1 that $\overline{z} > \dfrac{\theta_1 \underline{z}_1}{(\theta_1 - \theta_2)}$ it follows that the condition of non-negative consumer surplus can be satisfied by some $z_2 \leq \overline{z}$.

It is easy to check that the incentive compatibility constraint is always satisfied for type 2 consumers. For this type of consumer *not* to want to buy the high-quality product it must be the case that $\theta_2 z_1 - p_1 < 0$. Given that $p_1 \leq \theta_1 z_1 - (\theta_1 - \theta_2)z_2$ this implies–$(\theta_1 - \theta_2)z_1 + (\theta_1 - \theta_2)z_2 < 0$. Because $z_1 > z_2$ and $\theta_1 > \theta_2$ this must be true. In other words, the prices given by (7.30) and (7.32) guarantee that type 1 consumers buy the high-quality product and type 2 consumers buy the low-quality product.

Now assume that there are N_i consumers of each type. Furthermore, suppose that variable costs of production do not depend on quality and so for simplicity we set the unit production costs of each good $c_1 = c_2 = 0$. Again for simplicity assume that there are no fixed costs as well. Given that $p_1 = \theta_1 z_1 - (\theta_1 - \theta_2)z_2$ and $p_2 = \theta_2 z_2$ the firm's total profit is:

$$\begin{aligned} \Pi = N_1 p_1 + N_2 p_2 &= N_1\theta_1 z_1 - N_1(\theta_1 - \theta_2)z_2 + N_2\theta_2 z_2 \\ &= N_1\theta_1 z_1 - (N_1\theta_1 - (N_1 + N_2)\theta_2)z_2 \end{aligned} \tag{7.34}$$

The issue that we want to address now is what quality of goods, z_1 and z_2, will maximize the firm's profit. It is clear from equation (7.34) that the coefficient on z_1 is positive, given by $N_1\theta_1$. That is, profit rises as z_1 rises, so the firm should set z_1 as high as possible; that is:

$$z_1^* = \overline{z} \tag{7.35}$$

The firm should set the quality of its highest quality product at the maximum quality level possible.

For z_2 matters are not quite as straightforward. The impact of z_2 upon the monopolist's profit depends upon the sign of the coefficient, $N_1\theta_1 - (N_1 + N_2)\theta_2$. When this term is positive, the monopolist's profit decreases as z_2 increases. When it is negative, profit increases as z_2 increases. We need to examine these two cases separately.

Case 1: $N_1\theta_1 < (N_1 + N_2)\theta_2$

If $N_1\theta_1 < (N_1 + N_2)\theta_2$ then it follows from (7.34) that profit is increasing in z_2. In this case the firm should set $z_2 = z_1 = \overline{z}$. In other words, the firm should offer only one product and that product should be of the highest possible quality. The question now becomes whether the firm in this case should price the high-quality product to sell to both types of consumer or price it to sell only to type 1 consumers.

Selling to both types of consumer requires that the product be priced at $p^* = \theta_2\overline{z}$. Type 2 consumers have all their consumer surplus extracted but, given Assumption 1, type 1 consumers enjoy some consumer surplus. The firm earns a total profit of $(N_1 + N_2)\theta_2\overline{z}$. If, instead, the monopolist chooses to sell only to type 1 consumers, the product can be priced at $p = \theta_1(\overline{z} - \underline{z}_1)$, extracting all consumer surplus from each type 1 consumer by not supplying type 2 consumers. This strategy gives the firm a total profit of $N_1\theta_1(\overline{z} - \underline{z}_1)$. Comparing these two strategies tells us that that selling to both types of consumers is more profitable if:

$$N_1\theta_1(\overline{z} - \underline{z}_1) < (N_1 + N_2)\theta_2\overline{z} \Rightarrow N_1\theta_1 < (N_1 + N_2)\theta_2\frac{\overline{z}}{(\overline{z} - \underline{z}_1)} \tag{7.36}$$

Note that this case is defined by the condition that $N_1\theta_1 < (N_1 + N_2)\theta_2$. Further note that $\frac{\overline{z}}{\overline{z} - \underline{z}_1} > 1$. In other words, equation (7.35) holds. We can conclude that in Case 1, for which $N_1\theta_1 < (N_1 + N_2)\theta_2$, the monopolist offers a single product of quality $\overline{z}$ and prices it at $p^* = \theta_2\overline{z}$ in order to sell to both types of consumer.

Case 2: $N_1\theta_1 > (N_1 + N_2)\theta_2$

From (7.34) it is clear that in this case profit is decreasing in z_2 and so the firm has an incentive to offer two qualities that are as differentiated as possible. The firm will choose $z_1^* = \overline{z}$ and set z_2 as low as is feasible. This does not mean, however, that z_2 can be reduced to its minimum of $\underline{z}_2$. Remember that we must also satisfy the constraint that type 1 consumers receive non-negative consumer surplus from buying the high-quality good. That is, $\theta_1(z_1^* - \underline{z}_1) - p_1 \geq 0$. But we know that $z_1^* = \overline{z}$ and, from (7.33), $p_1 = \theta_1 z_1^* - (\theta_1 - \theta_2)z_2$. Substituting these into the non-negativity constraint gives $(\theta_1 - \theta_2)z_2 - \theta_1\underline{z}_1 \geq 0$. In other words the monopolist chooses:

$$z_2^* = \frac{\theta_1\underline{z}_1}{\theta_1 - \theta_2} \tag{7.37}$$

It is here that we see the impact of the assumption that the monopolist cannot distinguish the two consumer types. The monopolist would like to set z_2 even lower than is implied by equation (7.37) but cannot do so if the monopolist is to offer products that make the consumers self-select into their true types.

We can now work out the profit-maximizing prices for the two goods. Substituting (7.37) in (7.31) we find $p_2^* = \frac{\theta_2\theta_1\underline{z}_1}{\theta_1 - \theta_2}$. Similarly substituting (7.37) and $z_1^* = \overline{z}$ into $p_1 = \theta_1 z_1^* - (\theta_1 - \theta_2)z_2$, we find that $p_1^* = \theta_1(\overline{z} - \underline{z}_1)$. In other words, type 1 consumers are charged their maximum willingness to pay for the highest quality possible, $\overline{z}$, and type 2 consumers are charged their maximum willingness to pay for the lower quality $z_2^* = \frac{\theta_1\underline{z}_1}{\theta_1 - \theta_2}$. In offering both goods, the monopolist extracts all the consumer surplus but has to compromise on the qualities that are offered. Aggregate profit is:

$$\Pi = N_1\theta_1(\overline{z} - \underline{z}_1) + N_2\frac{\theta_2\theta_1\underline{z}_1}{\theta_1 - \theta_2} \tag{7.38}$$

In comparing the prices that the monopolist sets in the two cases, we can identify the intuition behind the result that in one case the monopolist wants to offer only one (high-) quality good while in the other the firms wants to offer both a high-quality and a low-quality good.

We saw that when only one, high-quality good is offered it is priced at $p^* = \theta_2\overline{z}$ in order to have it sell to both types of consumer. When a high-quality and low-quality good are offered, the high-quality good is priced at $p_1^* = \theta_1(\overline{z} - \underline{z}_1)$ while the low-quality good is priced at $p_2^* = \frac{\theta_2\theta_1\underline{z}_1}{\theta_1 - \theta_2}$. It follows immediately from Assumption 1 that $p_1^* > p^*$ and $p_2^* < p^*$. Offering two quality-differentiated goods allows the monopolist to charge a higher price to type 1 consumers but forces the monopolist to lower the price it charges to type 2 consumers. For this strategy to be profitable, there needs to be "sufficiently many" type 1 consumers as compared to type 2. This is exactly the property captured by the condition that the two-product strategy should be adopted only if $N_1\theta_1 > (N_1 + N_2)\theta_2$.

7.3 **Practice Problem**

General Foods is a monopolist and knows that its market for Bran Flakes contains two types of consumers. Type A consumers have indirect utility functions $V_a = 20(z - z_1)$ while type B consumers have indirect utility functions $V_b = 10z$. In each case z is a measure of product quality, which can be chosen from the interval [0,2]. There are N consumers in the market, of which General Foods knows that a fraction η is of type A and the remainder is of type B.

a. Suppose that General Foods can tell the different consumer types apart and so can charge them different prices for the same quality of breakfast cereal. What is the profit maximizing strategy for General Foods?

Now suppose that General Foods does not know which type of consumer is which.

b. Show how its profit maximizing strategy is determined by η.
c. What is the profit maximizing strategy when $z_1 = 0$?

7.6 EMPIRICAL APPLICATION: PRODUCT QUALITY AND MARKET SIZE

One important insight that comes from formal consideration of vertically differentiated markets is that quality tends to increase as the market size grows. The intuition behind this insight is most easily seen in our initial discussion of a vertical quality market in which the inverse demand curve is of the general form:

$$P = z(K - Q) \tag{7.39}$$

The advantage of this specification is that the market size is totally captured by the parameter K. Thus, if $K = 50$, as in our earlier example, the maximum market demand at $P = \$0$ is $Q = 50$. However, if $K = 100$, the maximum demand at $P = \$0$ is $Q = 100$. We can repeat this comparison at all other prices and the same relative result will emerge. Holding quality z constant, total demand in the market at any price P is greater the larger is K.

Consider now our earlier example in which the marginal production cost was independent of quality z and for convenience set to zero, while the overhead design cost was quadratic, that is, $F(z) = 5z^2$. As before, we can solve for the optimal quantity by recognizing that marginal revenue is given by: $MR = zK - 2zQ$. Equating this to the assumed marginal cost value of zero, yields:

$$Q = \frac{K}{2} \Rightarrow P = z\frac{K}{2} \tag{7.40}$$

In turn, this means that the firm's profit is given by:

$$\pi(z) = \frac{K^2}{4}z - 5z^2 \tag{7.41}$$

Thus, every increment in quality z raises revenue by $K^2/4$, and we know from before, that every such increase in quality has a marginal cost of $10z$. Equating this marginal revenue and marginal cost then yields

$$z = \frac{K^2}{40} \tag{7.42}$$

Again, it is easy to check that when $K = 50$, this yields $z = 62.5$ as we found in our initial example. More generally though, note that the profit-maximizing choice of z increases with our measure of market size, K.

The foregoing intuition is quite general. It also applies when the marginal production cost rises with quality. In fact, it holds when there is competition so that different firms offer different quality products though here it typically means that it is the quality of the best product that will rise with market size.

In short, there is a general prediction that larger markets ought to offer better quality products. It is this prediction that Berry and Waldfogel (2010) test in a recent paper. For this purpose they look at two sets of local markets—those for newspapers and those for restaurants—where each local market corresponds to one of 283 metropolitan statistical areas defined by the US Census Bureau. We focus on their newspaper results here because this market is closest in spirit to the intuitive argument above.

Berry and Waldfogel (2010) define newspaper quality in a number of ways. Because more content should mean better quality, one measure is simply the number of pages the newspaper has. For a collection of different newspapers, we might instead take the average number of pages (AVEPAGE) or, in line with our analysis above, the number of pages in the largest newspaper (MAXPAGE). An alternative, input-based measure of quality is the number of reporters on staff, again averaged across all papers (AVESTAFF) or taken at its largest value for a given community (MAXSTAFF). The number of staff reporters may be particularly important at the local level, as it is likely to reflect the extent to which the paper covers local news as opposed to printing syndicated, national reports.[11]

The various measures of newspaper quality are then regressed on a measure of the metropolitan area population, as a measure of market size, along with other variables meant to control for various factors that may influence the quality choice—the metropolitan median income; the percent of the population with some college education; the percent that are young (under age thirty-five); and the percent that are old (over age sixty-five). The Berry and Waldfogel (2010) results are shown in Table 7.1 below for regressions that use the natural logarithm of the quality and market size variables so that the estimated coefficients are naturally treated as elasticities, i.e., as a ratio of percentage changes.

The estimates across the first row strongly confirm the hypothesis that product quality rises with market size. Thus, as the population grows by 10 percent, the number of pages in the average and largest metropolitan area grows by 2 and 3 percent, respectively, and each result is statistically significant at the 1 percent level. Similarly, as the metropolitan population grows by 10 percent, the number of staff reporters on the average and largest newspaper grows by 48 and 56 percent, respectively. Again, these results are very statistically significant.

Moreover, the highest quality paper is also the one with the largest market share. For example, New York's paper with the most pages is the *New York Times* and its metropolitan market share is essentially the same as the shares of the next two largest papers—the *Daily*

[11] Averages were circulation-weighed averages.

Table 7.1 Newspaper quality and market size*

	Dependent Variable			
	ln(AVEPAGE)	*ln(AVESTAFF)*	*ln(MAXPAGE)*	*ln(MAXSTAFF)*
ln(POP)	0.208 (0.021)	0.475 (0.025)	0.287 (0.015)	0.560 (0.025)
Median Income	−0.001 (0.005)	0.009 (0.006)	0.005 (0.004)	0.025 (0.006)
% College	1.106 (0.388)	0.900 (0.479)	1.025 (0.275)	0.961 (0.477)
% Young (< 35)	2.387 (1.115)	1.73 (1.380)	1.119 (0.790)	0.428 (1.375)
% Old (> 65)	2.480 (1.113)	0.183 (1.377)	1.982 (0.789)	0.006 (1.371)
Constant	2.59 (0.549)	2.611 (0.680)	3.165 (0.389)	3.010 (0.677

*Standard errors in parentheses.

News and the *Post*—combined. Thus, the highest quality choice is invariably the decision of the firm with the most market share, which is a bit more in the spirit of the analysis in this chapter.[12] Overall then, the newspaper quality and market size seem to be very positively correlated.

Summary

This chapter has investigated product-differentiated strategies that a monopolist may employ when it sells to consumers with diverse tastes. By offering a line of products, the firm can better expropriate consumer surplus and increase profit. First we considered horizontal product differentiation. In this scenario, consumers differ in their preferences for specific product characteristics. Some prefer yellow, some black, some soft, some hard, some sweet, and some sour. By selling different varieties of the product, the monopolist expands its market and simultaneously enhances its ability to charge customers higher prices in return for selling a variety of product that is close to their most preferred flavor, color, or design.

A feature of this kind of market is that the monopolist tends to offer too much variety—a prediction for which there is a good bit of supportive casual evidence. However, the monopolist's incentive to over-supply variety is mitigated if the firm is able to price discriminate. Indeed, perfect or first-degree price discrimination encourages the firm to offer consumers the same amount of variety as the socially optimal case.

We also investigated the monopolist's strategy when products are vertically differentiated. In this case, all consumers agree that higher quality is better, where quality is measured by some observable feature, or set of features of the product. Consumers, however, differ in their willingness to pay for quality. In the case in which the monopolist offers only one type of product and quality is costly, we found that the monopolist may choose too low a quality. The monopolist may also have in the vertically differentiated case an incentive to offer a range of different qualities in order to exploit the differences in consumers' preferences. In doing so, however, the firm faces an incentive compatibility constraint and must choose quality and price such that the different types of consumer will purchase the quality targeted to their type. These constraints encountered in

12 However, recall our warning from Chapter 1 that structure (and market shares) are endogenous. The high quality of a paper is as much responsible for that paper's market share as the firm's market power is responsible for the paper's high quality.

second-degree price discrimination in Chapter 6. One empirical prediction that emerges from this analysis is that in vertically differentiated products, the quality of the best product will tend to rise as the market size increases to allow a fuller exploitation of any scale economies in making a better product. Evidence from urban newspaper markets where quality is measured in terms of variables such as average staff size or average number of pages confirms this hypothesis.

We have cast our theoretical discussion mainly in the context of monopoly. Yet the practices we have described are often employed by companies that are far from perfect monopolists without significant rivals. This reflects the fact that imperfectly competitive firms often have a very powerful incentive to offer a range of differentiated products, whether they are horizontally or vertically differentiated. Indeed, imperfectly competitive firms often have a very strong incentive to pursue such differentiation as an important tactic to deal with rivals. We will discuss this point in subsequent chapters. Here we simply note that the empirical study of urban newspaper markets reported in this chapter also tends to confirm this view. Two papers in the same city rarely offer readers the same quality of news coverage.

Problems

1. A monopolist faces the following inverse demand curve: $P = (36 - 2Q)z$; where P is price; Q is her total output; and **z** is the quality of product sold. **z** can take on only one of two values. The monopolist can choose to market a low-quality product for which $z = 1$. Alternatively, the monopolist can choose to market a high-quality product for which $z = 2$. Marginal cost is independent of quality and is constant at zero. Fixed cost, however, depends on the product design and increases with the quality chosen. Specifically, fixed cost is equal to $65z^2$.

    a. Find the monopolist's profits if profits are maximized *and* a low-quality design is chosen.
    b. Find the monopolist's profits if profits are maximized *and* a high-quality design is chosen
    c. Comparing your answers to 1(a) and 1(b), what quality choice should the monopolist make?

2. In the early 1970s, the six largest manufacturers of ready-to-eat breakfast cereals shared 95 percent of the market. Over the preceding twenty years, these same manufacturers introduced over eighty new varieties of cereals. How would you evaluate this strategy from the viewpoint of the Hotelling spatial model described earlier in the chapter?

3. Crepe Creations is considering franchising its unique brand of crepes to stall-holders on Hermoza Beach, which is five miles long. CC estimates that on an average day there are 1,000 sunbathers evenly spread along the beach and that each sunbather will buy one crepe per day provided that the price plus any disutility cost does not exceed \$5. Each sunbather incurs a disutility cost of getting up from resting to get a crepe and returning to their beach spot of 25 cents for every $1/4$ mile the sunbather has to walk to get to the CC stall. Each crepe costs \$0.50 to make and CC incurs a \$40 overhead cost per day to operate a stall. How many franchises should CC award given that it determines the prices the stall holders can charge and that it will have a profit-sharing royalty scheme with the stall holders? What will be the price of a crepe at each stall?

4. Return to Problem 3 above. Suppose now that CC requires that each stall holder deliver the crepes in its own designated territory. How many franchises should now be awarded if we make the standard assumption that the effort costs of the stall holders are the same as those of the sun bathers? How would your answer change if the stall holders instead incurred effort costs half as much as those of the sun bathers, that is, if their costs were 12.5 cents for every quarter mile of distance?

5. Imagine that Dell is considering two versions of a new laptop. One version will meet high performance standards. The other will only meet medium performance standards. To make the second, Dell uses cheaper

materials and then crimps the keyboard of the high-performance machine with the result that the marginal cost of the each product is an identical \$500. There are two types of consumers for the new laptop. "Techies" have the (indirect) utility function $V_t = 2000(z - 1)$. "Norms" have the (indirect) utility function $V_n = 1000z$, where z is a measure of product quality. Dell can choose the quality level z for each machine from the interval (1,3), subject only to the restriction that the medium-performance machine have a lower z quality than the high-performance machine. If Dell knows that there are N_t Techies and N_n Norms, and if Dell also can identify which type any consumer is, what is its optimum price and product quality strategy?

6. Return to Problem 5, above. Suppose Dell cannot identify each customer but only knows the numbers of each type. Show that Dell's profit-maximizing strategy is determined by the relative numbers of each type.

7. A monopolist faces an inverse demand curve given by: $P = 22 - Q/100z$, where z is an index of quality. The monopolist incurs a cost per unit of: $c = 2 + z^2$.
   a. How do increases in product quality z affect demand?
   b. Imagine that the firm must choose one of three quality levels: $z = 1, z = 2$, and $z = 3$. Which quality choice will maximize the firm's profit? What profit-maximizing output and price are associated with this profit-maximizing quality level?

8. Return to Problem 7, above. What is the quality choice that will maximize the social welfare? If the monopolist were constrained to produce this socially optimal quality, what price would the monopolist charge?

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Appendix

LOCATION CHOICE WITH TWO SHOPS

Shops have identical costs. Symmetry implies each is located a distance d from each market endpoint.

1. $d \leq 1/4$: If d is less than $1/4$, then the maximum full price that can be charged if all consumers are to be served is determined by the consumers at the market center ($x = 1/2$) and is equal to a price p such that when transport costs are included, they pay a full price equal to V. Hence, the maximum price is:

$$p(d) + t\left(\frac{1}{2} - d\right) = V \Rightarrow p(d) = V - t\left(\frac{1}{2} - d\right) \qquad (7.A1)$$

   Aggregate profit at this price is also a function of d and is given by:

$$\pi(d) = [p(d) - c]N = \left(V + td - \frac{t}{2} - c\right)N \qquad (7.A2)$$

This profit increases as d gets larger. It follows therefore that d should never be less than 1/4.

2. $d > 1/4$. If d is greater than 1/4, the maximum price if all consumers are to be served is determined by consumers at the market endpoints ($x = 0,1$). The maximum price now satisfies:

$$p(d) + td = V \Rightarrow p(d) = V - td \tag{7.A3}$$

Aggregate profit is now

$$\pi(d) = [p(d) - c]N - (V - td - c)N \tag{7.A4}$$

This is decreasing in d. Hence, d should never exceed 1/4. Given that d should also never be less than 1/4, that profit maximization implies that $d = 1/4$ exactly.

THE PROFIT MAXIMIZING NUMBER OF RETAIL OUTLETS

Recall that the profit to the firm if it has n outlets (or product variants) is:

$$\pi(N, n) = N\left(V - \frac{t}{2n} - c\right) - nF \tag{7.A5}$$

If we ignore the integer constraint on n we can find the profit-maximizing number of retail outlets by differentiating (7.A5) with respect to the number of retail outlets n to give the first-order condition:

$$\frac{\partial\pi(N, n)}{\partial n} = \frac{Nt}{2n^2} - F = 0 \tag{7.A6}$$

Solving for n gives the profit-maximizing number of retails outlets

$$n^* = \sqrt{\frac{Nt}{2F}} \tag{7.A7}$$

OPTIMAL PARTIAL MARKET PRICE

Assume that the left-hand shop is located 1/4 mile from the left-hand end of the market. At a price p this shop sells to consumers located within distance r on each side such that $p + tr = V$, or $r = (V - p)/t$. Total demand to this shop is, as before, $2rN$. Profit to this shop is, therefore:

$$\pi = 2N(p - c)(V - p)/t \tag{7.A8}$$

Differentiating with respect to p gives the first order condition:

$$\frac{\partial\pi}{\partial p} = \frac{2N}{t}(V - 2p + c) = 0 \tag{7.A9}$$

Solving for the optimal price p^* then gives:

$$p^* = (V + c)/2 \tag{7.A10}$$

At this price, profit to each retail outlet is:

$$\pi = \frac{N}{2t}(V - c)^2 \tag{7.A11}$$

THE SOCIALLY OPTIMAL NUMBER OF RETAIL OUTLETS

The optimal number of retail outlets (product variants) minimizes total transportation and set-up costs:

$$C(N, n) = \frac{tN}{4n} + nF \tag{7.A12}$$

Minimizing (7.A12) with respect to the number of retail outlets n yields:

$$n^o = \sqrt{\frac{Nt}{4F}} \tag{7.A14}$$

OPTIMAL CHOICE OF OUTPUT AND QUALITY

Let demand be given by:

$$P = z(\theta - Q) \tag{7.A15}$$

Let marginal production costs be zero but the design cost be quadratic in quality z so that:

$$C(Q, z) = \alpha z^2 \tag{7.A16}$$

It follows that the firm's profit function is:

$$\pi(Q, z) = PQ - C(Q, z) = z(\theta - Q)Q - \alpha z^2 \tag{7.A17}$$

Solving for the optimal output Q^* then gives:

$$Q^* = \theta/2 \tag{7.A19}$$

Now differentiate the profit function with respect to quality choice z to give the first-order condition:

$$\frac{\partial \pi(Q, z)}{\partial z} = (\theta - Q)Q - 2\alpha z = 0 \tag{7.A20}$$

Substituting the optimal quantity Q^* from (7.A19) in (7.A20) gives:

$$z^* = \theta^2/8\alpha \tag{7.A21}$$

8

Commodity Bundling and Tie-In Sales

On November 5, 1999, Judge Thomas Penfield Jackson issued his "Findings of Fact" in the Microsoft antitrust trial that served subsequently as the basis for Judge Jackson's guilty verdict in the trial five months later on April 3, 2000. Among other things, Judge Jackson concluded that Microsoft's *Windows* operating system and its *Internet Explorer* web browser constituted separate products that could, in principle, stand alone but that Microsoft had bundled together as one package. Judge Jackson's focus was on the use of such bundling as an illegal tying of the two products aimed at extending Microsoft's operating systems monopoly to the browser market. Any defense against this charge must offer an explanation for such bundling that is not related to extending monopoly power.

The remedy that Judge Jackson ordered was that Microsoft be broken into two separate companies, one that would produce the operating system and the other that would produce software components such as Microsoft *Office* and *Internet Explorer*. Judge Jackson's judgment was reversed on appeal, with the proposed settlement being that Microsoft share its application programming interfaces, making it easier for competitors seeking to offer *Windows*-based applications to ensure that their software would operate seamlessly on the *Windows* platform.

A subsequent complaint was brought by the European Commission, accusing Microsoft of abusing its dominant position by bundling *Windows Media Player* (*WMP*) with the *Windows* operating system. A preliminary judgment in 2003 required Microsoft to offer a version of *Windows* without *WMP* and to provide the information necessary for a competitor to offer a media player that would operate effectively on the *Windows* platform. Microsoft was also fined €497 million, a fine that was increased to a further €860 million in 2012 based on the finding that Microsoft had delayed implementing the 2004 judgment.

Is Microsoft's behavior unique to that technology company? Far from it. The truth is that most firms—both those with market power and those without it—sell more than one good, and bundling or tying between a firm's different products is frequently observed. What are the possible gains to the firm from tying together the sale of its products? Are they solely the anti-competitive, entry-deterring motives that worried Judge Jackson and the European Commission? Does bundling raise both profit and efficiency, or does it earn profit at the expense of efficiency? Do consumers win or lose from these bundling and tying tactics? These are the questions we investigate in this chapter.

That consumers might actually gain from bundling seems possible when we examine the prices that Microsoft charges, not for its *Windows* operating system but for its software applications. The Microsoft *Office* suite is one of the most popular applications packages. *Office Professional* 2010 contains the *Word, Excel, Outlook, PowerPoint, Access*, and *OneNote* programs, priced in September 2012 at $400. You can buy the individual components separately, *Word, Excel, Outlook*, and *Access* selling for $140 each and *OneNote* for $80, a total of $780. In other words, there is a bundle discount of $380. The question then becomes: what incentive does Microsoft have to engage in such bundling? How does offering the *Office* bundle help raise Microsoft's profit?

Before proceeding we should make our analysis a bit more precise. In some cases, firms like Microsoft market two or more products as an explicit bundle comprised of fixed amounts of the individual components. Thus, the *Office* suite contains exactly one copy of each of the constituent programs; a fixed price menu at a restaurant contains one of each of the included courses; and a holiday travel package might specify *one* return flight to London, *five* nights' accommodation, and *three* West End plays.

There is an alternative to bundling, commonly referred to as tying. Under this strategy a firm *ties* the sale of one product to the purchase of another but does not control the proportions in which the two products are consumed. Under a tying strategy the purchase of some amount of one good (the tying good) requires that the buyer purchase a second product (the tied good). For example, in the early days of business machines and computers IBM sold its machines under the requirement that the buyer also use IBM-produced tabulating cards. In other words, the purchase of the machine was tied to the additional purchase of IBM cards.[1] We differentiate this from commodity bundling because IBM did not specify the number of cards that the consumer had to purchase.

More recent examples of tied sales are not difficult to find. If you buy a computer printer you also commit yourself to buying the unique ink cartridges that fit into that printer. Hewlett-Packard cartridges do not fit Canon printers nor vice versa. Similarly, Sony's *Play Station* game cartridges do not work on either a Nintendo *Wii* or a Microsoft *Xbox* system. What is tied in all these cases is the brand (and seller) of the associated product, not its quantity. You can always reduce your demand for Hewlett-Packard ink cartridges by being very strict with yourself on how many drafts of a term paper you actually print out! These modern examples of tie-in sales are *technology* based rather than *contractual* as in the IBM case. Yet, whether contractual or technical, the issues we wish to address are the motivations for and the implications of both tying and bundling practices. It is to a more formal analysis of these questions that we now turn.

8.1 COMMODITY BUNDLING AND CONSUMER VALUATION

We begin with a story told almost thirty years ago by Nobel laureate, George Stigler, who was one of the first to understand bundling as a means of exploiting differences in consumer valuations of the goods on offer.[2] At the time that he published his brief analysis he was responding to a recent Supreme Court case involving the movie industry. Throughout the 1950s and 1960s, airing older Hollywood films was a substantial part of television fare. Film distributors who owned the rights to the films sold presentation rights for a fee to local

[1] This tying policy was challenged as a violation of the Clayton Act in *International Business Machines* v. *U.S.*, 298 U.S. 131 (1936). Similar charges arose repeatedly in the many private antitrust suits against IBM in the following decades.

[2] Stigler (1968).

television stations. However, they rarely sold films individually. Instead, they sold them in packages typically combining screen gems such as *Casablanca* and *Treasure of the Sierra Madre* with such "grade B" losers as *Gorilla Man* and *Tear Gas Squad*.[3] Stigler's insight was to recognize that while every television station valued the first two films (or others of similar quality) more than the last two films, the relative valuations of the two types of movies might well vary from station to station. Such differences provide a motive for the observed bundling.

A modified version of Stigler's example goes as follows. Suppose that there are two films, X and Y, and two stations (located in different cities), A and B. Each station's reservation prices for the two films are as follows:

	Maximum Willingness to Pay for Film X	*Maximum Willingness to Pay for Film Y*
Station A	\$8,000	\$2,500
Station B	\$7,000	\$4,000

As you may recall from earlier chapters, the film distributor can exploit these different valuations by applying discriminatory prices. However, as you may also recall, price discrimination must surmount the twin problems of identifying which station is which and then avoiding arbitrage between stations. Suppose that this is not possible. Then the distributor must charge a uniform price for each film, in which case its best bet is to charge \$7,000 for film X and \$2,500 for film Y. At these prices, both stations buy both films, and the distributor's total revenue is \$19,000.

Bundling, however, permits further revenues to be earned. Instead of selling the two films separately, suppose that the distributor offers the films in a bundle to the two stations for a combined price of \$10,500. Because both stations value the bundle at least this highly, the distributor sells both films to both stations. Its revenue now rises to \$21,000.

The reason that bundling raises revenue is straightforward. It reduces the variation in consumers' willingness to pay. In turn, this reduction in variance effectively makes the demand curve more elastic with the result that a relatively small price reduction will generate a substantial demand increase. In the film example above, selling a second unit of film X requires a price drop of \$1,000 while selling a second unit of film Y requires a price drop of \$1,500 when each is sold separately. When offered as a bundle however, selling a second packaged unit requires a price drop of only \$500. Bundling works because the variation in the willingness to pay for individual products is likely to be reduced when those products are packaged together.

Stigler's insight into bundling is surely valid. However, his analysis is incomplete on a number of fronts. First, his model implies that for bundling to be profitable consumer valuations must be distributed in a particular way. Suppose, for example that Station B also has a value for film Y of \$2,500. Then the bundle price is \$9,500, implying a total revenue of \$19,000 with bundling which does no better than offering the films separately. In this case, there is no variation in the willingness to pay for film Y and bundling is not a profit-enhancing strategy. Second, Stigler's analysis does not address the central concern of the US Department of Justice and the European Commission: bundling as an entry deterring

[3] See *United States v. Loew's Inc*., 371 U.S. 38 (1962).

strategy. Third, Stigler's model fails to consider the strategy of *mixed bundling*—that is, selling both products individually as well as in a bundle. It is to these issues that we now turn.

To do so we begin with a variant of a (relatively) simple model developed by Nalebuff (2007). Assume that there are two goods, labeled 1 and 2. Each of these goods is produced with constant marginal (and average) cost that for the moment we assume to be zero. In other words, we assume that there are no cost advantages of multiproduct production. In particular, there are no scope economies of the type discussed in Chapter 4. Accordingly, the marginal cost of producing a bundle or a package consisting of one unit of each good is also zero.

We assume that each consumer buys exactly one unit of each good per unit of time provided that the price charged is less than the reservation price for that good. The consumer's reservation price, or maximum willingness to pay, for good 1 is R_1 and for good 2 is R_2. We further assume that the consumer's reservation price for a commodity bundle consisting of one unit of each good is $R_B = R_1 + R_2$. This assumption, that the reservation price for the bundle is the sum of the reservation prices for the individual goods, is a common one (and one made by Stigler as well). Yet the assumption is, at least in some circumstances, restrictive. If the two goods are complementary goods, such as nuts and bolts, the assumption is almost certainly false. We expect that the willingness to pay for bolts is quite low in the absence of any nuts and vice versa. In other words, for complementary goods the reservation price for the bundle is likely to be higher than the sum of the separate reservation prices for each good consumed separately. Yet while the assumption that $R_B = R_1 + R_2$ is restrictive, it is also useful. It permits us to focus explicitly on the profit and other motives for bundling. We return to the case of complementary goods in section 8.3.

Suppose that consumers differ in their separate valuations of the two goods—that is, the values of R_1 and R_2 (and so R_B) vary across consumers. Some consumers have a high R_1 and a low R_2; for others just the reverse is true. Some place a high value on both goods. For others, R_1 and R_2 are both quite low. If we draw a quadrant with R_1 on the horizontal axis and R_2 on the vertical axis as in Figure 8.1, then our assumptions allow us to define each

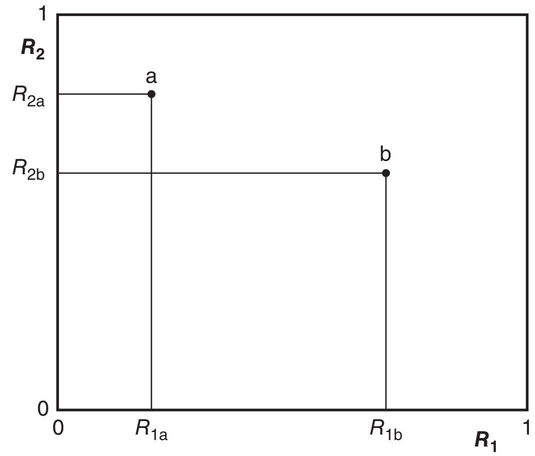

Figure 8.1 Consumer reservation prices

consumer's type by a point in the (R_1, R_2) quadrant. For example, consumers of type a in Figure 8.1 have reservations prices R_{1a} for good 1 and R_{2a} for good 2 while consumers of type b have reservations prices R_{1b} for good 1 and R_{2b} for good 2.

We make two further assumptions. First, we assume that that consumer valuations R_1 and R_2 are distributed on the range [0, 1] so that the "market" can be described by the unit square as in Figure 8.1. Secondly, we assume that consumers are uniformly distributed at density D over this market. In other words, there are as many consumers of type a as there are of type b or of any other type in the market. These might on first sight appear to be limiting assumptions, but Nalebuff (2007) shows that if anything they understate the power of bundling to increase profit and deter entry.

8.1.1 Bundling and Profitability

Suppose first that the firm prices its two products separately, setting a price p_1 for good 1 and p_2 for good 2 as in Figure 8.2. It follows that all consumers with reservation prices $R_1 \geq p_1$ buy good 1 and all consumers with reservation prices $R_2 \geq p_2$ buy good 2. In Figure 8.2, all consumers in region A buy only good 1, those in region B buy only good 2, those in region C buy both goods 1 and 2, while those in region D buy neither good. This non-italicized D implies a portion of the market space while the italicized D implies market density. Aggregate demand for good 1 is the number of consumers in the rectangle A + C and for good 2 is the number of consumers in the rectangle B + C. In other words, $q_1 = D(1 - p_1)$ and $q_2 = D(1 - p_2)$.

Writing these demand functions in our familiar inverse form we have:

$$p_1 = 1 - q_1/D;\ p_2 = 1 - q_2/D \tag{8.1}$$

from which we derive the marginal revenues:

$$MR_1 = 1 - 2q_1/D;\ MR_2 = 1 - 2q_2/D \tag{8.2}$$

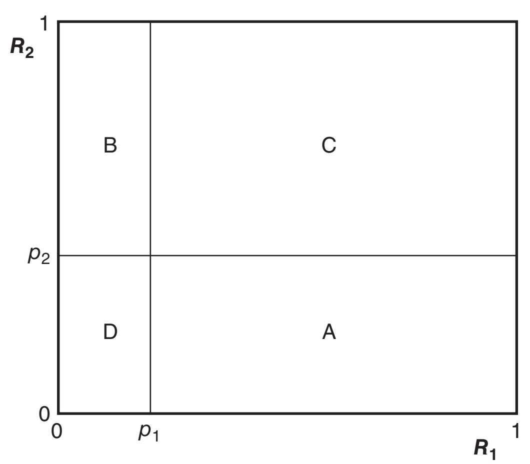

Figure 8.2 Consumers' reservation prices and simple monopoly pricing
At monopoly prices p_1 and p_2 Group A buys only product 1, Group B buys only product 2, Group C buys both goods, and Group D buys neither.

Equating marginal revenue with marginal cost (assumed equal to zero) gives

$$q_1 = q_2 = D/2$$

and from (8.1)

$$p_1 = p_2 = 1/2.$$

These are just the monopoly prices for the two products when they are sold separately. Profit from this non-bundling strategy is:

$$\pi_{nb} = 0.5D$$

Assume instead that the firm decides to offer the two products only as a bundle, with the bundle priced at $p_B < 1$.[4] This is illustrated in Figure 8.3.

Now consumers are partitioned into two groups. Each consumer in region E has reservation prices for the two goods the sum of which is greater than p_B and so buys the bundle. By contrast, each consumer in region F has reservation prices for the two goods the sum of which is less than p_B and so does not buy the bundle. Aggregate demand for the bundle is the number of consumers in region E, which is the total numer of potential consumers D minus the number of consumers in the triangle F. In other words, aggregate demand for the bundle at price p_B is

$$q_B(p_B) = D - Dp_B^2/2 = D(1 - p_B^2/2) \tag{8.3}$$

Profit from this bundling strategy is (recall that marginal costs are assumed to be zero):

$$\pi_B(p_B) = p_B D(1 - p_B^2/2) \tag{8.4}$$

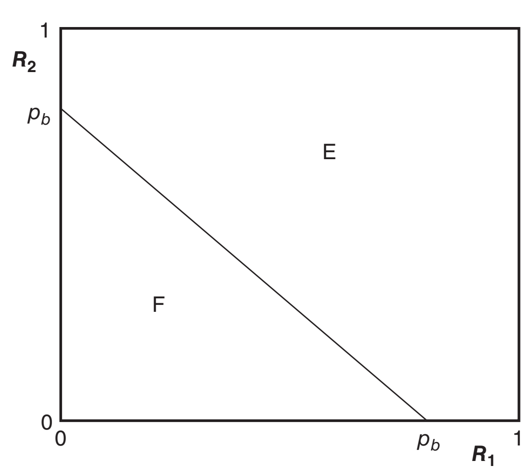

Figure 8.3 Monopoly pricing of a pure bundle of goods 1 and 2
At the bundle price p_B consumers in Group E buy the bundle and consumers in Group F do not.

[4] As shown below, the optimal bundle price is always less than sum of the non-bundled monopoly prices.

Table 8.1 Profit from bundling

Bundle Price p_B	*Profit*
1	$0.5D$
0.9	$0.536D$
0.8	$0.544D$
0.7	$0.529D$
0.6	$0.492D$
0.5	$0.438D$

Table 8.1 evaluates this profit function for a range of bundle prices, from which we can conclude that the optimal bundle price is approximately $p_B = 0.8$. (We show in the Appendix to this chapter that the profit maximizing bundle price is actually $p_B = 0.816$ and that the resulting profit from the bundling strategy is $0.5443D$.)

As you can see, bundling increases profit by approximately 8.8 percent, not bad but perhaps not a lot to write home about or cause concern to the anti-trust authorities. Which brings us to the other possibility: that bundling is an entry-deterring device.

8.1.2 Bundling and Entry Deterrence

We continue with our simple model but now assume that the incumbent firm faces the threat of entry by a potential challenger that, by incurring fixed entry costs of F, can offer a perfect substitute for the incumbent's product 2. The incumbent remains the sole producer of product 1 whether or not entry takes place.[5]

Suppose first that the incumbent does not adopt a bundling strategy. Because it faces no challenge in its market for product 1, its price for that product is unaffected at $p_1 = 1/2$ and its profit from selling product 1 remains $D/4$. By contrast, in its product 2 market the incumbent has to identify a price that will deter entry. Suppose that the incumbent sets a price of $p_2 < 1/2$. The best strategy for the potential entrant is to just undercut that price, thereby stealing all of the incumbent's product 2 consumers. In Figure 8.4, consumers in regions A and C buy product 1 from the incumbent, while those in regions B and C switch to purchase product 2 from the entrant provided only that the entrant sets a price $p_2 - \varepsilon$ "just less" than p_2.

Profit to the entrant is

$$\pi_E = Dp_2(1 - p_2) - F \tag{8.5}$$

In order to deter entry, the incumbent has to set p_2 to ensure that $\pi_E < 0$. Define $f = F/D$, so that f is entry cost per consumer. We show in the Appendix that the entry-deterring price for the incumbent is

$$p_2^{nd} = \frac{1}{2}(1 - \sqrt{1 - 4f}) \tag{8.6}$$

[5] Assuming that the entrant can offer only one product replicates our Microsoft example. Nalebuff (2007) assumes that the entrant can randomly produce either good 1 or good 2, which introduces complications that we would rather avoid. We address the credibility of entry deterrence in a two-product case in subsequent chapters.

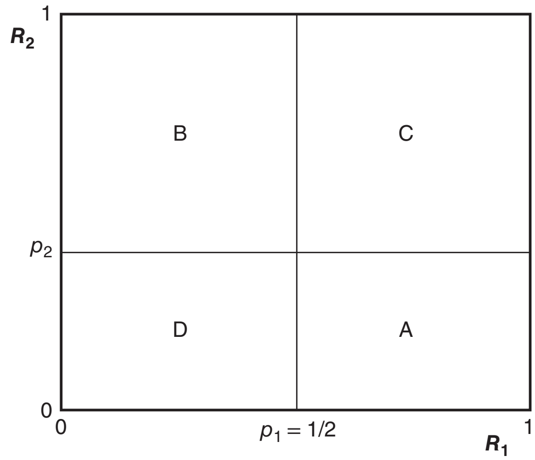

Figure 8.4 An incumbent threatened by entry—no bundling
The entrant sells product 2 to consumers is Groups B and C; the incumbent sells product 1 to consumers in Groups A and C.

Rather than use calculus, however, we adopt a simpler approach. Equation (8.5) can be used to identify, for a range of product 2 prices, the entry cost per consumer above which entry is unprofitable and so is deterred. Suppose, for example, that the incumbent sets price $p_2 = 0.4$. Then, from equation (8.5), the entrant, by just undercutting this price, earns profit $0.4D(1 - 0.4) - F = 0.24D - F$. This is negative, and entry is deterred, for $f = F/D \geq 0.24$. The results for this analysis are presented in Table 8.2.

Now think of this another way. Suppose that entry cost per consumer is $f = 0.24$. Then from Table 8.2 we can see that the incumbent can deter entry by setting its product 2 price at "just less" than 0.4: a price that completely limits entry. By applying such a *limit price* the incumbent earns aggregate profit $D(0.25 + 0.24) = 0.49D$. The first term in brackets is the monopoly profit from product 1 and the second is profit from product 2 given that price is set to deter entry. More generally, we can see from Table 8.2 that if the entrant's entry cost per consumer is f, entry deterrence gives the incumbent aggregate profit $D(0.25 + f)$.

This kind of entry deterrence is always profitable for the incumbent provided only that $f > 0$. Note also that entry is actually blockaded—not possible even if the incumbent adopts the simple monopoly price for product 2 —provided that $f > 0.25$.

Table 8.2 Entry deterrence—no product bundling

Incumbent Price for Product 2	*Entry Deterring Cost per Consumer f*	*Aggregate Incumbent Profit*
0.5	0.25	$0.5D$
0.4	0.24	$0.49D$
0.3	0.21	$0.46D$
0.2	0.16	$0.41D$
0.1	0.09	$0.34D$

Now suppose that the incumbent adopts a product bundling strategy, setting the bundle price at $p_B \leq 1$ and assume that the potential entrant sets its product 2 price at p_2. Consumers face three choices: continue to buy the bundle; switch to buying product 2 from the entrant, as a result of which the consumer cannot buy product 1; buy nothing. The consumer, as usual, picks the option that maximizes consumer surplus.

Consider a consumer with reservation prices (R_1, R_2). If this consumer buys the bundle from the incumbent the consumer surplus is $CS_B = R_1 + R_2 - p_B$ while if the consumer switches to buying only product 2 (from the entrant) the consumer surplus is $CS_2 = R_2 - p_2$. The consumers that switch to the entrant have reservation prices that satisfy two constraints:

$$CS_2 > CS_B \Rightarrow R_2 - p_2 > R_1 + R_2 - p_B \Rightarrow R_1 < p_B - p_2 \tag{8.7}$$

$$CS_2 > 0 \Rightarrow R_2 > p_2 \tag{8.8}$$

Constraint (8.7) ensures that the consumer prefers to purchase product 2 from the entrant rather than the bundle of product 1 and product 2 from the incumbent, while constraint (8.8) ensures that the consumer prefers to purchase product 2 from the entrant than to purchase nothing.

These constraints tell us that the consumers that switch from buying the bundle to buying product 2 from the entrant are consumers (i) with relatively low reservation prices for product 1—the product that they give up—and (ii) relatively high reservation prices for product 2—the product that they continue to purchase. Intuitively, the entrant in competing with the incumbent's bundled product is most likely to capture those consumers who really like product 2 but place a low valuation on product 1.

These constraints are illustrated in Figure 8.5. Constraint (8.8) is simply illustrated. Now consider constraint (8.7). Because the line $p_B p_B$ has slope -1, the distance *ab* equals the distance *bc* and both *ab* and $bc = p_B - p_2$. Thus all consumers with reservation prices to the left of the vertical line *dce* satisfy constraint (8.7) and all consumers in the region A + B satisfy *both* constraints (8.7) and (8.8).

In the absence of entry, consumers in regions B, C, and D purchase the bundle while consumers in regions A, E, and F do not. Post-entry, consumers in regions A and B purchase product 2 from the entrant, consumers in regions C and D continue to buy the bundle from the incumbent, while consumers in regions E and F buy neither the bundle nor the entrant's product 2.

It is here that we see the beginning of an explanation for why bundling might be an entry-deterring strategy. Suppose that the incumbent, instead of bundling, had priced the two products separately, with product 2 priced at p_2 and product 1 priced at $p_1 = p_B - p_2$ in Figure 8.5. If the entrant had priced product 2 at "Just less" than p_2 as in our analysis above, the entrant would have gained all consumers in regions A, B, and C, many more consumers than are gained when the incumbent bundles.

We can make this more precise. As we have seen in Figure 8.5, given that the incumbent sets the bundle price at p_B the entrant, setting its product 2 price at p_2, gains consumers in region A + B, whose area is $(1 - p_2)(p_B - p_2)$. Profit to the entrant is then:

$$\pi_E = Dp_2(1 - p_2)(p_B - p_2) - F \tag{8.9}$$

A comparison with equation (8.5) indicates that, as we just suggested, the bundling strategy by the incumbent makes entry much less profitable, in other words, easier to deter.

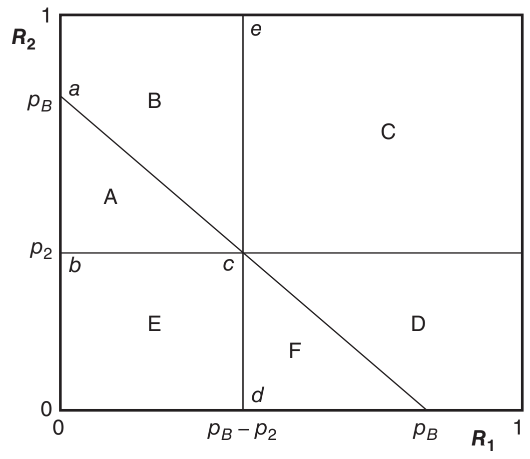

Figure 8.5 An incumbent threatened by entry—pure bundling
Post-entry consumers in Groups A and B buy product 2 from the entrant, consumers in Groups C and D buy the bundle from the incumbent, consumers in Groups E and F do not buy from either the incumbent or the entrant.

With bundling, the incumbent actually has to go through a two-stage thought process in formulating its entry-deterring strategy. First, for any bundle price, the incumbent should expect the entrant to choose its entry price to maximize its profit as given by equation (8.9). We derive the optimal price for the entrant in the Appendix. Second, given this price for the entrant, the incumbent has to identify the bundle price that just deters entry.

Rather than take this analytical approach, however, we mirror the non-bundling case by presenting a simplified numerical analysis. Table 8.3 gives the potential entrant's profit, *ignoring its entry costs*, for a range of combinations of the bundle price p_B and the entrant's price p_2. Given our analysis in the previous section, we can confine our attention to bundle prices less than 0.8.

Suppose first that the incumbent acts as a monopolist facing no entry threat and sets a bundle price of 0.8. Then Table 8.3 tells us that the best the entrant can do is set a price for product 2 of approximately 0.3, giving the entrant profit of $0.105D - F$. This tells us that entry is blockaded with the bundling strategy for any entry cost per consumer $f > 0.105$. Contrast this with the non-bundling strategy. We saw there that for entry to be blockaded requires that $f > 0.25$. In other words, bundling significantly increases the range of entry

Table 8.3 Entrant's gross profit—product bundling

	Bundle Price p_B			
p_2	0.8	0.7	0.6	0.5
0.35	0.102	0.080	0.057	0.034
0.3	0.105	0.084	0.063	0.042
0.25	0.103	0.0844	0.066	0.047
0.2	0.096	0.08	0.064	0.048
0.15	0.083	0.07	0.057	0.045
Incumbent Profit	$0.544D$	$0.529D$	$0.492D$	$0.438D$

costs for which the incumbent is free of the threat of entry without the need to adopt a specific entry-deterring price.

We can repeat this analysis for different incumbent prices for the bundle. Suppose, for example, that the bundle is priced at 0.7. Then the entrant will set its product price p_2 to approximately 0.25, earning profit $0.0844D - F$. We can put this another way. Suppose that entry cost per consumer is $f = 0.0844$. Then the incumbent can deter entry by setting a bundle price "just less" than 0.7, earning profit $0.529D$. Similarly, if entry cost per consumer is $f = 0.066$, the incumbent can deter entry by setting the bundle price "just less" than 0.6, earning profit $0.492D$, and if entry cost per consumer is $f = 0.048$ entry is deterred by a bundle price of 0.5, giving the incumbent profit of $0.438D$.

We summarize these results in Table 8.4 from which we can see the real strategic power of bundling as an entry deterring device. If $f > 0.25$, entry is blockaded whether or not the incumbent bundles and bundling increases profit, but only by 8.8 percent. If $0.25 > f > 0.105$, entry is feasible without bundling but blockaded by bundling. Product bundling increases profit by up to 53 percent. At lower entry costs per consumer, bundling is less profitable, but even with f as low as 0.048 bundling increases profit by 47 percent.

The conclusion to be drawn from this analysis is straightforward. Product bundling is indeed a potent entry-deterring strategy, justifying the concerns that the anti-trust authorities have with this strategy.

8.1.3 Mixed Bundling

While Microsoft attempted to apply a pure bundling strategy with respect to the sale of its *Windows* operating system (bundling *Windows* with *Explorer* and *Windows Media Player*), it applies a rather different strategy with respect to its *Office* suite of programs. As we noted above, consumers can purchase the full suite of *Office* programs *or* they can purchase some but not necessarily all of the individual programs. This is an example of *mixed bundling*.

A possible explanation for the difference in strategy can be suggested. Microsoft had an effective monopoly on operating systems with its *Windows* program and so had the potential to leverage that monopoly into browsers and media player software. By contrast, Microsoft faces competition from established companies offering word processing, spreadsheet, and presentation programs. The best that it can do is to adopt some kind of profit maximizing strategy, mixed bundling being one such strategy.

Table 8.4 Bundling and entry-deterrence

Entry Cost per Consumer F	*Incumbent Entry-Deterring Profit*		*Profit Increase from Bundling*
	Non-Bundling	*Bundling*	
0.25	$0.5D$	$0.544D$	8.8%
0.20	$0.45D$	$0.544D$	20.9%
0.15	$0.40D$	$0.544D$	36%
0.105	$0.355D$	$0.544D$	53.2%
0.0844	$0.3344D$	$0.529D$	58.2%
0.066	$0.316D$	$0.492D$	55.7%
0.048	$0.298D$	$0.438D$	47%

Returning to our simple model of the last two sections, the monopolist applying a mixed bundling strategy offers to sell the two goods separately at specified prices, respectively, of p_1 and p_2 (which are not necessarily the monopoly prices) and also sells them as a bundle at price p_B (again not necessarily the monopoly pure bundle price). Of course, for this to make sense, it must again be the case that $p_B < p_1 + p_2$. Otherwise, no consumer would ever purchase the bundle. Figure 8.6 illustrates such a strategy. The monopolist offers consumers the possibility of buying either product 1 or product 2 individually at the stated prices or buying them as a bundle at price p_B.

We now show that consumers are partitioned by this strategy into four groups. To do so, we need to determine the conditions under which a consumer will prefer to buy only one of the two goods or the bundle or nothing.

Clearly, anyone who values good 1 at more than p_1 and good 2 at more than p_2, that is, anyone who is willing to buy both goods at the individual prices, will buy the bundle because its price is less than the sum of the individual prices. Consider now a consumer whose reservation price for good 1 is less than p_1. If this consumer buys anything, the consumer will buy either the bundle or only good 2. Of course, the consumer will make the choice that gives the greater consumer surplus. Suppose then that the corresponding reservation prices are R_1 for good 1 and R_2 for good 2. If the bundle is purchased, the consumer pays p_B and gets a consumer surplus of $CS_B = R_1 + R_2 - p_B$. If only good 2 is bought, the consumer gets a consumer surplus of $CS_2 = R_2 - p_2$.

This type of consumer will buy only good 2 if two conditions are satisfied. First, $CS_2 > CS_B$, which requires that $R_1 < p_B - p_2$. Second, $CS_2 > 0$, which requires that $R_2 > p_2$. We have already seen these conditions in our discussion of entry deterrence: see Figure 8.5. It follows that all consumers in the region *hef* in Figure 8.6, such as consumer y, buy only good 2.

By exactly the same argument, a consumer will buy only good 1 if two conditions are satisfied: first $R_2 < p_B - p_1$ and second $R_1 > p_1$. The difference $p_B - p_1$ is illustrated in Figure 8.6 by the line *jad* and all points to the right of *ab* represent consumers for whom $R_1 > p_1$. Therefore, all consumers with reservation prices in the region *dab*, such as consumer x, will buy only good 1.

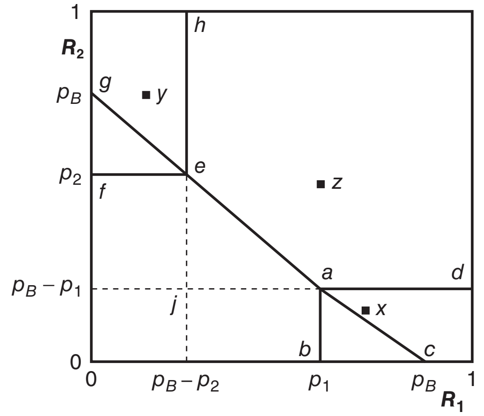

Figure 8.6 Monopoly pricing with mixed bundling
The firm sets prices p_1 for product 1, p_2 for product 2, and p_B for the bundle. Consumers in *dab* buy only product 1, consumers in *hef* buy only product 2, consumers in *daeh* buy the bundle, and consumers in *feab* buy nothing.

Now consider a consumer for whom $R_2 > p_B - p_1$ and $R_1 > p_B - p_2$. This is a consumer whose reservation price for good 1 is to the right of *jeh* and for good 2 is above *jad*. If such a consumer buys anything at all it will be the bundle, as this gives more consumer surplus than either only good 1 or only good 2. For this consumer to buy the bundle it is then necessary that $R_1 + R_2 > p_B$, which means that the reservation prices must put the consumer above the line *caeg* in Figure 8.6. In other words, all consumers in the region *daeh*, such as consumer z, will buy the bundle.

This leaves only the region *feab*. What will be the choice of these types of consumers? Their reservation prices are less than the individual prices of the two goods, so they will not buy either good individually. In addition, the sum of their reservation prices is less than the bundle price, so they will not buy the bundle. Consumers in *feab* do not buy anything.

Derivation of the optimal individual and bundle prices for our "simple" model is actually very complex. For the interested reader the derivation is provided in this chapter's Appendix. It turns out that for this model these prices are $p_1 = p_2 = 2/3$ and $p_B = 0.862$, giving the monopolist aggregate profit $0.549D$, greater than either simple monopoly pricing or pure bundling.

8.1.4 A Worked Example

When we compare either pure or mixed bundling with simple monopoly pricing, it is clear that mixed bundling always increases the monopolist's *sales*. What is less clear is whether bundling will increase the monopolist's *profits*. What we should expect is that the profit impact of commodity bundling will depend upon the distribution of consumer preferences for the goods being offered and the costs of making those goods, issues that our formal model has not really considered. An example will serves to illustrate this and some of the other ideas introduced so far.

Assume that the monopolist knows that it has four consumers, A, B, C, and D, each interested in buying the two goods, 1 and 2. The marginal cost of good 1 is $c_1 = \$100$ and of good 2 is $c_2 = \$150$. Each consumer has reservation prices for these two goods, as given in Table 8.5, and buys exactly one unit of either good in any period so long as its price is less than the reservation price for that good. Each consumer will consider buying the goods as a bundle provided that the bundle price is less than the sum of the reservation prices.

Suppose that the monopolist decides to sell the goods unbundled and adopts simple monopoly pricing. Table 8.6 allows us to identify the profit-maximizing monopoly prices for the two goods. Profit from good 1 is maximized at \$450 by setting a price of \$250 and selling to consumers B, C, and D. Profit from good 2 is maximized at \$300 by setting a price of \$450 and selling only to consumer A. Total profit from simple monopoly pricing is, therefore, \$750.

Table 8.5 Consumer reservation prices

Consumer	*Reservation Price for Good 1*	*Reservation Price for Good 2*	*Sum of Reservation Prices*
A	50	450	500
B	250	275	525
C	300	220	520
D	450	50	500

Table 8.6 Determination of simple monopoly prices

Price	*Quantity Demanded*	*Total Revenue ($)*	*Profit ($)*	*Price*	*Quantity Demanded*	*Total Revenue ($)*	*Profit ($)*
450	1	450	350	450	1	450	300
300	2	600	400	275	2	550	250
250	3	750	450	220	3	660	210
50	4	200	−200	50	4	200	−400

Now consider the pure bundling strategy. The firm can: 1) choose a bundle price of \$525, which will attract only consumer B; 2) choose a bundle price of \$520, which will attract consumers B and C; or 3) choose a bundle price of \$500, which will attract all four consumers. The third strategy is preferable because it yields a total profit of $4(\$500 - \$100 - \$150)$, or \$1,000. Pure bundling is, in this case, preferable to simple monopoly pricing. However, under bundling, consumer A is able to consume good 1 and consumer D is able to consume good 2 even though they each value the relevant good at less than its marginal production costs. (This is also a feature of pure bundling in the previous model if we introduce non-zero marginal costs to that model.)

Can a mixed bundling strategy do better? Suppose first that the monopolist merely combines the simple monopoly and pure bundling strategies. That is, the firm sets a price of \$250 for good 1, \$450 for good 2, and \$500 for the bundle. How will consumers respond to this pricing and product offering? Consumer A will not buy just good 1, and is indifferent between buying the bundle or only good 2 because in either case, the consumer earns zero surplus. However, the firm is definitely not indifferent. The firm makes a profit of \$300 if consumer A buys just good 2 but only \$250 if consumer A buys the bundle. Hence, the firm would like to find a way to encourage consumer A to opt only for good 2.

Now consider Consumer D. This consumer earns the greatest surplus if only good 1 is purchased, in which case consumer surplus is \$200. Therefore, Consumer D will buy only good 1 and the profit to the monopolist from that sale will be \$150. In this consumer's case, the monopolist would actually prefer that Consumer D buy the bundle at \$500 from which the monopolist earns a profit of \$250. Finally, consider consumers B and C. They are each unwilling to buy either good separately at the stated prices. However, each will buy the bundle giving a combined profit to the monopolist from both sales of \$500.

Adding up the sales and related profits, we find that the proposed mixed bundling strategy gives the monopolist a total profit of \$900 or \$950, depending upon whether consumer A buys the bundle or only good 2. This is certainly better than simple monopoly pricing profit derived earlier of \$750. But it is not as good as the profit of \$1,000 earned in the pure bundling case of selling only the bundle at a price of \$500.

However, with a little thought, it is easy to see how the monopolist can alter the current mixed bundling strategy to raise profits further. The insight is to change the prices to sort customers into different purchase choices. We have already noted that Consumer A is indifferent to buying just good 2 or the bundle at the current prices. A slight rise in the bundle price say, to \$520, will definitely tilt this consumer to purchasing just good 2. Suppose that in addition the firm also raises the price of good 1 to \$450, so that the new price configuration is: $p_B = \$520$, $p_1 = \$450$, and $p_2 = \$450$. Consumer A will now buy good 2. Consumer D will continue to buy good 1 and Consumers B and C will continue to buy the bundle. However, the price increases for good 1 and the bundle, respectively, let the monopolist earn an additional profit of \$200 on its sale of good 1 to Consumer D, and \$40 on its two bundle sales to Consumers B and C, while guaranteeing profit of \$300 from Consumer A. Total profit is $\$300 + \$270 + \$270 + \$350 = \$1{,}190$, which *does* exceed our pure bundling maximum.

This is actually the best that the monopolist can do in this example. The monopolist has extracted the entire consumer surplus of consumers A, C, and D and all but \$5 of the consumer surplus of consumer B. In other words, the monopolist has done nearly as well as it would have done if it had been able to adopt first-degree price discrimination.

Mixed bundling (in which the bundle price is less than the price of buying each component separately) is always at least as profitable as pure bundling. The reason is simple enough to see. The worst that a mixed bundling strategy can do is to replicate the pure bundling strategy by setting arbitrarily high individual prices and a bundle price equal to the pure bundle price. However, it will usually be possible to improve on this by setting individual component prices that are sufficiently low to attract those who really just want the one item but high enough to earn more profit than can be earned from the bundle.

We should note, though, that while mixed bundling must always improve profits relative to pure bundling, it is not always the case that some sort of bundling is more profitable than no bundling at all. A drawback to bundling—one illustrated in the previous example—is that it can lead to an outcome in which some of the consumers who buy the bundle actually have a reservation price for one of the goods that is less than marginal production cost. This is inefficient and so the firm too would prefer a different pricing scheme. Our example also demonstrates that bundling, whether pure or mixed, is likely to be profitable only when the variation in consumer valuations of the goods is significant. In our example, consumers A and D—who buy a single good—have very different valuations of the individual goods. In contrast, consumers B and C—who buy the bundled good—have very similar valuations. Adams and Yellen (1976) made clear that the gains from bundling arise from the differences in consumer valuations.

> Some people may value an appetizer relatively highly (soup on a cold day), others may value dessert relatively higher (Baked Alaska, unavailable at home), but all may wish to pay roughly the same amount for a complete dinner. The à la carte menu is designed to capture consumer surplus from those gastronomes with extremely high valuations of particular dishes, while the complete dinner is designed to retain those with lower variance. (Adams and Yellen 1976, 488)

We can see the same basic point in the context of the Stigler example with which we started. If station A valued both movies at \$8,000 and station B valued both at \$3,500, the differences in the relative valuation of the products would vanish. In that case, bundling would no longer be a profitable strategy.

Note also that because the bundle price p_B is less than the sum of the individual prices $p_1 + p_2$ commodity bundling can be viewed as discriminatory pricing. The lower bundle price serves to attract consumers who place a relatively low value on one or other of the two goods but are willing to pay a reasonable sum for the bundle. The two separate prices serve to extract surplus from those customers who have a great willingness to pay for only one of the products. We would therefore expect most multiproduct firms with monopoly power to engage in some sort of mixed bundling.

Mixed bundling is in fact a common practice. Restaurants serve combination platters and also offer items individually. Resorts often offer food and lodging both separately and as a package. Software companies sell individual products but also offer packages consisting of several applications, such as Microsoft's *Office* package. Some of this surely reflects price discrimination efforts.

8.1 **Practice Problem**

A cable company has two services. One service is the Basic Service channel. The other is the Walt Disney Movie channel. The potential subscribers for the services—students, families, hotels, schools, young adults, and retirees—regard the two services as separate alternatives, that is, not as complementary products. So, the demands for the two services are completely unrelated for each and every consumer. Each buyer is characterized by a pair of reservation prices as shown in the table below. The marginal cost of each service is $3. Assume there are equal numbers of consumers in each category.

a. If the services are sold separately and not offered as a bundle, what price should the cable operator set for each service? What profits will be earned? Which consumers will subscribe to which service?
b. Suppose that the operator decides to pursue a mixed bundling strategy. What price should be set for the bundled service? What price should be set for each service if purchased individually? Which consumers buy which options, and what are the cable operator's profits?
c. How would your answers to the first two questions be changed if the marginal cost of producing each service had been $10 instead of $3?

Reservation Prices for Each Cable Service by Type of Subscriber

	Basic Service ($)	*Disney Channel ($)*
Students	5	15
Families	11	9
Hotels	14	6
Schools	4	16
Young Adults	0	17
Retirees	17	0

8.2 REQUIRED TIE-IN SALES

Tie-in sale arrangements differ from bundling in that they tie together the purchase of two or more products without prescribing the amount that must be bought of at least one of these products. A further difference commonly but not always observed is that the tied goods typically exhibit a complementary relationship with each other whereas bundled goods need not. We now turn to a somewhat magical example to illustrate why tying is often an effective marketing strategy.

Consider an imaginary product called a *Magicam* that is produced by only one firm, Rowling Corp. A *Magicam* is much like an ordinary camera with one exception—the figures in a *Magicam* photograph can actually move and even wave back at the picture viewer because of Rowling's patented, magical method of placing the images on film. In all