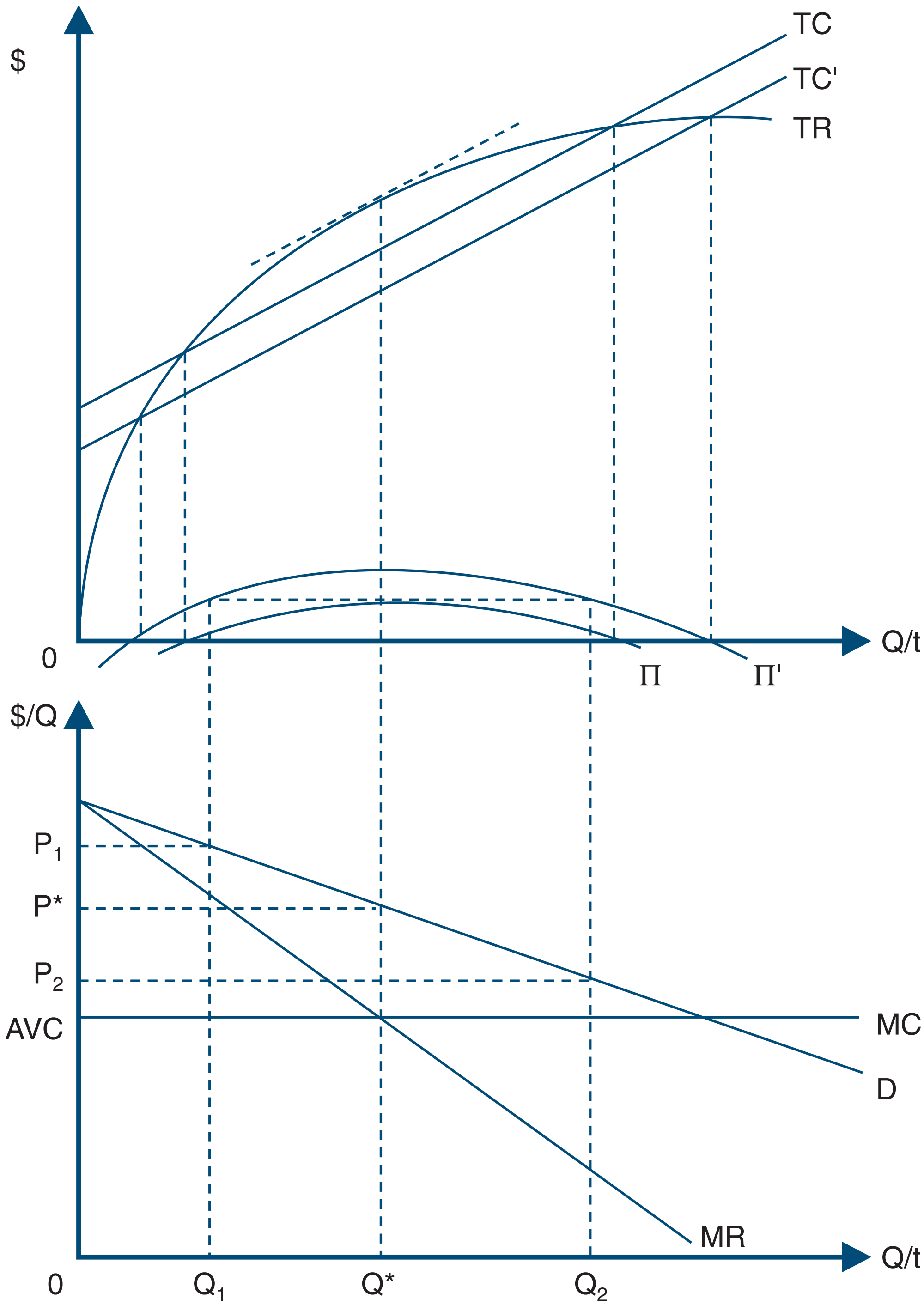
Search Costs and the Range of Acceptable Markup Rates

Search costs, as you know, are the costs associated with finding information. The search costs of estimating price elasticity and/or the demand and TVC functions can be avoided by using simple pricing rules like markup pricing. If search costs are avoided the markup rate can be "wrong" (i.e., not profit-maximizing) to some extent yet still allow the firm to make greater profit as compared to first undertaking information search activity and later setting the profit-maximizing price (but having higher overhead costs due to the expenditures on search activity). We show the extent to which the markup can be wrong in Figure 8.6 for a presumed case where search activity, if undertaken, would increase the firm's total fixed costs (TFC) by a substantial amount.[8] We exaggerate the size of the search costs in Figure 8.5 to allow a clear explanation of the effect.

In Figure 8.5, the curve labeled TC shows the total costs including the search costs, while the curve labeled TC′ represents total costs when search costs are avoided. You will note that these total cost curves emanate from the vertical axis at the level of total fixed costs and rise at a constant rate (equal to MC) reflecting a linear TVC curve. The vertical difference between the total revenue curve, TR, and the TC curve is mapped as the profit curve Π (the Greek letter pi) while the vertical difference between the TR and the TC′ curve is mapped as the profit curve Π′. Notice that the "no-search-costs" profit curve Π′ lies above the "search-cost-included" profit curve Π for a considerable range of outputs, this range being shown as Q_1 to Q_2 in the lower graph.

8. Search costs are a fixed (or overhead) cost because they are unrelated to output levels (and thus are not a variable cost). Search costs would be expended and then become a sunk cost that the firm hopes will be paid for later by the contribution margins of units sold.

Figure 8.6: The range of acceptable markup rates for the firm avoiding search costs



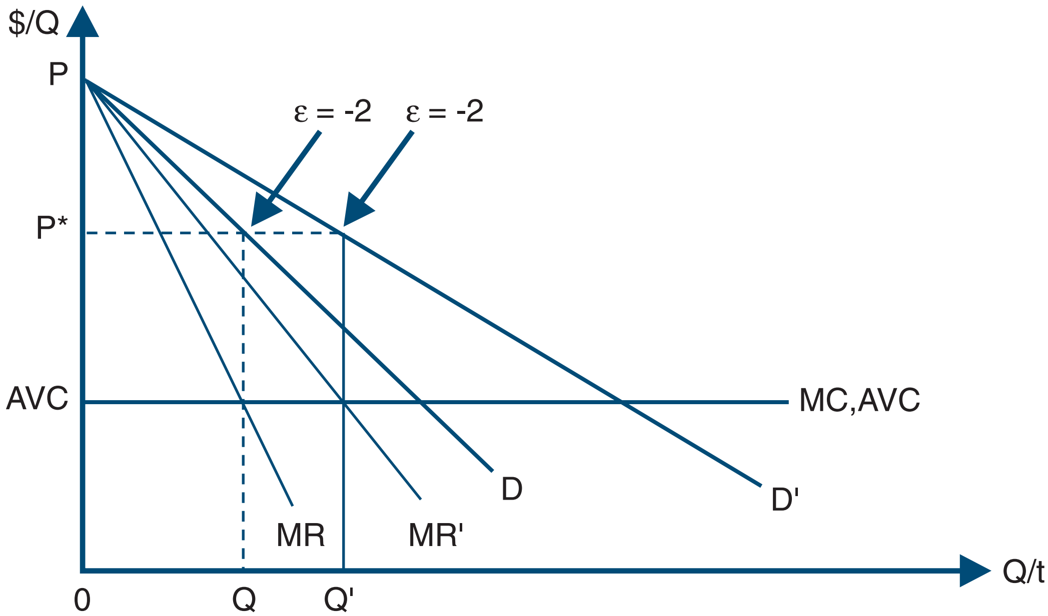
The profit-maximizing price and output levels, with or without search costs, are shown as P* and Q* where MR = MC. But note that price could be anywhere between P_1 and P_2 if search costs are avoided and yet allow profit (on Π′) to exceed the profit available after incurring search costs (on Π). In terms of markup rates, while the profit-maximizing markup rate in this example looks to be about 50% (at P*), the markup rate could range anywhere between about 80% at P_1 to about 20% at P_2 and still earn more profit (if search costs are avoided) compared to first spending the search costs and then setting price at the profit-maximizing level P*. So you can see there is a lot of room for error in choosing the markup rate! But, be cautioned that this example shows extraordinarily high search costs as a proportion of total costs; in most cases the range for error in the markup rate will be somewhat smaller than in this "teaching example." Note also that the range of acceptable markup rates will be smaller if price elasticity in the relevant range of outputs is higher (causing the demand curve to be less steeply sloping). If the demand curve is not as steep (as in Figure 8.6), the range of "wrong" markup rates that nonetheless allow greater profit, will be smaller, other things being equal. So, managers must first ask themselves the question: "What is the likely magnitude of search costs that would need to be spent to gain suitably reliable estimates of the cost and revenue curves?" Then, they must couple this estimate with their best estimate of the price elasticity of demand to complete an analysis of whether their chosen markup rate is likely to be profit-maximizing if they avoid search costs.

Markup Pricing and Demand Shifts

When the demand curve shifts (due to a change in one of the "shift variables" such as customer incomes or advertising) the profit-maximizing price (and hence the profit-maximizing markup rate) would generally need to change because the price elasticity of demand will be different at the new price level associated with each quantity level. But in the case of **iso-elastic demand shifts**, where the price elasticity stays the same at each output level when the demand curve shifts, the same markup rate remains profit-maximizing despite the shift of the demand curve. In Figure 8.7, we show an iso-elastic demand shift from D to D′ that involves a rotation of the demand curve while maintaining the same price axis intercept value, shown as P. Since the demand curve rotates from the same intercept point, the marginal revenue curve must also rotate to maintain its "same intercept, twice the slope" relationship with the demand curve. But, as you can see in Figure 8.7, the shifting demand curve does not require a change in the profit-maximizing price, because MR = MC at the same price level (P*) as before. Quantity demanded increases from Q to Q′ units per period due to the shift in demand but the same price (P*) and markup rate (100%) remain appropriate because the price elasticity remains the same ($\varepsilon = -2$) at both price-quantity combinations.[9]

9. Note that although price elasticity stays the same for any given price level despite shifts in the demand curve, the price elasticity changes as we move along each demand curve. A different concept is the iso-elastic demand *curve*, where price elasticity is the same at all points along a given demand curve—such curves must be rectangular hyperbolas where the rectangular areas under all points on the curve, where the area is defined by each price (height) times its associated quantity (width), are the same. Looking back at the price elasticity formula you will appreciate that for elasticity to remain at the same level at different prices, the changes in the slope of the curvilinear demand curve ($\Delta P/\Delta Q$) must be exactly offset by the change in the ratio of P/Q as we "move down" the demand curve.

Figure 8.7: Constant markup rate despite an iso-elastic shift of the demand curve



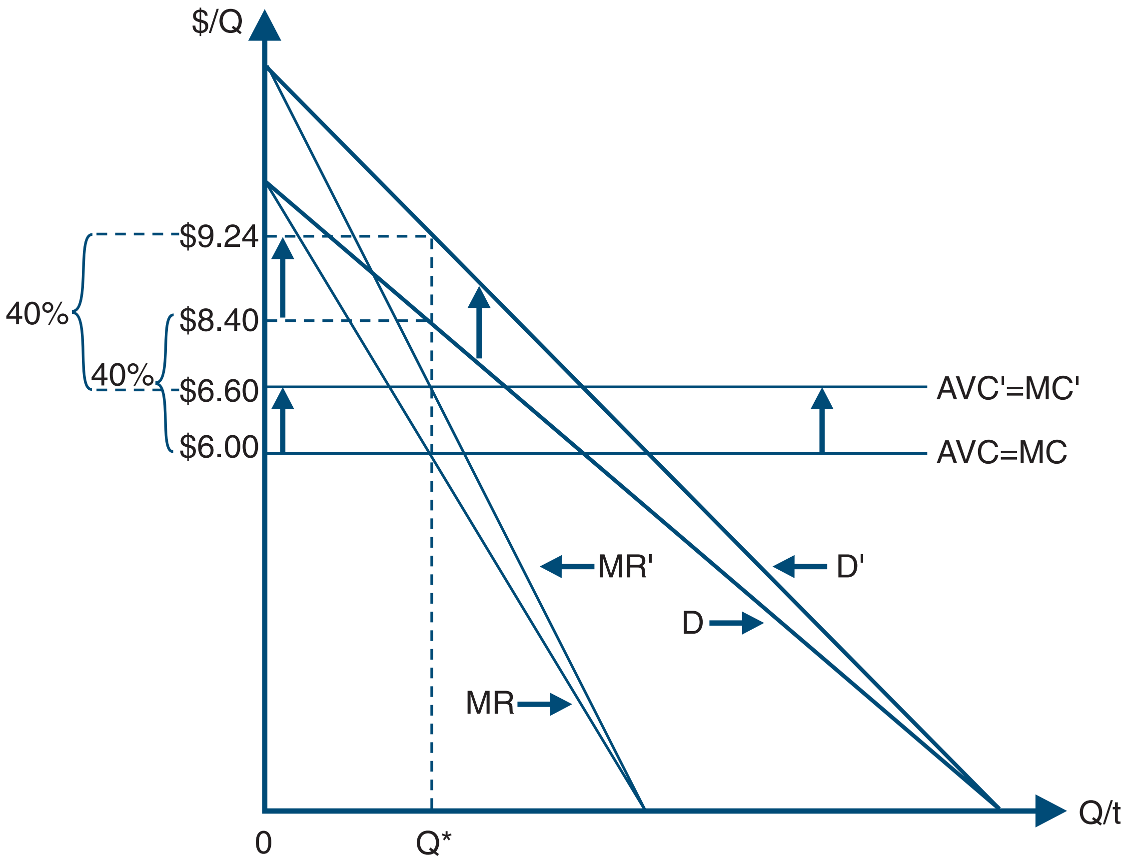
It is probably unlikely that a demand shift would be precisely iso-elastic, but we have seen in the preceding section that it does not need to be so for a continuation of the same markup rate to remain the profit-maximizing policy if significant search costs must be expended to find the exact intercept and slope of the demand curve. What we have demonstrated here is that iso-elastic demand shifts mean that the firm does not have to change its price level. Thus, the demand shifts that are somewhere close to being iso-elastic will make it likely that the existing markup rate remains profit-maximizing. This reduces the financial incentive to incur search costs to identify the precise location of the demand and costs functions.

Inflation is caused by an excess of aggregate demand over aggregate supply of all goods and services resulting in increased costs and a decrease in the value of the national monetary unit.

Markup Pricing and Cost Shifts due to Inflation

Inflation is the continuing increase in cost and price levels due to the decrease in the value of the national monetary unit (i.e., the dollar). At the firm level, management may find that their AVC has risen, for example, by 10% over the past year and that this has reduced their profit. They may wonder whether they should simply raise their price level by 10% to restore their profit margin and overall profit level, or whether they should increase prices by more or less. The answer depends on how much more their customers can afford to pay. If customers' incomes have also risen by 10%, this product will require the same proportion of their incomes as it did before the period of inflation. In Figure 8.8, we show a situation where each point on the initial demand curve (D) has shifted vertically by a constant proportion—10% in this case—to the new demand curve D′. This reflects each customer's ability to pay 10% more for each unit of quantity demanded. Similarly, the AVC = MC curve has shifted vertically by 10% due to inflationary increases in the cost of direct materials, direct labor, and variable overheads. Note that the new marginal cost and revenue curves (MC′ and MR′) cross at the same output level (Q*) as the pre-inflation MC and MR curves. Also note that the profit-maximizing markup remains the same, at 40% in this case. Thus, in the case where customers' incomes and the firm's AVC rise by the same percentage due to inflation (or, indeed for reasons that apply only to this firm and its customers) it is profit-maximizing to continue to use the same markup rate as before.

Figure 8.8: Constant markup rate with inflationary shifts of both demand and costs



Note that Figure 8.8 is drawn in *nominal-dollar terms*, that is, using the nominal values for costs and prices. In **real terms**—constant purchasing power terms—neither the demand curve nor the costs curves would have shifted at all. But, people generally think (and make purchases) in nominal dollar terms. Managers must be aware of their customers' perceptions of the firm's price increases and ensure that they are not perceived to be passing on more than is justified by their cost increases. In this case, AVC increased by 60 cents and, yet, the price was increased by 84 cents, which, although not an increase in real terms, might be perceived as such by customers. In most cases, of course, the customer is not privy to the magnitude of cost increase suffered by the firm. But in some cases the magnitude of cost increase *is* known to the public; for example, when the Federal Reserve Bank raises the rate at which it lends money to the commercial banks, by, say, 50 basis points (e.g., from 3.5% to 4%), home-mortgage holders typically complain loudly if the commercial banks subsequently raise their mortgage rates by more than 50 basis points—from 5% to more than 5.5%. Yet as we have seen above, the profit-maximizing home mortgage rate may well be higher than 5.5% if the commercial banks' other direct costs and variable overheads have also increased. Managers in this case must argue to their customers that their other costs have gone up, while, at the same time, assuring their shareholders that they are trying to maximize shareholder return on investment.

We should note in this context that fixed costs, comprising depreciation charges against revenue for capital costs incurred in preceding periods plus unavoidable present period costs such as managers' salaries, lease costs, and so on, may not have increased at the rate of inflation in the current production period (due to lags in salary increases, longer term agreements on lease costs, and so on). Thus, the increase in the firm's contribution to overheads and costs due to the application of a constant markup rate during inflationary times might actually increase profit, rather than simply restoring the profit rate to the prior level. Thus, those customers (and the business press) who criticize the commercial banks who "pass on more than their cost increase" may have a valid point. On the other hand, their managers would argue that salaries and lease costs must be adjusted upwards in subsequent periods (to retain the use of resources and to maintain production efficiency) and that the "leads and lags" roughly offset each other in the longer term.

Markup Pricing as a Coordinating Device

Finally, in justification of markup pricing, we note that it provides a simple and effective means for firms who compete in oligopolistic markets, where mutual dependence must be recognized, to coordinate their price increases in inflationary times or in response to other cost increases that apply specifically to firms in that industry. By all firms independently using a markup pricing rule, the firms each raise their prices in "conscious parallelism" (see Chapter 7), and, thus, avoid raising their price independently and suffering a highly-elastic demand reaction along the upper half of the kinked demand curve. Coordination of price increases by oligopolists allows their market shares to remain the same, other things remaining equal. Retaining market share is important to firms because it avoids fluctuations in output levels and the consequent need for fluctuations in the purchases of variable inputs and the hiring of direct labor.

8.3 Pricing Topics

In this final section, we examine some variations on the theme of profit-maximizing prices. We shall consider *price discrimination*, in which different customers are charged different prices, and *bundle pricing*, where the prices of products that are complementary in consumption are adjusted to increase the firm's overall profits.

Price Discrimination

Price discrimination, for our purposes here, is defined as the practice of charging different prices to different buyers (or groups of buyers) for essentially the same product, where customer differences mean they are more or less willing to pay higher prices. Note that under the United States' Robinson-Patman Act, price discrimination is defined as systematically charging different prices to different people *for identical products sold under the same circumstances* and is illegal. However, here we are considering products sold under different circumstances where those circumstances effectively produce different attributes of the product, such as the convenience of immediate versus delayed delivery. We shall consider three types of price discrimination. You will likely recognize that it is happening all around us in the business world and that customers willingly pay higher prices in some circumstances.

Auctions

Auctions are examples of **first-degree price discrimination**, defined as the seller forcing the buyer to pay the maximum or close to the maximum that the buyer is willing to pay. An auction discriminates against customers who are willing to pay more by requiring them to pay higher prices, and ultimately allows only the person who was willing to pay the most to actually purchase the product. There are two styles of auction. In a so-called **English auction**, prices are bid upwards sequentially by competing buyers until the last bid made is the highest price that anyone is prepared to bid, and thus, the sale is made to the last bidder. English auctions are routinely used to establish the price of highly differentiated or unique items such as racehorses, paintings, the bric-a-brac of celebrities, and private homes or apartments. The winning bidder is charged a relatively high price, and that price is determined by the maximum price that the second-highest bidder was prepared to pay plus the small increment included in the last bid by the winning bidder. Note that the winning bidder may have been prepared to pay even more, but only had to offer slightly more than the second-most-keen buyer. English auctions are now prevalent online—you can buy (or sell) a wide variety of items in an auction procedure on eBay or similar auction-based websites.

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Auctions are often used to establish the price of highly differentiated items. Auctions can occur in person or through websites such as eBay, which allow potential buyers to bid on a wide variety of items online.

Auctions are typically used where it is difficult to decide what is the appropriate price for the item that the seller wishes to sell, and the auction mechanism allows the best price (on the day, given the attendance of all interested potential buyers) for the seller to be achieved. Alternatively, it allows the buyer to get a bargain if no one else is interested in bidding the price higher. All potential buyers have a **reservation price**, which is the maximum price they would be willing to pay for the item. As the bid price moves above their reservation prices the potential buyers drop out of the bidding until only one is left. As long as the highest bid exceeds the **seller's reserve price**, which is the minimum that the seller is prepared to accept for the item, then a sale is made.

A **Dutch auction** sees the price level offered by the seller move *downward* from an unrealistically high level until a point where one of the potential buyers jumps in and accepts the latest price offered by the seller. This is how flowers are sold by the Dutch at the flower auctions in Holland, hence the name. Other large markets, such as fish markets, also use the Dutch auction method since it is an efficient way to sell large quantities of product in the shortest possible time. But how does it work? Again, all buyers need to form a personal view, before the bidding starts, as to the highest price they would pay (their reservation price). This, in turn, is based on how much the item is worth to them in revenue or in intrinsic terms. For example, suppose a New York flower merchant knows that he or she can sell 40 dozen roses at $30 each and that buying them at $15 per dozen in Amsterdam would provide an acceptable profit margin after airfreight and other costs. The New Yorker is thus unwilling to jump in as the price ticks down from $20 to $19, $18, $17, and $16, but jumps in when the price ticks down to $15. If that buyer were to wait any longer, someone for whom $14 is a satisfactory price would jump in, and the New York merchant would miss out on the opportunity to make profit.[10]

In ordinary markets where the market clearing price (i.e., the one that causes supply to equal demand) is received by all sellers and paid by all buyers, this price is *less than* the reservation price for all except the marginal buyer—who is the buyer willing to pay no more than the market price. All other buyers were willing to pay more than the market price but did not have to (assuming a downward-sloping demand curve, i.e., differentiated products). Note that a demand curve is, after all, simply a line joining the reservation prices of all the buyers in the market.

Prices Based on Urgency of Demand

Second-degree price discrimination involves discriminating among groups of buyers on a time or urgency basis. Those who want to buy the product soonest pay a higher price than those who are willing to wait until later. The sale of innovative new electronic and software products typically involve higher prices at first for the pioneer's product, with lower prices subsequently as the pioneer's AVC curves shift downwards due to the learning curve and as new rivals enter the market with competitive prices for their own version of the new product. Another example is the pricing of tickets for new movie releases. First runs in city theaters are priced substantially above the second runs in suburban and rural theaters. Later, the movie is typically shown on cable television (for a subscription fee) and, finally, it is shown on free-to-air television (supported by advertising revenue). Another common example is provided by passenger airfares—business users usually book flights at relatively short notice whereas tourists and people visiting family members can plan ahead—hence, airlines discriminate on the basis of how urgently you want to fly.

10. "Ticks down" is the appropriate wording because Dutch auctions typically use a large clock-like dial and the single hand is first ratcheted around to start ticking down from a very high price. Each tick is followed by a very short pause (like a cheaper watch) or in some cases (like a Rolex) the hand slides smoothly around the dial. The buyers either yell when they reach their reservation price, or to avoid arguments about who was slightly faster, the auction house provides buttons to push so that the buyer might win by milliseconds.

Some rural and suburban moviegoers certainly do go to the city to see first-run movies. They do this because their reservation price to see a particular movie is above the price asked by the city movie theater. But, city markets are relatively **thick markets**, while suburban and rural markets are relatively **thin markets**, meaning that there is a relatively large number of buyers willing to pay the first-run price in the city compared to a relatively small number of buyers willing to pay the first-run price in suburban and rural markets. Accordingly, it is profit-maximizing for the movie producer to show a new movie first in larger city theaters for a higher price and later in smaller suburban and rural theaters for a lesser price.

Figure 8.9: Pricing based on urgency of demand

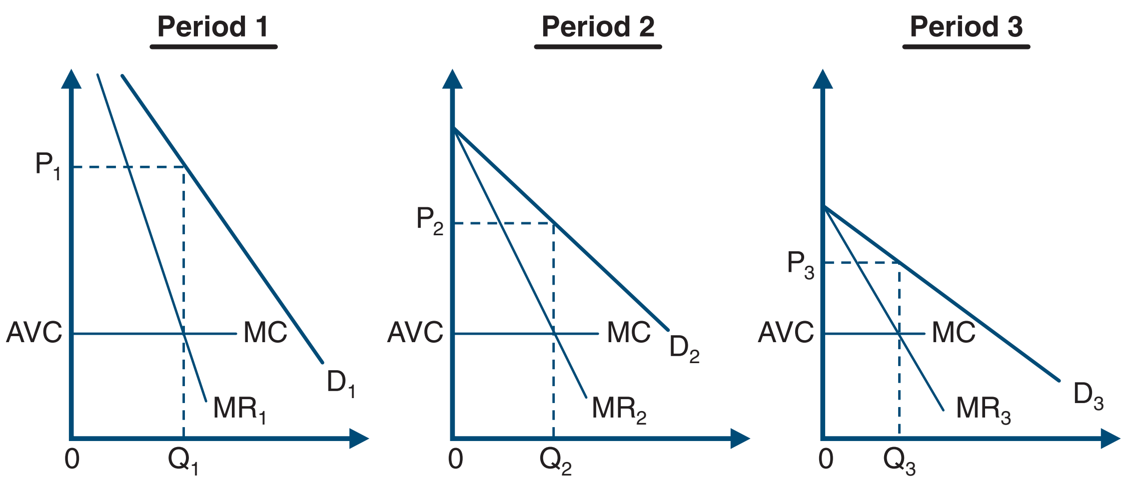


Figure 8.9 demonstrates the circumstance in which the demand for the new product in period 1 (e.g., first-run movies), shown as D_1, is relatively strong, and the profit-maximizing price and sales, P_1 and Q_1 respectively, are found where MC = MR_1.The demand for the product in period 2 is less strong, shown as D_2. The buyers represented here include those who did not buy the product in period 1 (those whose reservation prices are less than P_1) *plus* new buyers who have entered the market as a result of reading favorable reviews or listening to word-of-mouth endorsements for the new movie or new product in general. The profit-maximizing price in period 2 is thus P_2. Similarly in period 3, the demand curve D_3 is made up of those who did not purchase in period 1 or 2 because their reservation price is below P_2, as well as new buyers who have now entered the market after learning about the new product and the benefits it offers. Thus, the price level is reduced period by period as the seller discriminates among buyers based on their reservation prices which reflect their urgency to purchase the new product.

Prices Based on Differing Elasticities of Demand

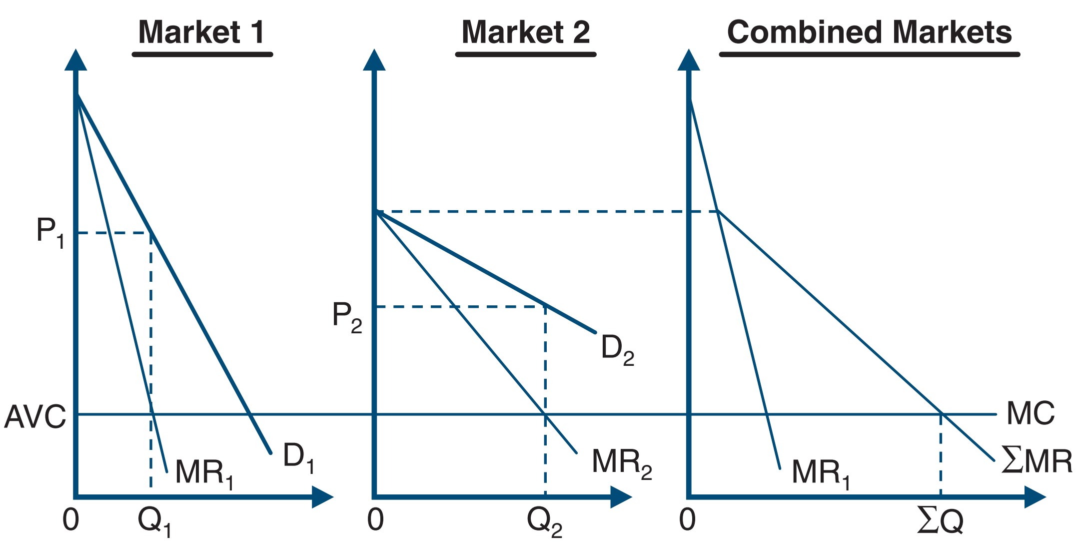
Third-degree price discrimination is a situation whereby a seller can simultaneously charge two or more different prices to customers who have differing price elasticities of demand for the same product or service. Examples of third-degree price discrimination are the telephone and electricity price differentials between household users and business users of these services. Telephone companies may also charge different amounts for

Telephone service is an example of third-degree price discrimination. Telephone companies often charge different rates for long-distance calls according to the time and day of the week they are placed.

long-distance calls according to whether they are made during business hours or in the evenings and on weekends. When signing up for these services in the first instance, the seller wants to know whether it is a business account or a private (household) account. Sellers charge businesses a higher price because their demand is less elastic—the business must use the phone and use electricity in the normal conduct of their business, and employees will be less interested in saving electricity or in shortening their phone calls than will householders who, after all, have to pay their own bills. Also, businesses need to make calls in business hours because people may resent receiving business calls after hours, or because they only have a work phone number and want to reach the other person at their desk. Householders can wait until the evening or weekends to call friends or family at their homes (or on their cell phones).

Another common situation is that the firm has both a domestic market and an export market for its output (see Figure 8.10). Its domestic price can be somewhat higher than its export price because the price elasticity of demand in the export market is typically much higher, due to the greater presence of substitutes and rival suppliers, and also customer income levels in export markets may be lower than domestic customers' incomes. In Figure 8.10, we demonstrate how the firm should choose two different prices for two different groups of customers such that it maximizes its overall profit.

Figure 8.10: Third degree pricing discrimination



Note in Figure 8.10 that demand is shown to be relatively more inelastic in market 1 and relatively more elastic in market 2. The manager's task is to choose the total output level and then allocate it between markets 1 and 2 such that MC = MR in both markets. To do this we need to find an aggregate measure of marginal revenue; we do this by the horizontal addition of the MR_1 and MR_2 curves. In the third panel of Figure 8.10 we show the ΣMR curve (Σ is the Greek letter sigma) which connotes the horizontal sum of the two MR curves. Note that it follows MR_1 until MR_2 "kicks in" at which point it kinks and represents the sum of both MR_1 and MR_2. The ΣMR curve falls to intersect the MC curve at the total output level shown as ΣQ in the right-hand part of Figure 8.10, where ΣQ is necessarily the sum of Q_1 and Q_2. Thus, the firm should set price P_1 in market 1 and price P_2 in market 2 to maximize its profit.[11]

While a firm may suspect that the price elasticity of demand differs significantly between two main groups of customers that demand its product, it will typically require significant expenditure on search activity to estimate those price elasticities with any great accuracy. We have seen that if managers do know the firm's AVC = MC level, or, more generally, the shape of the MC curve, they can make "informed guesses" about the price elasticities based on their knowledge of the customers from previous market experience. Given these estimates managers can derive the demand and marginal revenue curves that are needed to find the profit-maximizing price and output levels. While these estimates may contain substantial errors, we know that there is scope for error due to the avoidance of more expensive search processes that are not invoked by making educated guesses. Managers who believe that one group of their customers is substantially more price elastic than the rest might find a way to isolate these two groups of customers and tentatively raise the price against the more inelastic group and lower the price faced by the more elastic market. Before too long the result of this market experiment would be clear—sales in the more elastic market would expand more than the sales in the less elastic market fell and profits would increase, or not. If it seems to be working the manager might push the experiment a little further to see if profit can be increased still further. If the experiment fails, the manager could revert to the former pricing strategy.

Simple rules often suffice; for example, airlines simply charge less for airfares if the duration of the return trip involves a Saturday night. They reason that most business travelers want to be home for the weekend and, thus, charge more for flights between any particular two cities if the trip does not include a Saturday night stopover. Similarly, textbook publishing companies charge more for textbooks sold in the wealthier U.S. market than they do for the same textbooks sold in less-wealthy foreign countries, with the price being different according to the shipping address. Cheaper U.S. textbooks sold in Asia are often labeled: "Not for resale in the U.S.," and legal action is threatened if a bookseller were to buy books at export prices and attempt to resell them in the United States at domestic prices. Given the knowledge managers should have about the firms' markets, they should

11. In the case where MC is an upward sloping curve, this curve should be superimposed on the ΣMR curve in the third panel of Figure 8.10, and at the MC level where it intercepts the ΣMR curve, a horizontal line would be drawn back across the other two panels to find the output levels at which the MR curves (MR_1 and MR_2 respectively) fall to meet that MC level in each of the two markets. To demonstrate that you understand this, visualize the upward sloping MC curve in the right-hand panel of Figure 8.10 that would cause the prices and outputs shown to be profit maximizing. Hint: it needs to cut the ΣMR curve at output level ΣQ.

be able devise a decision rule that effectively separates their customers into two or more discrete groups based on differing price elasticity of demand, and then set different prices for different subgroups of customers.

Bundle Pricing

Bundle pricing is the practice of combining two or more products and selling them at a single "package" price that is less than the combined prices of the products if sold separately. The purpose of bundle pricing is to induce the buyer to spend more than they would have if they had only bought one unit of the product, and thus increase the overall revenue of the firm. You have likely seen many examples of bundle pricing. A coffee shop might offer coffee for $3 and a croissant for $1.50 if sold separately, or offer both for $3.95 as a package deal. Computer software is typically bundled with computer hardware at a single price. Restaurants offer fixed-price menus that include, for example, soup, main course, and dessert for a single price that is less than the *a-la-carte* menu prices of these items added together. Retailers offer free parking if you buy something at their store. Professional sports teams and symphony orchestras offer season tickets that are less than the total price of tickets to all the individual performances.

Bundling Complementary Goods

As long as the incremental revenue accruing to the firm from the bundle price exceeds the incremental costs of producing and selling the two or more products, the firm will increase its profits by practicing bundle pricing. Let's consider the example of the offer of a pair of complementary goods, such as coffee and a croissant, for $3.95. Assume that the average variable cost of each is constant and, thus, equal to marginal costs, and that there are no incremental fixed costs, so that the marginal cost of each is equal to the incremental cost of each, as shown in Table 8.2.

Table 8.2: Bundle pricing example—coffee and croissant for $3.95

Coffee sold separately		Croissant sold separately		Coffee and croissant bundle	
Incremental revenue	$3.00	**Incremental revenue**	$1.50	**Incremental revenue**	$3.95
Incremental costs		**Incremental costs**		**Incremental costs**	
Direct materials	$0.30	Direct materials	$0.40	Direct materials	$0.70
Direct labor	0.50	Direct labor	0.15	Direct labor	0.65
Variable overhead	0.20	Variable overhead	0.05	Variable overhead	0.25
Total incremental costs	$1.00	Total incremental costs	$0.60	Total incremental costs	$1.60
Contribution margin =	$2.00	**Contribution margin** =	$0.90	**Contribution margin** =	$2.35
Units sold before were 50		Units sold before were 20		Units sold before were 0	
Total contribution before =	**$100**	**Total contribution before** =	**$18**	**Total contribution before** =	**$0**
Units sold after will be 30		Units sold after will be 10		Units sold after will be 60	
Total contribution after =	**$60**	**Total contribution after** =	**$9**	**Total contribution after** =	**$141**

In this case, we can see that the coffee and croissant bundle makes a lesser contribution margin (i.e., $2.35) than the sum of the two component items (i.e., $2.90) but offering them in combination sells more coffees and croissants than before, such the total contribution rises from $118 before the introduction of bundle pricing to $210 after the introduction of bundle pricing. This happens because some customers who previously bought only coffee or only a croissant now see the bundle as a superior value proposition, and in addition some new buyers are attracted into the coffee shop because the bundle offers them a superior value proposition. Notice also that some buyers continue to buy just coffee or just a croissant at the *a-la-carte* prices. These extra 30 coffees contribute an additional $60 and the extra 10 croissants contribute an extra $9 to the $141 contributed by the bundle to make the total contribution from coffee and croissants $210.

From the customer's perspective, the bundle price offers an additional item for an additional amount of money that may be less than the customer's reservation price for that additional item. In this case if a customer who regularly buys coffee has a reservation price for a croissant of, say $1.25, that customer would not buy a croissant at the *a-la-carte* price of $1.50, but would buy one when it is included in the bundle price because it costs only an additional $0.95 over the cost of a coffee alone. Oppositely, a regular customer who buys only croissants and has a reservation price for coffee of say, $2.50, would not buy a coffee at the *a-la-carte* price of $3.00 but would buy one in the bundle because the additional cost of the coffee is effectively only $2.45 more than the croissant alone. Similarly, people whose reservation price for coffee is below $3 (say $2.75) and for a croissant is below $1.50 (say $1.25) would not be customers of this coffee shop at the *a-la-carte* prices but would now find the "coffee plus croissant" bundle price an attractive proposition because the bundle price of $3.95 is less than their combined reservation price of $4.00. Finally, some customers who currently buy both coffee and croissants at other coffee shops would be attracted to this particular coffee shop because it has effectively reduced its price for this combination of products.

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"Buy one get one free" and "25% off your next purchase" are examples of bundle pricing, which is used to entice consumers to spend more than they initially intended and thus increase overall revenue for the business.

Discounts for Larger Volumes

It may surprise you that discounts for larger volumes are another form of bundle pricing. Many firms offer a product in different sized packages and rather than multiplying the unit price by the number of units, often say things like "20% off the second meal"; or "three for the price of two"; or "pay for 4 nights, get the 5th night free" and so on. Similarly, Coca-Cola practices bundle pricing by offering its product in containers of various sizes—note that bottles that hold twice as much cola cost less than twice as much as the smaller bottle, for example. The larger sizes can be viewed as bundles, or multiples, of the smallest size offered for sale and the buyer is effectively given a discount per unit (per fluid ounce) for purchasing larger quantities.

Again, the customer will choose to buy the larger size container, or the greater number of units in the bundle, if the incremental cost to the buyer is less than the sum of his or her reservation prices for the extra volume or units provided. We illustrate this in Table 8.3 where we show the results of a market experiment where several different sizes of liquid detergent are offered at the prices indicated, as well as the reservation prices of three different buyers.

Table 8.3: Quantity discounts and reservation prices for three customers

Size of container (fluid ounces)	Seller's price for each size	Customer A's reservation prices	Customer B's reservation prices	Customer C's reservation prices
10	$2.00	$2.80	$2.50	$1.80
20	$3.50	$3.60	$3.30	$3.40
30	$5.00	$4.80	$4.20	$4.90
40	$6.25	$6.00	$5.00	$6.20
50	$7.50	$7.00	$5.50	$7.55

The shaded prices show where the customer's reservation price is greater than the seller's asking price. We see that customer A would buy either of the first two sizes because the bundle price is less than this customer's reservation price for each of these sizes. Customer B would only buy the smallest size because the bundle price of larger sizes exceeds his or her reservation price. Customer C would not buy any of the smaller sizes but would enter the market and buy the 50-ounce container if it is available at the price of $7.55 or less. If these three customers are representative of the market as a whole, this seller might decide to offer the product in the 10-, 20-, and 50-ounce sizes since it would sell a total of 90 ounces of detergent (rather than only 20 ounces if offering only the smallest size) for every three customers like these.

Whether the detergent firm will want to do that depends on the incremental costs of producing the larger-sized containers and filling them with detergent, of course. The rule, as you know, is that if the incremental revenue is greater than the incremental cost, then the firm should do it. In the simple example here with only three buyers, the incremental revenue of selling an additional 20-ounce container and a 50-ounce container is $11. If the market is made up of 100,000 buyers like these three, the incremental revenues would be $1.1 million, all other things being equal. So, if the incremental fixed costs of setting up additional filling lines, plus the incremental costs of the direct materials, labor, and variable overhead costs, are less than $1.1 million, it would appear to be a profit-making decision to go ahead with the three different sized containers of detergent.

Summary

In this chapter, we have applied theoretical concepts learned in the preceding chapters to the pricing decisions of the firm in practical situations where

1. the cost of information about the cost and revenue functions might be low enough to allow estimates to be made of the cost and revenue functions such that the manager can proceed to use the "marginalist pricing" rule of MC = MR and
2. the information search costs is expected to be higher such that the managers make the business decision to forego any further information search activity and use a markup pricing rule whereby a percentage markup over average variable costs is used to arrive at the price level to be charged.

Instead of obtaining estimates of the underlying demand function, we saw that an estimate of the price elasticity of demand provides enough information, given current price and quantity demanded data, to derive expressions for the firm's demand and marginal revenue curves. Particularly, if average variable costs are expected to be constant at the current observed level, it then becomes a simple matter to apply the marginalist pricing rule to find the profit-maximizing price and output level.

We saw that the marginalist pricing rule and the markup pricing rule can be reconciled—that for every price obtained by the MC = MR rule there is a corresponding markup rate that would arrive at the same price. We found that the profit-maximizing markup rate is determined by the price elasticity of demand, and that the size of the profit-maximizing markup is inversely proportional to the (absolute) value of the price elasticity; that is, the higher the price elasticity in absolute terms, the lower is the profit-maximizing markup rate. Thus, products with more and closer substitutes and for which price is a larger proportion of customers' incomes should be expected to carry smaller markup rates than products with few close substitutes and which are relatively inexpensive compared to customers' incomes.

Next, we showed that the avoidance of search cost provides a margin for error for the markup rate. This margin for error is wider the larger are the expected costs of information search necessary to gain reliable estimates of the cost and revenue curves. Thus, the actual markup rate utilized can diverge significantly from the true (but unknown) profit-maximizing rate, such that the actual price and quantity demanded are quite different from the profit-maximizing levels. Despite this, the firm can make a larger profit as compared to first incurring the search costs and then setting the profit-maximizing price and output. Further, demand shifts that are iso-elastic, or roughly so, will potentially leave the current markup rate as the profit-maximizing one and not require a recalibration of the markup rate. Also, shifts of the cost and demand curves due to inflation are also likely to leave the current markup rate as optimal if the curves are equally affected by inflation.

Finally, in this chapter we considered ways to increase profits by setting different prices for different customers, discriminating against those with higher reservation prices, more urgent demand, and less elastic demand. We also considered bundle pricing, which allows the firm to extract more revenue from customers and increase profits as long as the incremental revenue exceeds the incremental costs associated with this pricing strategy.

In the following two chapters, we continue to examine the pricing decision of business firms in the context of new products (Chapter 9) and competitive bidding and price tendering (Chapter 10).

Questions for Review and Discussion

1. If the regression equation that best fits the TVC data collected for a firm is a *linear* equation, does that mean that diminishing returns to the variable factors of production is not applicable to that particular firm? Why or why not?
2. Explain in words (and some symbolic notation) how knowledge of the current price and quantity demand levels, combined with an estimate of the price elasticity of demand at that price and quantity combination, can be used to derive an equation for the demand curve.
3. Suppose a firm chooses the price of its product by applying a 50% markup to its average variable costs, which are constant over the relevant range. Suppose also that top management agree that a 10% price increase would cause sales to fall by about 15%. What should they do now (if they want to maximize short-run profits)?
4. Explain why the demand for some products is more elastic than it is for other products.
5. Explain in your own words why the magnitude of search costs (that would be required to ascertain the demand and costs curves) is positively related to the range of prices (and markup rates) that allow the firm to make more profit than it could if it first incurred search costs and then set the price where MC = MR.
6. Explain why an outward shift of the demand curve that causes the value of price elasticity to be more or less unchanged at the current price level would not cause managers to want to raise the price.
7. If inflation causes the firm's costs to rise by a higher percentage than it causes customers' incomes to rise, explain whether the firm should raise or lower its markup rate to maximize its profit.
8. Suppose I own a valuable oil painting (e.g., the Mona Lisa) and wish to sell it. For a given group of potential buyers, which auction method, English or Dutch, would deliver the highest price, and why?
9. What is the difference between first-degree, second-degree, and third-degree price discrimination? On what bases does the discrimination occur?
10. Describe several ways that the firm might utilize bundle pricing to increase its profit from the same group of potential customers.

Decision Problems

1. You have been called in as a consultant to the manager of Smith's Bookstore who is wondering if the present price of $9.95 for paperback novels is profit maximizing. The firm has experimented with prices every week for the past six months and collected data on prices and quantities demanded for paperback novels sold each week. You conduct regression analysis of the data and obtain the following results (where P is in dollars and Q represents thousands of books sold per week):

Regression equation	$Q = 49.147 - 2.941P$
Coefficient of determination	$R^2 = 0.96$
Standard error of estimate	$S_e = 0.128$
Standard error of the coefficient	$S_\beta = 0.086$

Regression analysis of the firm's weekly total variable cost and sales levels over the same period provide the following information:

Regression equation	$TVC = 102.35 + 0.025Q^2$
Coefficient of determination	$R^2 = 0.92$
Standard error of estimate	$S_e = 0.232$
Standard error of the coefficient	$S_\beta = 0.003$

a. What is the profit-maximizing price for the paperback novels sold by this bookstore?
b. What is your prediction for the level of sales at that price, and what is your 95% confidence interval for sales at that price?
c. What is the price elasticity of demand at the price you are recommending?

2. The Laura Ann Boutique purchases a line of inexpensive dresses from an importer and pays \$30 per dress regardless of volume. These dresses are marked up by about one-third to sell at \$39.95 each and quantity demanded averages 300 dresses per week.

a. What would the price elasticity of demand have to be for that markup rate to be profit maximizing?
b. Laura Ann wants to maximize profit and is wondering if she is using the appropriate markup rate. Suppose she pays \$500 for a marketing student to conduct a survey of customers and this results in an estimate of price elasticity of $\varepsilon = -3.5$. What price is profit maximizing if this estimate can be regarded as being reliable?
c. Was it worthwhile for Laura Ann to spend the \$500 on search costs?

3. Archibald Tires buys car tires at an average price of \$600 per set of four, applies a 25% markup, and sells them for an average price of \$750 per set, regardless of volume. Archibald typically sells about 60 sets of tires per week at that price. Joe Archibald has conducted an informal survey of his customers and has estimated that if he raised his price by 10% he would lose 1 out of every 9 customers.

a. Derive an expression for the demand curve for these tires.
b. What is the profit-maximizing price and quantity demanded, based on Joe's estimate of price elasticity?
c. What do you advise Joe Archibald to do, and why?

4. The Thomas Tent Company has two markets for its mid-size tent, the domestic market and the export market. The demand curve for the domestic market is characterized by $P = 100 - 15Q$, while the demand curve for the export market is $P = 60 - 2.5Q$, where P is the price in U.S. dollars and Q represents thousands of tents. The firm has one production facility that manufactures the tents, which has a total cost function characterized by $TC = 10{,}800 + 20Q + 0.1Q^2$ in the relevant range of outputs.

a. What is the profit-maximizing level of mid-size tent production for the firm?
b. How should Thomas Tent divide this output between the two markets?
c. What price should be set in the domestic market?
d. What price should be set for the export market?

5. Greener Grass Company (GGC) competes with its main rival, Better Lawns and Gardens (BLG), in the supply and installation of in-ground lawn watering systems in the wealthy western suburbs of a major east-coast city. Last year, GGC's price for the typical lawn system was $1,995 compared with BLG's price of $2,100. GGC installed 9,130 systems, or about 55% of total sales and BLG installed the rest. (No doubt many additional systems were installed by do-it-yourself homeowners since the parts are readily available at hardware stores.) GGC has substantial excess capacity—it could easily install 25,000 systems annually, as it has all the necessary equipment and can easily hire and train installers. Accordingly, GGC is considering expansion into the eastern suburbs, where the homeowners are less wealthy. In past years, both GGC and BLG have installed several hundred systems in the eastern suburbs but generally their sales efforts are met with the response that the systems are too expensive. GGC has hired you to recommend a pricing strategy for both the western and eastern suburb markets for this coming season. You have estimated two distinct demand functions, as follows:

$$Q_w = 1{,}035.548 - 6.07164P_{gw} + 2.83P_{bw} + 2{,}100A_g - 1{,}500A_b + 0.2348Y_w$$

for the western market and

$$Q_e = 49{,}714.29 - 30.7692P_{ge} + 6.984P_{be} + 1{,}180A_g - 950A_b + 0.0825Y_e$$

for the eastern market, where Q refers to the number of units sold; P refers to price level; A refers to advertising budgets of the firms (in millions); Y refers to average disposable income levels of the potential customers; the subscripts *w* and *e* refer to the western and eastern markets, respectively; and the subscripts *g* and *b* refer to GGC and BLG, respectively. GGC expects to spend $1.5 million on advertising this coming year and expects BLG to spend $1.2 million on advertising. The average household disposable income is $55,000 in the western suburbs and $25,000 in the eastern suburbs. GGC does not expect BLG to change its price from last year, since it has already distributed its glossy brochures (with the $2,100 price stated) in both suburbs, and its TV commercial has already been produced. GGC's cost structure has been estimated as $TVC = 755.363Q + 0.005Q^2$ where Q represents single lawn watering systems.

a. Derive the demand curves for GGC's product in each market.
b. Plot graphically the demand and MR curves for each market, and also show GGC's combined marginal revenue curve (ΣMR) and its MC curve. Show graphically the quantities that should be produced and sold, and the prices that should be charged, in each market.
c. Confirm your quantity and price results algebraically.
d. Calculate the price elasticities of demand in each market and discuss these in relation to the prices to be charged in each market.
e. Add a short note to GGC management outlining any reservations and qualifications you may have concerning your price recommendations.

Key Terms

bundle pricing The practice of combining two or more products and selling them at a "package" price that is less than the combined prices of the products if sold separately. The purpose of bundle pricing is to induce the buyer to spend more and thus increase the overall revenue of the firm.

Dutch auction A "reverse" auction where the seller's bidding begins at an unrealistically high price then drops down progressively until somebody accepts the asking price, and thereby wins the item.

English auction An auction where the article's initial cost is set at a relatively low level, and then the potential buyers compete with each other, bidding the price higher until only one buyer with the highest bid price is left, who then wins the item.

first-degree price discrimination A system of pricing whereby the seller induces the winning buyer to pay at or near the maximum that the buyer is willing to pay for an item. Auctions are examples of first-degree price discrimination.

inflation A process by which the prices of goods and services in a given country continue to rise over a period of time, which means that people can buy fewer goods and services with any given amount of money due to the depreciation of the monetary unit (dollar).

iso-elastic demand shifts Shifts of the demand curve where price elasticity stays the same at any given price level. Thus, if marginal costs are constant, the same markup rate continues to be the profit-maximizing rate, despite shifts of the demand curve.

level of significance The degree of confidence we can have that the regression analysis of data from a sample indicates the true relationship that exists between the variables in the whole population.

marginalist pricing A form of pricing where the firm sets price using the "marginal cost equals marginal revenue" rule, by using data obtained by firms based on their prior production and market experience.

markup pricing The practice of setting price by adding an amount, calculated as a percentage of direct costs per unit (AVC), to the AVC, to determine the asking price of a product.

price discrimination A pricing practice where a firm (legally) charges its customers different prices for what is basically the same product (e.g., air travel) because that base product is delivered at different times or in different circumstances that contribute additional value to some consumers who are prepared to pay a higher price.

real terms An assessment of the monetary value of an asset or other item that is expressed in constant-purchasing power dollars, as distinct from nominal (or monetary) terms where price is expressed in terms of the face value of a currency that is depreciating due to inflation.

reservation price The maximum price that a buyer is willing to pay for a given item, or in the case of sellers, the minimum price for which they will sell an item.

second-degree price discrimination A pricing practice that involves charging higher prices to those whose demand is more urgent, and lower prices to those whose demand is less urgent, such as short-notice airfares costing more than advance-purchase airfares.

seller's reserve price The minimum price that the seller is prepared to accept for a given item in order for a sale to be made.

thick markets Markets that are relatively dense with many potential buyers of a particular item within a given radius of the seller(s), such as exists for most products in large cities.

thin markets Markets in which there are relatively few buyers in a given area, such as in rural and remote areas, or for products in dense areas of population that very few buyers need or can afford. Examples are the market for hip replacements or uncut diamonds.

third-degree price discrimination A pricing practice that involves charging higher prices to those whose demand is less price elastic, and lower prices to those whose demand is more price elastic, such as business class airfares costing more than economy class airfares.