PRICING

So far we have supposed the price of the firm's output is fixed. That is, the firm can sell as many units as it desires at a fixed price. Alternatively, the firm has no pricing power: it cannot offer a price above the competition without losing all customers. This is reasonable, for example, when customers can find close substitutes: when many competing firms exist and the product is a commodity. For example, the sugar farmer who creates a futures contract to sell all output at a fixed price can be viewed this way.

For many (most) goods the firm has some pricing power. Pricing power arises from lack of availability of close substitutes: lack of competitors and/or from producing a differentiated product. If the firm has some pricing power, the firm can set a price that is high relative to competitors. In this case, the firm makes more money on each unit, but of course sells less units: only those customers who really like the firm's product will buy it, the rest buy imperfect alternatives from competitors. Alternatively, the firm can cut prices and try to sell more units to make higher profits. Which is better of course depends on the properties of demand for the firm's product which is what we are going to study here.

We will also evaluate many common pricing strategies. Does "99 cent" pricing (pricing something equal to \$1.99 instead of \$2) work? When should we use coupons or rebates? What about setting the price equal to a fixed mark-up over costs? Why do some firms charge \$1 for a coke that costs 5 cents to make and \$2 for a burger that costs \$1.85 to make? We will also study "price wars" and other games firms play against each other.

I Market Demand Function

Quantity demanded is the number of the firm's product customers wish to purchase. What affects the quantity demanded?

1. Price of the product (P). (inversely related to demand).
2. Income of consumers (I). (positively related to demand).
3. Price of competitors. (positively related to demand).

4. Advertising (A). (positively related to demand).

5. Price of complementary goods. (inversely related to demand).

For example, the price of cruises is certainly affected by the price of a cruise the firm charges, income, the price of other cruise lines (and other competitors, such as vacation packages), advertising, and the price of goods like sun tan lotion, which are complementary with cruises.

Definition 22 *The* **Market Demand Function** *is the relationship between the quantity demanded of the product and the various factors that influence the quantity demanded.*

For example, the market demand for Dell computers might be:

$$Q = -700P + 500I - 200S + 0.01A \tag{88}$$

Here A is advertising, P is the price of a Dell computer, I is income, S is the price of software, and Q is the quantity demanded. Apparently, if Dell raises the price by \$1, then the quantity demanded falls by 700 units per year.

How do we find the market demand function? Similar to cost functions, we use company data and statistics. See below.

II Price Elasticity and the Optimal Pricing Policy

Price elasticity measures how sensitive the market demand function is to changes in the price the firm charges.

A Price Elasticity of Demand

Definition 23 *The* **Own Price Elasticity of Demand** *is the percentage change in quantity demanded from a one percent change in price.*

The price elasticity is our primary measure of the firm's pricing power. Formula:

$$e_p = \left(\frac{P}{Q}\right)\left(\frac{\partial Q}{\partial P}\right) \tag{89}$$

Alternative formula:

$$e_p = \frac{\text{percent change in } Q}{\text{percent change in } P} \tag{90}$$

As elasticity becomes more negative firms lose pricing power. Even a small rise in price would mean no goods are sold. As e_p gets larger (approaches 0), pricing power increases. Such firms may increase the price quite a bit and lose little customers.

elasticity	economics term	pricing power	level of competition
$e_p = -\infty$	perfectly elastic	none	perfect competition
$e_p < -1$	elastic	little	competitive
$e_p = -1$	unitary elastic	moderate	moderate competition
$-1 < e_p < 0$	inelastic	strong	imperfect competition
$e_p = 0$	perfectly inelastic	infinite	no competition

B Examples

Consider the example from Dell computer, with $S = A = 0$ and $I = 1$:

$$Q = 500 - 700P \tag{91}$$

$$e_p = \left(\frac{P}{Q}\right)\left(\frac{\partial Q}{\partial P}\right) = \left(\frac{P}{500 - 700P}\right)(-700) = \frac{-700P}{500 - 700P} \tag{92}$$

In general, the price elasticity varies with P: if $P = 0$ then $e_p = 0$. If $P = \frac{1}{2}$ then $e_p = \frac{-350}{150} = -2.33$.

Suppose instead the company raises the price from \$2 to \$3 and the quantity sold falls from 4 units to 2 units. Then using the alternative formula:

$$e_p = \frac{\frac{2-4}{4}}{\frac{3-2}{2}} = \frac{-\frac{1}{2}}{\frac{1}{2}} = -1 \tag{93}$$

C Examples and Determinants of Elasticity

Determinants of elasticity:

1. Level of competition (decreases elasticity).

2. Degree of product differentiation (increases elasticity).

3. Level of income (decreases elasticity).

4. Length of time (decreases elasticity).

Industry	Price Elasticity
Beer	-2.83
Wine	-1.12
music CDs	-6.3
Domestic Cars	-0.78
Foreign Cars	-1.09
Cigarettes	-0.42 (everyone) -0.8 (young adults)

Elasticities of products by an individual firm are generally lower (less pricing power). For example, the book quotes Phillip-Morris price elasticity for cigarettes at -0.69. Cigarettes are addictive. One might think you can raise the price indefinitely and addicts will continue to buy the product. But it is not so: makers of "discount" cigarettes will take your business. In addition, teenage consumers have little income and therefore cannot afford large price increases. Remember, the own price elasticity is affected largely by the availability of close substitutes, which is in turn determined by the number of competitors and how different their products are (product differentiation). The table indicates demand for Beer to be elastic: Products are differentiated (helped by prodigious amounts of advertising), but many competitors exist as well. Wine sales are more inelastic, perhaps wine drinkers have more income. Entertainment (music CDs) tend to be very elastic. A host of substitutes and competitors, including down-loaded music and movies exist.

D Example: Set the price to maximize profits

Suppose the firm is interested in maximizing profits, but now we allow the firm to change the price. For each price the firm may choose, there is a corresponding quantity that consumers

will demand. Conversely, for each level of quantity demanded, there is a corresponding price. For example if:

$$Q = 5 - 2P \tag{94}$$

Then:

$$P(Q) = \frac{Q-5}{-2} \tag{95}$$

In other words if we wish to sell 4 units, then we need to charge $\frac{-1}{-2} = \$0.50$.

Suppose total costs are $TC = 10 - \frac{1}{2}Q + Q^2$. We are maximizing profits:

$$\max \pi = TR - TC \tag{96}$$

Notice now total revenues are more complicated, since the price we can charge changes with the quantity produced:

$$\max \frac{Q-5}{-2}Q - \left(10 - \tfrac{1}{2}Q + Q^2\right) \tag{97}$$

$$\max -\tfrac{1}{2}Q^2 + 2.5Q - 10 + \tfrac{1}{2}Q - Q^2 = -1.5Q^2 + 3Q - 10 \tag{98}$$

$$-1.5 \cdot 2Q + 3 = 0 \quad \rightarrow \; Q = 1 \tag{99}$$

The optimal price to charge is then:

$$P(1) = \frac{1-5}{-2} = 2 \tag{100}$$

What is the elasticity?

$$e_p = \frac{\partial Q}{\partial P}\frac{P}{Q} = -2 \cdot \frac{2}{1} = -4 \tag{101}$$

Notice that the optimal pricing policy is one in which demand is elastic, where the firm has

little pricing power. If the firm had pricing power ($e_p > -1$) then the firm could raise prices with a relatively small decrease in sales. Thus it makes sense to raise prices when $e_p > -1$, so the optimal price has $e_p \leq -1$.

E Optimal pricing policy

I will now derive a formula that determines the optimal price and quantity produced.

$$\max \pi = TR - TC \tag{102}$$

Substitute in for Q:

$$\max \pi = P(Q) Q - TC \tag{103}$$

Take the derivative with respect to Q (here I am using an additional rule of calculus) and set equal to zero:

$$\frac{\partial P}{\partial Q} Q + P(Q) - MC = 0 \tag{104}$$

Notice that the derivative is part of the formula for elasticity:

$$\frac{1}{e_p} \frac{P(Q)}{Q} Q + P(Q) - MC = 0 \tag{105}$$

$$MR = P\left(\frac{1}{e_p} + 1\right) = MC \tag{106}$$

$$P = \frac{1}{\frac{1}{e_p} + 1} MC \tag{107}$$

Notice that the firm never chooses a price which results in an inelastic price elasticity. If $e_p > -1$ then marginal revenue is negative and so $MR < MC$. If the firm increases prices, then revenues rise because prices increase but the quantity sold falls only a little. Further

costs fall since we are producing less. The price is a constant mark up over marginal costs.

$$\text{Mark up } = \frac{P - \text{cost}}{\text{cost}} \tag{108}$$

$$\text{Mark up } = \frac{\frac{1}{\frac{1}{e_p}+1}MC - MC}{MC} \tag{109}$$

$$\text{Mark up } = \frac{1}{\frac{1}{e_p}+1} - 1 = \frac{-1}{e_p + 1} \tag{110}$$

Examples. If the price elasticity is -2, then $P = \frac{1}{-\frac{1}{2}+1}MC$, or $P = 2MC$, so we charge a mark up of $\frac{-1}{-2+1} = 1 = 100\%$ over marginal costs. As $e_p \to -\infty$, the firm has no pricing power and we must charge the minimum price possible, $P = MC$ (no mark up). Consider a swimming pool company who charges a 100% mark up over the *wholesale price* (for example, if the manufacturer charges \$10 for chlorine, then charge \$20). This is a mistake. Our mark up should be over marginal costs, which include things like labor. Further, the firm is not taking into account the elasticity (the pool store down the street sold the same stuff, so price elasticity was low).

III Other Elasticities

Definition 24 *The* **Income Elasticity of Demand** *is the percentage change in quantity demanded from a 1% change in consumers' income.*

Formula:

$$e_I = \frac{\partial Q}{\partial I}\frac{I}{Q} \tag{111}$$

We can think of income as the income of the consumer's who buy the product. But we can also think of income as the state of the economy as a whole. If the income elasticity is positive, a high income elasticity corresponds to quantity demanded being very sensitive to income. Consider two examples, Milk ($e_I = 0.05$) and European cars ($e_I = 1.93$). The economy (income) grew by 4% last quarter. We can expect demand for milk to rise by

$4 \cdot 0.05 = 0.2\%$, while demand for European cars should rise by $4 \cdot 1.93 = 7.72\%$. European cars are sensitive to income because they are not necessities. In good times, when income is rising, products with a high income elasticity do better (luxuries), however, products with a low income elasticity do better in bad times (necessities). A primary use of the income elasticity is thus in forecasting demand.

Here is the economic jargon for income elastiticty:

income elasticity	economics term
$e_I > 1$	Luxury Good, Normal Good
$0 < e_I < 1$	Necessity, Normal Good
$e_I < 0$	Inferior Good

Other elasticities can also be computed, for example the advertising elasticity.

IV Estimating Demand

To find the market demand function, we use the same technique as when we find the cost and production functions. We need to assemble data on quantity demanded and the various factors that affect quantity demanded, such as price and income. The data sources are similar:

1. Time Series Data. Get historical data on demand and price, income, etc.

2. Cross Section Data. Get data from various geographic locations.

3. Conduct a randomized study. Select a random set of consumers and change the price.

Note that the randomized study is easier here than in the case of estimating the production function. A famous example is Amazon.com, which recently randomized prices offered to consumers who went to their website (although there was a lot of uproar). Market demand functions need to be constantly re-estimated. Consumers sometimes buy without shopping around, based on, say a reputation for low prices. This can make demand look inelastic. But after a price change, consumers slowly learn the firm does not have the lowest price and switch, making demand elastic.

V Evaluating Pricing Strategies: Cost plus pricing

Now we will look at various pricing strategies and what economists think about them. Cost-plus pricing (similar to that used in the pool store example, above) is setting the price equal to a constant mark up over *average costs*. Examples: Onsale.com, sells at the "wholesale price plus a fixed transaction fee." Auto dealers sell at "dealer cost."

Of course, we want to set a constant mark up over *marginal costs*, not *average costs*. Further, "wholesale" costs ignore costs like labor. But on occasion, wholesale costs and marginal costs can be close. For example the auto dealer. The cost of rent, etc. are sunk costs. Even part of the inventory cost is sunk. The salesperson is paid with commission. Thus for retail cars the marginal cost is close to the wholesale price.

VI Evaluating Pricing Strategies: Price Discrimination

Definition 25 Price Discrimination *is selling a product at more than one price.*

Examples of price discrimination: coupons, rebates, college discounts, senior citizen discounts, and even selling products (with the same cost) at different prices in wealthy and poor neighborhoods.

Consider the market demand function $Q = 50 - 2P$. At $P = 5$, 40 units are demanded. At $P = 10$, 30 units are demanded. We lose 10 customers (assume each customer buys 1 unit) when we raise the price from 5 to 10. Who are the 10 price sensitive customers? Quite possibly these customers might be college students, seniors, or the poor. If we instead charge \$10 but with a senior citizen discount of \$5, then we can still sell to 40 customers, but raise the price for 30 of them.

A Example: Airline

Suppose demand for business travel (b) consumer travel (c) are:

$$P_c = 10 - Q_c \tag{112}$$

$$P_b = 20 - 1.5Q_b \tag{113}$$

Total costs are:

$$TC = 4 + 2\left(Q_c + Q_b\right) \tag{114}$$

We choose a price in each location to maximize profits:

$$\max \pi = TR - TC \tag{115}$$

$$\max P_c Q_c + P_b Q_b - \left(4 + 2\left(Q_c + Q_b\right)\right) \tag{116}$$

$$\max 10Q_c - Q_c^2 + 20Q_b - 1.5Q_b^2 - 4 - 2Q_c - 2Q_b \tag{117}$$

$$\max 8Q_c - Q_c^2 + 18Q_b - 1.5Q_b^2 - 4 \tag{118}$$

$$8 - 2Q_c = 0 \quad \rightarrow \quad Q_c = 4 \tag{119}$$

$$18 - 3Q_b = 0 \quad \rightarrow \quad Q_b = 6 \tag{120}$$

The prices are:

$$P_c = 10 - 4 = 6 \tag{121}$$

$$P_b = 20 - 1.5 \cdot 6 = 11 \tag{122}$$

We discriminate against the business traveler, by say, charging \$6 dollars for a flight that stays over on a Saturday, and \$11 for a flight that does not. Profits are:

$$\pi = 11 \cdot 6 + 6 \cdot 4 - 4 - 2\left(4 + 6\right) = 66 \tag{123}$$

With no price discrimination, total costs are:

$$TC = 4 + 2Q \tag{124}$$

Demand with a single price is:

$$P = 10 - Q_c \tag{125}$$

$$P = 20 - 1.5Q_b \tag{126}$$

Thus:

$$Q_c = 10 - P \tag{127}$$

$$Q_b = \frac{40}{3} - \frac{2}{3}P \tag{128}$$

$$Q == Q_c + Q_b = \frac{70}{3} - \frac{5}{3}P \tag{129}$$

$$P = 14 - \frac{3}{5}Q \tag{130}$$

Now doing the problem without price discrimination, we charge $P = 8$, sell $Q = 10$ units, and make profits of $8 \cdot 10 - 4 - 2 \cdot 10 = \$56$, less than in the case where we can discriminate.

B Degrees of discrimination

1. First degree: discriminate against every customer. Example: negotiated prices such as cars, Priceline.com.

2. Second degree: discriminate based on quantity purchased. Example: buy one, get second one at half price.

3. Third degree: discriminate against a group. Example: senior discounts.

First degree discrimination has the highest revenues. However, you have to pay your sales force more when they negotiate. More information about the customers are required.

C Pitfalls of discrimination

So discrimination raises profits if you can do it. Discrimination does not always work though:

1. Discrimination requires a lack of competition. If two auto dealers exist on the same block, the customer can negotiate the price down to marginal cost.

2. There are information costs. For example, the need to hire commission based sales people.

3. A target group is not always easy to identify. Some seniors and college students are wealthy, for example.

4. Arbitrage can sometimes result. Those with discounts can buy and resell to those who do not.

5. Legal restrictions. Price discrimination can be illegal. Example: minority scholarships.

VII Evaluating Pricing Strategies: 99 cent pricing

A common pricing strategy is "99 cent pricing" or charging \$1.99 instead of \$2. The first thing to remember is that this strategy entails certain time costs. Lines (say at the cash register) build up when the sale amount is not a round number. If the purchase is time sensitive, say lunches or snacks at an arena, then the manager must either hire additional clerks or lose sales. What are the benefits? One advantage is theft prevention. A clerk must make change and therefore open the cash register, creating a paper trail (99 cent pricing originated at the same time as the cash register). No evidence exists that consumers believe \$1.99 is really \$1.

VIII Evaluating Pricing Strategies: Flat rate pricing and price confusion

The pricing system above equates supply and demand. However, the price system at, say, an airline can get extremely complicated. Each flight has a different demand curve, and price discrimination increases the number of prices for each flight. In some cases, firms will use flat rate prices (one price for many similar goods) to attract customers.

Flat rate pricing cannot equate supply and demand for all goods. Therefore, shortages and surpluses often result. When the firm has a shortage or surplus of goods, profits fall, offsetting the gains made by attracting customers. In general, consumer's "pay" by having to buy earlier than desired, or face the possibility of a shortage.

For example, AOL charges a flat rate, rather than increase the price of the Internet during high-traffic business hours and reducing the rate at night (like cell phones do). Consumers still "pay" by dealing with a slow Internet during the daytime. AOL hopes that the flat rate price attracts more customers than are lost due to slow traffic.

Other industries, like cell phones, introduce a complicated pricing scheme on purpose to confuse customers. This is price discrimination. Like a coupon, only the most price sensitive customers will search for the lowest rate. However, a simple rebate system would likely create the same effect and not annoy the customers as much.

IX Evaluating Pricing Strategies: The popcorn problem

Sometimes the pricing of certain related products is very different. Consider popcorn at the Movies. Movie tickets are sold at a relatively small markup over marginal costs, but popcorn, which costs next to nothing to produce is sold for very high prices. Similarly for a hamburger and a coke.

Let us examine the possibile explanations. First let us dispense with the obvious answer. Unlike airports, which have a monopoly on air travel, one has a choice for resturants and movie theaters. Movie theaters cannot charge more for popcorn because consumers are trapped at the movie theater. Competition (usually fierce) exists since most customers can go to the theater with the lowest combined price of popcorn and tickets. A theater which lowered the price of popcorn could presumably increase sales dramatically.

One possible explanation is price discrimination against popcorn lovers. Are popcorn lovers less price sensitive? Perhaps, but again high competition tends to reduce price discrimination.

In the end, no fully satisfactory explanation has been put forward. This pricing strategy remains a mystery to economists.

X Evaluating Pricing Strategies: Other

We will look at "price wars" and "discount" pricing in the next section.