UC Berkeley
Haas School of Business
Economic Analysis for Business Decisions
(EWMBA 201A)
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Block II
Production and the costs production
Competitive markets and monopolistic markets

- The producers (not the film directed by Mel Brooks...)

$\Longrightarrow$ Production (PR 6.1-6.4) and the costs production (PR 7.1-7.2)

- Competitive markets

$\Longrightarrow$ Profit maximization (PR 8.1-8.6) and competitive markets (PR 9.1-9.6)

- Monopolistic markets

$\Longrightarrow$ Market power (PR 10.1-10.4)

Production (PR 6.1)

- In the production process, firms turn inputs (labor, capital, materials) into output.

- The theory of the firm explains how a firm makes (optimal) production decisions and how its costs vary with its output.

- Like the theory of the consumer, the theory of the firm can be used to predict, postdict (explain), and prescribe.

The production function

The production function indicates the (highest) output q that the firm can produce for a given combination of inputs.

For our purposes it is convenient to consider only the case of two inputs – capital K and labor L.

We can the write the production function as

$$q = F(K, L).$$

The Cobb-Douglas production function is widely used to represent the technology of production

$$q = K^{\alpha} \cdot L^{\beta}$$

where $\alpha, \beta > 0$.

The parameters of the Cobb-Douglas function, α and β, determine the marginal product of capital and labor.

The law of diminishing marginal returns (PR 6.4)

The law of diminishing marginal returns $\alpha, \beta < 1$ holds for most production processes:

$$\begin{aligned} F'_K &= \alpha K^{\alpha-1} L^{\beta} > 0 \\ F''_K &= (\alpha - 1)\alpha K^{\alpha-2} L^{\beta} < 0 \end{aligned}$$

and

$$\begin{aligned} F'_L &= \beta L^{\beta-1} K^{\alpha} > 0 \\ F''_L &= (\beta - 1)\beta L^{\beta-2} K^{\alpha} < 0. \end{aligned}$$

In competitive markets F'_K is the price of capital and F'_L is the market wage (more in two weeks).

Returns to scale

Returns to scale is the rate at which output q increases as inputs, K and L, are increased:

constant – output doubles when inputs are doubled

increasing / decreasing – output *more* / *less* than doubles when inputs are doubled.

Returns to scale vary considerably across and within industries. Other things being equal, the greater the return to scale in an industry, the larger the firms are likely to be (a natural monopoly).

The Cobb-Douglas production function exhibits increasing, constant, or decreasing returns to scale if

$$\begin{aligned} \alpha + \beta &> 1 \\ \alpha + \beta &= 1 \\ \alpha + \beta &< 1 \end{aligned}$$

respectively.

– PR Figures 6.6-6.10 and 7.3-7.8 here –

The short run vs. the long run (PR 6.1)

John Keynes: "The long run is a misleading guide to current affairs. In the long run we are all dead..."

- The "short" run is the period of time in which the quantities of one or more inputs cannot be changed.

- The "long" run is the period of time in which the quantities of *all* inputs can be changed.

- Typically, we assume that in the sort run labor is variable and capital is fixed (more later!)

Costs (PR 7.1)

Question: What is the cost of an activity (producing a good or service)?

- The obvious answer might seem "the money spent on that activity."

Like so many "obvious" answers, this is not (necessarily) the correct answer.

- The correct way to consider the cost to be the value of the most highly valued forgone activity the value of the best alternative decision).

$\Rightarrow$ Note: Economists describe this way of viewing cost as considering the *opportunity cost* of an activity or decision.

Accounting cost

- Actual expenses *plus* depreciation charges to capital (this naive view, focusing on expenditures can lead one to make bad decisions).

Economic cost

- Cost of utilizing inputs in production, including opportunity cost (for example, the imputed value of the forgone rent on owned office space).

$\Rightarrow$ Note: A sunk expenditure (cannot be recovered or avoided over the relevant decision-making horizon) is not an economic cost.

Competitive markets

Perfectly competitive markets

The *theoretical ideal* of perfect competition rest on three important assumptions:

[1] Price taking

Each individual firm (resp. consumer) sells (resp. buys) a sufficiently small proportion of total market output so its decisions have no impact on market price.

[2] Product homogeneity

The products of all the firms in the market are perfectly substitutable with one another so no firm can raise the price of its product above the price of the other firm without loosing all its business.

$\Rightarrow$ Oil, iron, lumber, cotton and other raw materials and so-called commodities are fairly homogeneous.

[3] Free entry and exit

Firms can easily enter or exit (if cannot make a profit) the market and consumers can easily switch from one firm to another.

$\Rightarrow$ There is fierce competition in the pharmaceutical industry but it cannot be perfectly competitive because firms hold patents that give them unique rights to produce drugs.

Q When a market is competitive?

A Most real-world markets are not perfectly competitive in the sense that each firm faces a horizontal demand curve (more below).

There is no simple rule of thumb to measure the *extent* to which a market is competitive. It is necessary to analyze the strategic interaction among market participants (game theory).

Simple pricing

In the model of perfect competition, each firm must charge the same price per unit to all of its consumers (no matter who the buyer is or how many units the buyer purchases). Simple pricing applies when

- the identity of the buyer cannot be observed or inferred at reasonable cost.

- the firm cannot prevent *arbitrage* among buyers when buyers can purchase multiple units.

Profit maximization by a competitive firm

A firm's profit is the revenue it takes in minus its cost. If we let $R(q)$ the revenue from selling q units, then its profit from selling q units is

$$\pi(q) = R(q) - C(q)$$

where $C(q)$ is the total cost of q units, and if the firm sets a price of p per unit – engages in simple pricing – then $R(q) = pq$.

In choosing the amount to produce and sell, the firm seeks to find the quantity q that maximizes profit $\pi(q)$. We use an asterisk to denote the profit maximizing quantity q^*.

The continuous case

Profit $\pi(q)$ is maximized at a point at which an additional (small) increment to output leave profit unchanged, that is

$$\frac{\Delta\pi}{\Delta q} = \frac{\Delta R}{\Delta q} - \frac{\Delta C}{\Delta q} = 0.$$

Thus, in the continuous case, a *necessary* condition for q^* to be the profit-maximizing output is that

$$\frac{\Delta R}{\Delta q} = \frac{\Delta C}{\Delta q}$$

(the $MR(q) = MC(q)$ rule).

The discrete case

Saying that q^* is the profit-maximizing quantity is the same as saying that

$$\pi(q^*) \geq \pi(q) \text{ for any } q \neq q^*.$$

In particular, consider the quantities $q^* - 1$ and $q^* + 1$. We know that

$$\pi(q^*) \geq \pi(q^* - 1) \text{ and } \pi(q^*) \geq \pi(q^* + 1),$$

and substituting $R(q) - C(q)$ for $\pi(q)$ yields

$$R(q^*) - C(q^*) \geq R(q^* - 1) - C(q^* - 1) \text{ and}$$
$$R(q^*) - C(q^*) \geq R(q^* + 1) - C(q^* + 1).$$

Rearranging,

$$R(q^*) - R(q^* - 1) \geq C(q^*) - C(q^* - 1) \text{ and}$$
$$C(q^* + 1) - C(q^*) \geq R(q^* + 1) - R(q^*).$$

Let $MR(q) = R(q) - R(q-1)$ and $MC(q) = C(q) - C(q-1)$ and rewrite this last pair of inequalities as

$$(i)\ MR(q^*) \geq MC(q^*) \text{ and } (ii)\ MR(q^* + 1) \leq MC(q^* + 1).$$

A *necessary* condition for q^* to be the profit-maximizing output is that expressions (i) and (ii) both hold true.

Sufficiency and the shutdown rule

The above results are only necessary conditions; that is, they only identify possible candidates for being the profit-maximizing quantity.

There is a condition, however, that insures that, if the firm should be in business at all, the conditions stated above are also sufficient.

We will establish the sufficiency condition for the continuous case (a similar argument applies to the discrete case).

If the following conditions hold

$$\begin{array}{ll} (i) & MR(q^*) = MC(q^*) \\ (ii) & MR(q) > MC(q) \text{ for all } q < q^* \\ (iii) & MR(q) < MC(q) \text{ for all } q > q^* \end{array}$$

then q^* is the profit-maximizing quantity for the firm to produce (if it should be in business at all).

Another way to view this result is that q^* is the profit-maximizing quantity (if it should be in business at all) if marginal revenue crosses marginal cost once at q^* and does so from above.

The marginal revenue of a competitive firm

In a competitive market, how much output the firm decides to produce and sell have no effect on the market price of the product (price taking). Therefore,

$$R(q) = pq \text{ for all } q.$$

and as a result the marginal revenue, average revenue and price are all equal. As a result, the profit maximizing quantity q^* of a perfectly combative firm satisfies

$$MC(q^*) = p$$

(if it should be in business at all).

– PR Figures 8.3 and 8.4 here –

The firm and market (short-run) supply curves

- The firm's supply curve of the firm specifies how much output the firm will produce at every possible price.

- The firm will produce at a point at which price is equal to marginal cost, but will shut down if price is below average variable cost.

- Therefore, the firm's supply curve is the portion of the marginal cost curve for which marginal cost is greater than average variable cost.

- The industry supply curve is the summation of the supply curves of the individual firms in the market.

– PR Figures 8.6 and 8.9 here –

The important takeaways are

- Marginal revenue equals marginal cost at the optimal quantity produced (this equality may be approximate in the discrete case).
- Marginal revenue comes from an underlying demand curve. Demand curves themselves come from consumer preferences (see below).

The individual and market demand curves

- Consumers tend to buy more of the good that has become cheaper and less of those that become *relatively* more expensive.

- The market demand relate the quantity of a good that all consumers in a market will buy to its price.

- Only factors that influence the demands of many consumers will also effect market demand.

The analysis of competitive markets

- The equilibrium price and quantity in a competitive market maximizes the economic welfare of producers and consumers.

- The model of competitive markets can be used to study the welfare effects of different government polices.

- Next we will evaluate the "gains" and "losses" to consumers and producers from different government polices.

– PR Figures 9.1, 9.2 and 9.5 here –

Monopolistic markets

Monopoly

- In contrast to perfect competition, a **monopoly** is a market that has only one seller but many buyers.

- A **monopsony** is exactly the opposite – is a market that has many sellers but only one buyer.

- Monopoly and monopsony are forms of **market power** – an ability to effect the market price.

- Our goal is to understand how market power works and how it effects producers and consumers.

The theory of monopoly is, on the face of it, simple and straightforward, but behind it lie some deep and interesting questions.

[1] How the monopoly came to be a monopoly, and why it stays that way?

[2] If the monopoly makes profit, why does not the industry attract entrants?

Standard stories, if given at all, get very fuzzy at this point. Hands start to wave, hems give away to haws, and on to the next subject...

Perhaps most importantly, the monopolist is the market so it completely controls the amount of output offered for sale (or the price per unit).

- When the monopolist decides how much to produce, the price per unit that it receives follows directly from the market demand.

- When the monopolist determines a price, the quantity it will sell at that price follows from the market demand.

The standard theory is that the monopoly set a quantity of output $Q \geq 0$ to maximize its profits (but we can also think of the monopoly choosing a price p).

Average revenue and marginal revenue

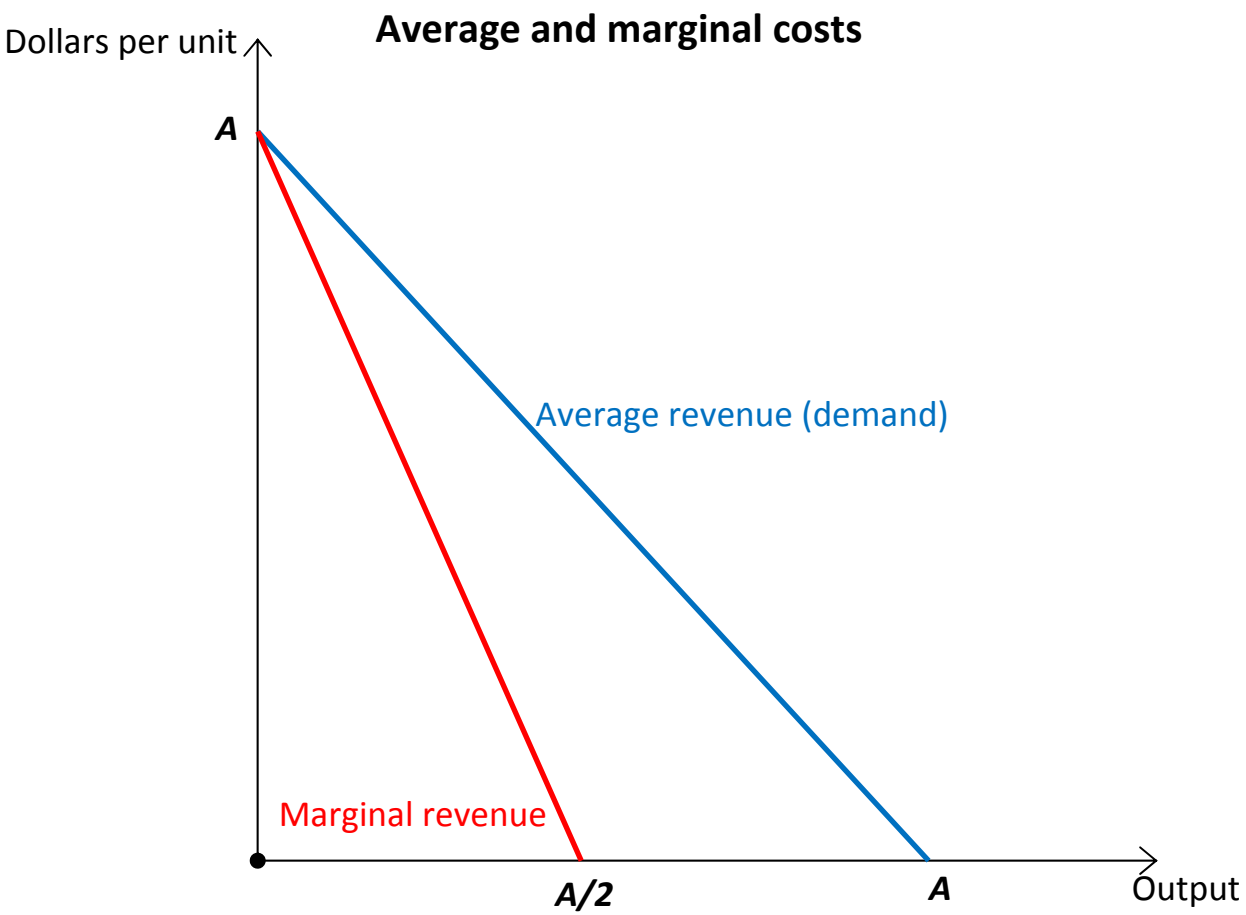
The monopolist's *average revenue* – the price it receives per unit sold – is the market demand curve.

To see the relationship among total, average, and marginal revenue, consider a monopolist facing a linear demand curve

$$P(Q) = A - Q \text{ where } A > 0.$$

Then,

$$R(Q) = P(Q)Q = AQ - Q^2 \qquad MR = \Delta R/\Delta Q = A - 2Q.$$


Average and marginal costs
Dollars per unit
A
Average revenue (demand)
Marginal revenue
A/2
A
Output

The monopolist's output decision problem

The monopolist's profit $\pi(Q)$ is the difference between revenue and cost

$$\pi(Q) = R(Q) - C(Q),$$

both of which depend on Q.

As Q increases, π will increase until it reaches a maximum and then start to decrease.

Hence, the profit-maximizing quantity of output Q^* is such that the marginal (incremental) profit resulting from a small increase in Q equals zero.

Algebraically,

$$\Delta\pi/\Delta Q = \Delta R/\Delta Q - \Delta C/\Delta Q = 0,$$

or equivalently,

$$\Delta R/\Delta Q = \Delta C/\Delta Q.$$

That is, we have the slogan that *marginal revenues* MR *equals marginal costs* MC.

An example

Suppose the cost of production is given by

$$C(Q) = 50 + Q^2$$

(a fixed costs of \$50 and a variable costs of and variable costs of Q^2) the demand is given by

$$P(Q) = 40 - Q.$$

Note well that

$$AC = C(Q)/Q = 50/Q + Q \qquad MC = \Delta C/\Delta Q = 2Q$$

$$R(Q) = P(Q)Q = 40Q - Q^2 \qquad MR = 40 - 2Q$$

Setting marginal revenue equal to marginal cost $MR = MC$ gives

$$40 - 2Q = 2Q,$$

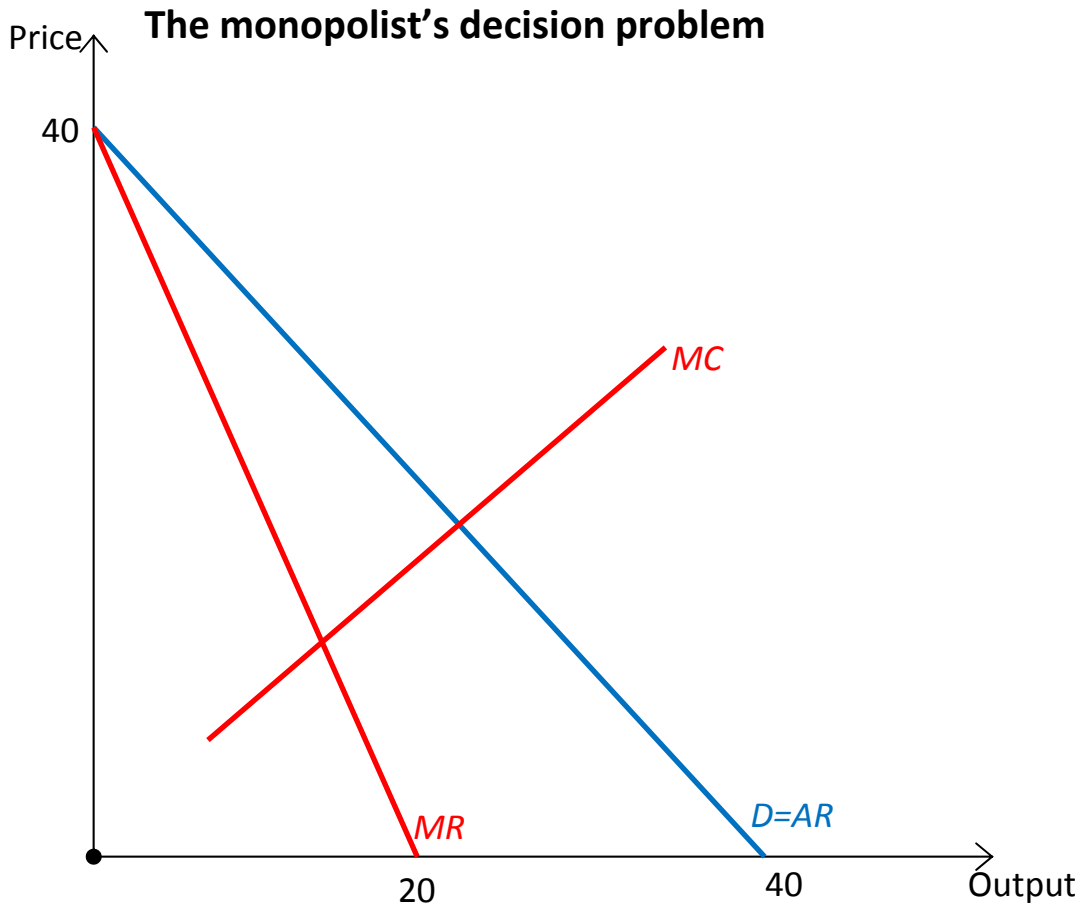
or $Q^* = 10$ (reaching the maximum profit of \$150).

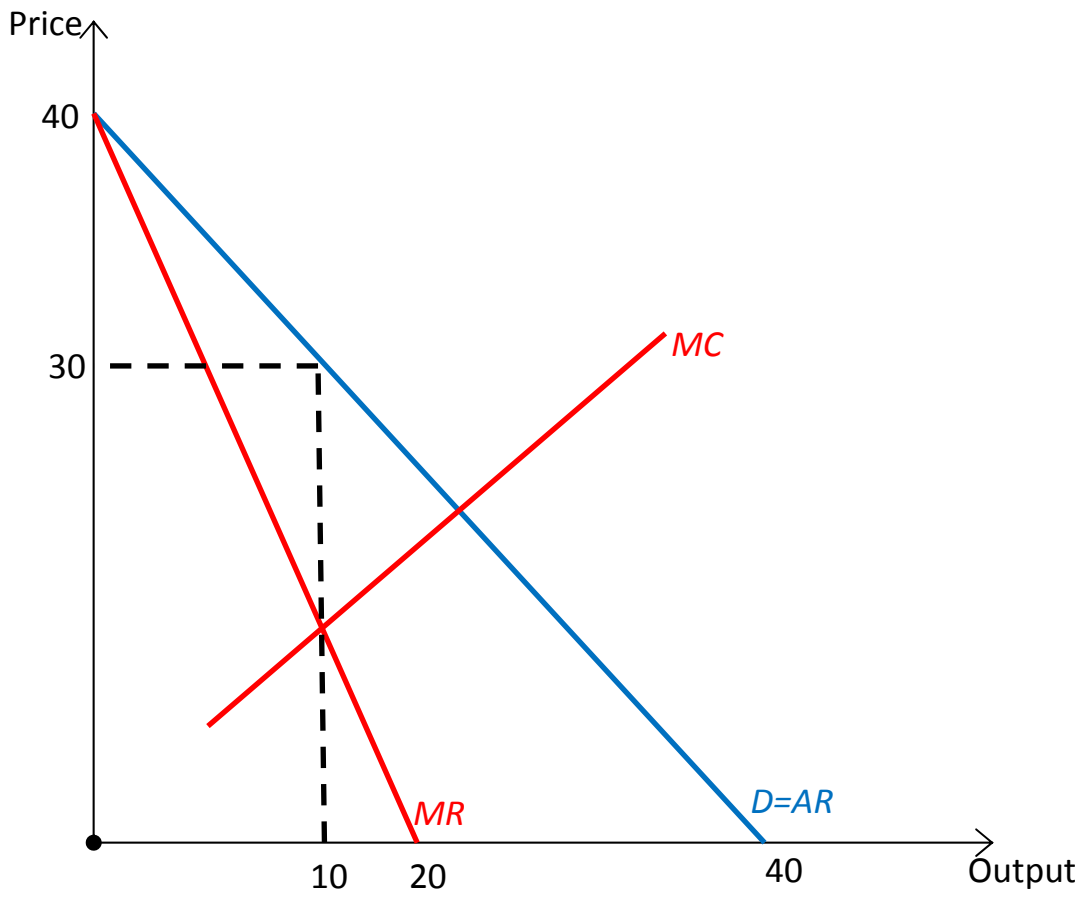
Alternatively,

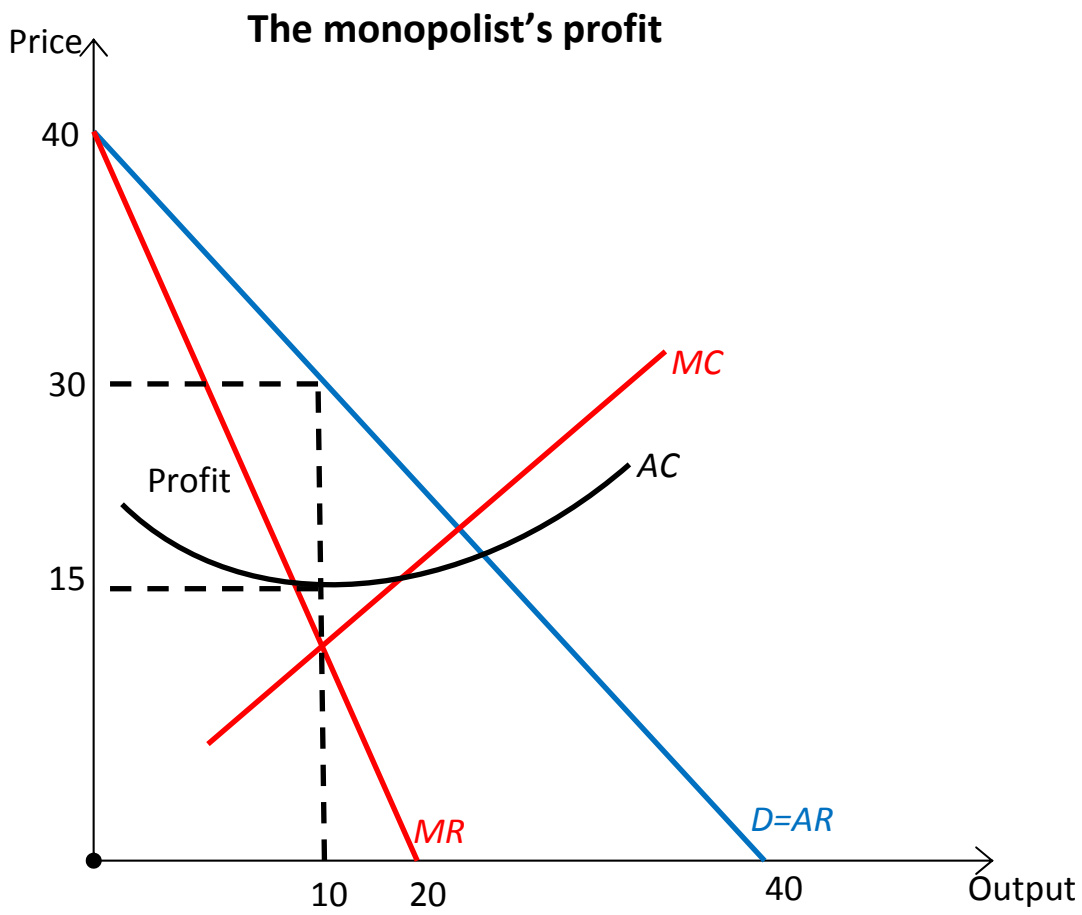
$$\begin{aligned} \pi(Q) &= R(Q) - C(Q) = P(Q)Q - C(Q) \\ &= (40 - Q)Q - 50 - Q^2 = 40Q - Q^2 - 50 - Q^2 \\ &= 40Q - 50 - 2Q^2. \end{aligned}$$

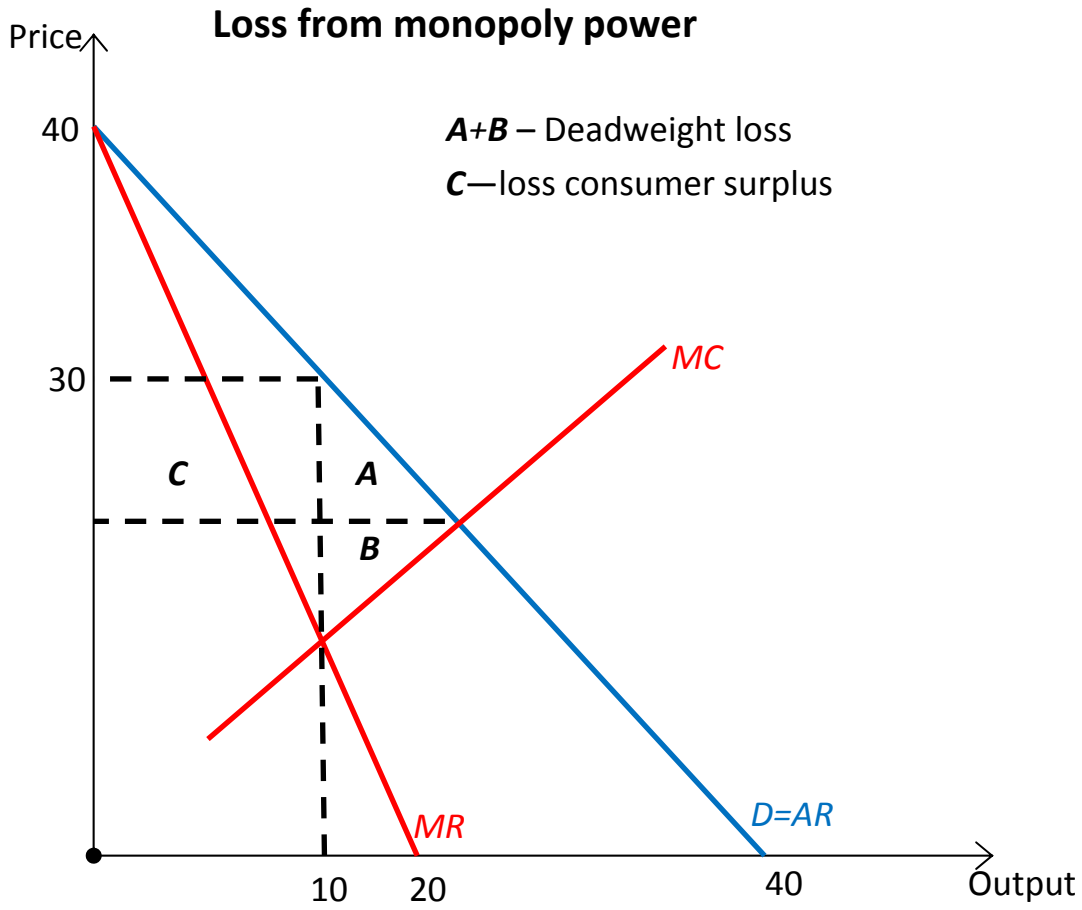
and setting $\Delta\pi/\Delta Q$ equal zero gives $40 - 4Q = 0$, or $Q^* = 10$.

Next we will give a geometrical procedure for doing this.


The monopolist's decision problem
Price
40
MC
MR
D=AR
20
40
Output


Price
40
30
MC
MR
D=AR
10
20
40
Output


The monopolist's profit
Price
40
30
15
Profit
MC
AC
MR
D=AR
10
20
40
Output


Loss from monopoly power
Price
40
30
A+B – Deadweight loss
C—loss consumer surplus
MC
C
A
B
MR
D=AR
10
20
40
Output

The "rule of thumb" for pricing

But a lot is wrong with the story just told – managers have only limited information of the average and marginal revenue curves facing their firms. To this end, so we need a rule of thumb that can be applied in the real-world.

Note that selling an extra unit *must* result in a small drop in price $\Delta P/\Delta Q$ which reduces the revenue from *all* units sold! We therefore rewrite the marginal revenue as follows

$$\begin{aligned} MR &= P + Q\frac{\Delta P}{\Delta Q} = P + P\left(\frac{Q}{p}\right)\left(\frac{\Delta P}{\Delta Q}\right) \\ &= P + P\frac{1}{E_d}. \end{aligned}$$

Recall that the price elasticity of demand – the percentage change (decrease) in quantity demanded of a good resulting from a 1-percent increase in its price – is given by

$$E_d = \frac{\Delta Q/Q}{\Delta P/P} = \frac{P}{Q}\frac{\Delta Q}{\Delta P}.$$

When we set marginal revenues to marginal costs we get

$$MR = P + P\frac{1}{E_d} = MC.$$

Rearranging,

$$P = \frac{MC}{1 + (1/E_d)}.$$

Monopoly power?

For a competitive firm, price equals marginal costs; for a firm with monopoly power, price exceeds marginal costs.

The Lerner Index of Monopoly Power (1934) given mathematically by

$$\begin{aligned} L &= \frac{P - MC}{P} \\ &= -1/E_d \end{aligned}$$

uses the markup ratio of price minus marginal costs to price to measure the monopoly power.

! Firms prices are sometimes below its optimal price so its monopoly power will not be noted by the Lerner Index.

Sources of market power

The more inelastic its demand curve, the more monopoly power the firm has. These factors determine a firm's demand elasticity:

[1] The elasticity of market demand.

[2] The number of firms in the market.

[3] The interaction among firms.

Maintaining monopoly

$\Longrightarrow$ Differentiated / branded goods.

$\Longrightarrow$ Barriers to entry (e.g., patents).

$\Longrightarrow$ Customer lock-in.

$\Longrightarrow$ Predatory pricing.

Summary

- In a competitive market there are many firms selling an identical product.
  - When one of these firms raises its price above the market price it loses all its customers.

- In a monopolized market, there is only one firm selling a given product.
  - When a monopolist raises its price it loses some, but not all, its customers.

! In reality, most industries are somewhere in between these two extremes.

- If a firm has some degree of monopoly power then it has more strategies than a firm in a perfectly competitive market.

- The problem faced by firms with some monopoly power is how to enhance and exploit their market power most effectively.

- Their objective – capturing more consumer surplus and converting it into additional profits for the firm.

- This goal can be can be achieved using *price discrimination*, that is charging different prices for different consumers.