6. Monopoly

I. DEFINITION

Monopoly is a market structure in which there is a single seller, there are no close substitutes for the commodity it produces and there are barriers to entry.

The main causes that lead to monopoly are the following. Firstly, ownership of strategic raw materials, or exclusive knowledge of production techniques. Secondly, patent rights for a product or for a production process. Thirdly, government licensing or the imposition of foreign trade barriers to exclude foreign competitors. Fourthly, the size of the market may be such as not to support more than one plant of optimal size. The technology may be such as to exhibit substantial economies of scale, which require only a single plant, if they are to be fully reaped. For example, in transport, electricity, communications, there are substantial economies which can be realised only at large scales of output. The size of the market may not allow the existence of more than a single large plant. In these conditions it is said that the market creates a 'natural' monopoly, and it is usually the case that the government undertakes the production of the commodity or of the service so as to avoid exploitation of the consumers. This is the case of the public utilities. Fifthly, the existing firm adopts a limit-pricing policy, that is, a pricing policy aiming at the prevention of new entry. Such a pricing policy may be combined with other policies such as heavy advertising or continuous product differentiation, which render entry unattractive. This is the case of monopoly established by creating barriers to new competition.[1]

II. DEMAND AND REVENUE

Since there is a single firm in the industry, the firm's demand curve is the industry-demand curve. This curve is assumed known and has a downward slope (figure 6.1).

We will use a linear demand function for simplicity. We have examined the properties of this form of demand in Chapter 2. They may be summarised as follows:

1. The demand equation, *ceteris paribus*, is

$$X = b_0^* - b_1^* P$$

The clause *ceteris paribus* implies that all the other factors (such as income, tastes, other prices) which affect demand are assumed constant. Changes in these factors will shift the demand curve.

[1] See also Chapter 13.

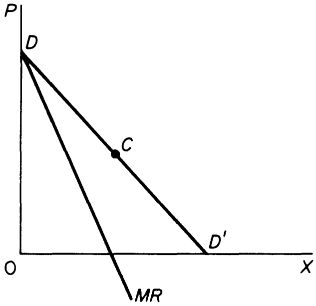

Figure 6.1

2. The slope of the demand curve is

$$\frac{dX}{dP} = -b_1^*$$

3. The price elasticity of demand is

$$e_P = \frac{dX}{dP} \cdot \frac{P}{X} = -b_1^* \cdot \frac{P}{X}$$

That is, elasticity changes at any one point of the demand curve.
(*a*) At point D the elasticity approaches infinity

$$e_P = -b_1^* \cdot \frac{P}{X} \rightarrow \infty$$

(*b*) At point D' the elasticity is zero

$$e_P = -b_1^* \cdot \frac{P}{X} = -b_1^* \cdot \frac{0}{X} = 0$$

(*c*) At the mid point C the price elasticity is unity

$$e_P = -1$$

4. The total revenue of the monopolist is

$$R = P \cdot X$$

Solving the demand equation for P we find

$$P = \frac{b_0^*}{b_1^*} - \frac{1}{b_1^*} X \infty$$

Setting $(b_0^*/b_1^*) = b_0$ and $(1/b_1^*) = b_1$ we may rewrite the price equation as

$$P = b_0 - b_1 X$$

Substituting into the revenue equation we find

$$R = PX = (b_0 - b_1 X)X$$

or

$$R = b_0 X - b_1 X^2$$

5. The average revenue is equal to the price:

$$AR = \frac{R}{X} = \frac{PX}{X} = P = b_0 - b_1X$$

Thus the demand curve is also the AR curve of the monopolist.

6. The marginal revenue is:

$$\frac{dR}{dX} = \frac{d(b_0X - b_1X^2)}{dX} = b_0 - 2b_1X$$

That is, the MR is a straight line with the same intercept as the demand curve, but twice as steep.

The general relation between P and MR is found as follows. Given

$$R = PX$$

$$MR = \frac{dR}{dX} = P\frac{dX}{dX} + X\frac{dP}{dX}$$

or

$$MR = P + X \cdot \frac{dP}{dX}$$

The marginal revenue is at all levels of output smaller than P, given that

$$P = MR - X\frac{dP}{dX}$$

and the term $(X(dP/dX))$ is positive (since the slope of the demand curve $(dP/dX) > 0$). Hence $P > MR$.

Intuitively, since demand is negatively sloping, the firm must lower its price if it is to sell an additional unit. The net change in total revenue, the MR, is the new (lower) price from selling the additional nth unit minus the loss the firm realises from selling all previous units $/n - 1)$ at the lower price:

$$MR_2 = P_2 - (n - 1)(P_1 - P_2)$$

Thus $MR_2 < P_2$, given $(n - 1) > 0$ and $(P_1 - P_2) > 0$

7. The relationship between MR and price elasticity e is

$$MR = P\left(1 - \frac{1}{e}\right)$$

Proof

We established that

$$MR = \frac{dR}{\partial X} = P + X\frac{\partial P}{\partial X}$$

The price elasticity of demand is defined as

$$e_P = -\frac{\partial X}{\partial P} \cdot \frac{P}{X}$$

Inverting this relation we obtain

$$\frac{1}{e} = -\frac{\partial P}{dX} \cdot \frac{X}{P}$$

Solving for dP/dX we find

$$\frac{dP}{dX} = -\frac{1}{e} \cdot \frac{P}{X}$$

Substituting in the expression of the MR we get

$$MR = P + X\left(-\frac{1}{e} \cdot \frac{P}{X}\right)$$

or

$$MR = P\left(1 - \frac{1}{e}\right)$$ Q.E.D.

III. COSTS

In the traditional theory of monopoly the shapes of the cost curves are the same as in the theory of pure competition. The AVC, MC and ATC are U-shaped, while the AFC is a rectangular hyperbola. However, the particular shape of the cost curves does not make any difference to the determination of the equilibrium of the firm, provided that the slope of the MC is greater than the slope of the MR curve (see below).

One point should be stressed here. The MC curve is *not* the supply curve of the monopolist, as is the case in pure competition. In monopoly there is no unique relationship between price and the quantity supplied (see below, p. 177).

IV. EQUILIBRIUM OF THE MONOPOLIST

A. SHORT-RUN EQUILIBRIUM

The monopolist maximises his short-run profits if the following two conditions are fulfilled: Firstly, the MC is equal to the MR. Secondly, the slope of MC is greater than the slope of the MR at the point of intersection.

In figure 6.2 the equilibrium of the monopolist is defined by point ε, at which the MC intersects the MR curve from below. Thus both conditions for equilibrium are fulfilled. Price is P_M and the quantity is X_M. The monopolist realises excess profits equal to the shaded area $AP_M CB$. Note that the price is higher than the MR.

In pure competition the firm is a price-taker, so that its only decision is output determination. The monopolist is faced by two decisions: setting his price and his output. However, given the downward-sloping demand curve, the two decisions are interdependent. The monopolist will either set his price and sell the amount that the market will take at it, or he will produce the output defined by the intersection of MC and MR, which will be sold at the corresponding price, P. The monopolist cannot decide independently both the quantity and the price at which he wants to sell it. The crucial condition for the maximisation of the monopolist's profit is the equality of his MC and the MR, provided that the MC cuts the MR from below.

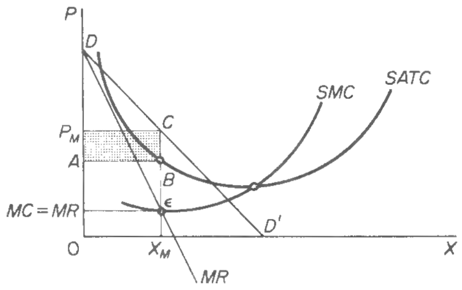

Figure 6.2

Formal derivation of the equilibrium of the monopolist

Given the demand function

$$X = g(P)$$

which may be solved for P

$$P = f_1(X)$$

and given the cost function

$$C = f_2(X)$$

The monopolist aims at the maximisation of his profit

$$\Pi = R - C$$

(*a*) *The first-order condition for maximum profit* Π

$$\frac{\partial \Pi}{\partial X} = 0$$

$$\frac{\partial \Pi}{\partial X} = \frac{\partial R}{\partial X} - \frac{\partial C}{\partial X} = 0$$

or

$$\frac{\partial R}{\partial X} = \frac{\partial C}{\partial X}$$

that is $MR = MC$

(*b*) *The second-order condition for maximum profit*

$$\frac{\partial^2 \Pi}{\partial X^2} < 0$$

$$\frac{\partial^2 \Pi}{\partial X^2} = \frac{\partial^2 R}{\partial X^2} - \frac{\partial^2 C}{\partial X^2} < 0$$

or

$$\frac{\partial^2 R}{\partial X^2} < \frac{\partial^2 C}{\partial X^2}$$

that is

$$\begin{bmatrix}\text{slope}\\ \text{of } MR\end{bmatrix} < \begin{bmatrix}\text{slope}\\ \text{of } MC\end{bmatrix}$$

A numerical example

Given the demand curve of the monopolist

$$X = 50 - 0{\cdot}5P$$

which may be solved for P

$$P = 100 - 2X$$

Given the cost function of the monopolist

$$C = 50 + 40X$$

The goal of the monopolist is to maximise profit

$$\Pi = R - C$$

(i) We first find the MR

$$R = XP = X(100 - 2X)$$

$$R = 100X - 2X^2$$

$$MR = \frac{\partial R}{\partial X} = 100 - 4X$$

(ii) We next find the MC

$$C = 50 + 40X$$

$$MC = \frac{\partial C}{\partial X} = 40$$

(iii) We equate MR and MC

$$MR = MC$$

$$100 - 4X = 40$$

$$X = 15$$

(iv) The monopolist's price is found by substituting $X = 15$ into the demand–price equation

$$P = 100 - 2X = 70$$

(v) The profit is

$$\Pi = R - C = 1050 - 650 = 400$$

This profit is the maximum possible, since the second-order condition is satisfied:
(*a*) from

$$\frac{\partial C}{\partial X} = 40$$

we have

$$\frac{\partial^2 C}{\partial X^2} = 0$$

(b) from

$$\frac{\partial R}{\partial X} = 100 - 4X \qquad \text{we have } \frac{\partial^2 R}{\partial X^2} = -4$$

Clearly $-4 < 0$.

We may now re-examine the statement that there is no unique supply curve for the monopolist derived from his *MC*. Given his *MC*, the same quantity may be offered at different prices depending on the price elasticity of demand. Graphically this is shown in figure 6.3. The quantity X will be sold at price P_1 if demand is D_1, while the same

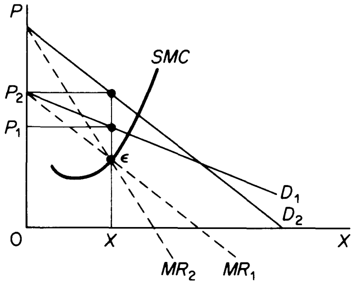

Figure 6.3

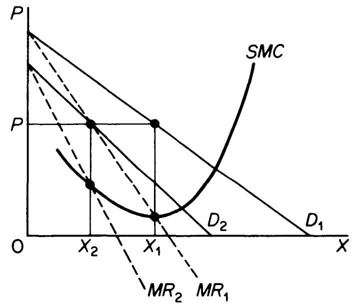

Figure 6.4

quantity X will be sold at price P_2 if demand is D_2. Thus there is no unique relationship between price and quantity. Similarly, given the *MC* of the monopolist, various quantities may be supplied at any one price, depending on the market demand and the corresponding *MR* curve. In figure 6.4 we depict such a situation. The cost conditions are represented by the *MC* curve. Given the costs of the monopolist, he would supply $0X_1$, if the market demand is D_1, while at the same price, *P*, he would supply only $0X_2$ if the market demand is D_2.

B. LONG-RUN EQUILIBRIUM

In the long run the monopolist has the time to expand his plant, or to use his existing plant at any level which will maximise his profit. With entry blocked, however, it is not necessary for the monopolist to reach an optimal scale (that is, to build up his plant until he reaches the minimum point of the *LAC*). Neither is there any guarantee that he will use his existing plant at optimum capacity. What is certain is that the monopolist will not stay in business if he makes losses in the long run. He will most probably continue to earn supernormal profits even in the long run, given that entry is barred. However, the size of his plant and the degree of utilisation of any given plant size depend entirely on the market demand. He may reach the optimal scale (minimum point of *LAC*) or remain at suboptimal scale (falling part of his *LAC*) or surpass the optimal scale (expand beyond the minimum *LAC*) depending on the market conditions. In figure 6.5 we depict

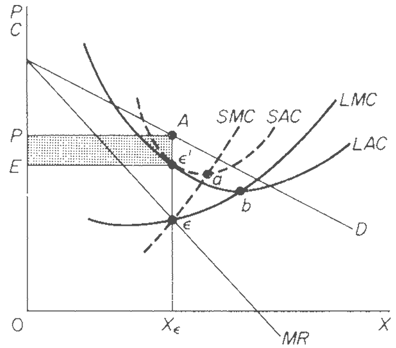

Figure 6.5 Monopolist with suboptimal plant and excess capacity

the case in which the market size does not permit the monopolist to expand to the minimum point of *LAC*. In this case not only is his plant of suboptimal size (in the sense that the full economies of scale are not exhausted) but also the existing plant is underutilised. This is because to the left of the minimum point of the *LAC* the *SRAC* is tangent to the *LAC* at its falling part, and also because the short-run *MC* must be equal to the *LRMC*. This occurs at ε, while the minimum *LAC* is at *b* and the optimal use of the existing plant is at *a*. Since it is utilised at the level ε′, there is excess capacity.

In figure 6.6 we depict the case where the size of the market is so large that the monopolist, in order to maximise his output, must build a plant larger than the optimal and overutilise it. This is because to the right of the minimum point of the *LAC* the *SRAC*

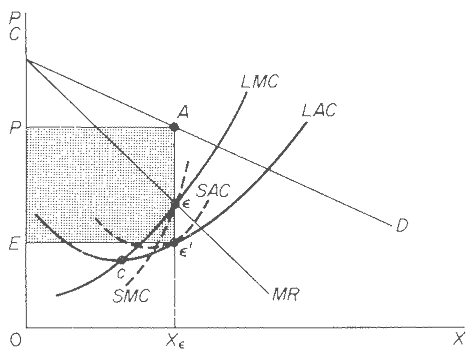

Figure 6.6 Monopolist operating in a large market: his plant is larger than the optimal (*c*) and it is being overutilised (at ε′).

and the *LAC* are tangent at a point of their positive slope, and also because the *SRMC* must be equal to the *LAC*. Thus the plant that maximises the monopolist's profits leads to higher costs for two reasons: firstly because it is larger than the optimal size, and secondly because it is overutilised. This is often the case with public utility companies operating at national level.

Finally in figure 6.7 we show the case in which the market size is just large enough to permit the monopolist to build the optimal plant and use it at full capacity.

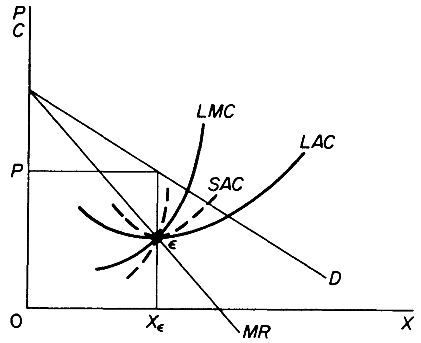

Figure 6.7

It should be clear that which of the above situations will emerge in any particular case depends on the size of the market (given the technology of the monopolist). There is no certainty that in the long run the monopolist will reach the optimal scale, as is the case in a purely competitive market. In monopoly there are no market forces similar to those in pure competition which lead the firms to operate at optimum plant size (and utilise it at its full capacity) in the long run.

V. PREDICTIONS OF THE MONOPOLY MODEL IN DYNAMIC SITUATIONS

In this section we will examine the effects on the monopolist's equilibrium of (*a*) a shift in the market demand, (*b*) a change in costs, (*c*) the imposition of a tax by the government.

A. SHIFT IN THE MARKET DEMAND

We saw in Chapter 5 that an upward shift in the market demand resulted (in the short run) in a new market equilibrium with a higher price and a lower quantity. In a monopoly market this may not be so. An upward shift of the market demand (provided that the new demand does not intersect the initial one) will result in a new market equilibrium in which the quantity produced will be larger, but the price may increase, remain constant or decrease. Let us examine these possibilities.

In the new equilibrium the price may remain constant while the quantity supplied increases. This case is shown in figure 6.8. Assume that the new demand curve is D_2, to the right of D_1. The shift in D will lead to a shift of the *MR* curve (from MR_1 to MR_2). Given the marginal-cost curve of the monopolist, the new equilibrium position is ε' where the price is the same as before, but the quantity produced is larger ($0X_2 < 0X_1$).