Sloan School of Management
Massachusetts Institute of Technology

15.013 – Industrial Economics for Strategic Decisions
Professor Robert S. Pindyck

Lecture Notes
on
Bundling and Brand Proliferation

(August 2013)

These lecture notes cover two related topics: bundling and brand proliferation. We will see how these two practices can help a firm deter entry and maintain market power. We will also see how bundling can have pro-competitive aspects.

First, we will discuss the use of bundling for a firm that produces complementary goods. We will see how, when there are strong complementarities, bundling can provide gains to consumers *and* to the firm. We will also see how bundling can be used as a means of deterring entry — perhaps beneficial to the firm, but not to consumers. Second, we will lay out a simple model of brand proliferation and examine its implications for entry deterrence. We will use the breakfast cereal industry as an example, although the model could apply to other products (such as packaged cookies) as well.

We will begin with a discussion of bundling. Then we will turn to product attributes, and the notion of local competition in a product attribute space. Afterwards, we will lay out a model which shows how a proliferation of brands can lead to a significant entry barrier.

1 Bundling

In 15.010, you studied bundling as a way of capturing consumer surplus. (If you were only semi-conscious at the time and don't remember any of this, you might want to go back to Pindyck and Rubinfeld, *Microeconomics*, Chapter 11, for a review.) There, you saw how bundling could be used as a means of price discrimination, and how its effectiveness depended on the extent to which consumers' reservation prices were negatively correlated. However,

little else was assumed about the way in which the demand for one good depended on the price or quantity of the other.

In these notes we will examine some additional reasons for bundling. First, when a firm produces products that are *complementary* to each other, bundling can increase profits, and also benefit consumers. Second, bundling can often be used as a way of reducing costs, in that it is cheaper to sell several goods together as bundle than to sell them separately. Third, there are situations in which bundling can be used as a very effective means of deterring entry.

1.1 Pricing of Complementary Products

Two products are *complements* when an increase in the sales of one product leads to an increase in the demand for the other product. Roughly speaking, complements are goods that tend to be used together. A good example of this (and one that we will discuss in class) is the complementarity between a computer *operating system* and *applications software* that runs on that operating system. Clearly, an operating system is of little use without applications to run on it, and applications are of little use without an operating system to run them on. Thus, an increase in the sales of Windows will lead to an increase in the demand for applications software that runs on Windows, and vice versa.

When two products are complements, a firm that produces *both* of them (e.g., the operating system and the applications software) should set lower prices than would two independent firms, each of which sells just one of the products. The reason is that a lower price for one product generates additional sales not only of that product, but also of the complementary product. A firm that produces both products *internalizes* this demand spillover, whereas independent single-product firms do not. Note that consumers benefit as a result; when one firmm produces both products, prices to consumers will be lower than when two separate firms produce the products.

So far, we have argued that a firm that produces two complementary products should set lower prices than would be set by two independent firms. We have not yet addressed the issue of bundling. Bundling becomes profitable when the profit-maximizing price for one of

the goods is zero (or negative).

Consider the following example. Suppose a single firm sells two complementary products with the following demand curves:

$$Q_1 = a_0 - P_1 - .5P_2$$

$$Q_2 = b_0 - .5P_1 - P_2\,.$$

Here Q_1 and Q_2 are the quantities of each good, and P_1 and P_2 are the prices. Note that the cross-price elasticities are negative, which means that the two goods are complements. An increase in P_2, for example, will cause Q_2 to fall, but that in turn will reduce the demand for Product 1, so Q_1 will also fall.

The firm wants to choose these prices to maximize its total profit:

$$\Pi = (P_1 - c_1)Q_1 + (P_2 - c_2)Q_2$$

where c_1 and c_2 are the marginal costs (assumed constant) of producing each good. For simplicity, we will assume that these marginal costs are equal, i.e., $c_1 = c_2 = c$. By substituting the demand equations for Q_1 and Q_2 into the expression for profit, and then maximizing profit with respect to the two prices P_1 and P_2, we can obtain the profit-maximizing prices in terms of the various parameters. Specifically, substituting the demand equations into the expression for profit gives:

$$\Pi = (P_1 - c)(a_0 - P_1 - .5P_2) + (P_2 - c)(b_0 - .5P_1 - P_2)$$

Taking the derivative of Π with respect to P_1 and setting it equal to zero gives:

$$2P_1 + P_2 = a_0 + 1.5c$$

Likewise, with respect to P_2:

$$2P_2 + P_1 = b_0 + 1.5c$$

Combining these two equations gives the optimal prices P_1 and P_2:

$$P_1 = (2a_0 - b_0 + 1.5c)/3$$

$$P_2 = (2b_0 - a_0 + 1.5c)/3$$

Suppose that the parameter values are $a_0 = 100$, $b_0 = 50$, and $c = 10$. In that case, the profit-maximizing prices are $P_1 = \$55$ and $P_2 = \$5$. Thus the firm should sell Product 2 *below its marginal cost*. Why? Because doing so generates more profit by stimulating additional sales of Product 1.

This simple example illustrates a more general — and very important — point: *A firm that produces two or more products with interrelated demands must price those products jointly.* (Setting prices jointly is called "product line pricing.") If instead the firm prices each product independently, its total profit will be reduced.

Now, what does this have to do with bundling? To see the connection, let's modify our simple example by setting $b_0 = 40$ instead of 50 as before. (All of the other parameter values remain the same.) You can check that in this case the profit-maximizing prices are $P_1 = \$58.33$ and $P_2 = -\$1.67$. Now, the relatively low demand for Product 2 coupled with the strong complementarity leads the firm to set the price of Product 2 *below zero* in order to stimulate sales of Product 1.

1.2 Bundling Complementary Products

In practice, a negative price is unlikely to be any more effective than a price of zero, because paying someone to take a product gives no guarantee that the person will actually use it. But there is clearly an incentive to distribute the product at no charge. If instead we set $P_2 = 0$, then the profit-maximizing price for the first good is $P_1 = \$57.5$. *The two goods can then be sold as a bundle, for a price of \$57.5*.

Why not just give the second good away instead of bundling the two goods? Because if a product is free, people can pick it up, perhaps out of curiosity, and then toss it in the garbage. If the marginal cost of producing the good is greater than zero, this will cost the firm money. The objective is to give away the second good as a way of increasing sales of the first good. Bundling achieves this.

It is important to emphasize that although this bundling arrangement is a way to "sell"

Product 2 at a price of zero, there is no guarantee that $57.50 is the profit-maximizing price of the bundle. Pricing the bundle optimally is actually quite complicated, because it depends on the *distribution of consumer preferences* across the two goods. Determining that distribution can be difficult. At this point, we just want to make it clear that bundling can be a reasonable solution to the pricing of strongly complementary products.

Now suppose that each of the two products was produced by a separate firm, and each firm chose a price to maximize its own profits. Of course, each firm must consider what the price charged by the second firm will be. A reasonable assumption is that the result will be a Nash equilibrium — each firm chooses a price to maximize its own profit, taking the price of the other firm as fixed, but assuming that the other firm is also maximizing its profit. You should be able to show that in such a situation the prices charged for the two products will be *higher* than in the case where they are produced by a single firm, so that consumers would be worse off.

An important issue in the government's antitrust case against Microsoft was the bundling of Internet Explorer (the browser) with the Windows operating system. The operating system and the browser are clearly complementary products. Given that marginal costs are very low, it may well be the case that the profit-maximizing price for the browser is zero or negative, so that bundling is warranted. This is a "pro-competitive" argument for bundling the browser with the operating system. (As those of you who followed the case know, there were also some anti-competitive arguments.)

There can be other pro-competitive benefits from bundling complementary products. Consider the sales and service of diagnostic imaging equipment, such as CT scanners and MRI machines. (The principle applies to other high-tech equipment such as heavy-duty copiers or mainframe computers.) CT scanners and MRI machines must be serviced frequently in order to keep them perfectly calibrated. The manufacturers of CT scanners and MRI machines (GE, Siemens, Philips, Toshiba, Picker International, and a few others) typically provide service for their own machines, and offer extended service contracts when they sell the machines. About 10 percent of machines, however, are serviced by independent service organizations (ISOs), who often complain that they are at a competitive disadvantage to the

manufacturer in trying to provide service. The machine and the servicing of the machine are clearly complementary products, which alone can make the bundling of sales and service desirable. But bundling has the added advantage that it avoids *finger pointing* - arguing over who is to blame when the machine does not work properly.

1.3 Bundling to Reduce Costs

Another pro-competitive reason to bundle products together is to reduce costs. Selling shoes in pairs is an obvious example. In principle, left shoes and right shoes could be sold separately. But left shoes and right shoes are highly complementary products, and most people (unless they have two left feet) want one of each. Selling shoes in pairs is less costly than selling them separately — money is saved on packaging, inventory maintenance, sales accounting, etc. Thus, left shoes and right shoes are almost always sold as a bundle.

For many automobiles, the "luxury package" often includes a bundle — power windows and door locks, sun roof, and leather seats. Why aren't these "extras" sold separately, so that a buyer could choose the power windows but skip the sun roof? The answer is that offering each "extra" separately is too costly in terms of inventory costs, and even production costs. Thus, these items are packaged together and sold as a bundle.

Office equipment — copiers, computers, etc. — is often sold with a bundled service contract. Why not separate service from sales? Because it is often more efficient (i.e., less costly) for the manufacturer to service its own equipment. In addition, having the manufacturer service its own equipment avoids the kind of finger pointing that can arise when a different firm provides service.

1.4 Bundling to Deter Entry

We now turn to the dark side of bundling: a means of deterring entry or forcing a small competitor out of the market, and thereby leveraging market power in the market for one product (Product A) to the market for a second product (Product B). This can work if a monopolist who produces Product A also produces Product B, but faces actual or potential competition in the market for B, and if the market for B is not perfectly competitive and

has economies of scale. In this case, by tying the two products together (by selling them only as a bundle), the monopolist may be able to increase its monopoly profits.

As a simple example, consider a small Caribbean island that has only one hotel, so that the hotel owner is a monopolist in the local market for hotel rooms.[1] The hotel has a restaurant, but there are also two small local restaurants on the island, so the hotel owner faces competition in the restaurant market. Guests at the hotel, as well as local residents on the island, can choose among these restaurants for their meals. Now suppose the hotel owner *bundles meals with its room rate*. (For example, initially hotel rooms went for $200 per night and meals — at the hotel or elsewhere — typically cost about $100 per day. Now, guests at the hotel are required to pay $270 per night, but this includes meals at the hotel.) In this case, hotel guests who might have eaten some or all of their meals in the local restaurants will instead eat at the hotel, because the cost of doing so is zero. The local restaurants will lose part of their customer base, and if they have high fixed costs, they may have to go out of business. If so, the hotel owner will have leveraged her market power into the restaurant market.

As a general matter, bundling can be effective when a firm has market power in the production of two goods, A and B, but faces potential competition from an entrant who is deciding whether to produce one of the goods. As we have seen with the Caribbean island example, bundling the two products together might help to deter entry (or force out a small competitor), because it reduces the size of the market that the entrant (or competitor) will face. In particular, bundling allows the incumbent monopolist to defend both products without having to set low prices for each. Bundling is particularly effective in this case when demands for the two products are *positively* correlated and marginal costs are low.[2]

To see this, suppose demands are perfectly positively correlated, i.e., consumers willing to pay $100 for one product are also willing to pay $100 for the second. Suppose a monopolist

[1] This example is from Dennis Carlton and Michael Waldman, "The Strategic Use of Tying to Preserve and Create Market Power in Evolving Industries," *RAND Journal of Economics*, 2002.

[2] This discussion is based in part on Barry Nalebuff, "Bundling as an Entry Barrier," *Quarterly Journal of Economics*, Feb 2004.

has been producing both of these products and selling each at a price of $100. In this case, the monopolist could bundle the two products and sell the bundle for $200. Now consider an entrant who thought of coming into the market and selling the second product at a price of $100. In this case, the entrant would face a greatly reduced demand, since most consumers would be better off simply paying $200 for the bundle. Depending on the size of the sunk cost and fixed cost needed to enter the market, this could well deter entry. We will discuss this in more detail in class.

An example of such bundling is Microsoft Office, in which Word, Excel, and Power Point are sold in a bundle as an office "suite." The demands for these products are positively correlated — consumers who use Word are more likely to want Excel and/or Powerpoint than consumers who do not use Word. In addition, marginal costs are very low. By selling these products as a bundle, Microsoft reduces the potential market for a firm that is considering entry with, say, a new spreadsheet program.

1.5 Bundles Competing Against Bundles

Microsoft, of course, is not the only software firm that sells products in a bundle. Corel, for example, also sells an office suite that includes WordPerfect, Quattro Pro (a spreadsheet program), and Presentations; and Sun Microsystems sold a similar suite called StarOffice. And many other firms compete with each other through the use of bundles. For example, McDonalds' Value Meals compete against comparable bundles offered by Burger King and Wendy's; travel companies compete by offering vacation packages (airline tickets, hotel room, and rental car); and medical device manufacturers (such as Covidien, which was formerly part of Tyco, Johnson & Johnson, and Boston Scientific) compete by offering discounted bundles of products to hospitals.

Does competition among bundles enhance or reduce market power? If you think about this for a minute (or in this case, several minutes), you will see that it *reduces* market power. Why? Because *bundling products together reduces the heterogeneity of consumer valuations, and thereby makes the demand curve more elastic.*

To see this, suppose Firms 1 and 2 compete with each other in the markets for Products A

Table 1: Reservation Prices

Group	A1	A2	B1	B2	Bundle 1	Bundle 2
x	\$200	\$100	\$100	\$200	\$300	\$300
y	\$100	\$200	\$200	\$100	\$300	\$300

and B. In each market, the products are differentiated, so some consumers might prefer Firm 1's Product A but Firm 2's Product B, other consumers might prefer Firm 2's Product A but Firm 1's Product B. If consumers have strong preferences for each of the two products, the two firms will have considerable market power in each market. But now suppose that each of the firms sells its two products as a bundle. What will happen to consumer preferences? To some extent, they will "even out." For example, those consumers who had a strong preference for Firm 1's Product A but Firm 2's Product B will be relatively indifferent between the two bundles. Thus, the firms will be forced to compete more aggressively on price.

To make this a bit more concrete, suppose that there are two groups of consumers, with 1000 in each group. Group x greatly prefers Firm 1's version of Product A and Firm 2's version of Product B. Group y has the opposite preferences. The reservation prices for each group are shown in Table 1.

Suppose that both firms sell their products individually. As you can see from Table 1, both firms will charge \$200 for each of their products. Group x will buy Product A from Firm 1, and Product B from Firm 2, and Group y will do the opposite. Each firm will sell 1000 units of each of its products, and earn a profit of (2000)(\$200)=\$400,000. Prices are high in this case because the products are differentiated.

Suppose instead that both firms sell their products as bundle. Then each firm will charge \$300 for its bundle. Consumers will be indifferent as to whom they buy from, so the firms will split the market. Each will sell 1000 bundles and earn \$300,000. Note that prices are now lower because the bundles are not differentiated.

If the firms do worse by competing with bundles, why do they bundle? (Assume entry deterrence or predation is not the objective.) The reason is that the firms are in a kind of Prisoners' Dilemma, where bundling is a dominant strategy. To see this, suppose Firm 1

bundles, but Firm 2 sells its products individually.

Firm 1 could then charge \$300 for its bundle, sell to all 2000 consumers, and earn \$600,000. Firm 2 would charge \$100 for each of its products. Customers would then discard one of the products in the Firm 1 bundle, and buy that product from Firm 2. Firm 2 would then sell 1000 units of each of its products, and earn \$200,000. Firm 1 would do very well with this strategy, but at the expense of Firm 2, which will quickly decide to also bundle. Thus, each firm will have a strong incentive to bundle. (See Table 2.)

Table 2: Prices, Quantities, Profits

Strategies	Firm 1	Firm 2
Both firms sell products individually	$P_{A1} = P_{B1} = \$200$ $Q_{A1} = Q_{B1} = 1000$ $\pi_1 = \$400,000$	$P_{A2} = P_{B2} = \$200$ $Q_{A2} = Q_{B2} = 1000$ $\pi_2 = \$400,000$
Both firms sell bundle	$P_{BUNDLE} = \$300$ $Q_{BUNDLE} = 1000$ $\pi_1 = \$300,000$	$P_{BUNDLE} = \$300$ $Q_{BUNDLE} = 1000$ $\pi_2 = \$300,000$
Firm 1 bundles, Firm 2 sells individually	$P_{BUNDLE} = \$300$ $Q_{BUNDLE} = 2000$ $\pi_1 = \$600,000$	$P_{A2} = P_{B2} = \$100$ $Q_{A2} = Q_{B2} = 1000$ $\pi_2 = \$200,000$

1.6 Tying

Tying is related to bundling, but as we will see, is sometimes broader in nature. The term refers to any requirement that two or more products be bought or sold together. As a hypothetical example, General Electric might tie the sale of its CT scanners to the sale of a service contract. Or Toyota might tie the sale of its cars to the sale of its parts, by requiring that if any part must be replaced, it can only be replaced with a Toyota part or else the warranty will become invalid. Because tying can enable a company to leverage its market power in one product into the market for a second product, it can be anti-competitive. Thus tying is generally (but not always) prohibited under the U.S. antitrust laws. GE cannot require the buyer of one its CT scanners to also buy a GE service contract (although 90% of customers to buy the service contract), and Toyota cannot invalidate the warranty if the

owner of the car uses a non-Toyota part.

Companies will sometimes work around the prohibition on tying through the use of mixed bundling. Medical device manufacturers such as Covidien and Johnson and Johnson are a good example. Covidien cannot require a hospital that buys its endoscopes to also buy its pulse oximeters. Instead they offer the products separately (so that hospitals can buy items on an a la carte basis), but they also offer them as a bundle at a greatly discounted price. Thus hospitals have a strong incentive to buy all of the products together from a single supplier.

Technical Ties. Sometimes technology can be used to create what is effectively a tie. The idea is that a firm will use technical compatibility to tie products together in a way that allows the company to leverage its market power. This is easiest to understand in the context of a recent antitrust example: Microsoft and Sun Microsystems competing in *server operating systems*. (Sun was acquired by Oracle Corporation in January 2010.)

In 2002, Sun sued Microsoft, claiming that Microsoft used a technical tie to push Sun out of the market for server operating systems. At the time, Microsoft had about a 40% to 50% share of operating systems used to run servers, but had a share of at least 90% in desktop operating systems. Thus most of the time a server will be "talking" to a desktop machine running Windows. Sun claimed that Microsoft engineered Windows to make it much more compatible with Microsoft's server OS, and given that much of the Windows OS code was secret, Sun could not overcome Microsoft's resulting advantage, and sales of its Solaris server OS suffered. Sun claimed that in effect, Microsoft was using a technical tie to leverage its market power in desktop operating systems into the market for server operating systems.

The case was settled in April 2004. Microsoft agreed to pay Sun $700 million to resolve the antitrust case, and another $900 million to resolve some related patent issues. Sun and Microsoft also agreed to share their technologies in a way to avoid incompatibilities (i.e., avoid any further technical tie).

2 Competition in Attribute Space

For a product like breakfast cereals, we can characterize individual brands in terms of their positions in an *attribute space*. In the case of cereals, an important attribute is sweetness; some cereals contain a large amount of sugar per ounce, and others contain little or no sugar. Another important attribute is perceived nutritional value, or what I will call "healthfulness." For example, some cereals are promoted as a source of vitamins, others as a source of dietary fiber, others as having high protein, low fat, or some combination of these things. (A key here is *perceived* nutritional value, which may differ from the actual nutritional value or healthfulness of the product.) Still another attribute is crispiness or crunchiness; consumers differ considerably in terms of their preferences for this attribute.

Since I can only draw a diagram in two dimensions, Figure 1 shows an array of cereals in a product attribute space that contains two attributes: sweetness and "healthfulness." Kellogg Special K, for example, has almost no sugar and is also viewed as a very "healthful" cereal (in part because it is high in protein). But note that sweetness and "healthfulness" are not mutually exclusive characteristics; Kellogg's Raisin Bran and Post Raisin Bran, for example, both contain large amounts of sugar, but are positioned as nutritious cereals because of their high fiber content. Figure 2 shows an attribute space that compares sweetness to crunchiness. Post Grape Nuts is among the crunchiest of all cereals; if you prefer something that gets soft and soggy after sitting in milk for a few minutes, try Corn Flakes or Cheerios.

Although our focus will be on brand proliferation and entry deterrance, you should understand how product attribute space can be a valuable tool for the design and introduction of new products and brands. For example, Figure 3 shows a product attribute space for beer. Do you see how this could be used by a company trying to decide what kinds of new beers to introduce? What additional information would the company need?

Local Competition. An important characteristic of interbrand competition is that it occurs in product attribute space on a *local* basis. In other words, each brand only competes with other brands that are close to it in attribute space. Thus, Cocoa Crispies, Sugar Pops, and Froot Loops compete with each other, and to some extent with Frosted Cheerios, but

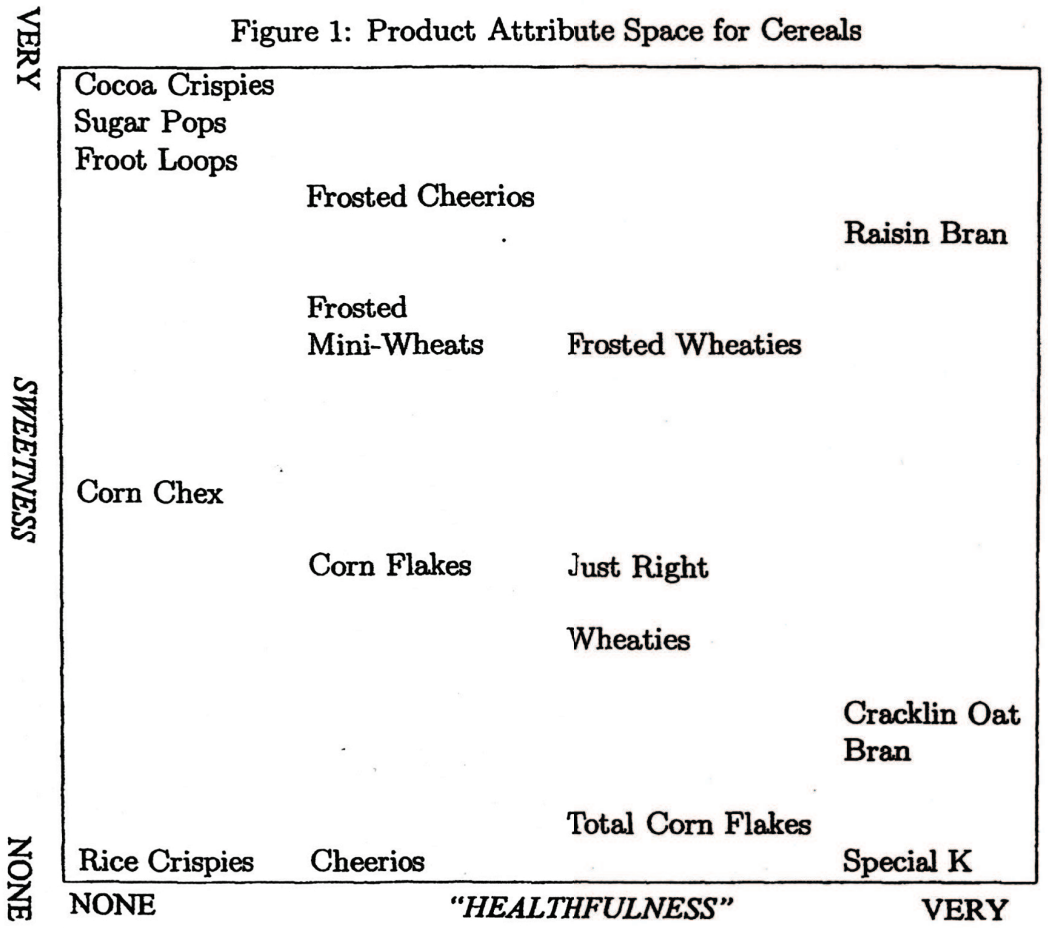

Figure 1: Product Attribute Space for Cereals

they do not compete with Corn Flakes, Raisin Bran, or Wheaties. Put another way, a small change in the price of any one brand will only be felt by the closest neighbors in product attribute space. This kind of localized rivalry is very important.

The local nature of competition among brands is evident in the way supermarkets organize the various brands of cereal on their shelves. Sweet and less "healthful" cereals are grouped together, apart from the "'healthful" (and less sweet) cereals. This can be seen from Figure 4, which shows a group of sweet cereals on the shelf of a local supermarket, and Figure 5, which shows a group of "healthful" cereals. There would be no point in the supermarket mixing the sweet and "healthful" cereals, because for consumers interested a

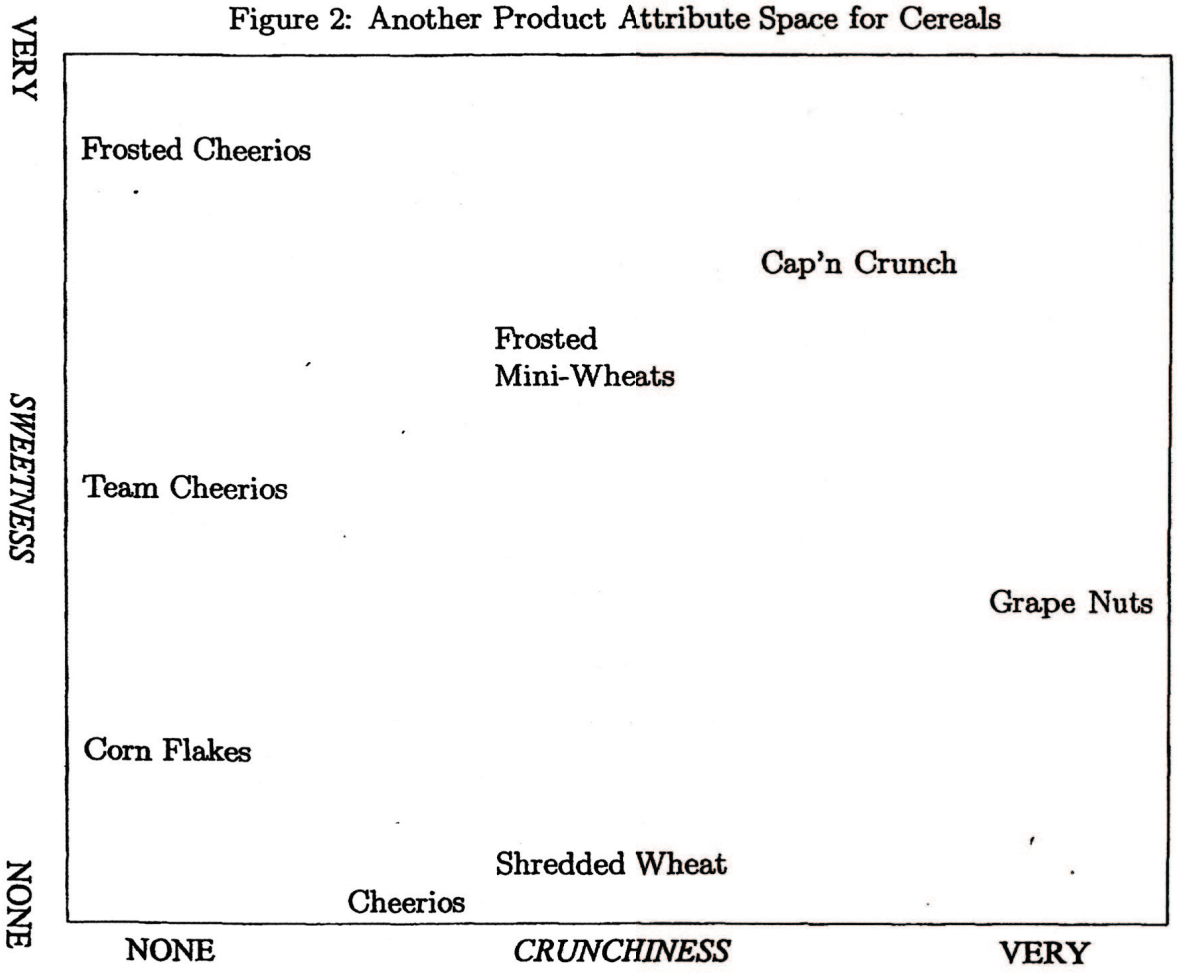

Figure 2: Another Product Attribute Space for Cereals

sweet cereal, the "healthful" ones are simply irrelevant.

Brand Immobility. Another important characteristic of the market is that to a great extent there is *immobility* in product attribute space. In other words, once a brand enters the space, it is very difficult to later change its position. For example, if a brand such as Cocoa Crispies is originally positioned as a very sweet and non-nutritious brand, it is difficult, even with a great deal of advertising, to later reposition it as a highly nutritious brand. As we will see, local competition and immobility in attribute space have important implications for the use of brand proliferation as a means of deterring entry.

These two characteristics of product attribute space — localized competition and brand

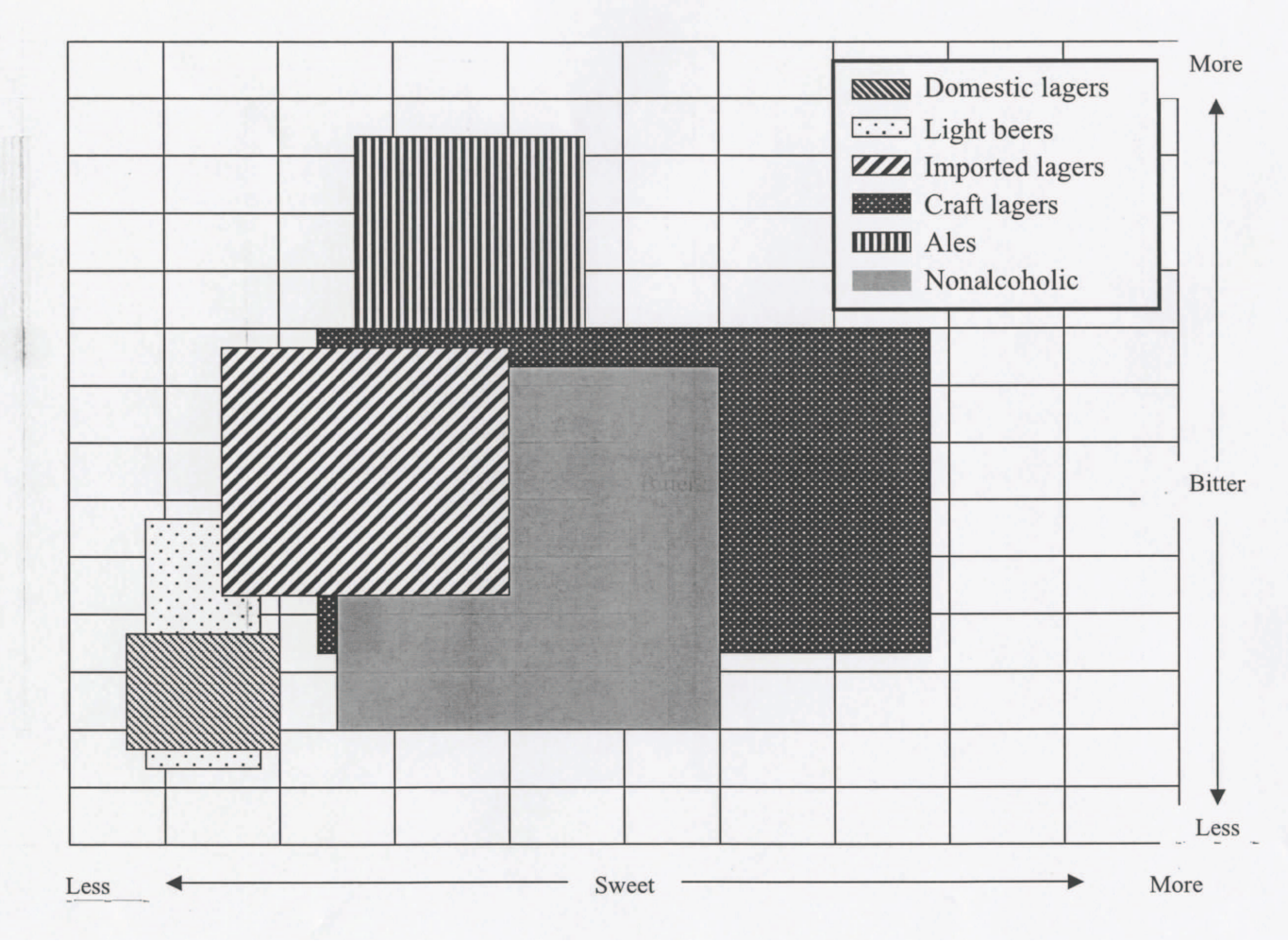

Figure 3: Product Attribute Space for Beer

immobility — are very important. As we will see, they make it possible for firms to deter entry by proliferating brands.

3 Brand Proliferation as a Barrier to Entry

Now let us turn to a simple model that shows how brand rivalry by itself can be an entry barrier, in much the same way that scale economies can be. We will assume that the products of interest have the following characteristics: (1) there is increasing returns at the brand level; (2) there is localized rivalry among brands in product attribute space; and (3)

Figure 4: Sweet and Less "Healthful" Cereals

there is relative immobility of brands in product attribute space.[3]

We have already dealt with characteristics (2) and (3). Characteristic (1) — increasing returns at the brand level — means that the average long-run total cost of producing and marketing a brand is a declining function of the quantity produced. In particular, we will assume that the long-run *total* cost of producing and marketing a brand is given by:

$$C(q) = F + vq \tag{1}$$

where F is fixed cost and v is the per-unit variable cost. (For example, F might include "slotting allowances" paid to supermarkets.)

We will also assume that consumers patronize brands in attribute space that are closest to their own preferences. Of course, the more brands there are, the greater the amount of competition between brands, so that sales of any one brand will be a declining function of the total number of brands. On the other hand, more brands enable consumers to purchase

[3]This model was first developed by Richard Schmalensee, "Entry Deterrence in the Ready-to-Eat Breakfast Cereal Industry," *The Bell Journal of Economics*, 1978, vol. 9, 305–327.

Figure 5: Some "Healthful" Cereals

products that come closer to their own personal attribute preferences, so that *total* industry sales will increase with the number of brands. Specifically, we will write the demand function for *each brand* as:

$$q(p, N) = a(p)b(N) \tag{2}$$

where p is price, and N is the total number of brands. We will assume that $b(N)$ is a decreasing function of N, but that $Nb(N)$ is an increasing and concave function of N. Thus, total sales increase as N increases, but the market-expanding effect of additional brands has decreasing returns. This is illustrated graphically in Figure 6.

For simplicity, we will assume that all brands charge the same price p. We will also assume that all potential entrants face a demand curve that has a sharp kink at that price p. In other words, prices above p will not be matched, and those below p will be matched with retaliatory price cuts. Thus, any new entrant would also charge the same price p.

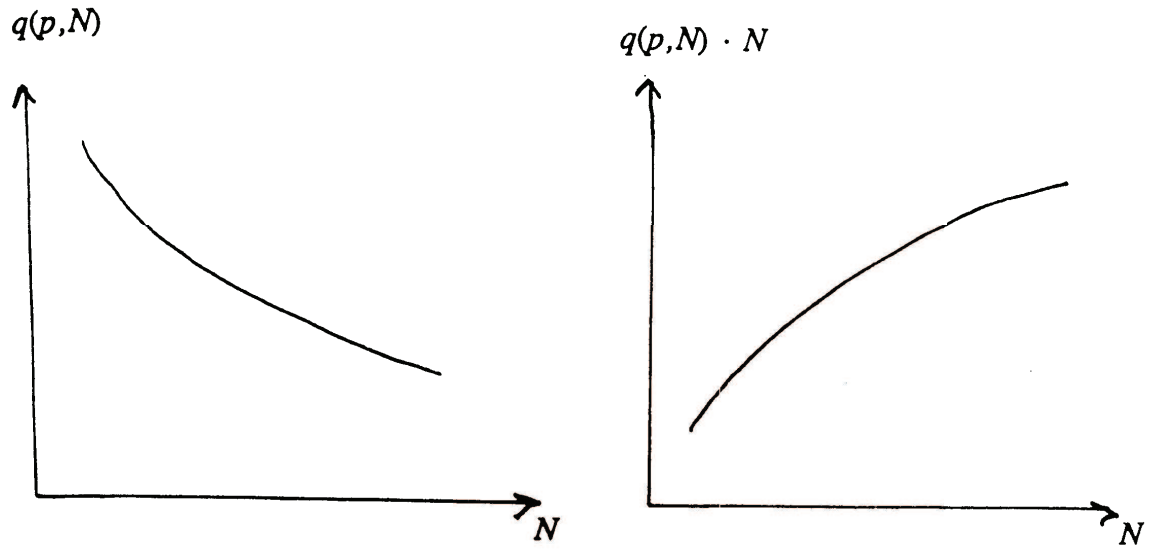

Figure 6: (a) Demand for Brand (b) Behavior of $q(p, N) \cdot N$

Finally, the *profits* of a typical brand are given by:

$$\pi(p, N) = A(p)b(N) - F \tag{3}$$

where $A(p) = (p - v)a(p)$. Given p, let N^* be the solution of $\pi(p, N^*) = 0$. *All established brands are therefore profitable as long as* $N < N^*$. This is illustrated in Figure **??**, which shows the profit to a typical brand as a function of the total number of brands.

We will consider a very simple description of product attribute space. We will assume that product attribute space is given by a circle with unit circumference. This is illustrated in Figure 8. Suppose there are four brands. Where will those four brands position themselves on the circle? Clearly they would all like to be as far away from each other as possible. Hence the brands will be positioned as shown in the figure — each one at a distance of $\frac{1}{4}$ away from the nearest competitor. Note that for each competitor, the local "brand density" is 4. In other words, each competitor sees a density of four brands per unit of attribute space.

Now suppose a new entrant comes in. A new entrant would do best by locating mid-way between two existing brands (and thereby serving those consumers least well served by the existing brands). In the example shown in Figure 8, the new entrant would find itself at a distance of $\frac{1}{8}$ from its nearest rival. Thus, from the point of view of this new entrant, the

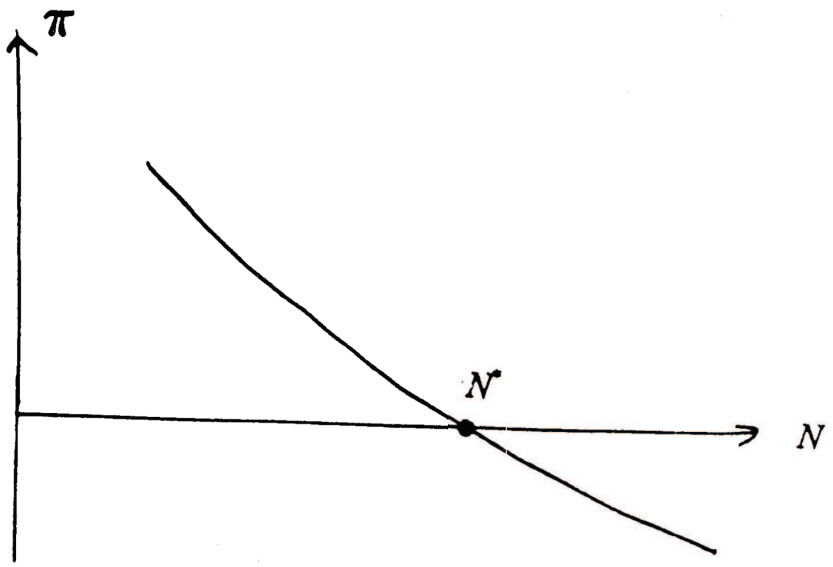

Figure 7: Profits of a Typical Brand

local brand density is now 8, not 4.

In general, we could imagine that there are already N brands evenly distributed around the unit circle. In that case the average brand density would be N. Suppose that N is such that

$$N^*/2 < N < N^*$$

In this case, each of the existing brands will make a profit, because $N < N^*$. However, what happens if a new entrant tries to come in? Since that entrant would face a local brand density of $2N$, it would suffer losses. Knowing this, a rational firm would not try to enter.

We have seen here that with localized competition, entry creates a major increase in crowding in the relevant part of attribute space, regardless of conditions (e.g., high profits) elsewhere in the attribute space. With restricted mobility, the entrant cannot expect existing brands to "make room" for him by changing their locations, so that the initial crowding that entry creates will persist, and an entrant will remain unprofitable.

Note the importance of brand immobility in product attribute space. Suppose some marketing genius could come up with a technique that would allow brands to reposition

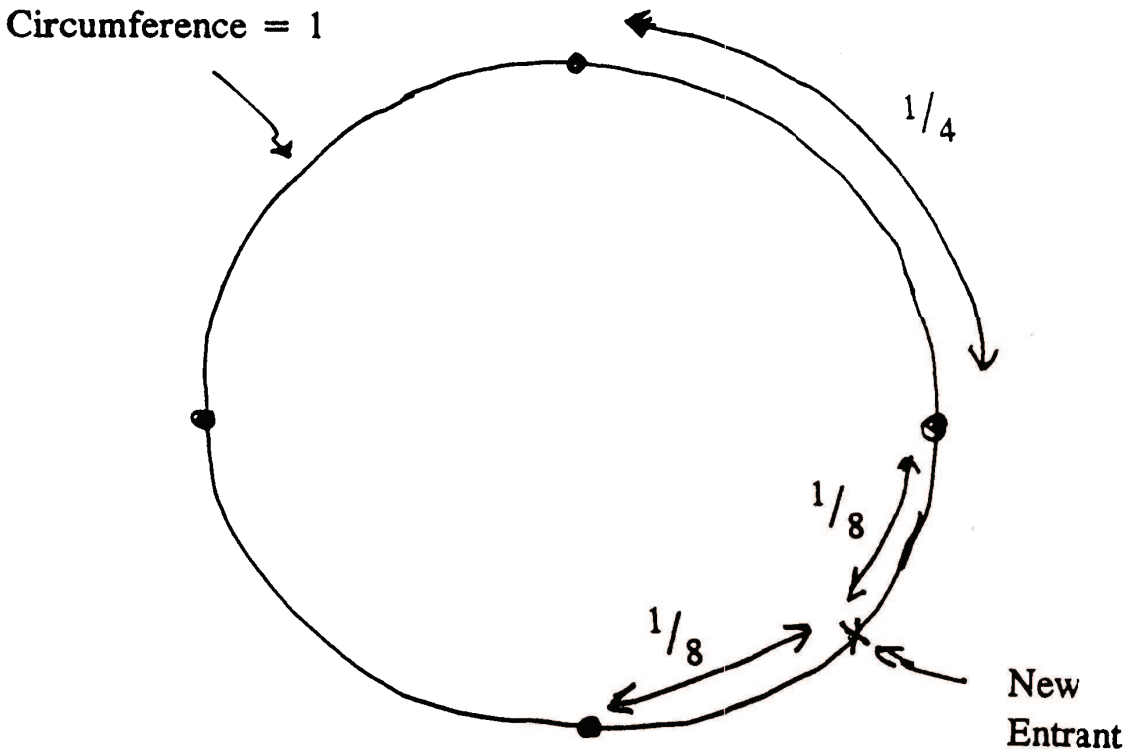

Figure 8: Brand Location in Attribute Space

themselves in product attribute space at low cost. Would such an invention be welcomed by incumbent firms? You should be able to see that it would in fact threaten the profitability of the industry. This is another example of a situation in which restricted mobility (a seeming disadvantage) gives existing firms a competitive advantage.

Finally, suppose existing firms in the industry wanted to collude (implicitly or otherwise) to deter entry. What would be the most efficient way to do so? They could threaten any potential entrant with predatory pricing, but that might not work because once prices were later increased, entrants would come knocking at the door again. A better scheme is simply to increase the total number of brands. Brand proliferation can provide a natural entry deterrent.

3.1 Nature of Inter-Firm Competition

In this model, we would expect to see only limited price competition. However, we would expect to see very aggressive competition through advertising and new product introductions. Furthermore, this will be a self-reinforcing process. The more effectively established brands are differentiated through advertising, the less incentive any seller has to engage in price competition (and recall our discussion about choosing how to compete in the context of the beer industry.) Also, to the extent that advertising expenditures are fixed costs, they help to deter entry. An existing brand will be kept on the market as long as its variable costs are covered, while an entrant will only come in if it can expect to cover total costs.

Also note that aggressive advertising makes sense from what we know about the optimal advertising-to-sales ratio. Recall that the optimal advertising-to-sales ratio is given by

$$A/pq = -E_A/E_p$$

where E_A is the advertising elasticity of demand, and E_p is the price elasticity of demand.[4] In this case the advertising elasticity of demand is relatively high, and the price elasticity is relatively low. Thus the advertising-to-sales ratio should be high. However, this means that much of the extra profits from entry deterrence will be wasted away by heavy advertising, and by the introduction of new brands. In the breakfast cereal industry, profits have still been historically high. But imagine how much higher they would have been if firms had somehow colluded to advertise less. Since much of this advertising is a social loss from the point of view of consumers, the total loss to consumers from entry deterrence has been large.

3.2 Evolution of the Breakfast Cereal Industry

Table 3 shows the evolution of market shares by the major cereal producers since 1950. Note that the acquisition of Post and Nabisco by Philip Morris, (eliminating the Nabisco brands), and the exiting of Ralston at the end of 1993, has left four major branded companies.

Although prices and margins remain very high, the incumbent firms are facing some important threats. Here are a couple of questions to think about.

[4]If you have forgotten this, go back and read Pindyck & Rubinfeld, *Microeconomics*, Section 11.6.

Table 3: Volume Market Share (Percent)

	1950	1960	1970	1980	1990	1993	1999	2003	2008	2011
Kellogg	35.2	45.9	45.5	40.9	37.5	36.5	32.0	29.0	33.0	32.0
General Mills	22.3	19.5	19.7	19.9	24.4	24.3	32.0	30.0	25.0	28.0
Post*	26.8	19.6	19.3	15.6	11.1	11.9	16.0	14.5	15.0	13.0
Quaker***	5.5	3.6	7.8	8.6	7.8	7.4	9.0	13.5	7.0	7.0
Malt-O-Meal									5.0	6.0
Nabisco*	6.6	6.0	4.8	4.9	4.4	3.1	(Post)			
Ralston**	3.5	5.3	3.7	6.5	6.1	4.2				
Private label, Other					5.6	9.2	11.0	13.0	15.0	15.0

* Philip Morris
** Exited at end of 1993
*** A Subsidiary of PepsiCo, Inc.

1. During the past 15 years, there has been increased entry in the breakfast cereal market by *private labelers*. What is it that in the past has made entry by an aggressive private labeler difficult? What has changed in the last decade to allow greater entry by private labelers?

2. Given this model of entry deterrence, how can we explain the successful entry of "natural cereals," which were introduced by new firms during the 1970s? Sales of natural cereals declined during the 1980s and 1990s, but have had a resurgence in recent years. An example is the Kashi line of cereals (see the picture below). How do you explain this?

Figure 9: Kashi GoLean Cereal