

Unit 7. Firm behaviour and market structure: monopoly

Learning objectives:

- to identify and examine the sources of monopoly power;
- to understand the relationship between a monopolist's demand curve and its total and marginal revenue curves;
- to compare a monopolist's price, level of output and profit with those of a firm operating in a perfectly competitive market;
- to learn how and why competitive markets achieve an efficient allocation of resources, whereas monopolists do not; and show the efficiency loss due to monopoly;
- to understand the model of price discrimination as a dimension of monopoly behaviour.

Questions for revision:

- ✓ The relationships among the short-run and long-run costs: total, average and marginal;
- ✓ Total and marginal revenue;
- ✓ Elasticity and producers' total revenue;
- ✓ The profit-maximizing rule;
- ✓ Profit maximization by a competitive firm in the short run and in the long run;
- ✓ Market supply under perfect competition;
- ✓ Equilibrium and efficiency of a competitive market;
- ✓ Dead weight loss;
- ✓ Per-unit tax, competitive equilibrium and efficiency.

7.1. Market structure determinants

Pure monopoly is a market structure with a single producer which supplies the good that has no close substitutes to a great number of consumers who act independently and are not able to influence the level of market price by their individual decisions.

High barrier for entry to the market and for exit from the market are the typical feature of a monopoly. These are the following.

- ✓ Legislative barriers to entry: patents and copyrights; government licenses or franchises;

- ✓ Technological barriers to entry: economies of scale relative to market size; network economies. The minimum efficient scale is the minimum output at which a firm's long-run average cost curve stops declining. The minimum efficient scale as related to the size of the market determines the number of firms that is appropriate for the industry. There is a natural monopoly when the minimum efficient scale is relatively large as compared to size of the market.
- ✓ Strategic barriers to entry: actions of a monopoly (investment, price-setting, exclusive control over important inputs) that prevent entry of potential competitors to the market.

7.2. Profit maximization by a monopoly

Let's consider the first order condition of maximum of profits under monopoly:

$$\begin{aligned} \frac{dPR}{dQ} = MR - MC &= p(Q) \left(1 + \frac{dp(Q)}{dQ} \cdot \frac{Q}{p(Q)} \right) - MC \\ &= p(Q)(1 + E_q^d) - MC = p \left(1 + \frac{1}{\frac{dQ(p)}{dp} \cdot \frac{p}{Q(p)}} \right) - MC \\ &= p \left(1 + \frac{1}{E_p^d} \right) - MC = 0. \end{aligned}$$

Thus according to the first-order condition the profit-maximizing output of a monopoly (Q_m) is found at the intersection of marginal revenue and marginal cost curves (see fig. below):

$$MR = p \left(1 + \frac{1}{E_p^d} \right) = MC.$$

Recollect, for a price-taker $\frac{dp(Q)}{dQ} = 0$, and $MR = p$. A monopolist faces a downward-sloping demand curve, so $MR(Q) \neq p(Q)$. Since $\frac{dp(Q)}{dQ} < 0$, marginal revenue is smaller than the price: $MR(Q) < p(Q)$. A monopolist can sell additional unit of output only by cutting price for all units of the product. $MR > 0$, so $E_p^d < -1$, i.e. monopolist never produces on the inelastic portion of the demand curve.

The second order condition of profit maximization says that the second derivative of profit function at the point where marginal revenue is equal to marginal cost should be negative (or at least zero):

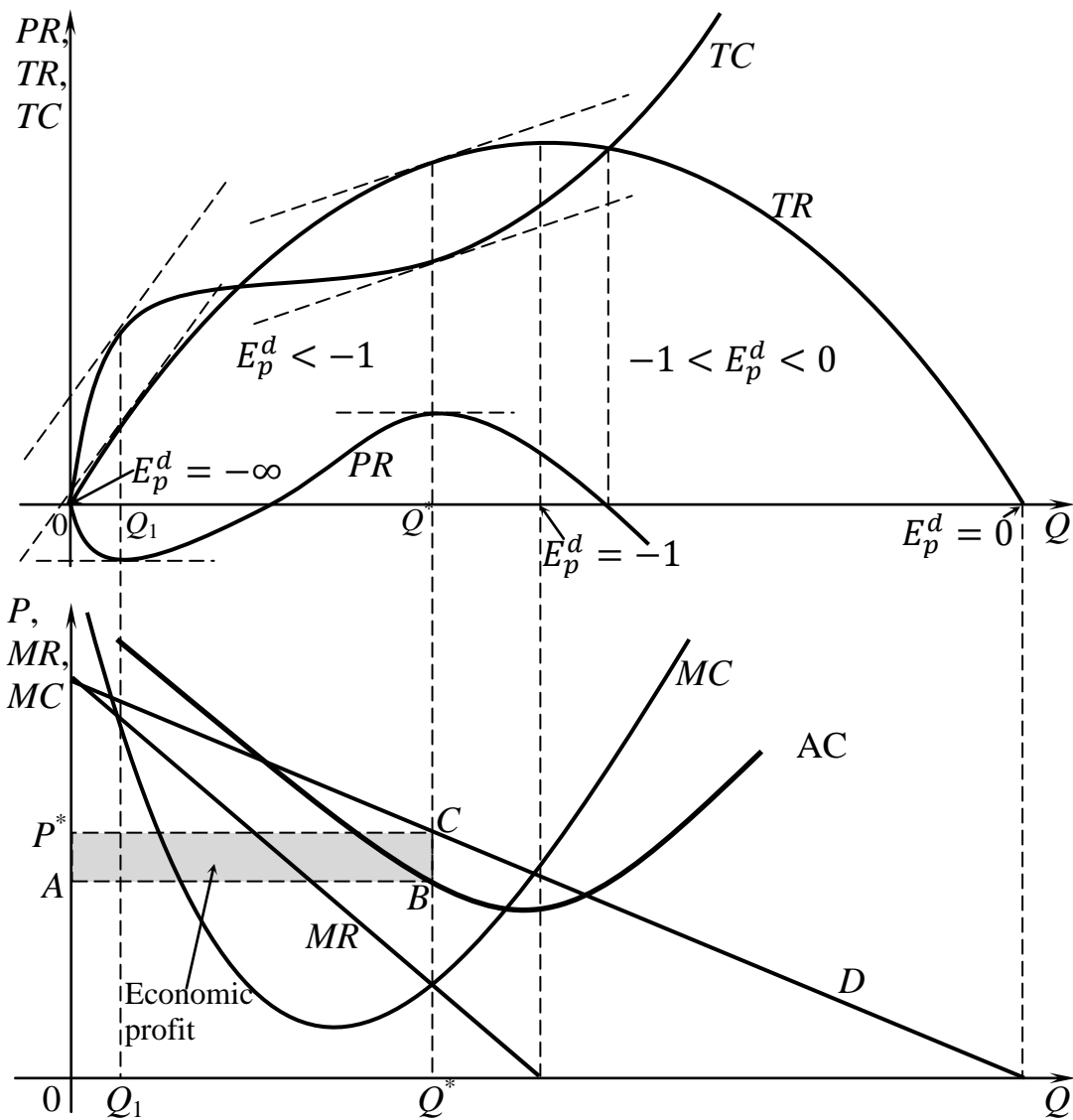
$$\frac{d^2PR}{dQ^2} = \frac{d^2TR}{dQ^2} - \frac{d^2TC}{dQ^2} \leq 0,$$

i.e.

$$\frac{d^2TR}{dQ^2} \leq \frac{d^2TC}{dQ^2}, \text{ or } MR' \leq MC'.$$

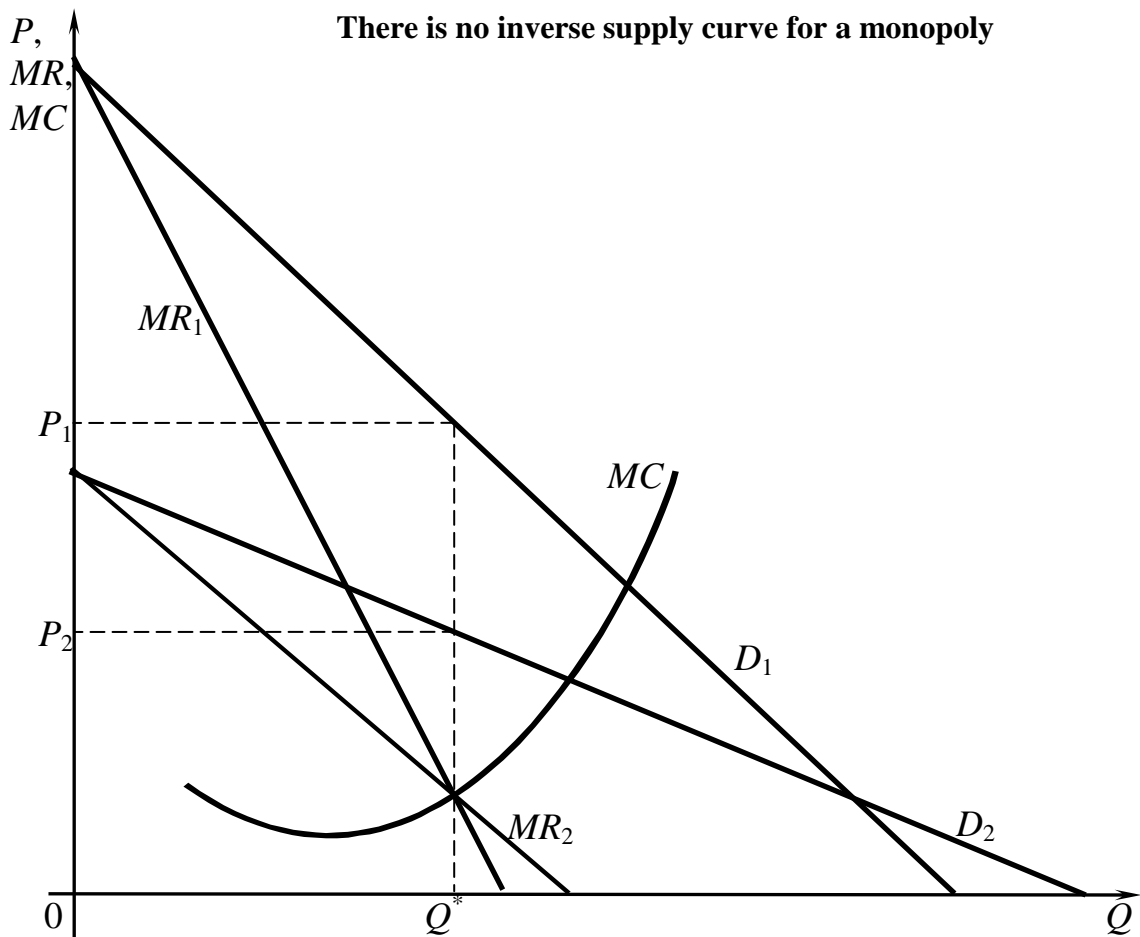
The second order condition is satisfied in the figure below at the increasing portion of marginal cost curve in the point Q^* , where $MC' > 0$, and $MR' < 0$. In the point Q_1 , where marginal cost is downward-sloping, the monopoly earns minimum profits, i.e. it incurs maximum losses.

A monopoly sets the price P^* in accordance with market demand (D). Total revenue of the monopoly is the area $0P^*CQ^*$. Total cost is equal to the area $0ABQ^*$ ($TC=AC(Q^*) \cdot Q^*$). The monopoly earns economic profit P^*ABC (shaded area in the figure below).

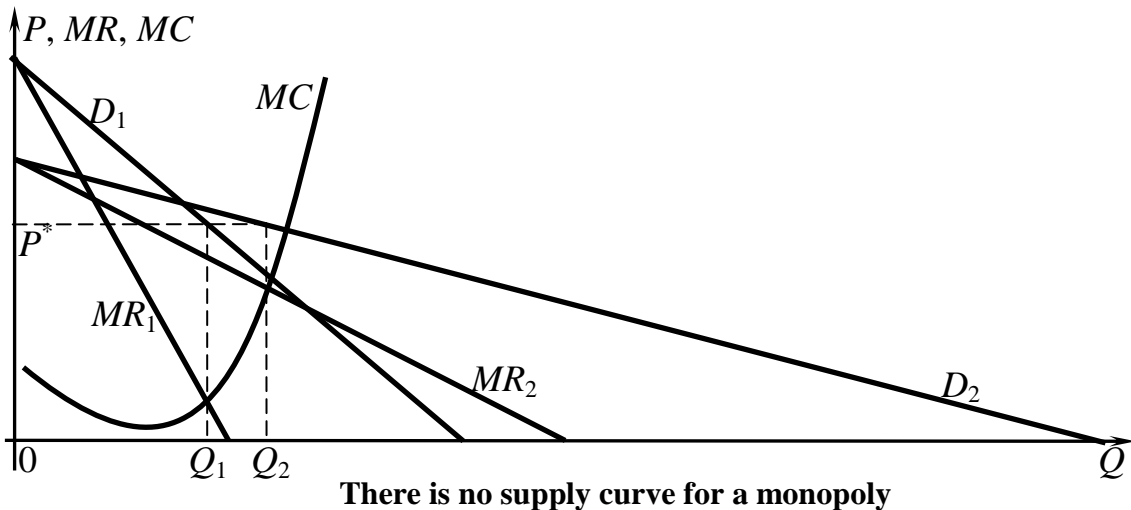


Profit-maximizing monopoly

There is no supply curve for a monopoly. One and the same monopolistic output may correspond to different price levels due to changes in market demand. There is no functional correspondence between quantity supplied and market price for a monopoly (see the figure below).



And vice versa. One and the same price level may correspond to different quantities supplied by a monopoly due to changes in market demand. There is no functional correspondence between market price and optimal output for a monopoly (see the figure below).



7.3. Monopoly power. Inefficiency of monopoly

Market power is an ability of a firm to raise the price for its product higher as compared to competitive price level which is equal to marginal

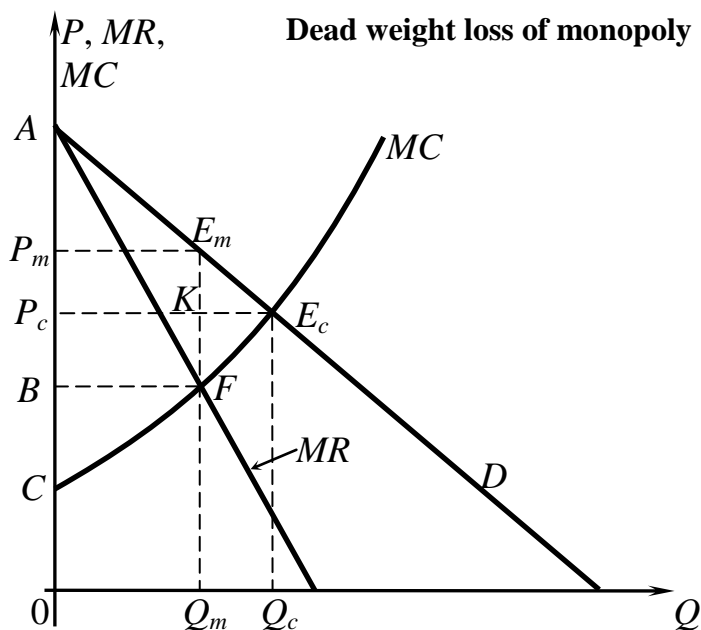
costs of producing equilibrium output. Market power can be measured by Lerner index:

$$L = \frac{p - MC}{p} = \frac{p - MR}{p} = \frac{p - p \left(1 + \frac{1}{E_p^d}\right)}{p} = -\frac{1}{E_p^d}$$

The expression of Lerner index shows that monopolistic power is limited by price elasticity of demand (E_p^d). The more elastic the demand, the lower is the market power of the firm.

Monopolistic market structure brings dead weight loss to society. Suppose that an industry that was initially perfectly competitive has transformed into a profit-maximizing monopoly. Assume that the monopoly has a linear and upward sloping marginal cost curve, and it earns economic profits. Let's compare output and price of the monopoly with the output and price of the perfectly competitive industry. Competitive market equilibrium is given by intersection of demand (D) and supply (MC) curves. The equilibrium competitive output (Q_c) is bigger than the monopolistic one (Q_m), and competitive price (P_c) is lower as compared to that under monopoly (P_m) (see the figure below).

Let's show the changes in consumer surplus (ΔCS), producer surplus (ΔPS) and dead weight loss (DWL) caused by monopolization of the industry: $\Delta CS = S_{P_c P_m E_m E_c}$, $\Delta PS = S_{P_m E_m K P_c} - S_{F K E_c}$, $DWL = S_{E_m E_c F}$ (see the figure below).



7.4. Monopoly and efficiency: government controls (price ceiling)

Consider a monopoly with an upward sloping marginal cost curve. Suppose that monopoly operates in a market with linear demand: $P = a - bQ$, where a and b are constant values. The profit-maximizing output of an unregulated monopoly is Q_m (see the next two figures below). Use the demand curve AB to find the equilibrium price for the product of the firm P_m that corresponds to the profit-maximizing output Q_m .

Now suppose that the government has set a price ceiling which is lower than the equilibrium price P_m . The demand curve for the monopoly's product with the price ceiling \bar{P} consists of two segments: D_1 and D_2 (see the next two figures below). D_1 is the horizontal segment at the level of the price ceiling: $[\bar{P}F]$ when output is less or equal to Q_1 . If output is greater or equal to Q_1 the demand curve coincides with market demand without price ceiling along the segment $[FB]$. This is the second part of demand with the price ceiling D_2 . Summing up, the expression of demand with the price ceiling is the following:

$$P = \begin{cases} \bar{P} & \text{if } Q \leq Q_1, \\ a - bQ & \text{if } Q \geq Q_1. \end{cases}$$

Furthermore, it is necessary to get total revenue curve:

$$TR = \begin{cases} \bar{P}Q & \text{if } Q \leq Q_1, \\ aQ - bQ^2 & \text{if } Q \geq Q_1. \end{cases}$$

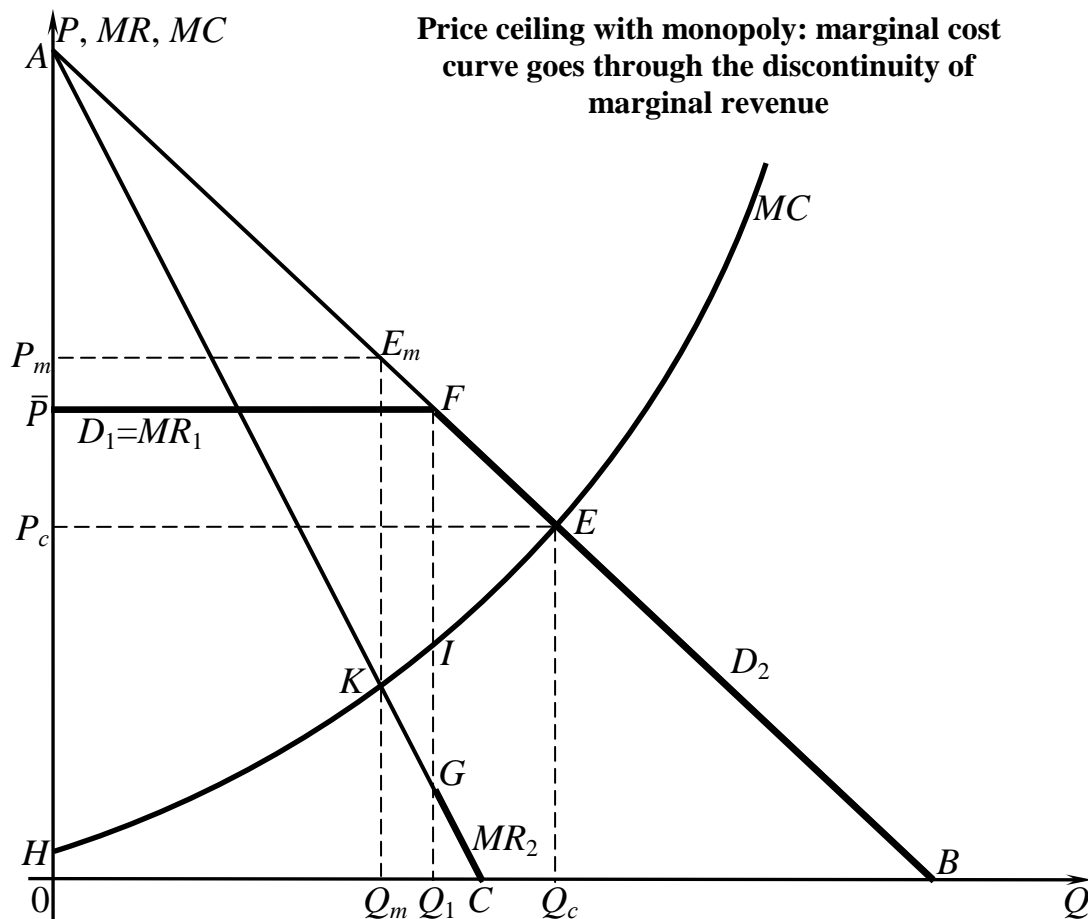
Marginal revenue is the change in total revenue due to incremental change in output:

$$MR = \frac{dTR}{dQ} = \begin{cases} \bar{P} & \text{if } Q < Q_1, \\ a - 2bQ & \text{if } Q > Q_1. \end{cases}$$

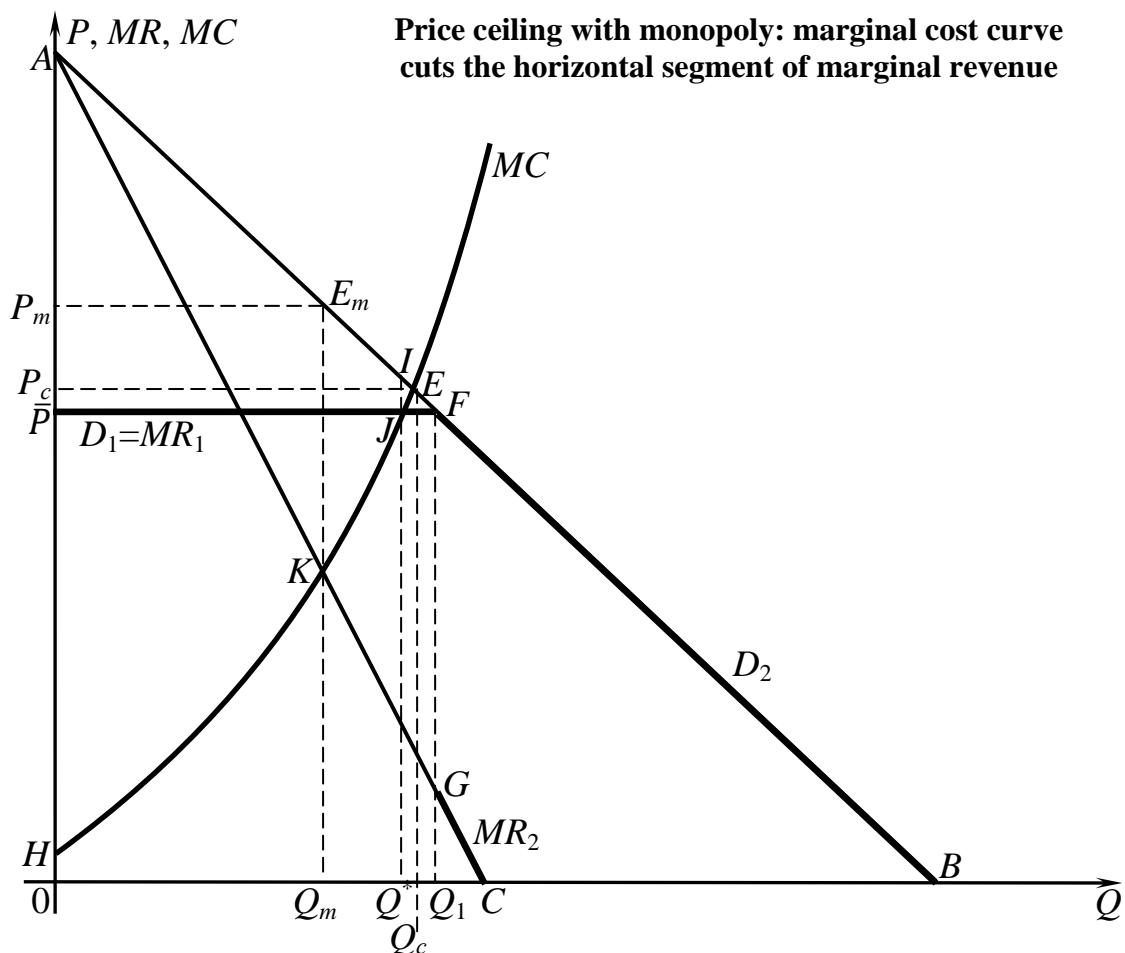
That is, marginal revenue consists of two segments MR_1 and MR_2 (see the next two figures below). It coincides with demand curve if output is less than Q_1 ; marginal revenue is linear and twice as steep as demand curve if output is greater than Q_1 . Marginal revenue is discontinuous when output is equal to Q_1 .

There are two possibilities as far as equilibrium price and output of the monopoly with the price ceiling are concerned. The first one is when marginal cost curve (MC) goes through the range of discontinuity of marginal revenue (see the figure below). In this case $MR > MC$ if $Q < Q_1$, and $MC > MR$ if $Q > Q_1$. It follows that it pays for the firm to increase output if $Q < Q_1$, because additional unit of output yields additional profit:

$\frac{dPR}{dQ} = MR - MC > 0$. If $Q > Q_1$ the situation is opposite: $\frac{dPR}{dQ} = MR - MC < 0$, so it pays for the firm to decrease output because it will increase profit. Consequently, optimal output with the price ceiling in this case is $Q^* = Q_1$. Substitute it into demand schedule to get optimal price \bar{P} .



The second possible case is when marginal cost curve (MC) crosses horizontal segment of marginal revenue MR_1 (see the figure below). In this case use $MR=MC$ rule to get optimal output with the price ceiling Q^* . Substitute it into demand schedule to get optimal price \bar{P} .



In the first case equilibrium output with the price ceiling is $Q^* = Q_1$. It is bigger than equilibrium output without the price ceiling (Q_m) (fig.A). In the second case equilibrium output with the price ceiling is $Q^* < Q_1$. It is bigger than equilibrium output without the price ceiling (Q_m) (fig.B). In both cases equilibrium price with the price ceiling is \bar{P} . It is lower than equilibrium price without the price ceiling (P_m).

Let's now consider social losses due to the allocative inefficiency of the regulated monopoly. Social welfare under perfect competition is represented by the triangle HAE .

In the first possible case consumers' surplus is the triangle $\bar{P}AF$; producer's surplus is the area $\bar{P}FIH$, dead weight loss is the triangle IFE (see the last but one figure above).

In the second possible case consumers' surplus is the area $\bar{P}AIJ$; producer's surplus is the triangle $\bar{P}JH$, dead weight loss is the triangle JIE (see the last figure above).

In both case (S_{IFE} and S_{JIE}) welfare losses with regulation are smaller as compared to that of an unregulated monopoly (S_{KE_mE}) (see the

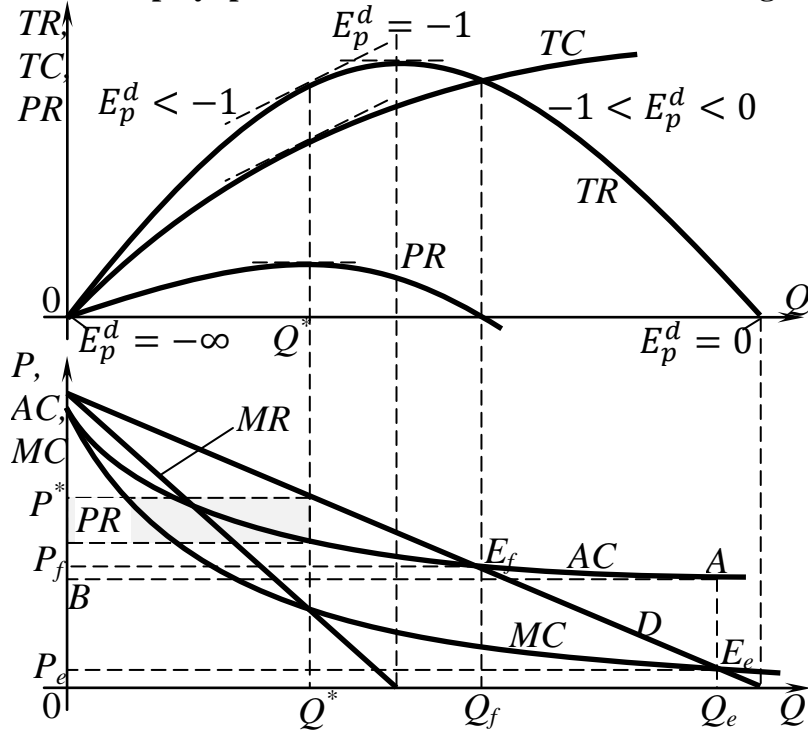
last two figures above). Thus a price ceiling reduces social costs of monopoly.

7.5. Natural monopoly

A pure monopoly may be artificial (as a result of legislative or government regulation) or may be caused by natural conditions of the industry. Natural monopoly is a market structure with high entrance barriers which emerge due to huge economies to scale and a large minimum efficient production size at a relatively narrow market. There are economies of scale over the entire possible range of output. Average cost is declining within the boundaries set by market demand. There is the single efficient producer at the market.

Unregulated profit maximizing natural monopoly will produce Q^* units of output and set the price P^* (see the figure below). The goal of government regulation of natural monopoly is to make it increase output as close as possible to the long run competitive output, i.e. minimum of AC . There are two ways of government price setting for the natural monopoly: fair price versus efficient price. Fair price is set equal to average cost of the monopoly. In this case the firm will choose output Q_f and set the price P_f . This type of price setting will cost the government nothing, because revenue of the natural monopoly will cover all the costs. Efficient price is set equal to marginal cost. In this case the monopoly will produce Q_e units of output, but it will incur losses because the price P_e for the product will be lower than AC . This type of government regulation requires the subsidy from the government to cover the losses of the firm which are equal to the area AE_eP_eB (see the figure below).

Natural monopoly: profit maximization and dilemma of regulation



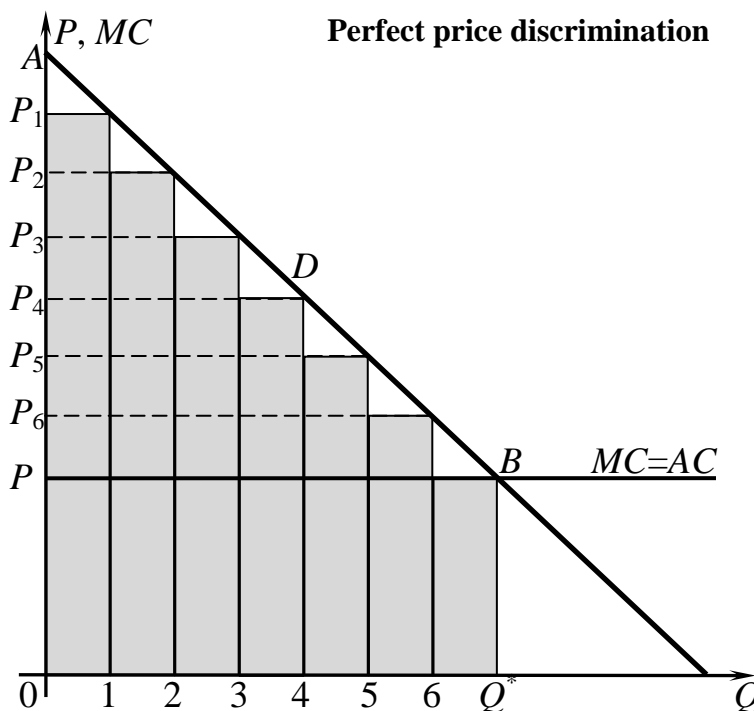
7.6. Price discrimination

Price discrimination is a situation when different customers are charged different prices for one and the same good produced at the same cost. For a price discrimination to be valid the so called “no resale condition” must hold, i.e. the customers who have bought the good at a lower price should not be able to sell it to other customers at a higher price.

There are different types of price discrimination. A monopoly practices perfect (first degree) price discrimination when each customer is charged her reservation price. Reservation price is the highest price a customer is ready to pay for a good. Suppose that the firm operates under constant returns to scale. Then it pays for the firm to sell Q^* units of the good and the lowest price for the last unit of the product sold will be P . Total revenue of the discriminating monopoly if it can increase output by discrete units will be the sum of shaded rectangles at the graph below. Each of the rectangles is equal to the revenue from an additional unit of the good sold. If market demand is continuous total revenue of the firm will be represented by the area $0ABQ^*$. Total production cost will be equal to the area $0PBQ^*$. So in discrete case the profit of the monopoly is the sum of the shaded rectangles above $MC=AC$ curve (see the figure below).

In continuous case the profit will be represented by the triangle PAB . Unlike nondiscriminating monopoly there is no dead weight loss

under perfect price discrimination because the monopoly produces the competitive output and the whole consumer surplus is appropriated by the firm. It constitutes the firm's profit.



The second type (degree) of price discrimination is the sale of bundles of goods. Their size depends on the level of demand of target customers. The monopolist cannot identify the level of demand of a given consumer, so the goal of the seller is to create incentives for the consumer so as she could show her level of demand. Bundles for the consumers with high purchasing capabilities are composed so as to give them at least the same level of utility as when they buy the bundles designed for the consumers with low demand.

The third type (degree) of price discrimination supposes that there is a definite market segmentation. Unlike the second type of discrimination in this case the monopolist is able to correspond each customer with one of the market segments. Discriminating monopolist chooses output at the market segments so that marginal revenue is equal at each segment (see the figure below):

$$MR_1 = p_1 \left(1 + \frac{1}{E_p^{d_1}} \right) = MR_2 = p_2 \left(1 + \frac{1}{E_p^{d_2}} \right) = MC,$$

where $MR_1 = p_1 \left(1 + \frac{1}{E_p^{d_1}} \right)$ and $MR_2 = p_2 \left(1 + \frac{1}{E_p^{d_2}} \right)$ are the levels of marginal revenue at the first and the second segments of market demand.

The price mark-up at the segment with higher demand depends on its relative elasticity:

$$\frac{p_1}{p_2} = \frac{1 + \frac{1}{E_p^{d_2}}}{1 + \frac{1}{E_p^{d_1}}}$$

The price-discriminating monopoly produces the same volume of output as the non-discriminating one. The discriminating monopoly distributes its output between the segments of market demand so as to equate the corresponding levels of marginal revenue. The price-discriminating monopoly has an incentive to increase output sold at the more elastic segment of market demand and to decrease by the same quantity the supply to the less elastic segment of market demand as compared to non-discriminating firm so as the increase of total revenue at the more elastic segment overwhelms the decrease at the less elastic one.

