Introduction to Industrial Organization

Perfect Competition, Monopoly, and Dominant Firm

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Outline

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  - Shutdown decision for firms
  - Short-run and long-run equilibrium
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  - Assumptions
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  - Welfare and deadweight loss
- Dominant Firm
  - Assumptions
  - Equilibrium

Perfect Competition

Perfect Competition

- Assumptions:
  - Homogeneous products (only one single good)
  - Perfect information: All consumers and producers know the price and utilities for each person.
  - No transaction costs
  - No externalities
  - Many (infinite) buyers (consumers) and sellers (firms).
  - All firms and buyers are price takers. Price is determined by the market.

Profit Maximization

- The profit maximization problem for a single firm:

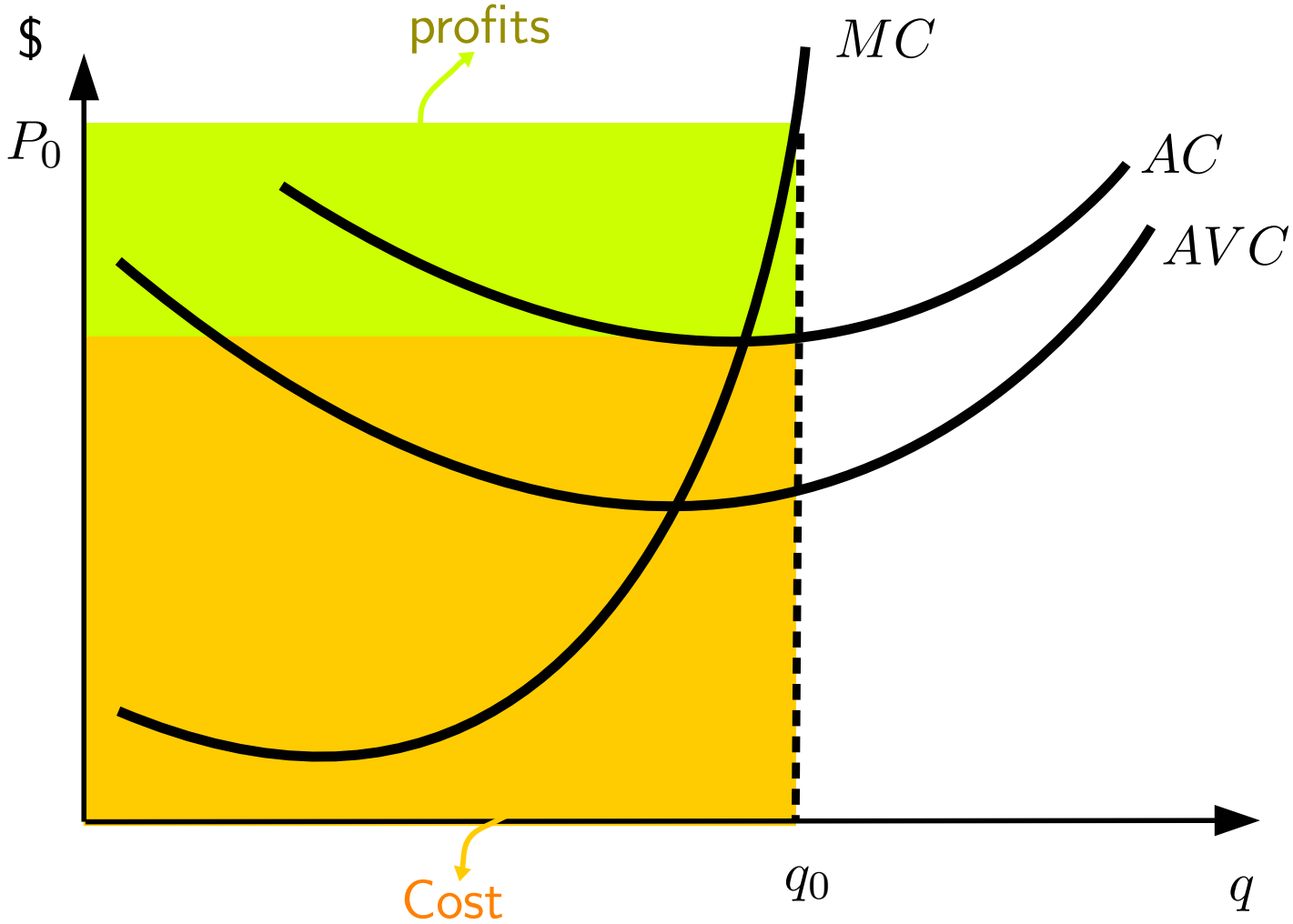
$$\max_q \pi = \max_q P \cdot q - c(q)$$

- First-order condition (F.O.C.):

$$\frac{\partial \pi}{\partial q} = 0 \Rightarrow P - \frac{\partial c(q)}{\partial q} = 0 \Rightarrow P = MC(q)$$

- Given a price P_0, the firm produces at the quantity level q_0, where $P_0 = MC(q_0)$.

Figure for Perfect Competition

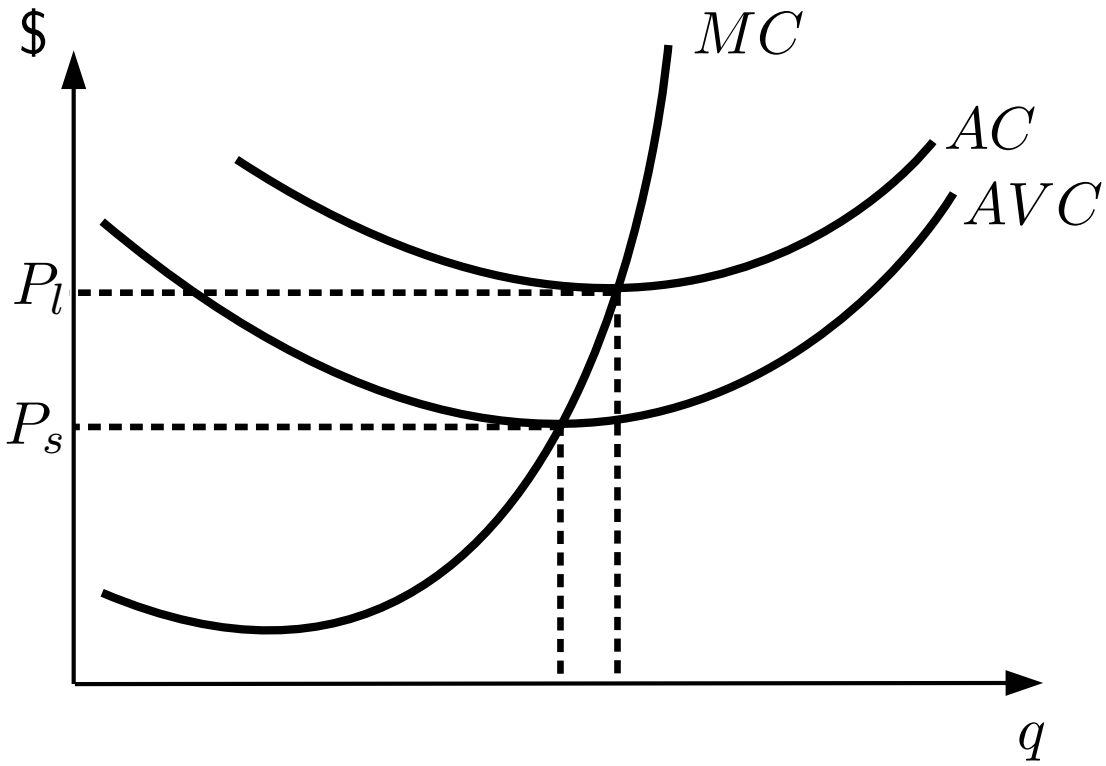


Shutdown Decisions (I)

- Total cost is $C(q_0) = q_0 AC(q_0)$.
- Supply curve: As price increases, the firm increase the production along the curve $MC(q)$.
- Shutdown decision:
  - The firm produces only if the revenues are higher than avoidable costs.
  - In the short run, avoidable costs are variable costs $VC(q)$ if all fixed costs are sunk. If $P \cdot q < VC(q) \Rightarrow P < AVC(q)$, then the firm will shut down.
  - In the long run, avoidable costs are total costs $C(q)$. If $P \cdot q < C(q) \Rightarrow P < AC(q)$, then the firm will shut down.
  - In the short run, if proportion α of fixed costs are not sunk, such as refundable rent, then avoidable costs are $VC(q) + \alpha F$. The firm will shut down if $P \cdot q < VC(q) + \alpha F \Rightarrow P < AVC(q) + \frac{\alpha F}{q}$

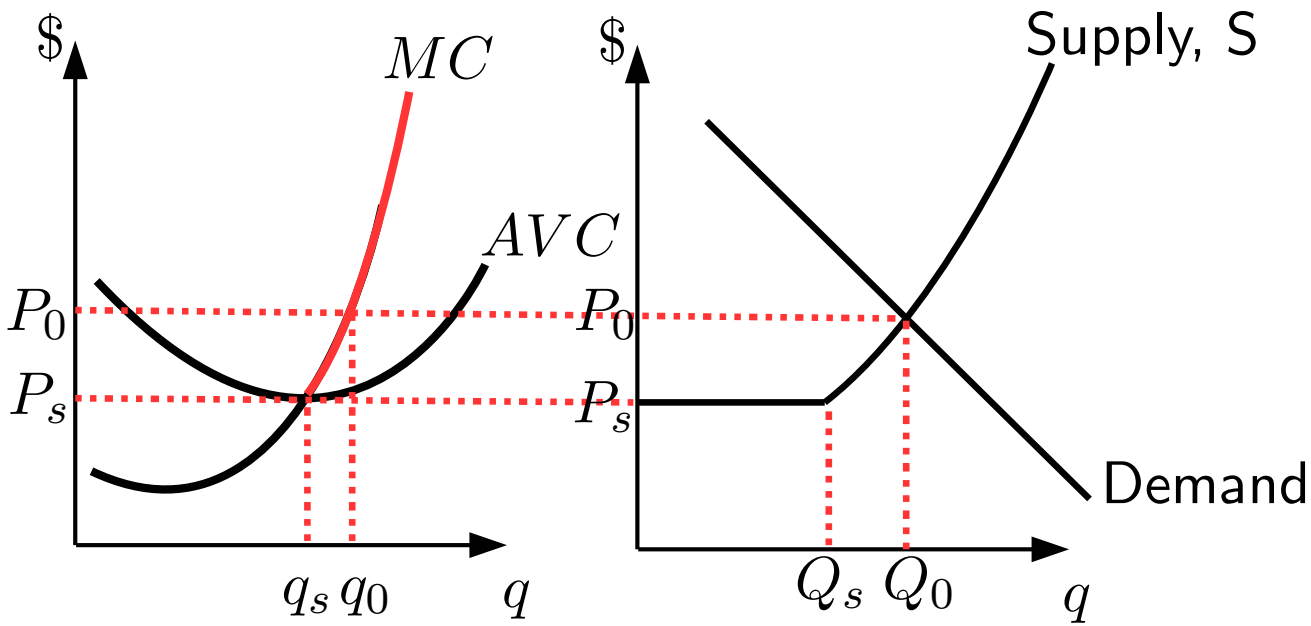
Shutdown Decisions (II)

- Short-run shutdown point P_s. (All the fixed costs are sunk.)
- Long-run shutdown point P_l.



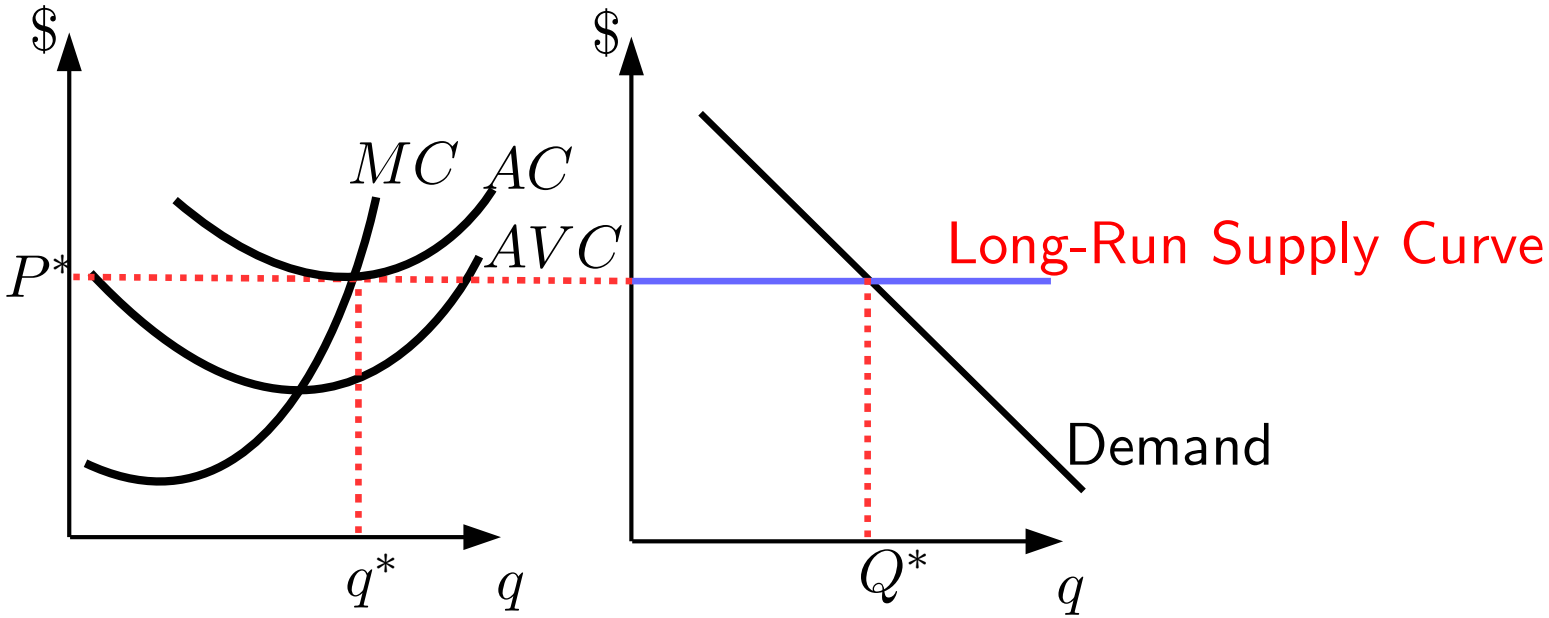
Short-Run Equilibrium

- There are n identical firms.
- Short-run market supply curve, S; Short-run equilibrium price, P_0, and quantity, $Q_0 = nq_0$. $(Q_s = nq_s)$
- Firms are making a positive profit.



Long-Run Equilibrium

- Firms are free to enter into the market.
- The equilibrium price, P^* = minimum of AC; the equilibrium number of firms, n^*; the equilibrium output $Q^* = n^* q^*$.
- Firms make zero profit because of free entry.



Long-Run Equilibrium

- Note: The long-run supply curve need not be flat. It may be upward-sloping.
  - Case 1: minimum of AC is rising in market demand.

    Example: An expansion of output causes the prices of some key inputs to increase.
  - Case 2: A few firms can produce at low costs.

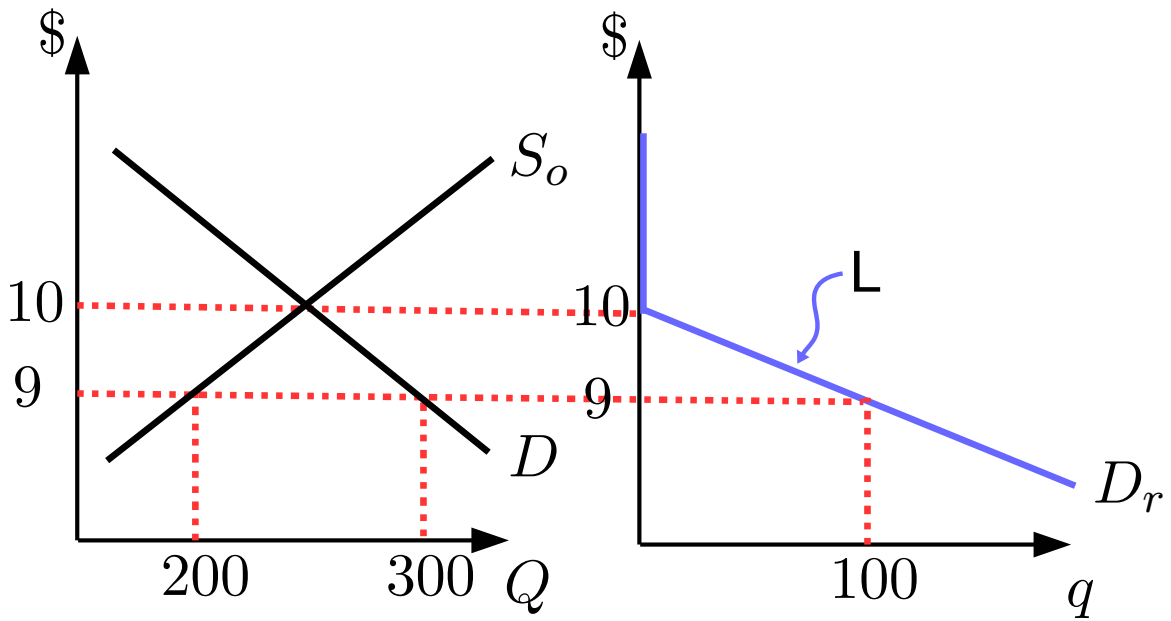
    Example: Two types of firms: n_1 low-cost, efficient firms with smaller AC_1, and n_2 high-cost firms with higher AC_2.

Residual Demand Curve

- Definition: The demand curve facing a particular firm is called the residual demand curve, $D_r(p)$

$$D_r(p) \equiv D(p) - S_o(p);\ D_r(p) = 0 \text{ if } S_o(p) > D(p),$$

where $S_o(p)$ is the supply of other firms.



Elasticities

- Price Elasticity of Demand/Supply

$$\epsilon = \frac{\frac{\Delta Q(P)}{Q(P)}}{\frac{\Delta P}{P}} = \frac{\Delta Q(P)}{\Delta P}\frac{P}{Q(P)}$$

- Example:
  - The slope of demand is very steep $\Rightarrow$ inelastic demand $|\epsilon| < 1$
  - The slope of demand is very flat $\Rightarrow$ elastic demand $|\epsilon| > 1$

Elasticities and the Residual Demand Curve (I)

- The elasticity of demand facing firm i is ϵ_i.

$$
\begin{aligned}
D_r(p) &= D(p) - S_o(p) \\
\Rightarrow \frac{dD_r(P)}{dP} &= \frac{dD(P)}{dP} - \frac{dS_o(P)}{dP} \\
\Rightarrow \frac{dD_r(P)}{dP}\frac{P}{q} &= \frac{dD(P)}{dP}\frac{P}{q} - \frac{dS_o(P)}{dP}\frac{P}{q} \\
\Rightarrow \underbrace{\frac{dD_r(P)}{dP}\frac{P}{q}}_{\epsilon_i} &= \underbrace{\frac{dD(P)}{dP}\frac{P}{Q}}_{\epsilon}\underbrace{\frac{Q}{q}}_{n} - \underbrace{\frac{dS_o(P)}{dP}\frac{P}{Q_o}}_{\eta_0}\underbrace{\frac{Q_o}{q}}_{n-1}
\end{aligned}
$$

$$
\Rightarrow \epsilon_i = n\epsilon - (n-1)\eta_0,
$$

where ϵ is the market elasticity of demand, and η_0 is the elasticity of supply of the other firm. $(Q_o = (n-1)q; Q = nq)$

Elasticities and the Residual Demand Curve (II)

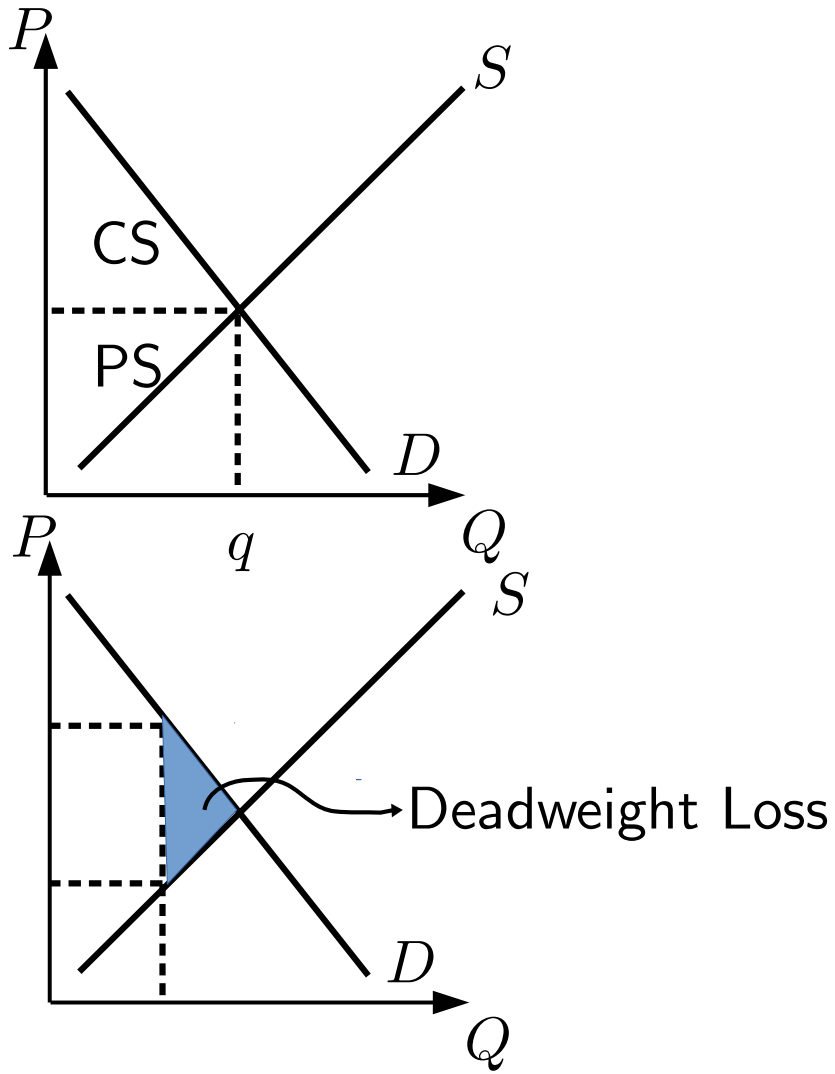
- The residual demand curve facing the firm is much flatter than the market demand curve.
- The single firm's demand elasticity is much higher than the market elasticity.

$$\epsilon_i = n\epsilon - (n-1)\eta_0$$

- Given the supply of other firms is completely inelastic ($\eta_0 = 0$), $\epsilon_i = n\epsilon$. For instance, if $\epsilon = -1$ and $n = 500$, then $\epsilon_i = -500$. The elasticity of demand facing a single firm is very large.
- In a perfect competition market, $n = \infty$. The elasticity of demand facing a firm is infinite, so the demand curve facing a competitive firm is horizontal at the market price. A competitive firm is a price taker.

Efficiency and Welfare

- Welfare = consumer surplus (CS) + producer surplus (PS)
- In the competitive equilibrium
  - Firms: $P = MC(q)$. Profits are maximized, so producer surplus is maximized.
  - Consumers: consumer surplus is maximized.
- Deadweight loss is defined as the welfare loss from the competitive equilibrium.



Summary and Example

- Summary:
  - Welfare is maximized under perfect competition.
  - Free entry is a crucial factor for perfect competition market, so the firms make zero profits in the long run.
  - All the firms are price takers.
- Example: U.S. agricultural markets
  - Many farms as sellers, and no farm has even 1 percent of total sales.
  - The elasticity of demand facing each farm is extremely large.

Crop	Estimated Market Demand Elasticity	Number of Farms	Each Farm's Residual Demand Elasticity
Fruits			
apples	-0.2	28,160	-5,620
grapes	-1.03	19,961	-20,560
Vegetables			
asparagus	-0.65	2,672	-11,140
cucumbers	-0.30	6,821	-2,046

Sources: Carlton and Perloff (2005)

Monopoly

Monopoly (I)

- Assumptions:
  - Only one firm in the market
  - Facing the downward-sloping demand curve($P(Q)$)
- Profit maximization problem:

$$\max_Q \pi = \underbrace{P(Q)Q}_{\text{Revenue}} - \underbrace{C(Q)}_{\text{Cost}}$$

- First-order condition:

$$\frac{\partial \pi}{\partial Q} = 0 \Rightarrow \underbrace{\frac{\partial P(Q)}{\partial Q}Q + P(Q)}_{\text{Marginal revenue}} - \underbrace{\frac{\partial C(Q)}{\partial Q}}_{\text{Marginal cost}} = 0$$

Monopoly (II)

- From F.O.C,

$$\frac{\partial P(Q)}{\partial Q}Q + P(Q) = MC(Q)$$

$$\Rightarrow \frac{\partial P(Q)}{\partial Q}\frac{Q}{P(Q)}P(Q) + P(Q) = MC(Q)$$

$$\Rightarrow P(Q)\left(1 + \frac{1}{\frac{\partial Q}{\partial P}\frac{P(Q)}{Q}}\right) = MC(Q),$$

  where $\frac{\partial Q}{\partial P}\frac{P(Q)}{Q}$ is the demand elasticity.

- We obtain

$$P\left(1 + \frac{1}{\epsilon}\right) = MC.$$

Example

- Deciding the price for monopoly is equivalent to deciding the quantity.
- There is no supply curve for monopoly.
- Example:
  - Inverse demand function: $P = a - bQ$
  - Cost function: cQ (constant marginal cost)
  - Maximization problem:

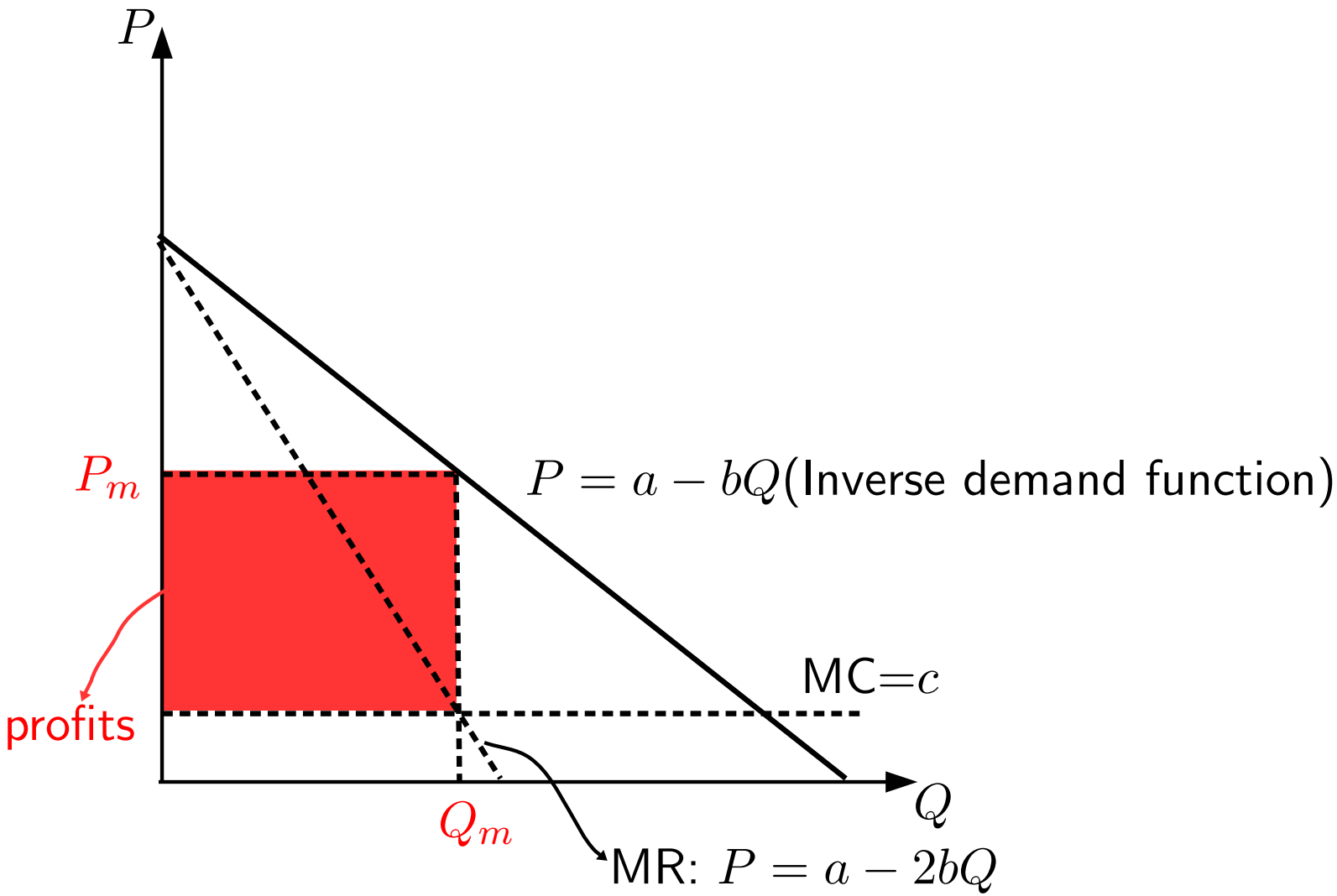
$$\max_Q (a - bQ)Q - cQ = aQ - bQ^2 - cQ$$

  - First-order condition:

$$\underbrace{a - 2bQ}_{\text{MR}} - \underbrace{c}_{\text{MC}} = 0$$

  - Marginal revenue: $a - 2bQ$; marginal cost: c.
  - Optimal output: $Q_m = \frac{a-c}{2b}$; optimal price: $P_m = \frac{a+c}{2}$.

Figure for Monopoly



Elasticity (I)

- From F.O.C:

$$P(1+\frac{1}{\epsilon}) = MC$$

$$\Rightarrow \underbrace{\frac{P-MC}{P}}_{\text{price-cost margin}} = \underbrace{-\frac{1}{\epsilon}}_{\text{positive}}$$

- The price-cost margin is also called the Lerner Index of market power.
- If the demand is very elastic, $\epsilon = -100$, then the price-cost margin is $\frac{1}{100}$. As $\epsilon \to -\infty$, $\frac{P-MC}{P} \to 0 \Rightarrow P \to MC$.
- If the demand is less elastic, $\epsilon = -2$, then the price-cost margin is $\frac{1}{2}$. The optimal price is much higher than the marginal cost.

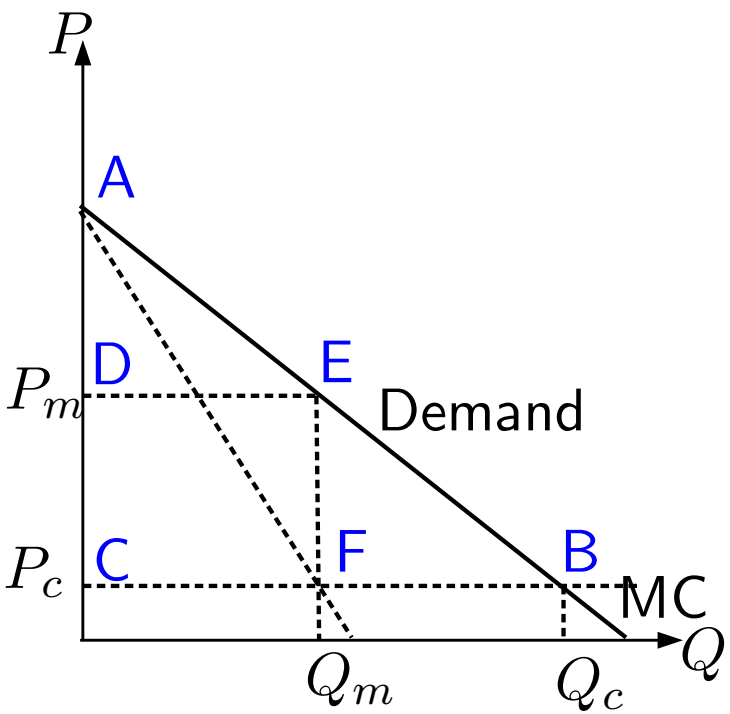
Elasticity (II)

- How about inelastic demand? $-1 < \epsilon < 0$

  Answer: Monopoly never operates on the inelastic portion of the demand. If so, raise the price!

- In actual markets, demand curves shift over time, so a rational monopoly should change its price over time.

Comparison with Competitive Market



- Price: $P_m > P_c$; Quantity: $Q_m < Q_c$
- Consumer surplus:
  - Competitive market: $\triangle$ ABC
  - Monopoly: $\triangle$ ADE
- Producer surplus (profits):
  - Competitive market: 0
  - Monopoly: $\square$ DEFC
- Total Welfare: $W_c > W_m$
  - Competitive market: $W_c =\triangle$ ABC $+ 0$
  - Monopoly: $W_m =\triangle$ ADE $+\square$ DEFC
- Deadweight loss $W_c - W_m =\triangle$ EFB

Creating and Maintaining a Monopoly

- All the firms merge or act as a monopoly. (We will address the detail in the oligopoly part)
- The firm takes strategic actions that prevent entry by other firms. (entry deterrence part)
- Three other reasons:
  - The firm may have special knowledge.
    - Example: one firm has a lower marginal cost.
  - The government may protect it from entry.
  - The market may only be large enough for a single firm to produce profitably.
    - When total production costs would rise if two or more firms produced instead of one, the single firm in a market is called a natural monopoly.
    - In some industries, such as electrical, gas, telephone, and cable television, there is a relatively high fixed cost.

Dominant Firm

Dominant Firm (I)

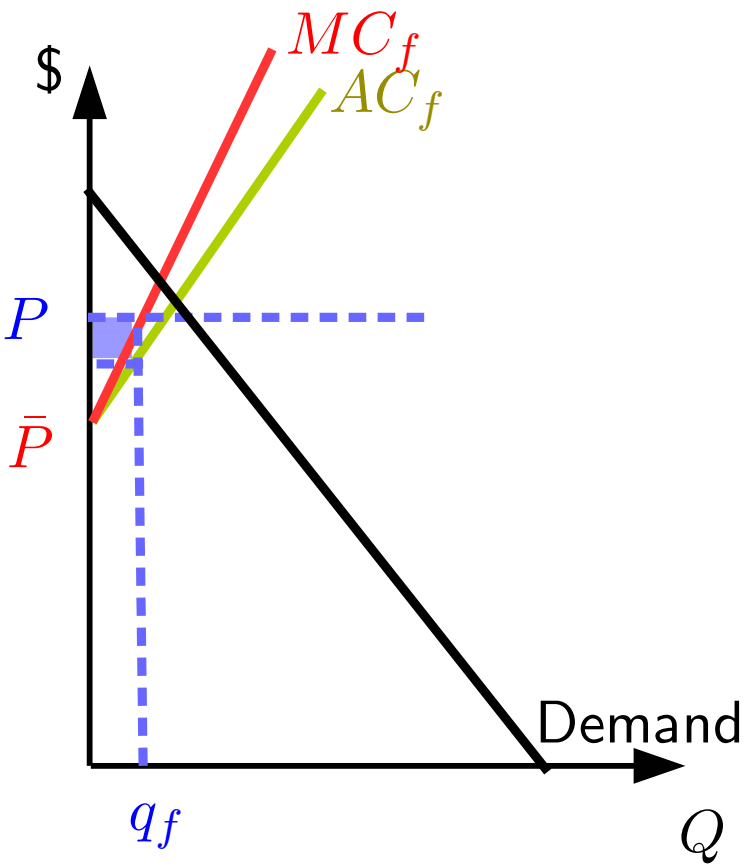
- Assumptions:
  - There is one firm (dominant firm) that is much larger than any other firm (fringe firm).
  - All firms, except the dominant firm, are price takers, determining their output levels by setting $P = MC$.
  - The number of firms is fixed (No-Entry Model); many fringe firms are free to enter into the market (Free-Entry Model).
  - Dominant firm knows the market's demand curve.
  - Dominant firm can predict how much output the competitive fringe will produce at any given price; that is, it knows fringe's supply curve.
- There is one dominant firm (d) and n fringe firms (f) in the market.
- Two types of models: free entry market / no entry market

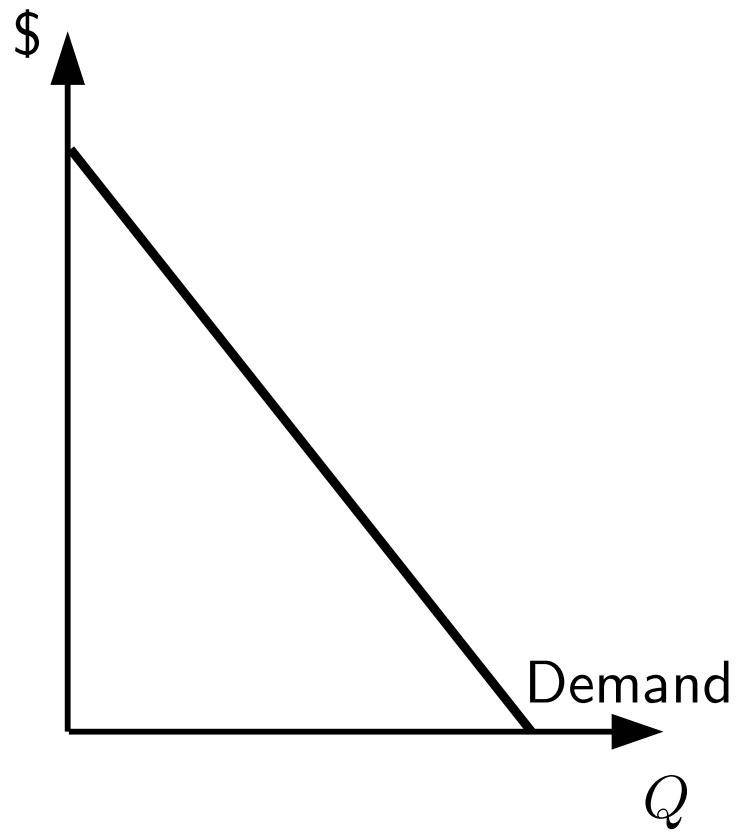
Dominant Firm (II)

- Reasons to be the dominant firm:
  - More efficient than its rivals: better management or better technology.
  - Early entrant: with lower costs, grow large optimally
  - Government may favor the original firm. For instance, USPS does not need to pay taxes or highway fees.
  - Superior product in the market
  - A group of firms may collectively act as a dominant firm (cartel)

Dominant Firm (No Entry) (I)

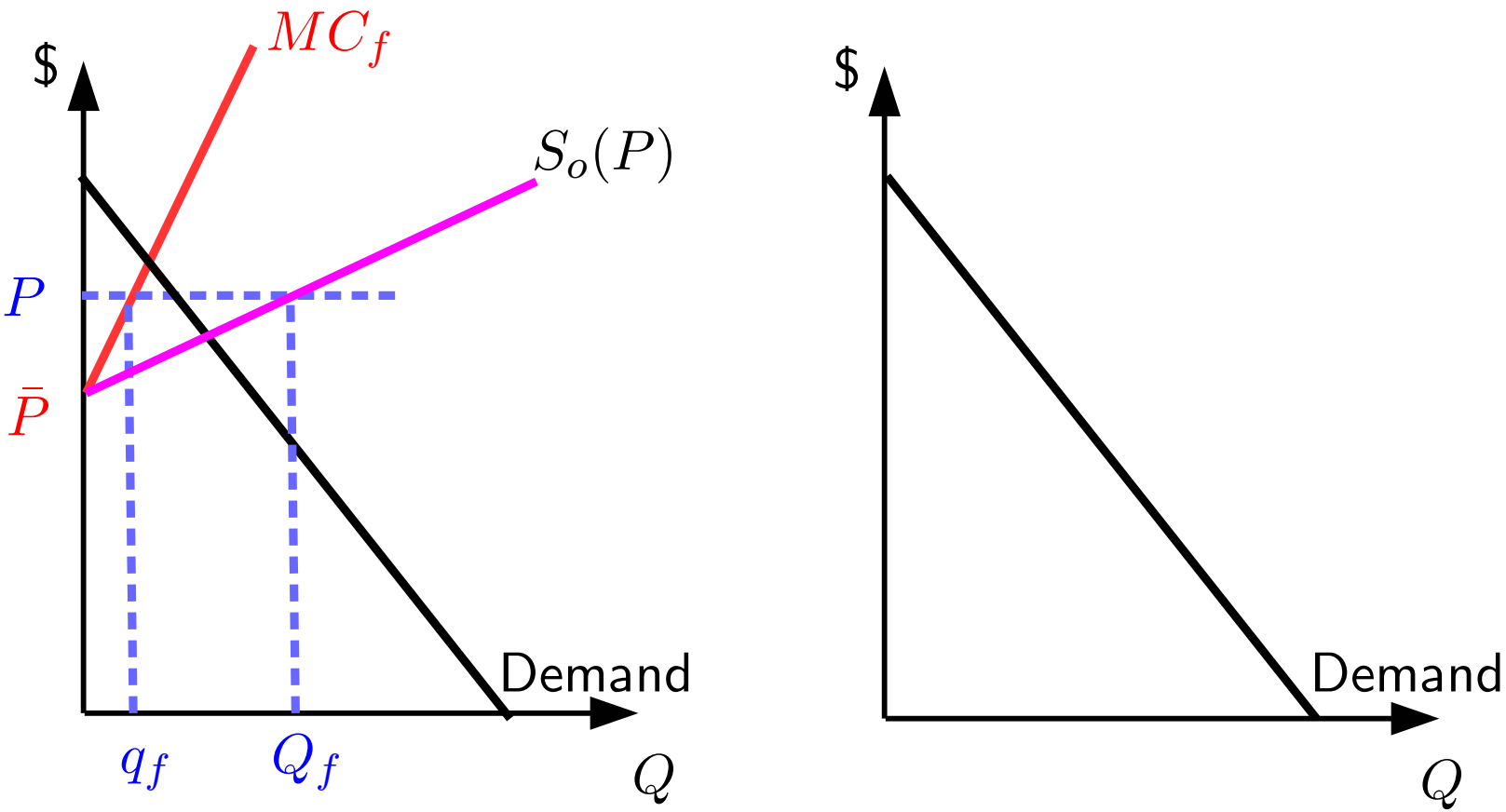
- The residual demand faces the dominant firm $D_d(P) = D(P) - S_o(P)$:





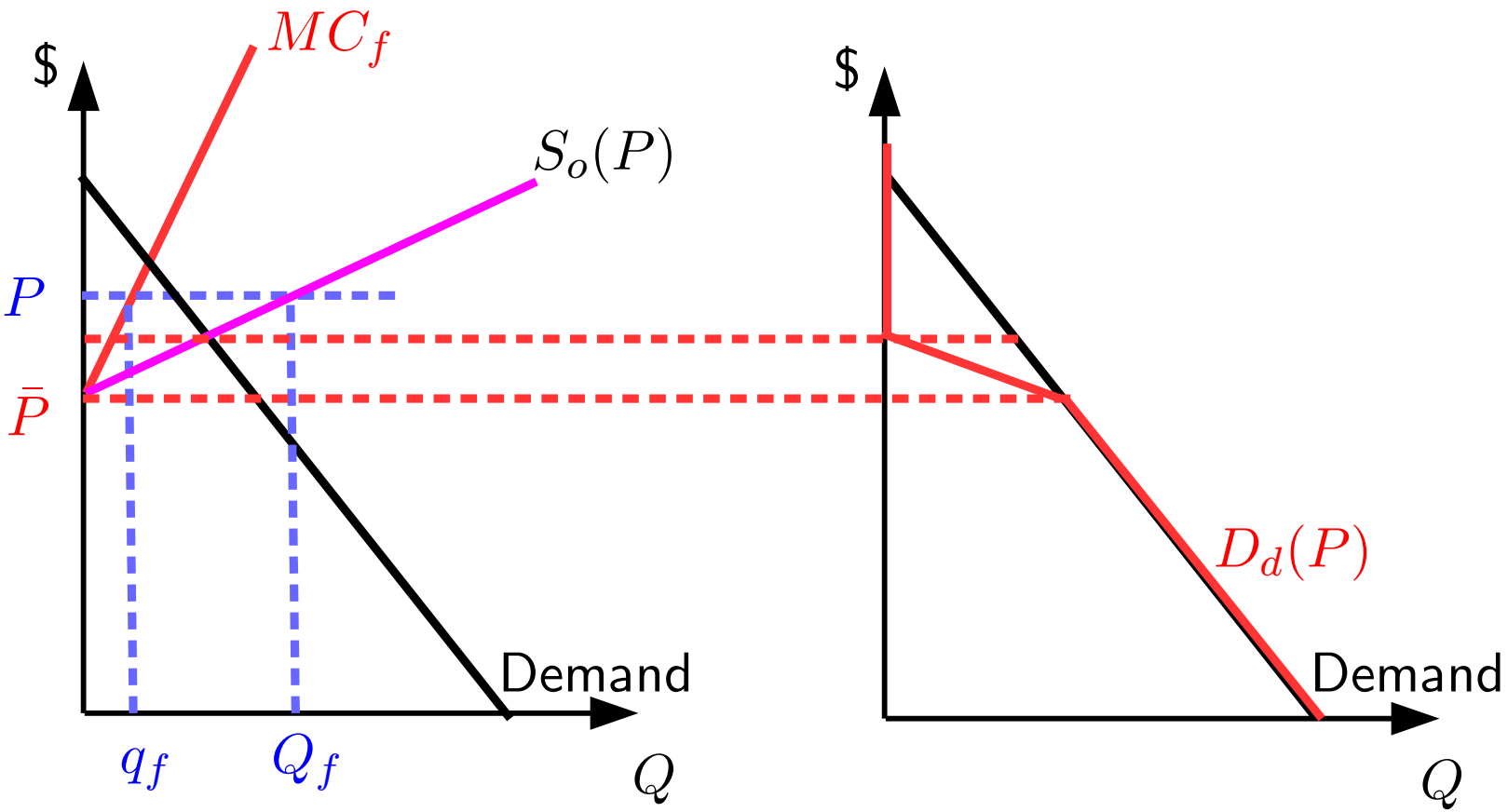
Dominant Firm (No Entry) (II)

- The residual demand faces the dominant firm $D_d(P) = D(P) - S_o(P)$:



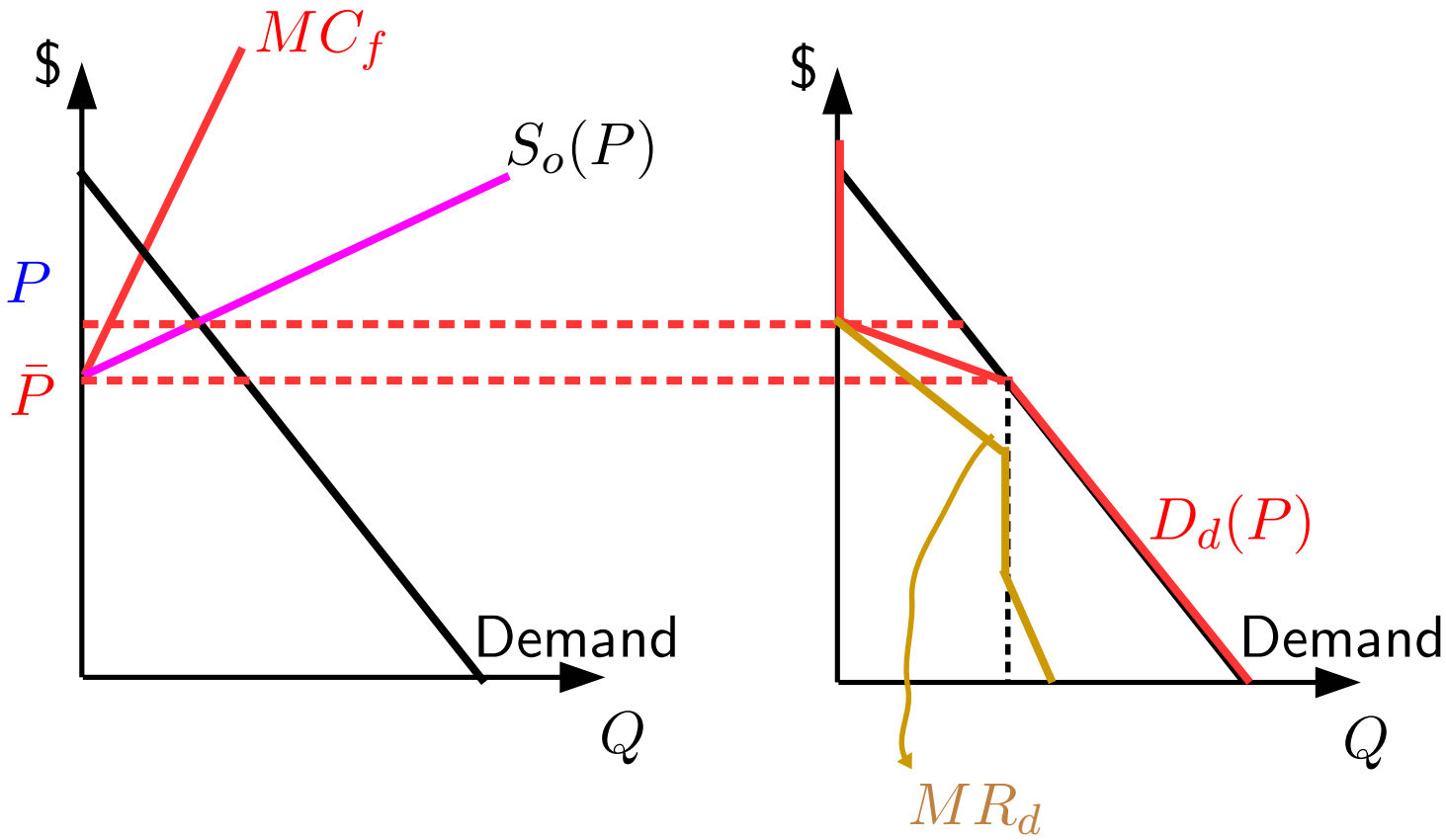
Dominant Firm (No Entry) (III)

- The residual demand faces the dominant firm $D_d(P) = D(P) - S_o(P)$:



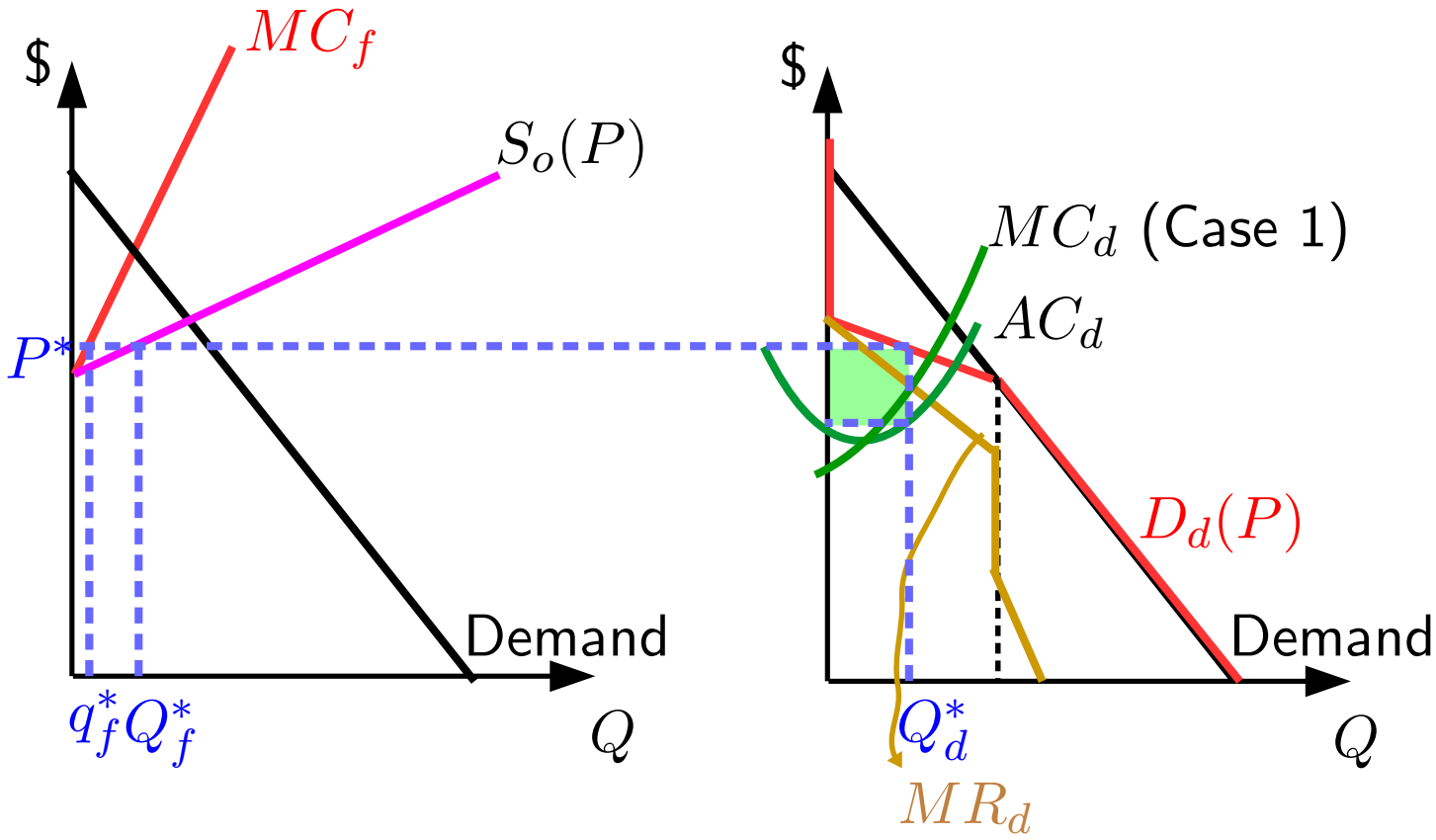
Dominant Firm (No Entry) (IV)

- Obtain the marginal revenue line MR_d from the residual demand curve



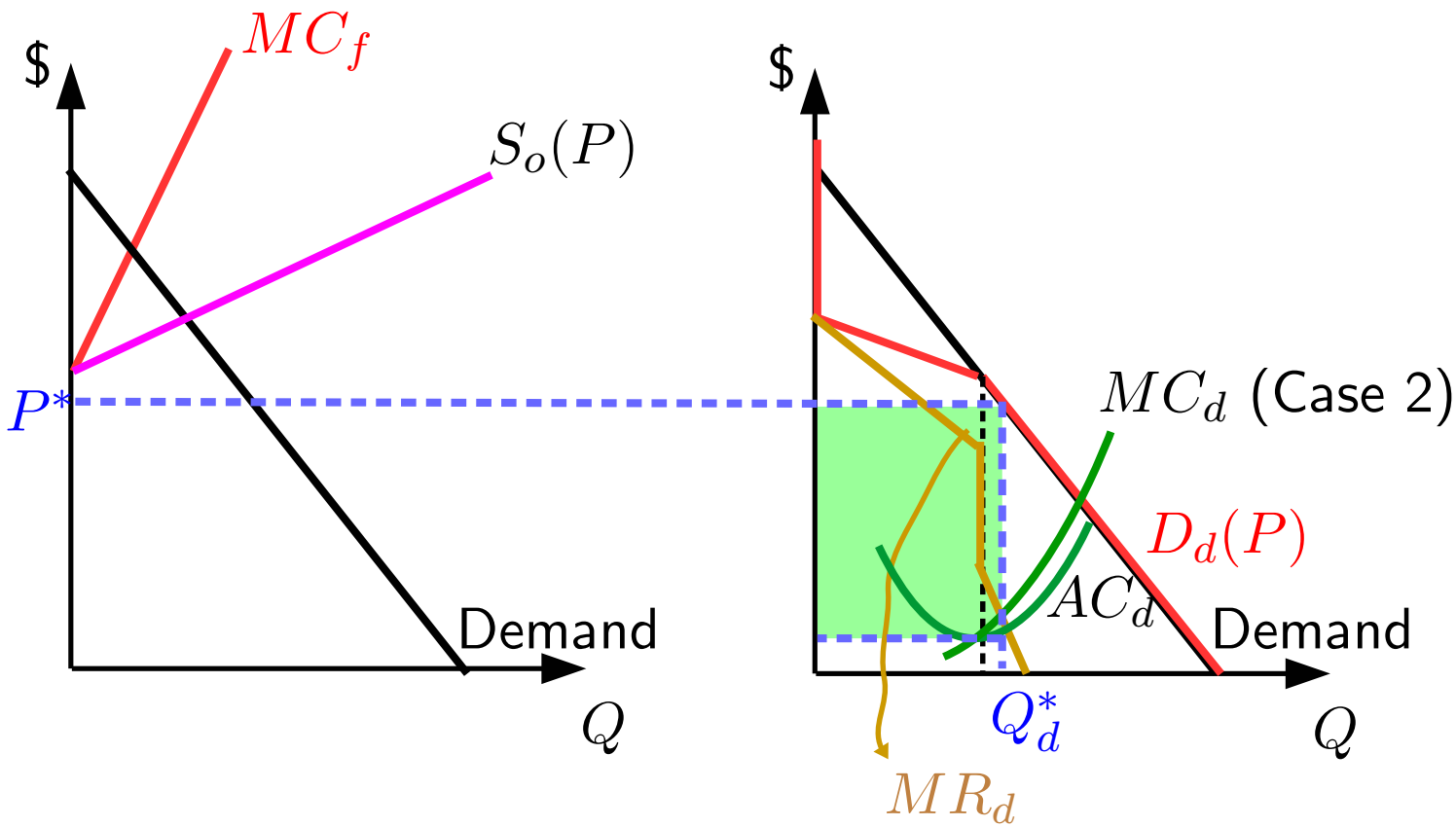
Dominant Firm (No Entry) (V)

- Case 1: Optimal price and quantity for dominant firm: P^* and Q_d^*; optimal quantity for each fringe firm: q_f^*.



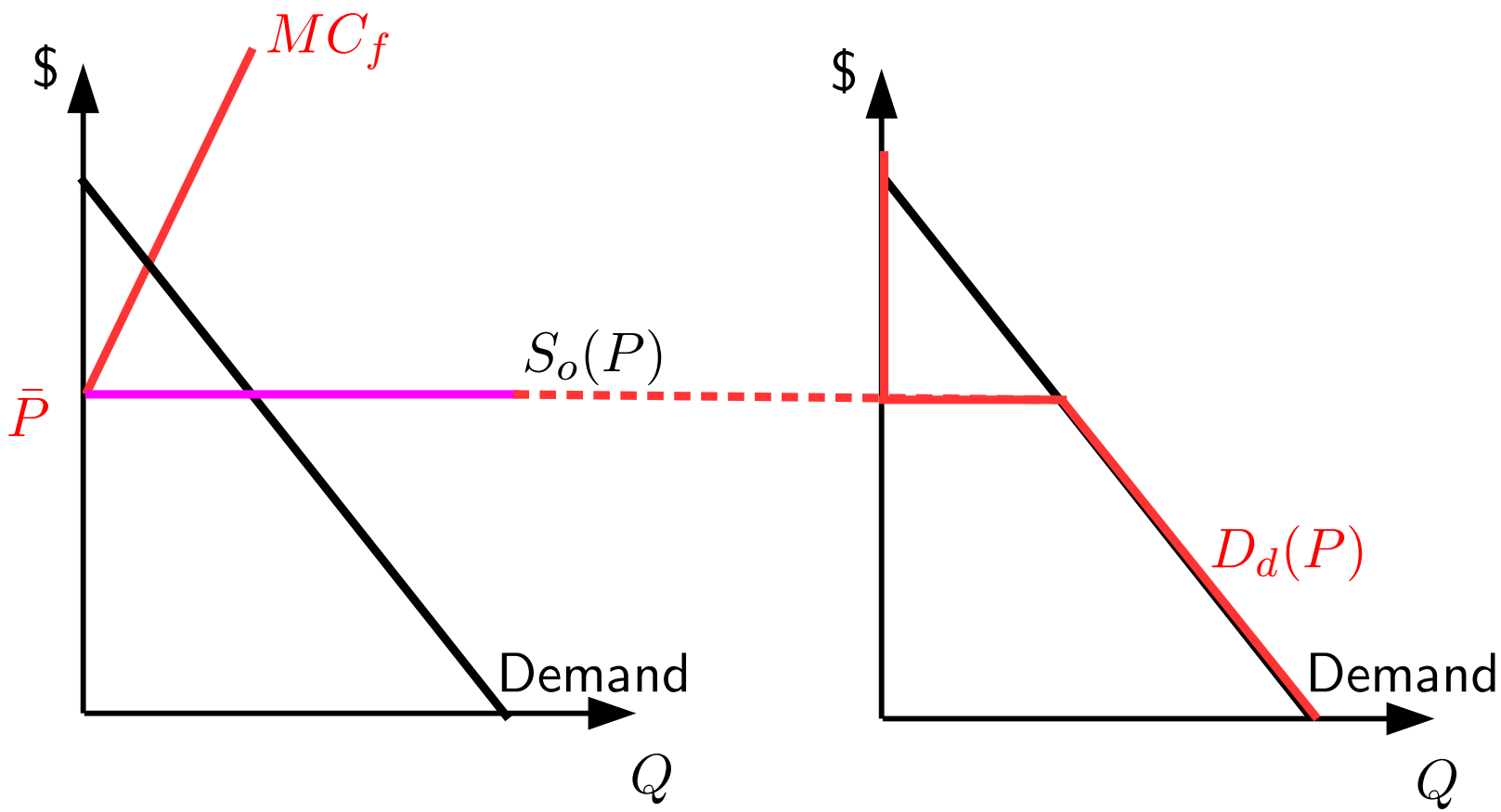
Dominant Firm (No Entry) (VI)

- Case 2: Optimal price and quantity for dominant firm: P^* and Q_d^*; optimal quantity for each fringe firm: $q_f^* = 0$. (Monopoly case)



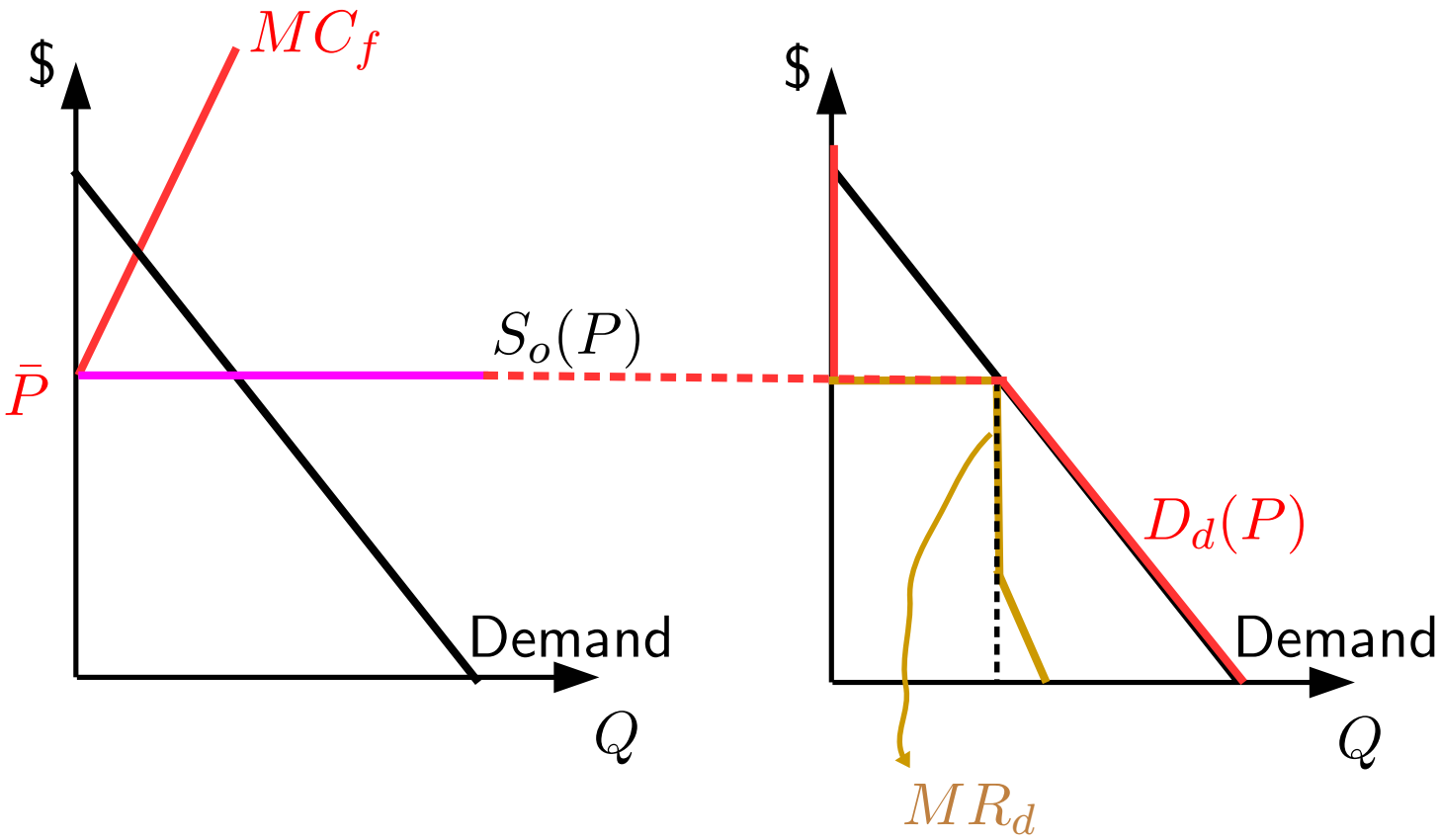
Dominant Firm (Free Entry) (I)

- If many fringe firms are free to enter into the market, then the residual demand faces the dominant firm:



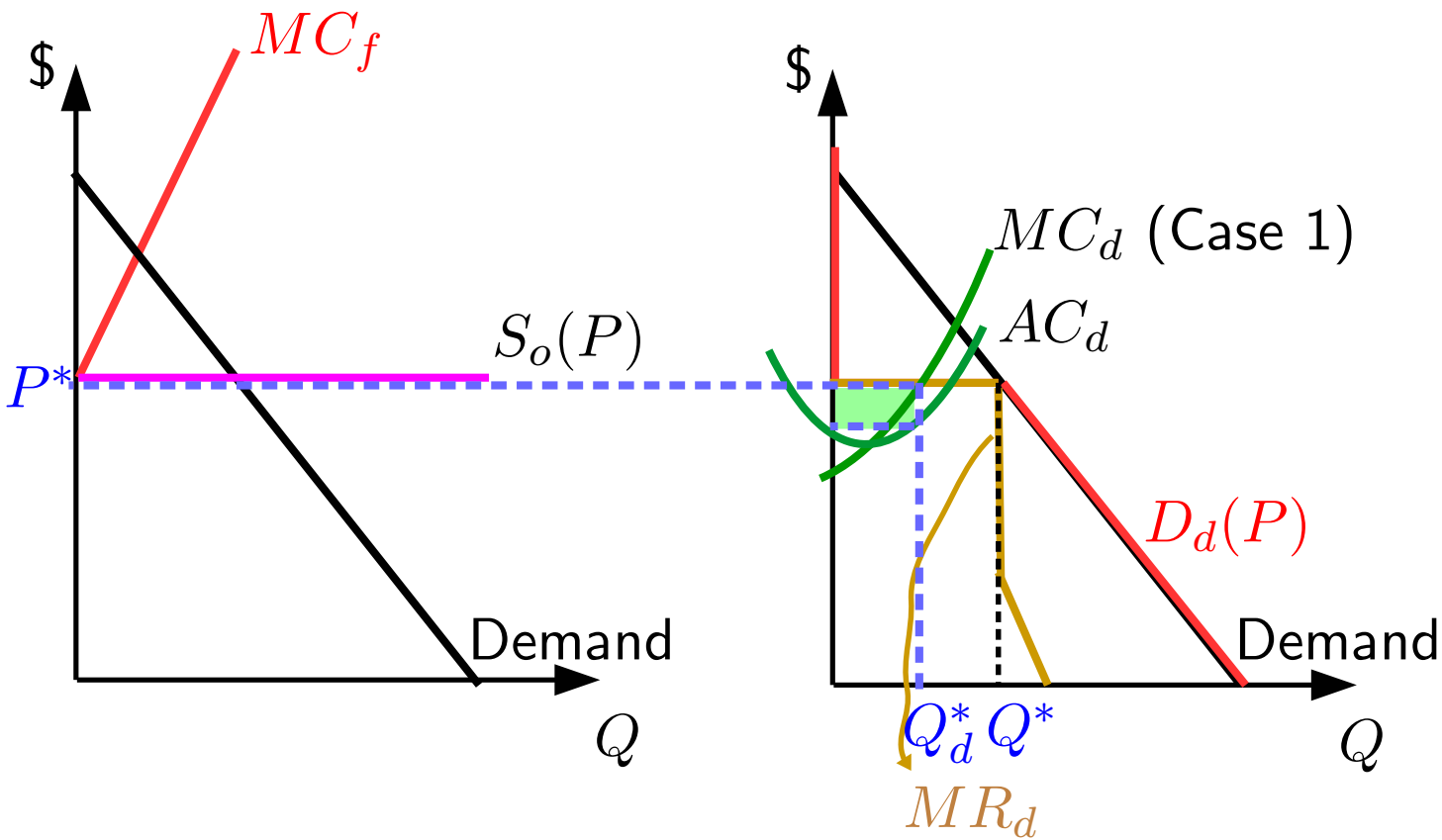
Dominant Firm (Free Entry) (II)

- Obtain the marginal revenue line MR_d from the residual demand curve



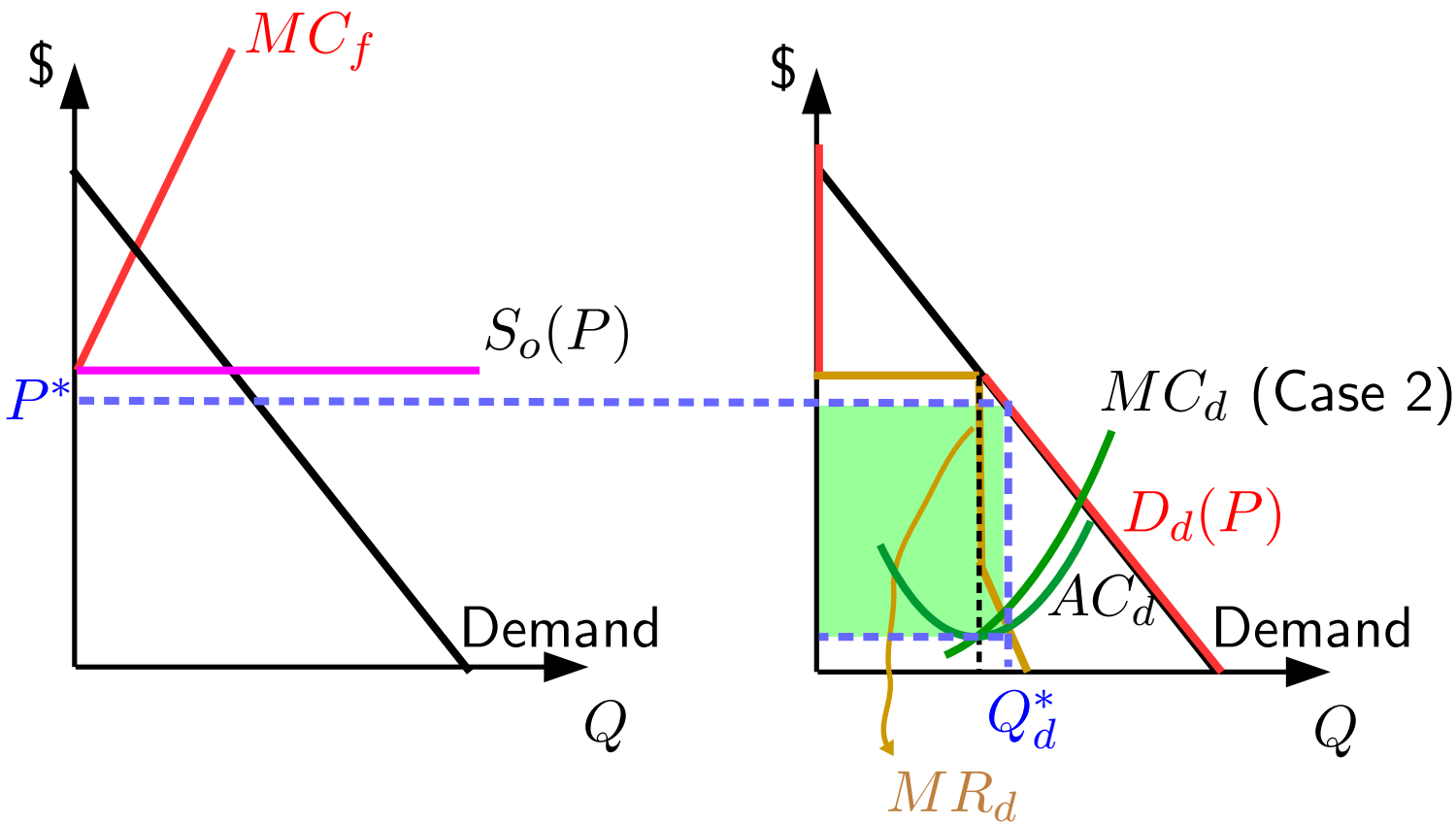
Dominant Firm (Free Entry) (III)

- Case 1: Optimal price and quantity for dominant firm: P^* and Q_d^*; optimal quantity for all the fringe firm: $Q_f^* = Q^* - Q_d^*$.



Dominant Firm (Free Entry) (IV)

- Case 2: Optimal price and quantity for dominant firm: P^* and Q_d^*; optimal quantity for each fringe firm: $q_f^* = 0$. (Monopoly case)



Homework 1

- Please provide an example for the dominant firm. If possible, show it.
- Do you think that this dominant firm has the market power to decide the price?
- Do you think that all the fringe firms are price takers?
- List some reasons in this market to be the dominant firm.
- Do you expect which kinds of market structure will be in the future?