Intermediate Microeconomics Lecture 10

Supply & Partial Equilibrium

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Market environments

- How does a firm decide how much product to supply?
  - goals, e.g. profit maximization
  - technology, e.g. cost function
  - market environments (市场环境)
- Market environments describe the ways that firms respond to each other when they make their pricing and output decisions
  - also referred to as market structure (市场结构)
- Four examples of market environments:
  - monopoly (垄断)
  - oligopoly (寡头)
  - monopolistic competition (垄断性竞争)
  - pure competition (完全竞争)

Market environments

- Monopoly
  - only one firm in this market
  - the only seller determines the quantity supplied/the market-clearing price
- Oligopoly
  - a few firms that sell identical products
  - the decisions of each influence the payoffs of the other firms
- Monopolistic competition
  - many firms that sell slightly different products
  - each firm's output level is small relative to the total
- Pure competition
  - many many firms that sell identical products

Pure competition

- Assumptions of pure competition
  - There are many buyers and sellers（有许多买者和卖者）
  - homogeneous product （同质产品）
  - freedom of entry and exit（进入与退出自由）
  - perfect information（完全信息）

Pure competition (cont.)

- Because there are many firms selling identical products, each individual firm is small relative to the whole market
- Each individual firm has no influence over the market price.
- In principle, each firm could decide how much to sell at what price, but
  - if its price is higher than the market price, then no one would buy from it;
  - if its price is lower than the market price, then every buyer would like to buy from it, but then the firm would like to raise its price.
  - implies that each firm would like to sell its product exactly at the market price.
  - firms are price-takers.

Pure competition (cont.)

- More specifically, from each firm's point of view, price of its product is fixed at the market price and all it has to worry about is how much to produce.
- Firms which are price takers are usually referred to as competitive firms.

Profit maximization

- Consider a competitive firm with a cost function $c(y)$.
- If the market price is p, then the firm's profit maximization problem is

$$\max_{y \geq 0} py\text{-}c(y)$$

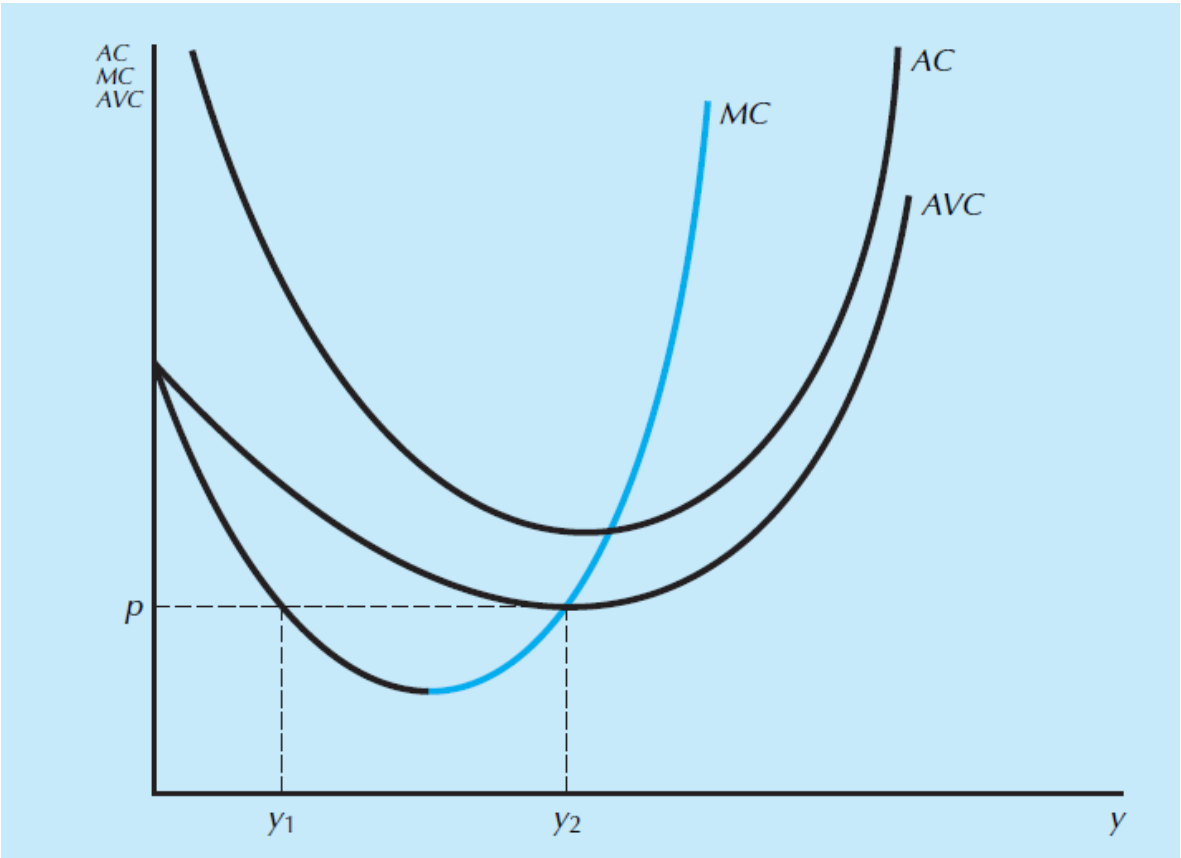
- A necessary condition (from the method of Lagrange multipliers) is

$$p \leq MC(y) \text{ with equality if } y > 0$$

- The equation $p = MC(y)$ gives us the inverse supply function
  - price as a function of output

Firm's supply curve

- There are two troublesome cases.
- The first case is when there are several levels of output where $p = MC(y)$.



Firm's supply curve (cont.)

- Which one will the firm choose?
- For the first intersection:
  - the MC curve is sloping down
  - increasing output raises profits
- The supply curve of a competitive firm must lie along the upwardsloping part of the MC curve
  - the "Giffen good" phenomenon cannot arise for supply curves

Firm's supply curve (cont.)

- The previous discussion is assuming that it is profitable to produce something
- It could be that the best thing for a firm to do is to shut down (停工)
- The firm is better off going out of business when

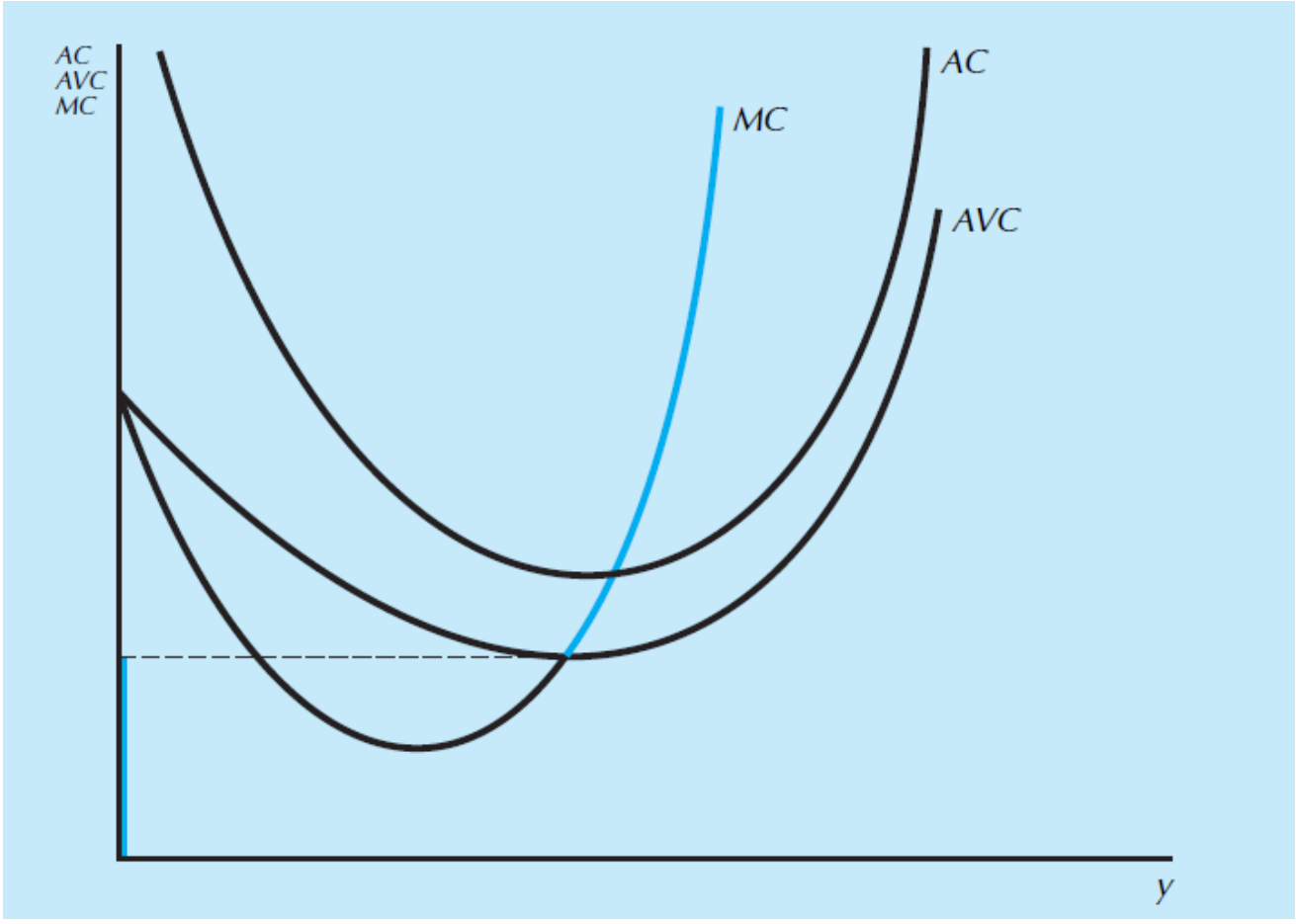
$$-F > py - c_v(y) - F$$

- Rearranging this equation gives us the shutdown condition

$$AVC(y) > p$$

- The supply curve is the upward-sloping part of the MC curve that lies above the AVC curve

Firm's supply curve (cont.)



Firm's supply curve (cont.)

- Assume a firm's short-run cost function is

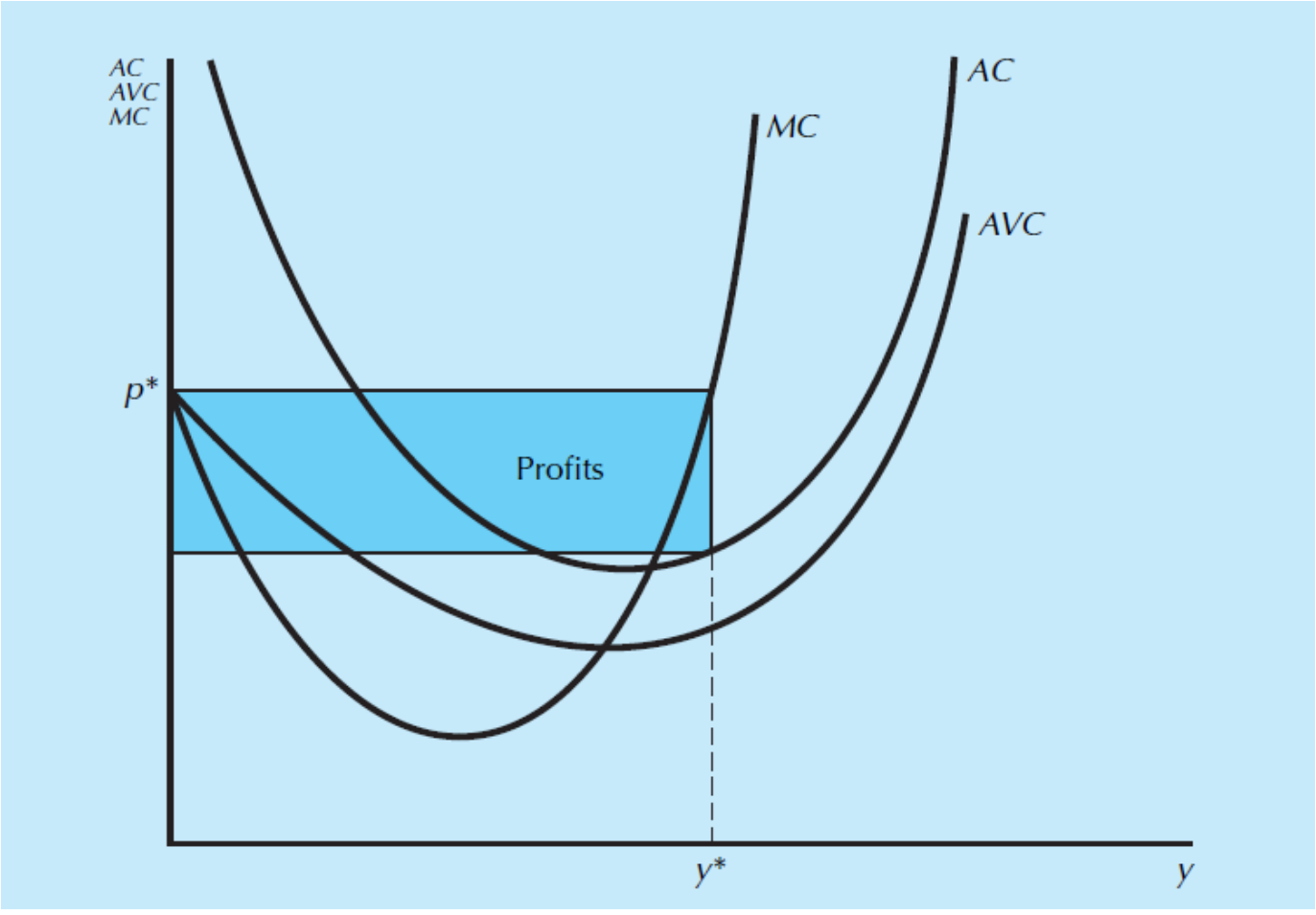
$$c_s(y) = 0.1y^3 - 2y^2 + 15y + 10$$

- Then this firm's short-run supply curve would be

$$S_s = \begin{cases} \frac{4+\sqrt{1.2p-2}}{0.6} & p \geq 5 \\ 0 & p < 5 \end{cases}$$

Profits and Producer's surplus

- If the market price is p and firm supplies y units of output, then the profit is $py - c(y)$ and this can be easily illustrated



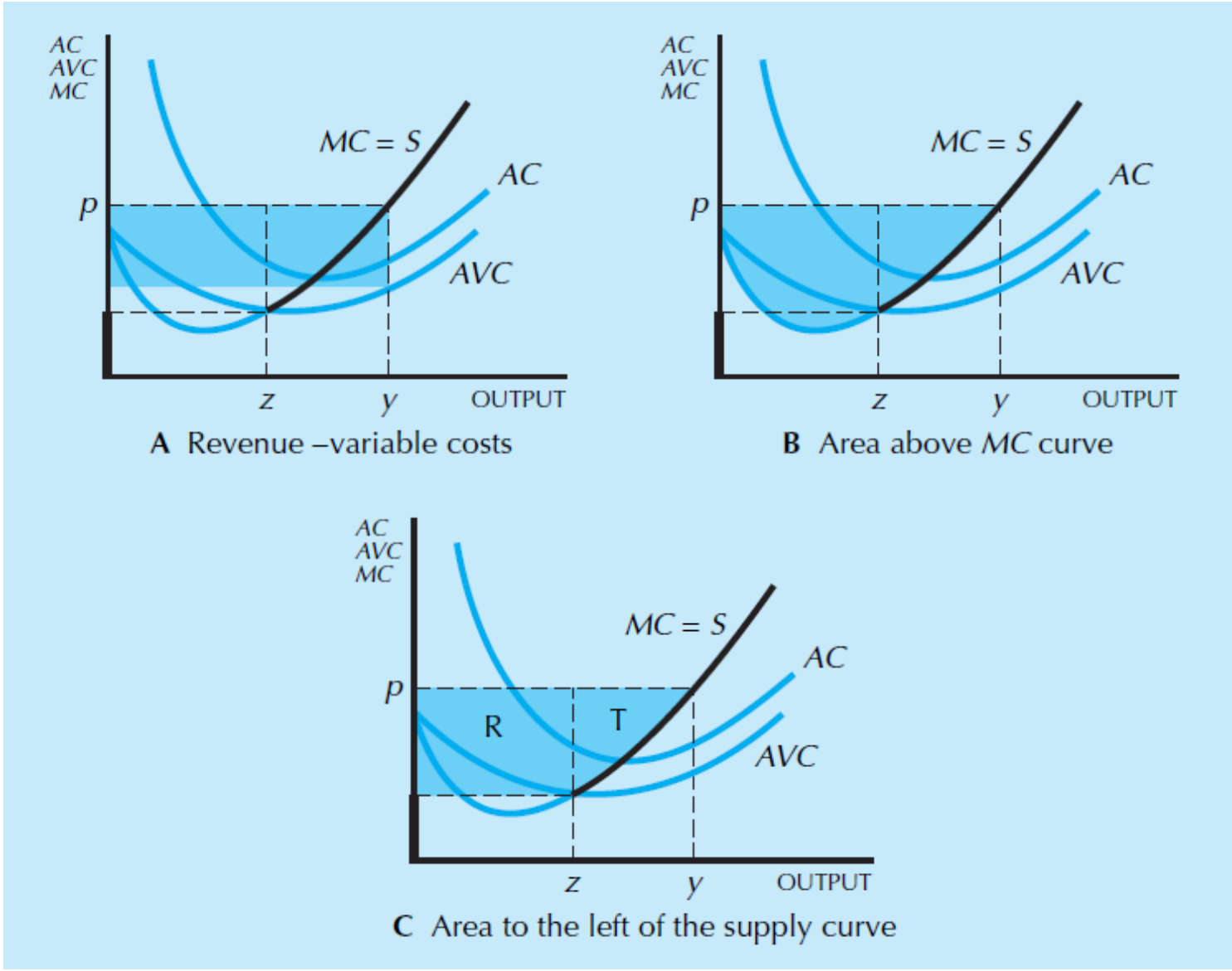
Profits and Producer's surplus (cont.)

- The producer surplus is the sum over all units produced of the difference between the market price of the good and the marginal cost of production

$$\begin{aligned} PS &= \int_0^{y^*} [p - MC(y)]dy \\ &= (py - c(y))|_0^{y^*} \\ &= py^* - c(y^*) - [0 - c(0)] \end{aligned}$$

- If the market price is p and firm supplies y units of output, then the producer's surplus is $py - c_v(y)$
- Therefore, we have $PS = \pi + F$

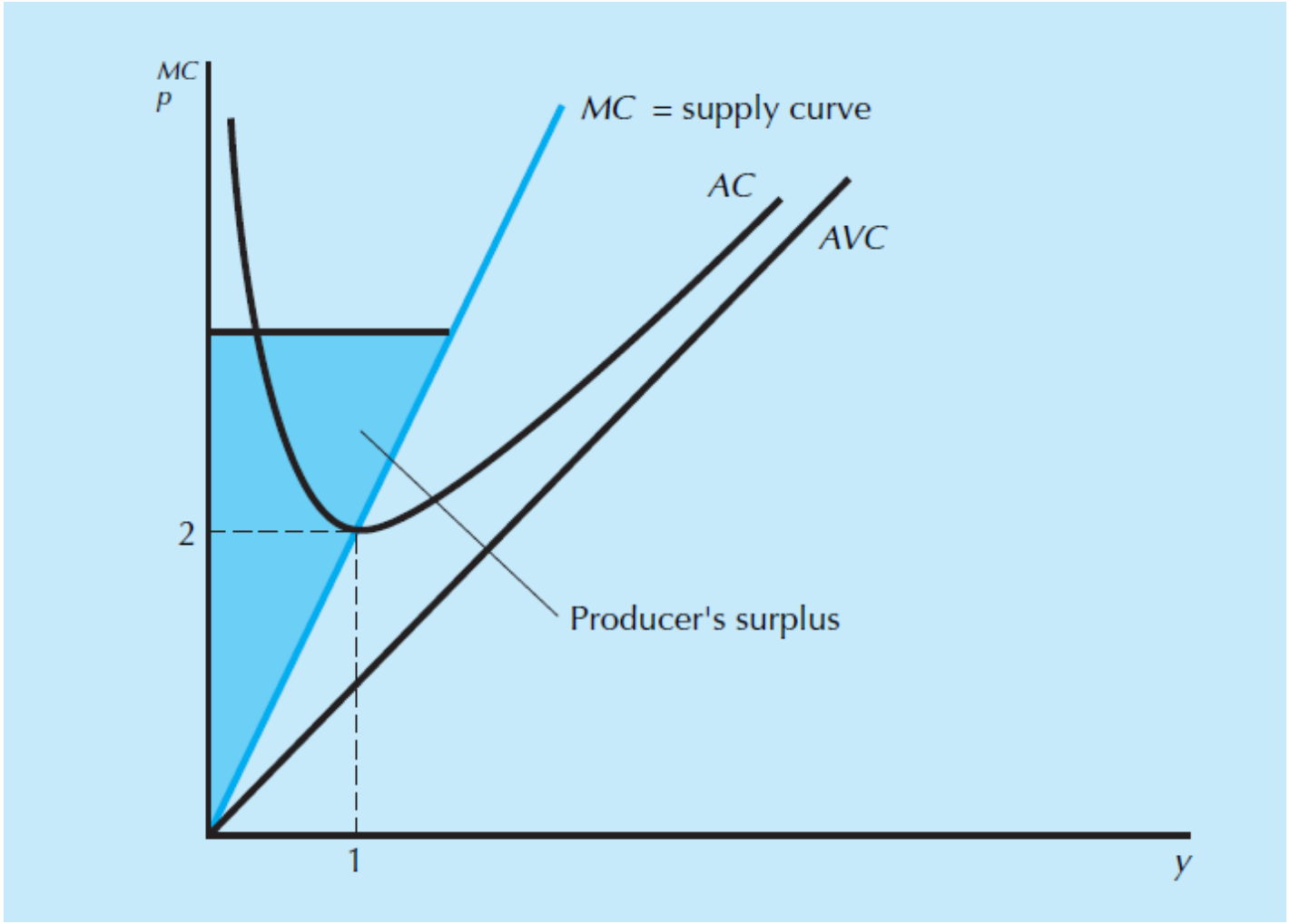
Profits and Producer's surplus (cont.)



An example

- Assume $c(y) = y^2 + 1$
- Then $MC(y) = 2y \Rightarrow y^*(p) = \frac{p}{2}$
- In this case profit is $p^2/2 - p^2/4 - 1 = p^2/4 - 1$.
- In addition producer's surplus is $(1/2) * (p/2)p = p^2/4$

An example (cont.)



Long-run supply

- There is nothing conceptually new if we want to consider firm's supply in the long-run.
- Let $c_L(y)$ be the firm's long-run cost function.
- If the market price is p, then the firm's long-run profit maximization problem is

$$\max_{y \geq 0} py - c_L(y)$$

- A necessary condition (from the method of Lagrange multipliers) is

$$p \leq MC_L(y) \text{ with equality if } y > 0$$

- So we only need to use the long-run cost function and then do the same exercises we did before.

Long-run supply (cont.)

- That is, the long-run supply curve will be given by

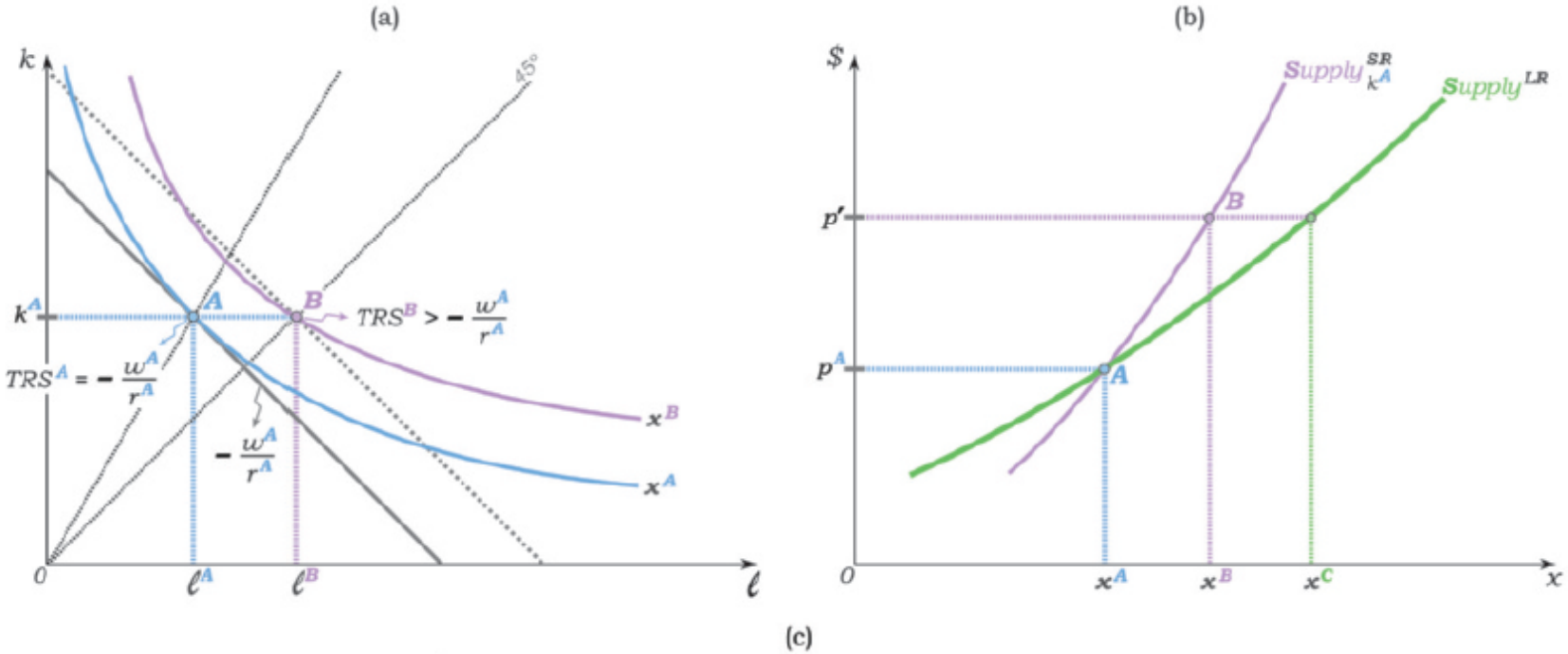
$$p = MC_l(y) = MC(y, k(y))$$

- The short-run supply curve is given by price equals marginal cost at some fixed level of k

$$p = MC(y, k)$$

- The long-run supply curve is more elastic than the short-run supply curve
  - when the price of output changes, the firm has more choices to adjust in the long run than in the short run

Short-Run versus Long-Run Supply Curves



Short-run industry supply

- We have seen how to derive a firm's supply curve from its *MC* curve.
- The industry supply curve will be the sum of the supplies of all the individual firms.
- In the short-run, the number of firms which can produce a certain product is finite and fixed.
- These firms "already exist" and are in some sense able to be up and running simply by acquiring the necessary variable inputs.

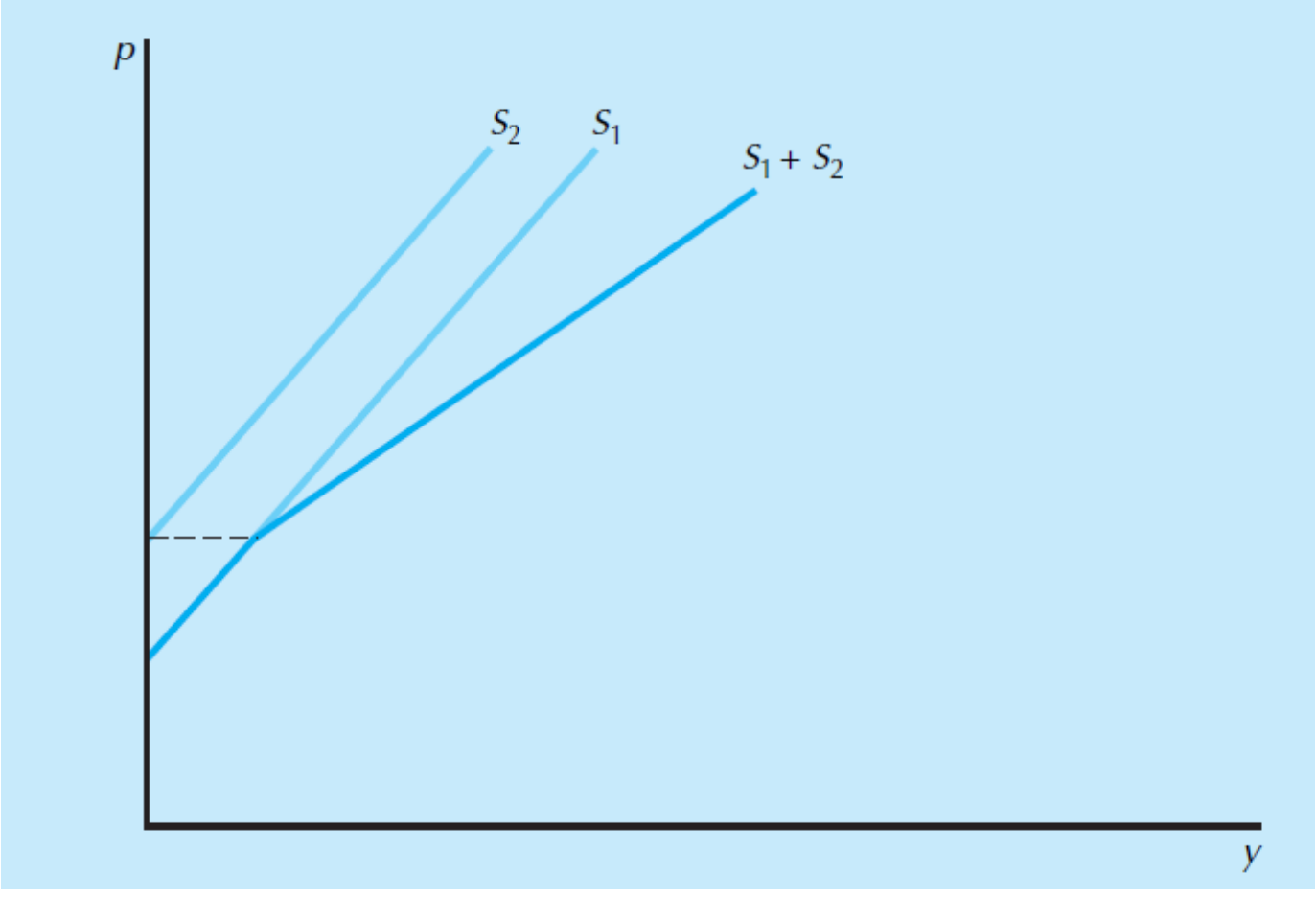
Short-run industry supply (cont.)

- Suppose there are n firms indexed by $i = 1, \cdots, n$.
- Firm i has a short-run supply curve $S_s^i(p)$.
- Then the total supply of this product is simply the sum of every firm's supply:

$$S_s(p) \equiv \sum_{i=1}^{n} S_s^i(p)$$

Short-run industry supply (cont.)

- An illustration of industry supply as the sum of individual supply



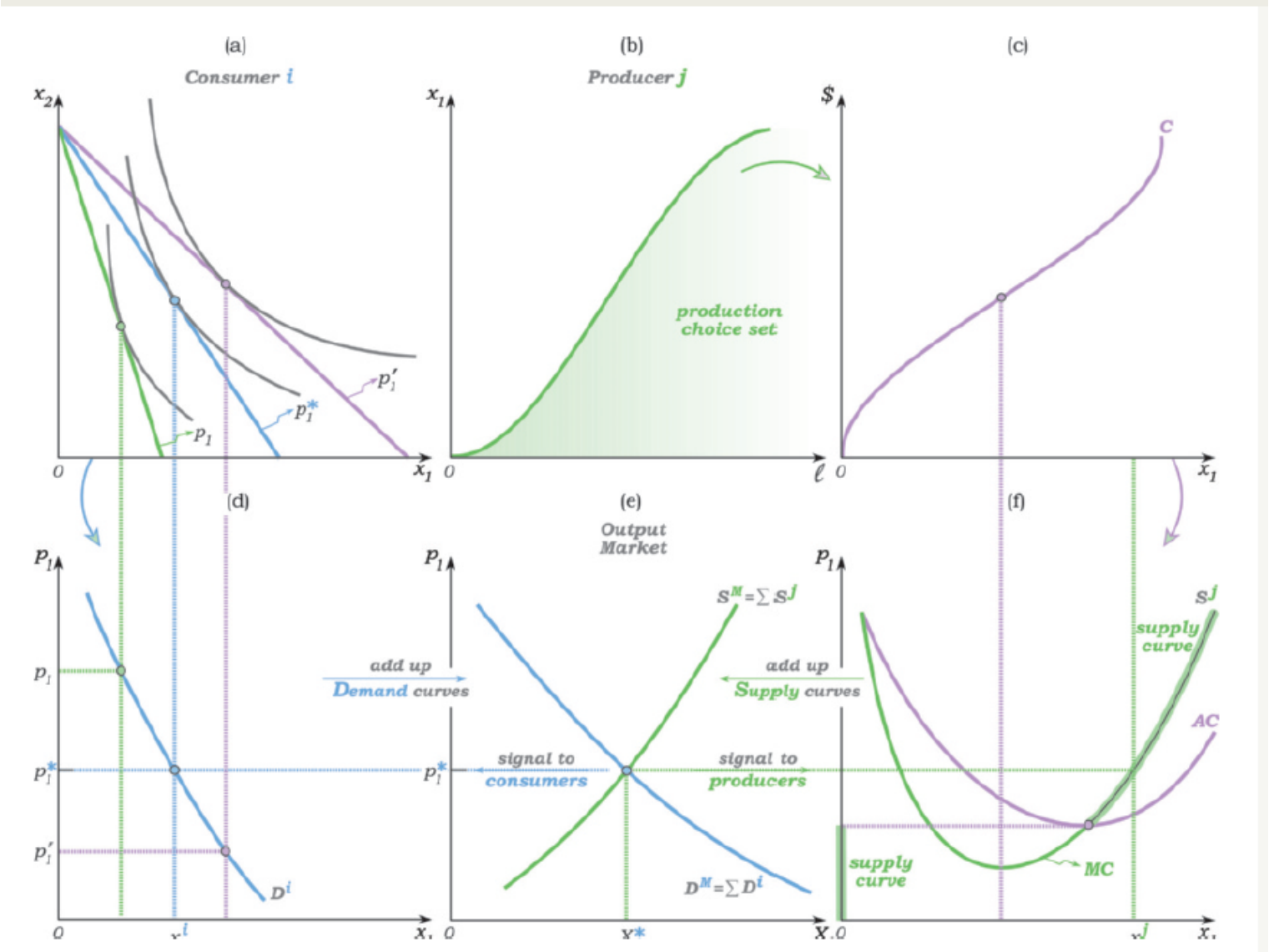
Short-run equilibrium

- Suppose the aggregate (or market) demand curve is $D(p)$.
- Then the intersection of the demand curve and supply curve is the short-run equilibrium of this industry.
- Formally, a short-run partial competitive equilibrium of this market (or industry) is a price-quantity pair (p^*, y^*) such that

$$D(p^*) = S_s(p^*) = y^*$$

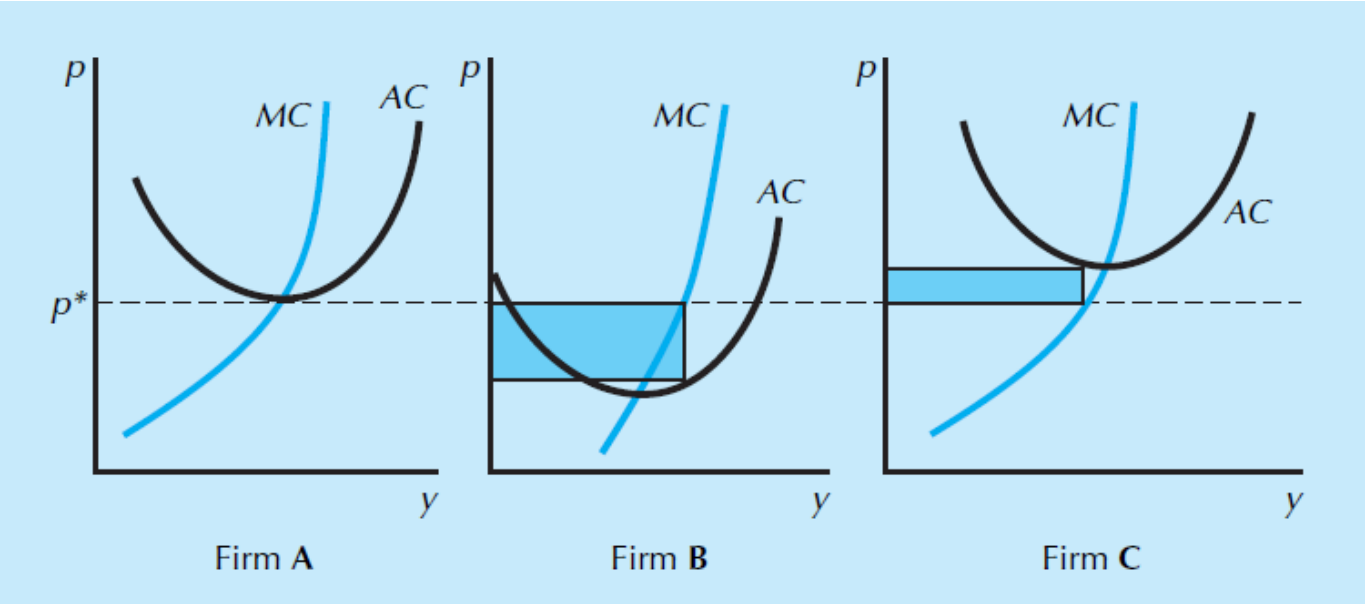
- So an equilibrium simply requires that demand be equal to supply.
  - market clears
- This is partial equilibrium
  - only consider one market, ignoring the interconnections among different markets.

Short-run equilibrium (cont.)



Short-run equilibrium (cont.)

- Because the technologies of these n firms might be different (but they produce the same products), it is possible that some of them make positive profits while some make negative profits.



Long-run equilibrium

- In the long run, incumbent firms are free to choose optimal levels of all inputs
  - they will move from their short-run to their long-run cost curves
- They are also free to leave the industry (exit)
- Moreover, new firms may decide to begin producing the good (entry).
- In most competitive industries there are no restrictions against new firms entering the industry
  - in this case we say the industry exhibits free entry

Long-run equilibrium (cont.)

- In a long-run equilibrium, we shall require that
  - the market clears
  - no firms has an incentive to enter or exit the industry.
- When do firms have incentives to enter or exit?
  - If some firms are making negative profits, they want to and will exit.
  - If some firms are making positive profits, firms outside the industry will adopt the technology of these firms and enter the industry.
- Therefore, condition 2 requires that all firms operating in this industry in the long-run earn zero profit.

Long-run equilibrium (cont.)

- Now for simplicity, we assume that firms are homogeneous.
- They all have the same long-run supply curve $S_l(p)$ and corresponding profit function $\pi(p)$.
- As before, the aggregate demand function is $D(p)$.
- A long-run partial competitive equilibrium is a triple (p^*, y^*, n^*) such that
  - $D(p^*) = n^* \times S_l(p^*) = y^*$(condition 1)
  - $\pi(p^*) = 0$ (condition 2)
  - p^*: equilibrium price; y^*: equilibrium quantity; n^*: equilibrium number of firms

Long-run equilibrium (cont.)

- Condition 1 is the usual market clearing condition
  - in equilibrium, total demand is equal to total supply.
- Condition 2 is zero profit condition
  - every firm operating in this industry must earn zero profit
  - in contrast to the short-run where the number of firms is exogenous, the number of firms in the long-run is endogenous

An example

- Suppose the long-run cost function is

$$c(y) = \frac{1}{3}y^3 - y^2 + 2y$$

- Therefore, the long-run MC is

$$LMC(y) = y^2 - 2y + 2$$

and

$$S_s = \begin{cases} \sqrt{p-1} + 1 & p \geq 1.25 \\ \\ 0 & p < 1.25 \end{cases}$$

An example (cont.)

- Now suppose that the aggregate demand is

$$D(p) = 90 - 24p$$

- If $p^* < 1.25$, then we know $S_I(p^*) = 0$ but $D(p^*) > 0$
- If $p^* > 1.25$, then each firm must earn positive profit because $p > LAC(S_I(p^*))$
- Then we are left with the case that every firm produces 1.5 at $p^* = 1.25$
- Market clearing condition leads to $n^* = 40$

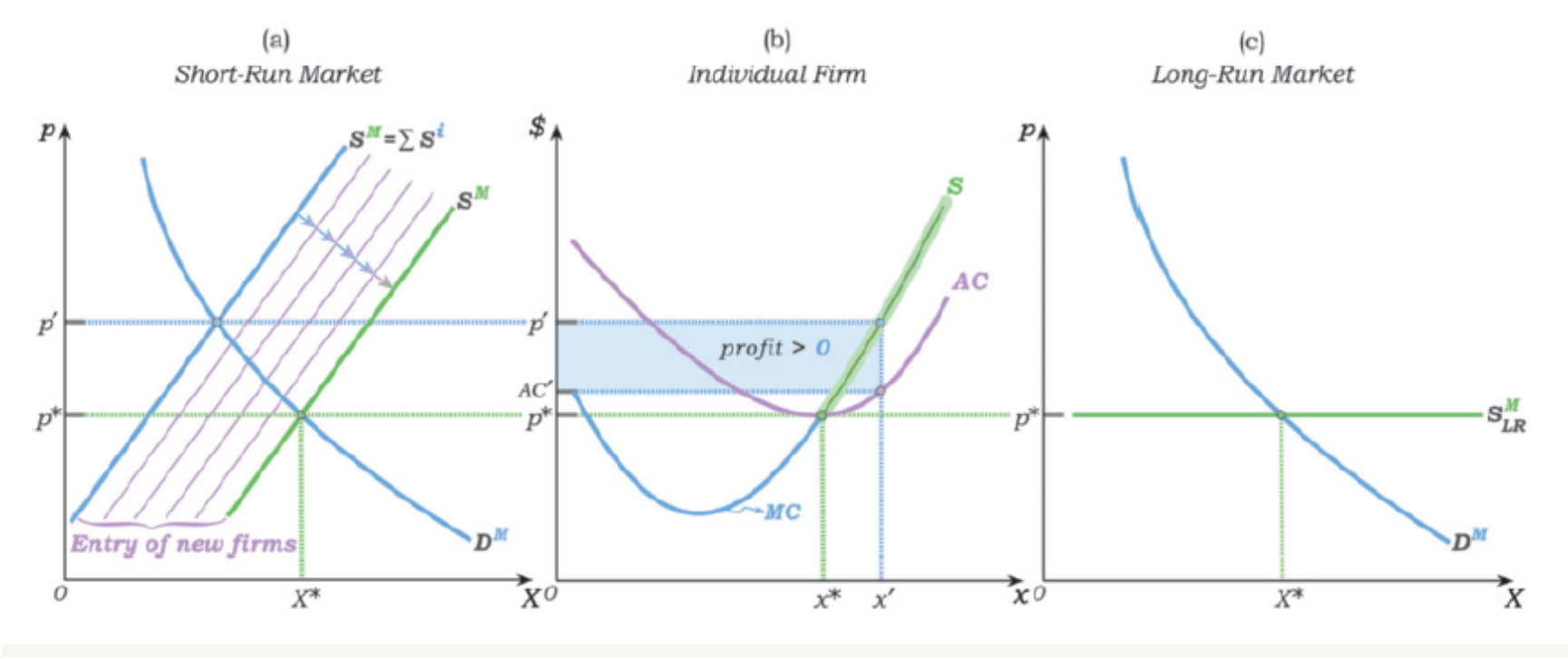
Equilibrium price

- In this example, the equilibrium price is equal to the lowest level of firm's long-run average cost.
- This is not accidental.
- Assume that the firm's long-run average cost function is minimized at $\tilde{y}$ and $LAC(\tilde{y}) = \tilde{c}$
- Assume also that $D(\tilde{c}) > 0$.

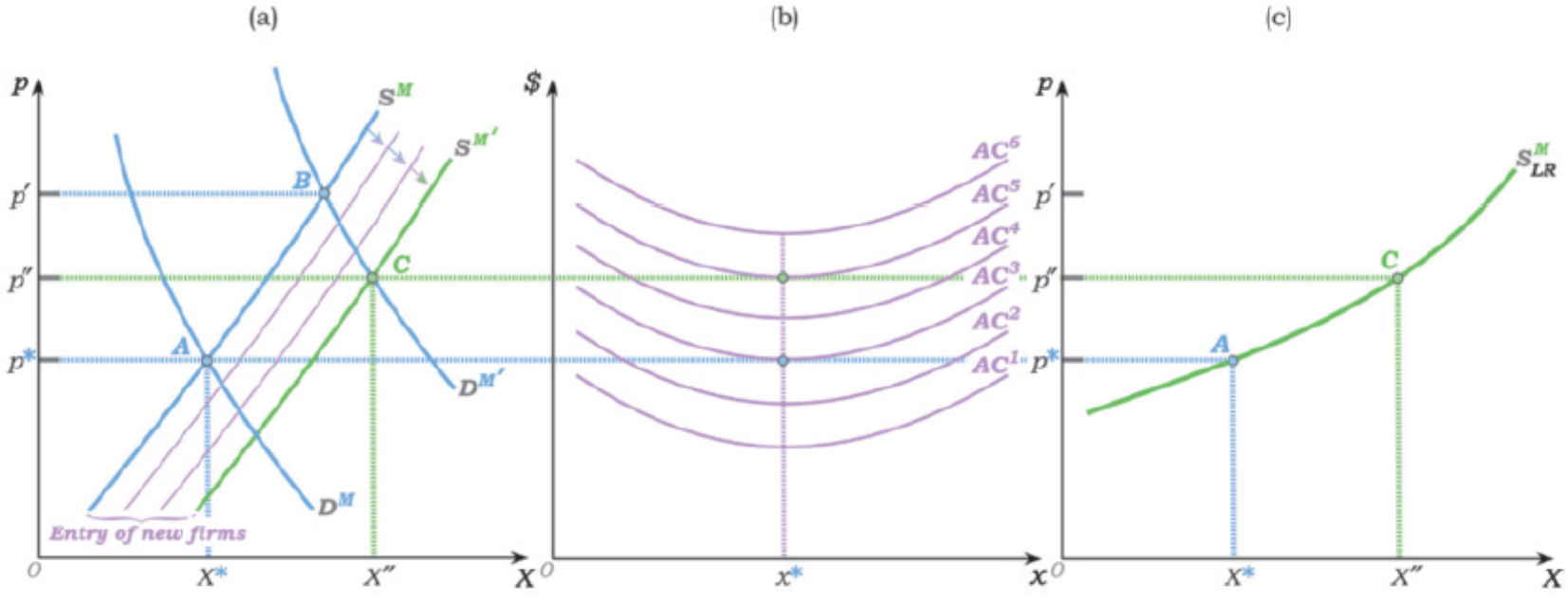
Equilibrium price (cont.)

- Any $p < \tilde{c}$ can not be an equilibrium price:
  - if every firm produces $y = 0$, then market does not clear;
  - if every firm produces $y > 0$, then $py - c(y) < y(\tilde{c} - \frac{c(y)}{y}) \leq 0$
- Any $p > \tilde{c}$ can not be an equilibrium price:
  - if every firm produces $y = 0$, then market does not clear;
  - if every firm produces $y > 0$, then
    $py - c(y) \geq p\tilde{y} - c(\tilde{y}) = \tilde{y}[p - \tilde{c}] > 0$
- So the only possible equilibrium price is $p = \tilde{c}$

Moving from short-run to long-run equilibrium

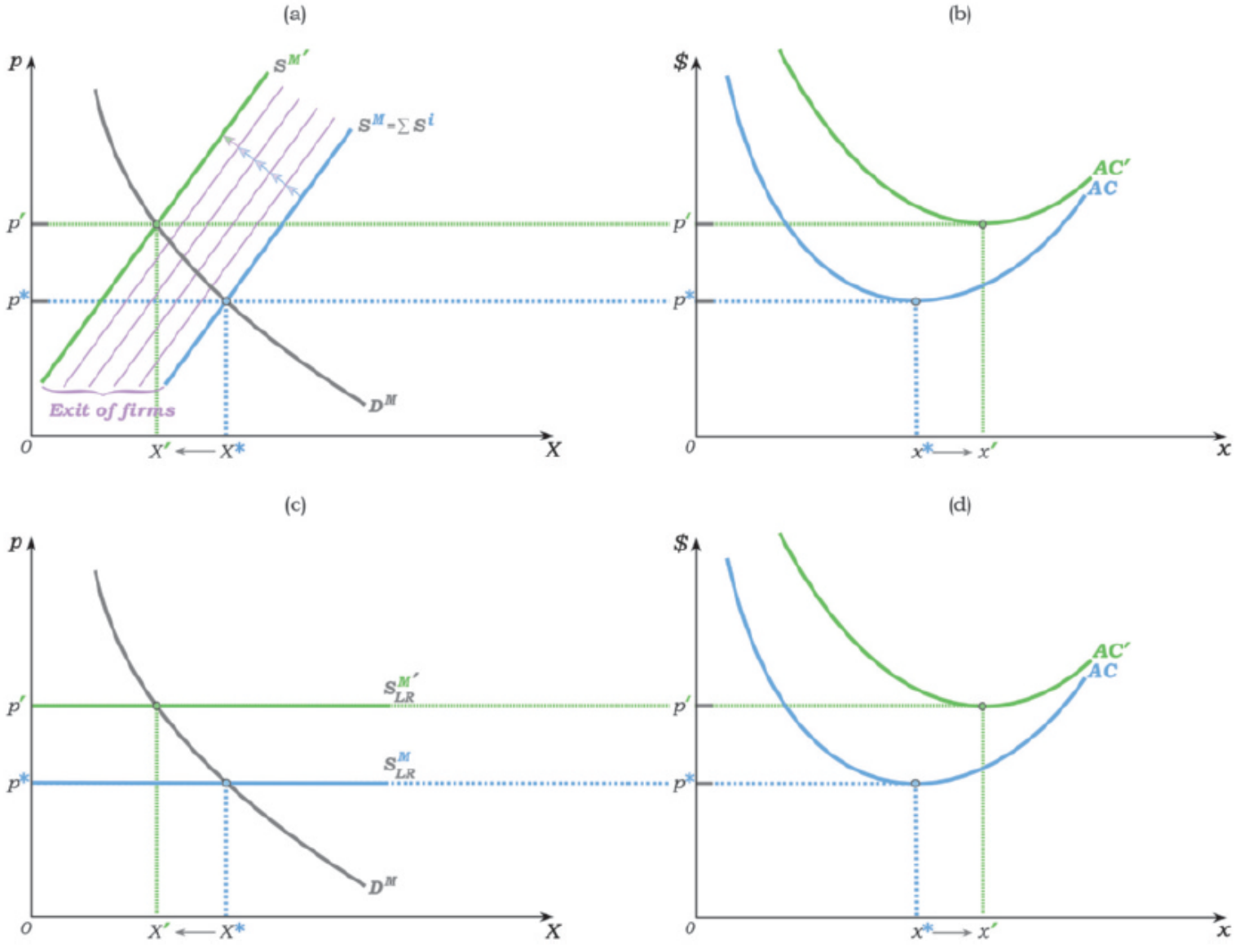


Long-run market supply when firms differ



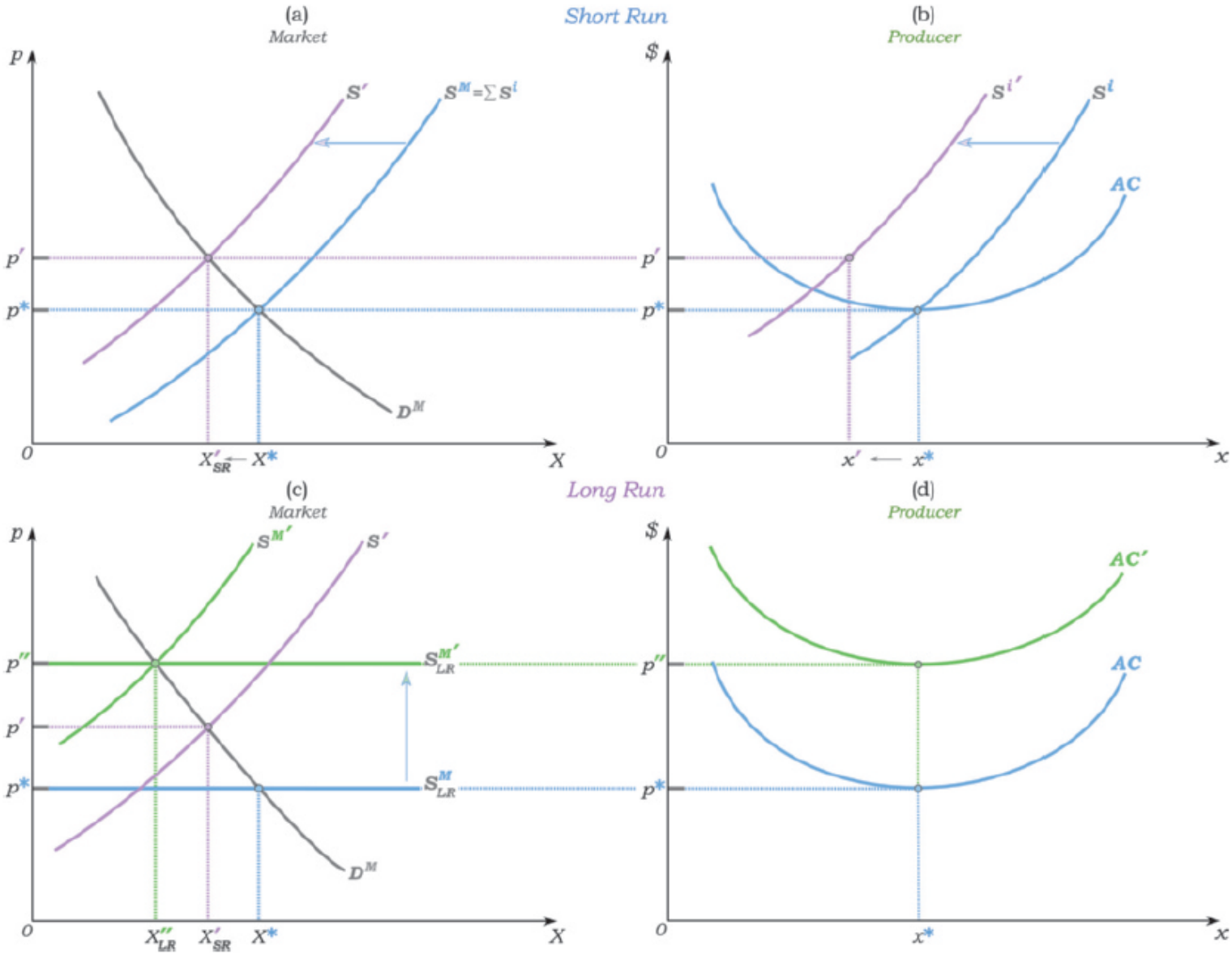
Changing conditions and changing equilibria

- A change in a long-run fixed cost



Changing conditions and changing equilibria (cont.)

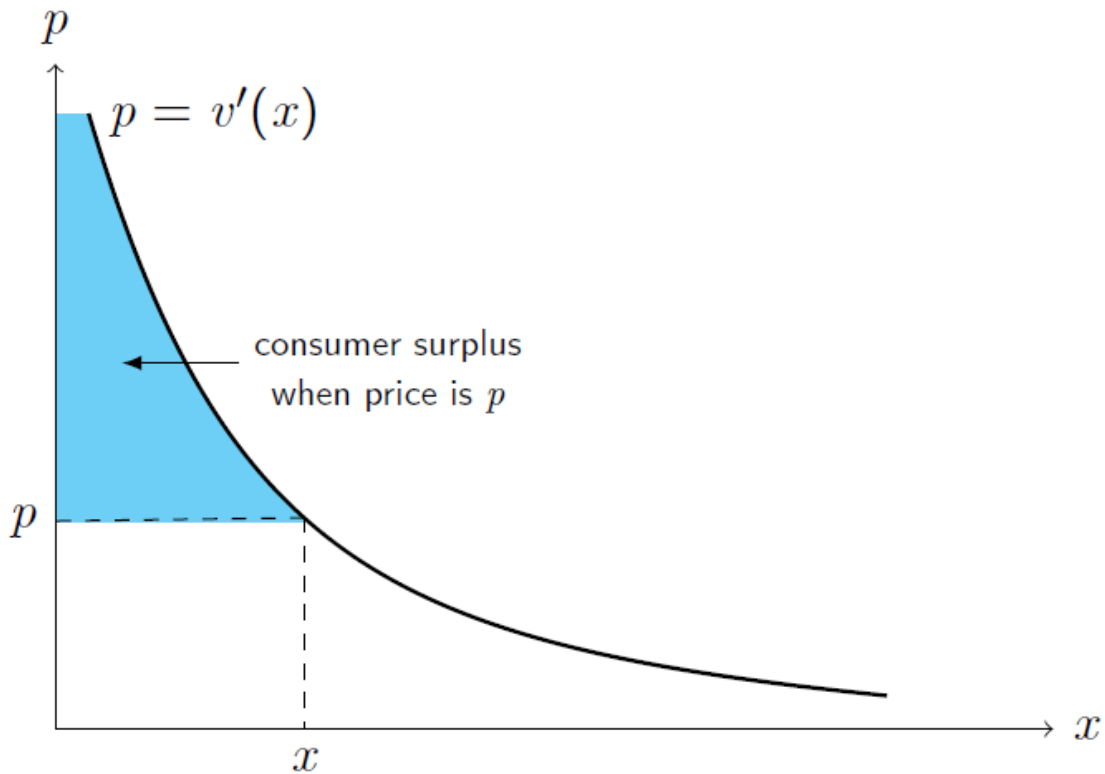
- An increase in the wage



Welfare analysis in equilibrium

- A market is Pareto efficient（帕累托有效率）if it achieves the maximum possible total gains-to-trade (total welfare)
  - there is no way to make someone better off without making anyone else worse off
- Otherwise a market is Pareto inefficient
- When is the market efficient?
- Recall that a quasi-linear utility function has the form $u(y, m) = v(y) + m$ where y is the amount of a consumption good and m is money
  - consumer's demand curve is $v'(y) = p$
  - consumer surplus is $v(y) - v(0) - py$ (since $v(y) - v(0) = \int_0^y v'(\tilde{y})d(\tilde{y})$)

Welfare analysis in equilibrium (cont.)



Welfare analysis in equilibrium (cont.)

- We've also learned that the producer surplus is

$$\begin{aligned} PS &= \int_0^y [p - MC(\tilde{y})]d\tilde{y} \\ &= py - c(y) - c(0) \end{aligned}$$

- In our discussion of "representative consumers," we noted the difficulty of treating market demand as if it had arisen from a single representative agent
  - income effects⇒distribution of wealth matters
- There are no analogous income effects to cause any difficulty in the discussion of producers
  - we can simply treat the market supply curve as if it was the supply curve of a single representative producer

Welfare analysis in equilibrium (cont.)

- Assume there are n consumers.
- Consumer i has a quasilinear utility $v_i(y) + m$
- Then consumer i's inverse demand curve is $p = v_i'(y)$
- Let consumer i's demand curve be $D_i(p) \equiv v_i'^{-1}(p)$
- The market demand is $D(p) = \sum_i D_i(p)$
- Finally, assume the representative producer's cost function is $c(y)$

Welfare analysis in equilibrium (cont.)

- Social surplus is the sum of consumers' surplus and firm's surplus
- Therefore, if each consumer buys y_i, the total surplus is equal to

$$\sum_i v_i(y_i) - \sum_i v_i(0) - (c(\sum_i y_i) - c(0))$$

- This is maximized if

$$v_1'(y_1) = v_2'(y_2) = \cdots = v_n'(y_n) = c'(\sum_i y_i)$$

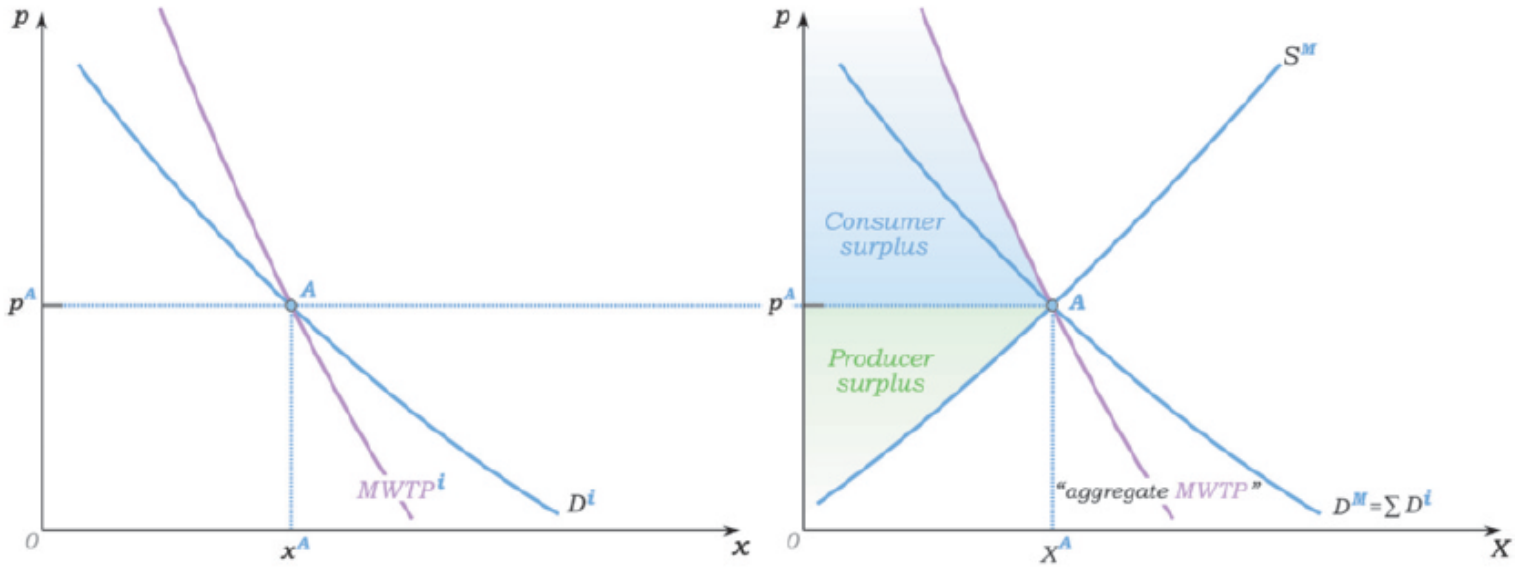
  - the optimal amount of consumption good is determined by the intersection of firm's MC and market demand

Welfare analysis in equilibrium (cont.)

- The decentralized competitive market therefore produces exactly the quantity the social planner would have chosen to produce if the planner's objective was to maximize the total surplus for society
- The first welfare theorem (福利经济学第一定理)
  - under certain conditions, markets are efficient
  - the invisible hand!
- Why?
  - the crucial role of information contained in prices
  - the crucial role of self interest

Welfare analysis in equilibrium (cont.)

- The first welfare theorem more general tastes



Welfare analysis in equilibrium (cont.)

Conditions underlying the first welfare theorem

- market prices actually operate as modeled
  - policy distortions of prices
- The only individuals whose welfare is affected by the production of a particular unit of are the producer and the consumer of that unit
  - externalities, social costs, and property rights
- all economic agents have the same information about the relevant aspects of the market
  - asymmetric information
- economic agents are "small" relative to the market
  - market power
- attaining efficient outcomes is the most desirable objective for society
  - alternative social objectives