Microeconomics
Class 4

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Recommended problems

Here are some recommended problems from the textbook by Pindyck and Rubinfeld. (I am referring to the Seventh Edition (English), but the problems in the other editions seem to be the same.)

Chapter 3.
Problems 5, 10, 15 and 16.

Chapter 4.
Problems 7, 11, and 13.

Chapter 7.
Problems 2, 3, 4, 8, 9, and 11.

Chapter 8.
Problems 4, 5, 6, 7, 8, 10, 11, 12, and 13.

Sections 7.3-7.4

- Opportunity costs.
- Accounting profit vs economic profit.
- User costs of capital.
- Optimal labour-capital mixture in the long term.

Production choice in the long-run

Short-run production and long-run production differ in two ways

1. In the *short run*, there is at least one fixed factor of production: capital (e.g. machinery, factories, etc.). But in the *long run*, the firm can buy (or sell) capital, to minimize production costs.
2. In the *short run*, the number of firms in the industry is *constant*. But in the *very long run*, firms may enter (or leave) the industry in response to abnormally high (or low) profits.

To explain these phenomena, we will need two more concepts:

- The difference between *accounting profit* and *economic profit* (due to *opportunity costs*). (Section 7.1)
- Production costs due to labour/capital mixture. (Sections 7.3-7.4)

7.1 Opportunity cost

- Suppose the interest rate is 5%.
- Suppose a firm borrows 100 000€ to buy new machinery.
- Assume (for now) that the machinery does not depreciate, so the firm could sell it later for 100 000€.
- What is the cost (per year) of owning this machinery?
- 5% x 100 000€ = 5000€/year.

7.1 Opportunity cost

- Now suppose the firm already *has* 100 000€ cash, so it can buy the machinery without borrowing. (And perhaps resell it later.)
- What is the yearly cost now? 0€/year?
- ***No!*** The ***opportunity cost*** is still 5000€/year, because the firm *could* have lent the 100 000€ to someone at 5% interest, and made 5000€/year.
- The ***opportunity cost*** of an investment is the return you *could have made*, if you had invested that resource in its *best alternative use* (e.g. investing in another sector, or lending it out at the current rate of interest.)

7.1 Economic profit versus accounting profit

- The concept of *opportunity cost* leads to a distinction between *accounting profit* and *economic profit*.
- The ***accounting profit*** of a firm is the difference between its *revenue* and its *expenses* (e.g. labour, materials, capital depreciation). This is the profit which is reported to shareholders.
- Each firm chooses its short-term production level to *maximize its accounting profit*.
- The ***economic profit*** is the difference between the firm's accounting profit and the opportunity costs of investment. A firm's long-term capital investments are intended to maximize *economic* profit.

7.1: Zero economic profit in the very long term

economic profit = (accounting profit)-(opportunity cost)

= (accounting profit)-(next-best return on investment).

- If economic profit> 0, then

(accounting profit) > (next-best return on investment),

so the *optimal investment* of your money is in this sector.

- Thus, new firms will move into any sector which offers a positive economic profit. (Assuming there is *free entry*.)
- Conversely, firms will move *out* of a sector which offers *negative* economic profit.
- Thus, in the very long-term equilibrium, *the economic profit will be* ***zero***.
- This does *not* mean that the accounting profit is zero.
- It just means that *accounting profit = opportunity cost*.

7.3 User cost of capital

- Earlier, we assumed (for simplicity), that the 100 000 € machinery did not depreciate.
- But in fact, machinery ***depreciates*** (gets damaged, wears out) every time you use it.
- So the cost of using a machine (or any other capital) has two components: the *opportunity cost*, and the *depreciation cost*.
- For simplicity, suppose the opportunity cost was just the interest rate times the market value of capital.
- Then we get the equation $K = d\,V + r\,V = (d + r)\,V,$

where K := the ***user cost*** of the capital, d := depreciation rate, r := the interest rate, and V := the market value of the capital.

Example: if the interest rate is r=5%/year, and the depreciation rate is d=8%/year, and V=100 000 € , then K = 13 000 €/year.

7.3 User cost of capital

- If owning capital is so expensive, why not just *rent* it?
- This makes no difference. In market equilibrium, the *rental cost of capital will be exactly equal to its user cost*.
- **Reason:** If a firm already owned the capital, it could choose between *using* it, *selling* it, or *renting* it to someone else.
- If rent > user cost, the firm would *rent* it to someone else.
- If rent < user cost, the firm would *sell* its capital, and use the money to rent the same capital back *from* someone else.
- In equilibrium, we must have rent = user cost.
- **Consequence**: In the long-term equilibrium, capital which is purchased is *economically equivalent* to capital which is rented, at a rental rate equal to the user cost K of capital.

7.3 Production in the long term.

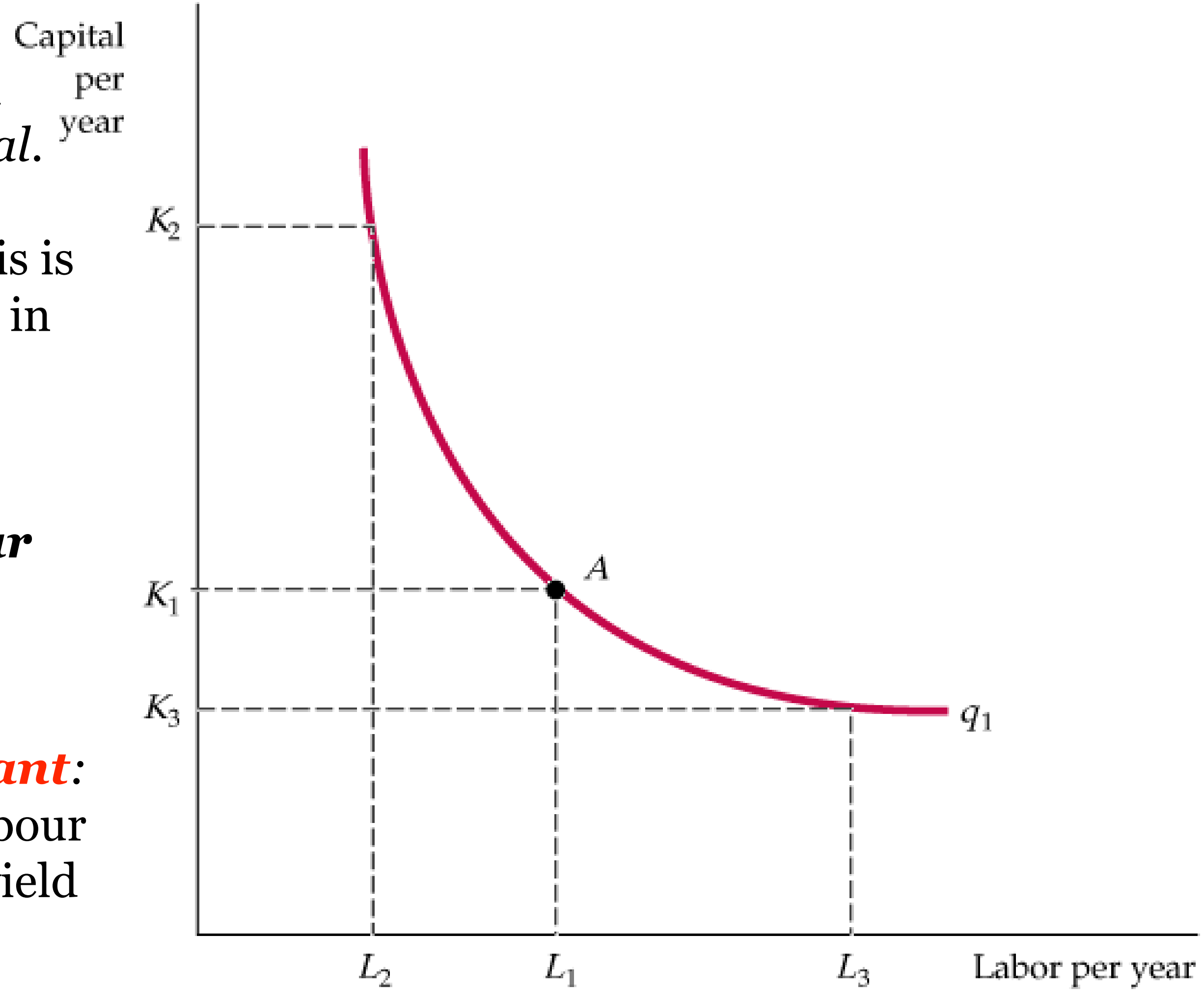
There are many different combinations of labour, capital, and other factors which can yield a particular level of output.

Here, for simplicity, let's suppose the only production factors are *labour* and *capital*.

In this graph, the vertical axis is ***capital costs*** *K* (expressed in terms of the *user cost* of the capital, per year).

The horizontal axis is ***labour costs*** *L* (e.g. wages x hours worked per year).

The **red curve** is an ***isoquant***: different combinations of labour cost and capital cost which yield the same output per year.



The combinations (K_1,L_1), (K_2,L_2), and (K_3,L_3) all yield the output level q_1.

The blue ***isocost lines*** describe the combination of inputs to production that cost the same amount to the firm (per year).

Isocost line C_1 is tangent to **isoquant** q_1 at A and shows that output q_1 can be produced at *minimum cost* with labor input L_1 and capital input K_1.

Other input combinations–L_2, K_2 and L_3, K_3–yield the same output but at *higher cost*.

However, this cost-minimization analysis assumes that the firm can vary its capital costs.

This is only true in the long-term, not in the short term.

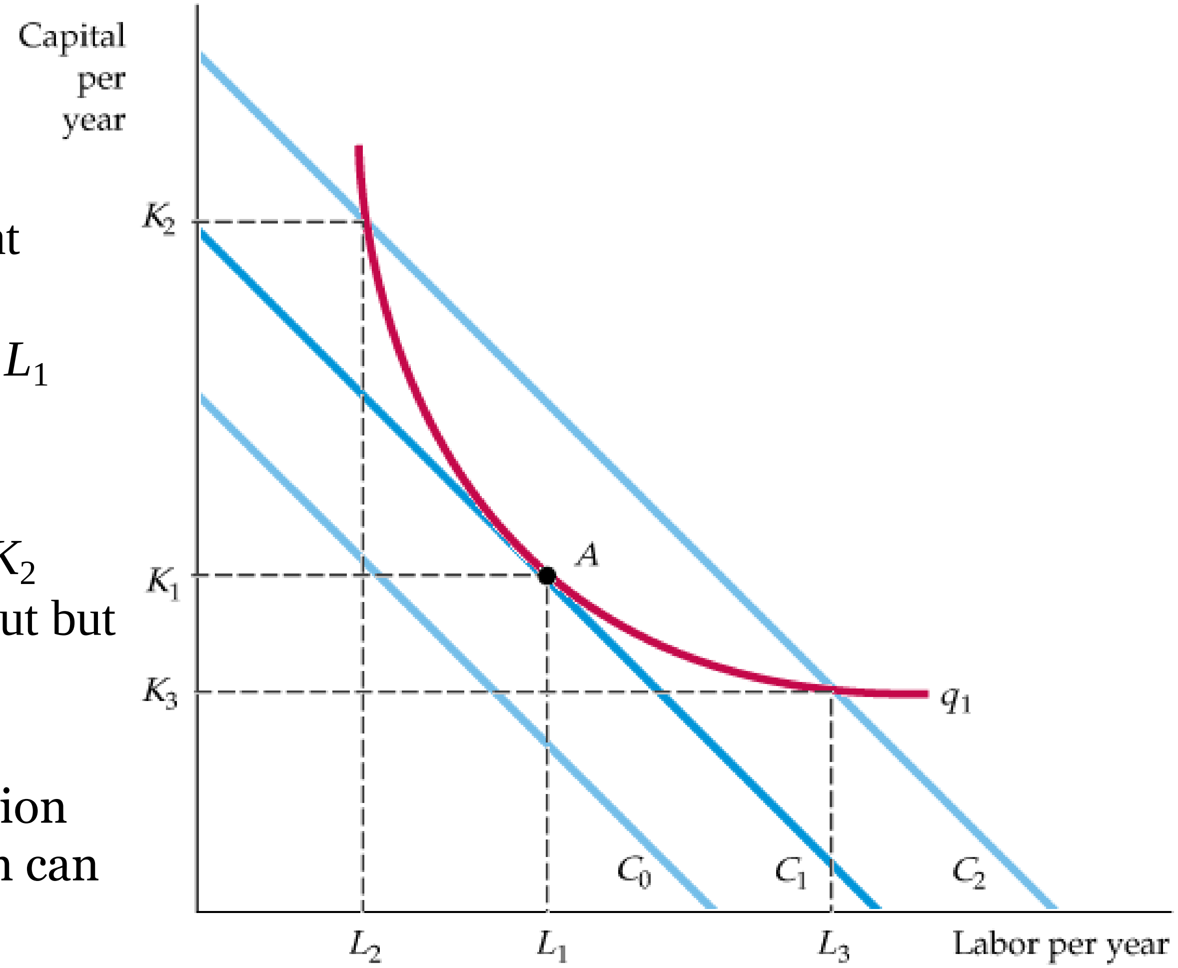
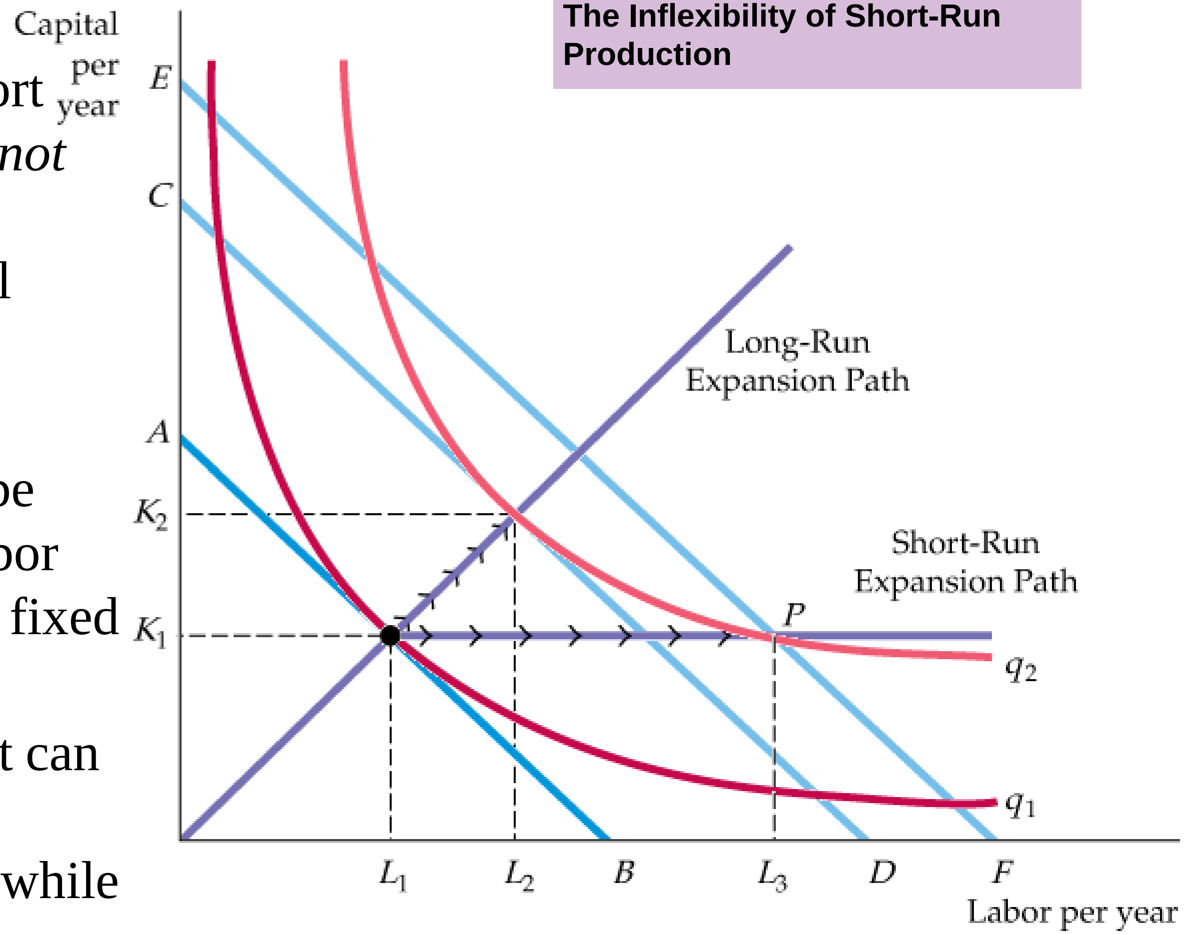


Figure 7.3 **Producing a Given Output at Minimum Cost**

The Inflexibility of Short-Run Production

Figure 7.7

The Inflexibility of Short-Run Production



When a firm operates in the short run, its cost of production may *not* be minimized, because of inflexibility in the use of capital inputs.

Output is initially at level q_1.

In the *short run*, output q_2 can be produced only by increasing labor from L_1 to L_3 because capital is fixed at K_1.

In the *long run*, the same output can be produced *more cheaply* by decreasing labor from L_3 to L_2, while increasing capital from K_1 to K_2.

- Recall that the **short-run average cost curve (SAC)** of a firm is the curve relating average cost of production to output when level of capital is *fixed*.

- In contrast, the **long-run average cost curve (LAC)** is the curve relating average cost of production to output when all inputs, including capital, are *variable*.

(**Note**: in the long term, there is thus *no distinction* between "total cost" and "variable cost".)

- Likewise, the **long-run marginal cost curve (LMC)** is the curve showing the change in *long-run* total cost when output is increased incrementally by 1 unit.

7.4 Economies and Diseconomies of Scale

As output increases, the firm's average cost of producing that output is likely to *decrease*, at least to a point.

This can happen for the following reasons:

1. If the firm operates on a larger scale, workers can specialize in the activities at which they are most productive.

2. Scale can provide flexibility. By varying the combination of inputs utilized to produce the firm's output, managers can organize the production process more effectively.

3. The firm may be able to acquire some production inputs at lower cost because it is buying them in large quantities and can therefore negotiate better prices. The mix of inputs might change with the scale of the firm's operation if managers take advantage of lower-cost inputs.

At some point, however, it is likely that the average cost of production will begin to *increase* with output level.

There are three reasons for this shift:

1. At least in the short run, limited factory space and machinery may make it more difficult for workers to do their jobs effectively.

2. Managing a larger firm may become more complex and inefficient as the number of tasks increases.

3. The advantages of buying in bulk may have disappeared once certain quantities are reached. At some point, available supplies of key inputs may be limited, pushing their costs up.

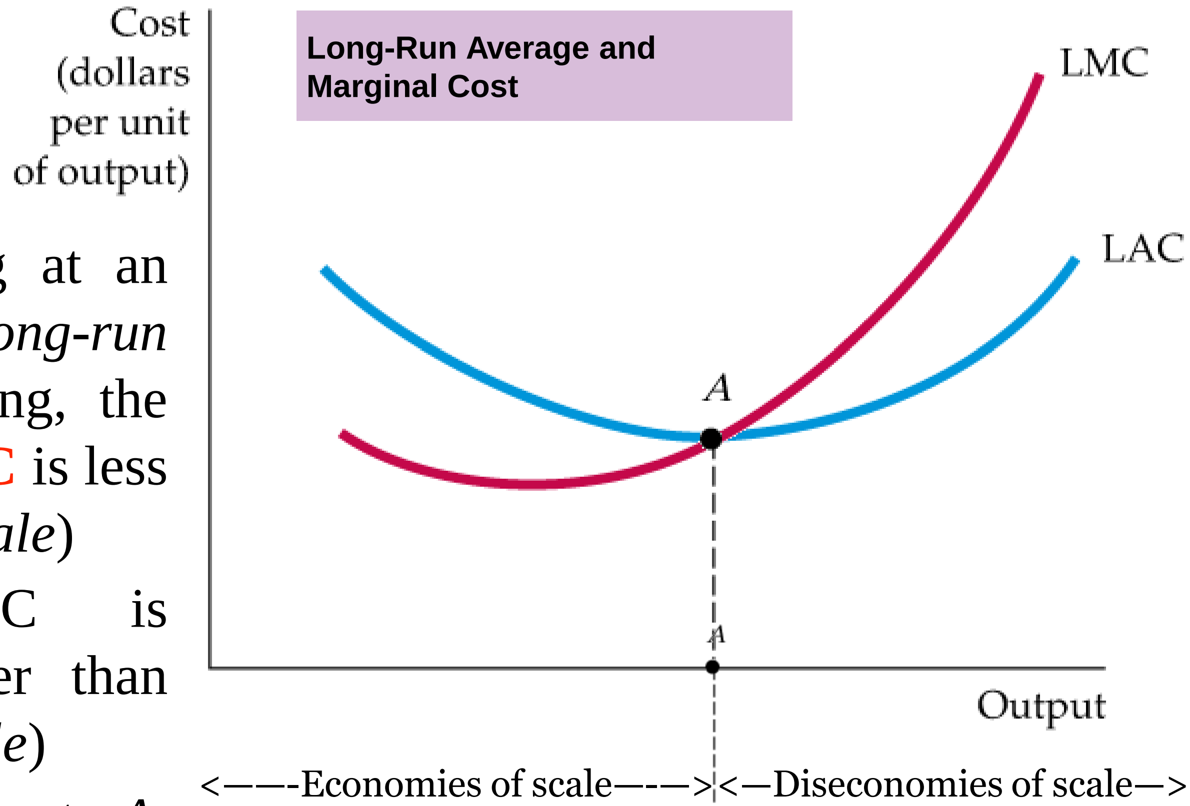
Long-Run Average Cost

When a firm is producing at an output at which the *long-run average cost* **LAC** is falling, the *long-run marginal cost* **LMC** is less than LAC. (*Economies of scale*)

Conversely, when LAC is increasing, LMC is greater than LAC. (*Diseconomies of scale*)

The two curves intersect at *A*, where the LAC curve achieves its *minimum*. This is called the ***minimum efficient scale*** of the firm. (This will be important later.)

Figure 7.8



Sections 8.7-8.8: Perfect Competition in the long run

Outline

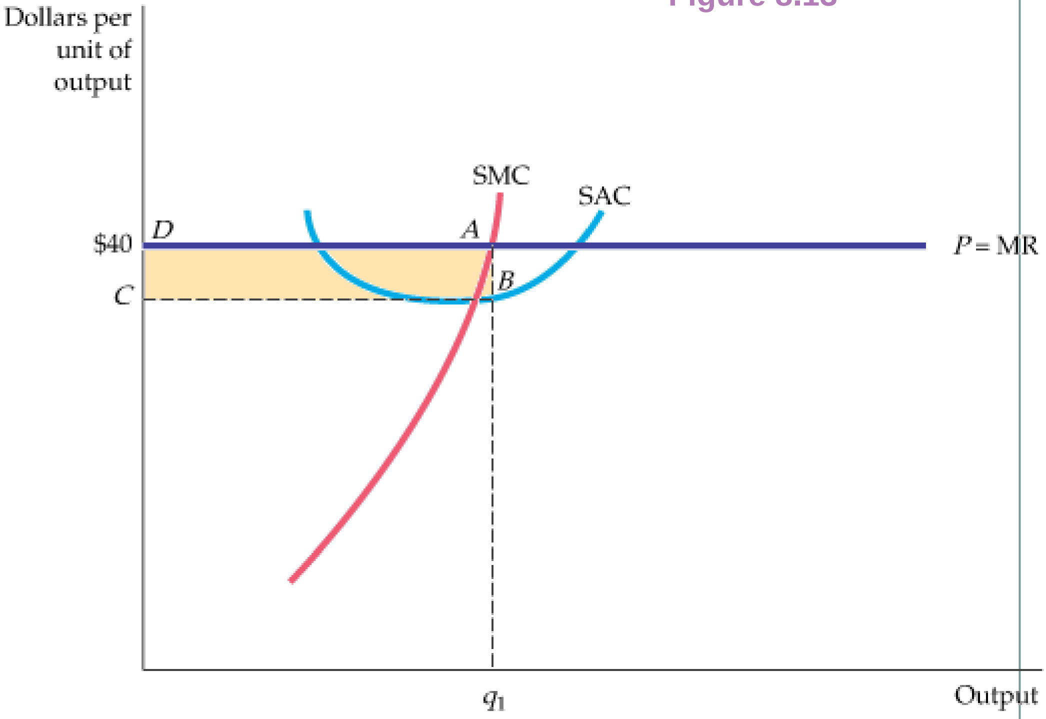
- Production choice
- Supply in the long-run
- Long-run equilibrium

8.7 Long-run profit maximization

In the *short term*, the firm cannot change its level of capital, so its marginal cost of production is described by the *short-term marginal cost* curve SMC.

Given a market price P, the firm maximizes profit (both *accounting profit* and *economic profit*) by choosing the production level q_1 such that $P = \text{SMC}(q_1)$. This yields a profit given by area(ABCD) (the **yellow rectangle**).

Figure 8.13



8.7 Long-run profit maximization

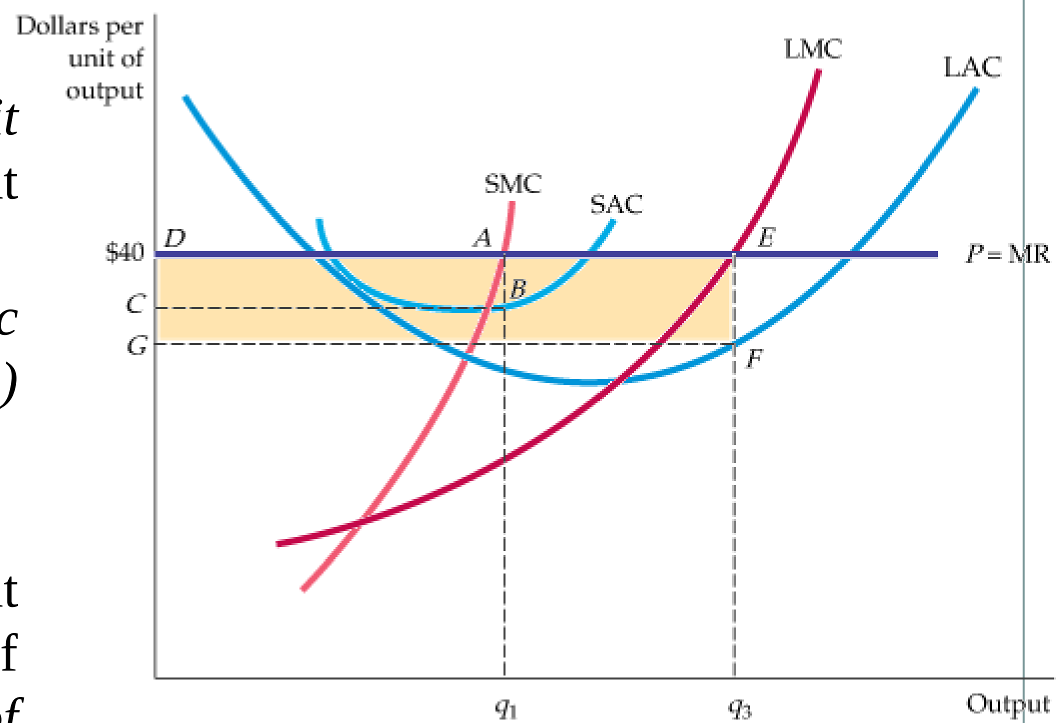
However, in the *long term*, the firm *can* change its level of capital investment, so its marginal cost of production is described by the *long-term marginal cost* curve LMC.

The firm *maximizes its economic profit* by choosing the output q_3 such that P=LMC(q_3).

Thus, the firm *increases its economic profit* from area(*ABCD)* to area(***EFGD***) by increasing its output in the long run.

(This maximizes *economic* profit because the long-term cost of production includes the *user cost of capital*, which in turn includes the *opportunity cost* of the capital.)

Figure 8.13



The long-run output of a profit-maximizing competitive firm is the point at which long-run marginal cost equals the price.

8.7 Entry and exit in the very long term

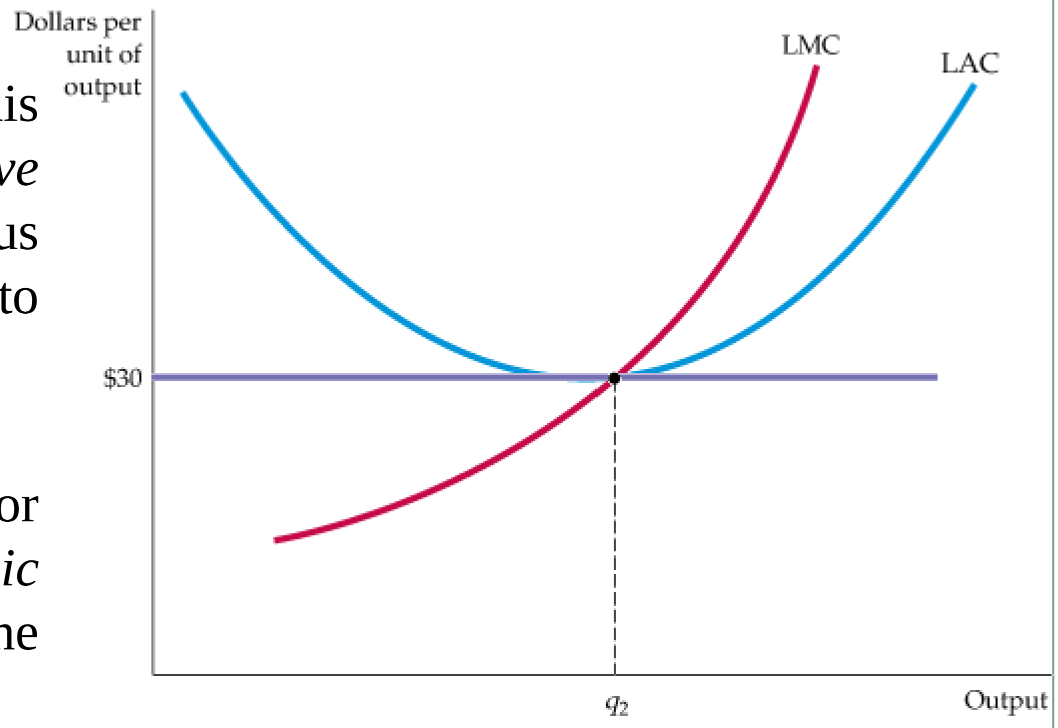
Note that the *minimum value* of LAC in this picture is $30.

If the *P* > $30, then firms in this sector are making a *positive economic profit* (as in previous slide). This will attract new firms to enter the sector.

If P < $30, then firms in this sector are making a *negative economic profit*. So then firms will *leave* the sector.

If *P* = $30, then firms in this sector are making *zero economic profit*. There is no incentive to either enter or leave the sector.

Figure 8.13



8.7 Very long-run competitive equilibrium

Entry and Exit

Long-Run Competitive Equilibrium

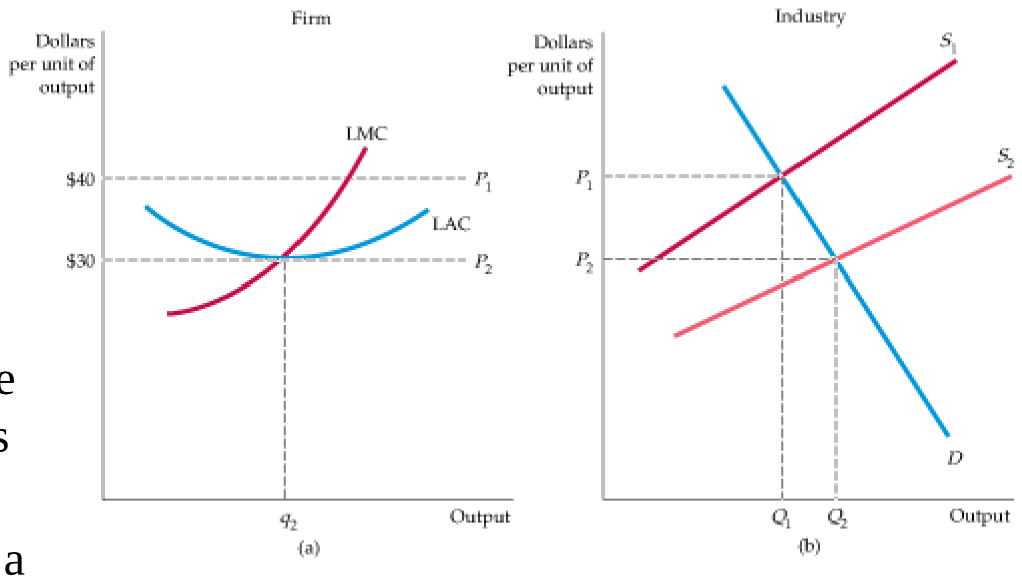
Initially the long-run equilibrium price of a product is $40 per unit, shown in (b) as the intersection of demand curve *D* and supply curve S_1.

In (a) we see that firms earn *positive profits* because long-run average cost reaches a minimum (at q_2) of $30 < $40.

Positive profit encourages entry of new firms and causes a shift to the right in the supply curve to S_2, as shown in (b). This drives down the equilibrium price…..

The *very long-run equilibrium* occurs at a price of $30, as shown in (a), where all firms earn ***zero economic profit*** and there is *no incentive to enter or exit the industry.*

Figure 8.14



8.7 Very long-run competitive equilibrium

Entry and Exit

In a market with entry and exit, a firm enters when it can earn a positive long-run profit and exits when it faces the prospect of a long-run loss.

A ***very long-run competitive equilibrium*** occurs when three conditions hold:

1. All firms in the industry are maximizing profit.
2. No firm has an incentive either to enter or exit the industry because all firms are earning zero economic profit.
3. The price of the product is such that the quantity supplied by the industry is equal to the quantity demanded by consumers.

8.7 Very long-run competitive equilibrium

Firms Having Identical Costs

To see why all the conditions for very long-run equilibrium must hold, first let's assume that all firms have identical costs.

Now consider what happens as many firms enter the industry in response to an opportunity for profit.

The industry supply curve will shift further to the *right*, until the market price falls to the threshold of zero economic profits. (Then no more firms will enter.)

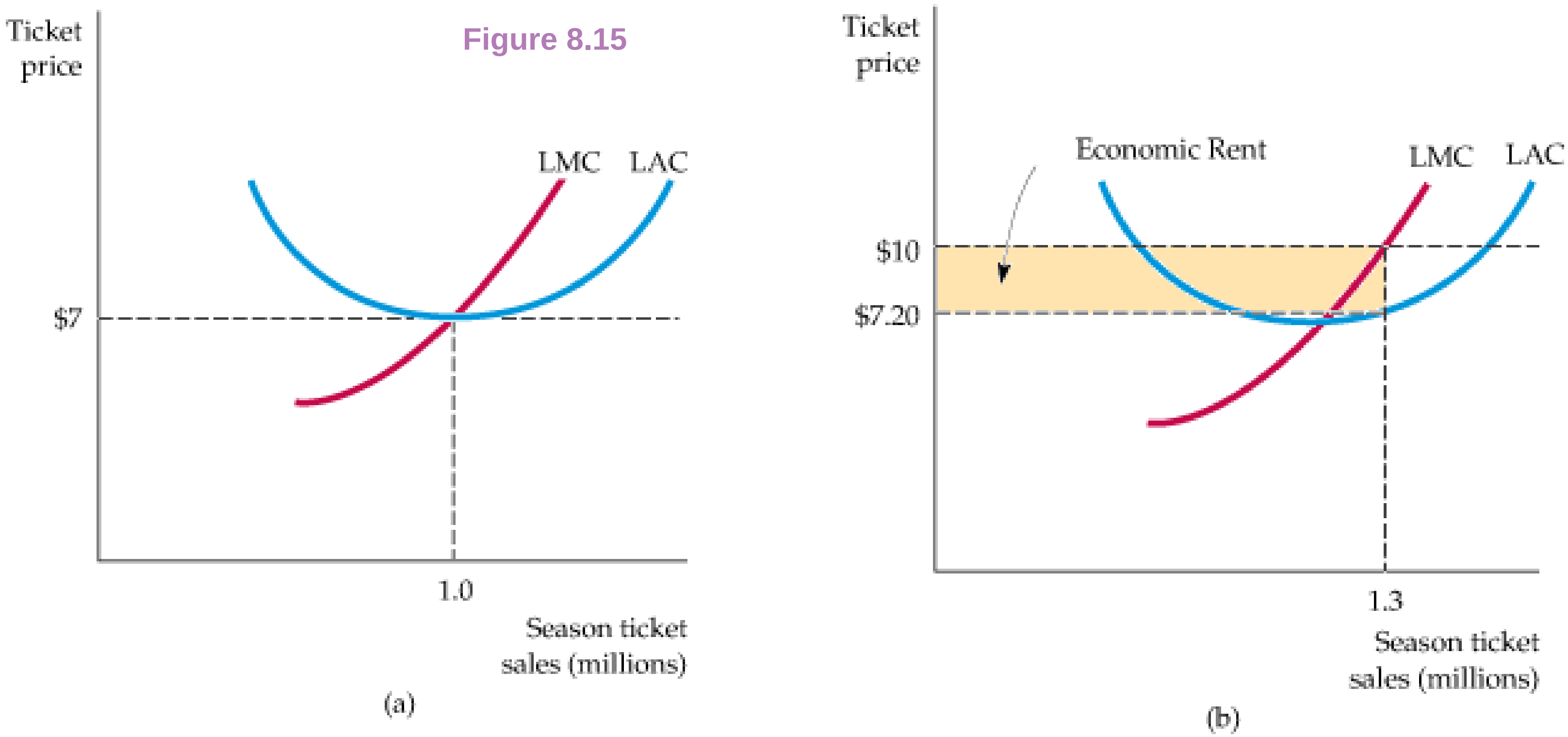
Firms Having Different Costs

Now suppose that all firms in the industry do *not* have identical cost curves. The firm with the lowest costs must have a secret or patented technology (otherwise, the other firms would simply copy its technology).

The distinction between *accounting profit* and *economic profit* is important here.

If the patent is profitable, then other firms in the industry would *pay* to use it. The increased value of a patent thus represents an *opportunity cost* to the firm that holds it, because it is a potential source of revenue which it is not exploiting.

8.7 Zero profit in very long-run equilibrium



In long-run equilibrium, all firms earn zero economic profit.

- In **(a)**, $7 is the minimum long-term average cost. If *P*< $7, then any level of production yields *negative economic profit*, so firms will eventually leave the sector.
- If *P*=$7, then the firm will produce 1 unit. This is the *minimum efficient scale* of production for this firm.
- In **(b)**, the demand is greater, so a $10 price can be charged. This yields a *positive economic profit*. This brings new firms into the sector.

8.7 Minimum efficient scale

- The *minimum efficient scale* (MES) is production level q^* at which a firm's long-run average cost (LAC) is minimized.
- If $q < q^*$ then LMC < LAC: there are *economies of scale*.
- If $q > q^*$ then LMC > LAC: there are dis*economies of scale*.
- Let minLAC = LAC(q^*) (i.e. LAC at the MES).
- If P > minLAC, then economic profit > 0, so in the very long term, new firms will enter the sector, and produce quantity q such that MC(q)=P.
- If P < minLAC, then economic profit < 0, and firms leave the sector (in the very long term).
- If P = minLAC, then firms are indifferent between entering or not the market. If a firm enters, it produces at q^* =MES.

- In a *constant-cost industry*, the very long-term supply curve is *entirely determined* by minLAC (see next slide).

8.8 Very long-term supply in a constant cost industry

A **constant-cost industry** is one whose very long-run supply curve is *horizontal,* because there are no *production externalities* between firms. In particular, the price of *production inputs* is unaffected by the level of production. (Example: grain)

In (b), the very long run supply curve in a constant-cost industry is a *horizontal line* S_L.

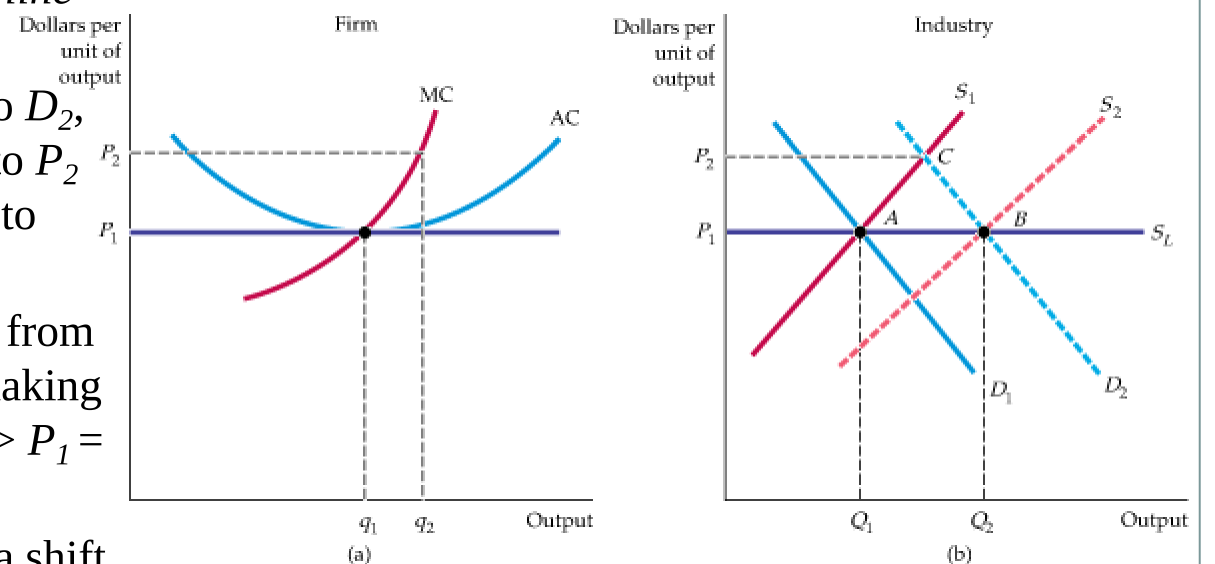
Suppose demand increases from D_1 to D_2, initially causing a price rise from P_1 to P_2 (represented by a move from point *A* to point *C*).

The firm initially increases its output from q_1 to q_2, as shown in (a). Now it is making *positive economic profit*, because $P_2 > P_1 =$ minLAC.

This attracts new firms. This causes a shift to the right in industry supply from S_1 to S_2.

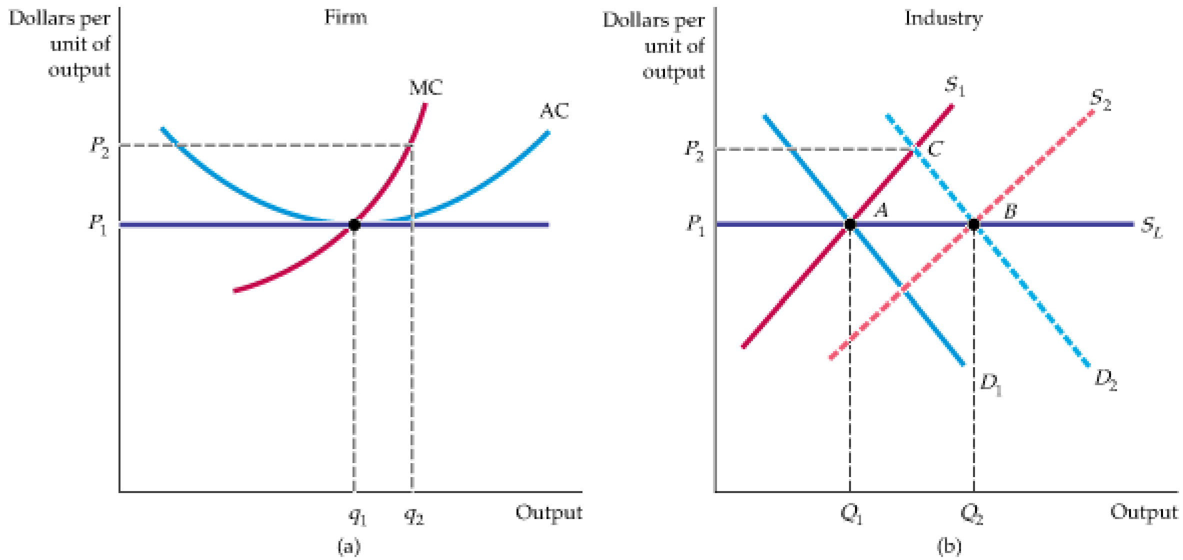
There are no production externalities, so production costs are unaffected by the increased output of the industry. Thus, entry occurs until the original price is obtained (at point *B* in (b)), and economic profit is zero.

Figure 8.16



The very long run supply curve for a constant-cost industry is a ***horizontal line*** *at a price that is equal to the long-run minimum average cost of production* (minLAC).

8.8 Very long-term supply in a constant cost industry



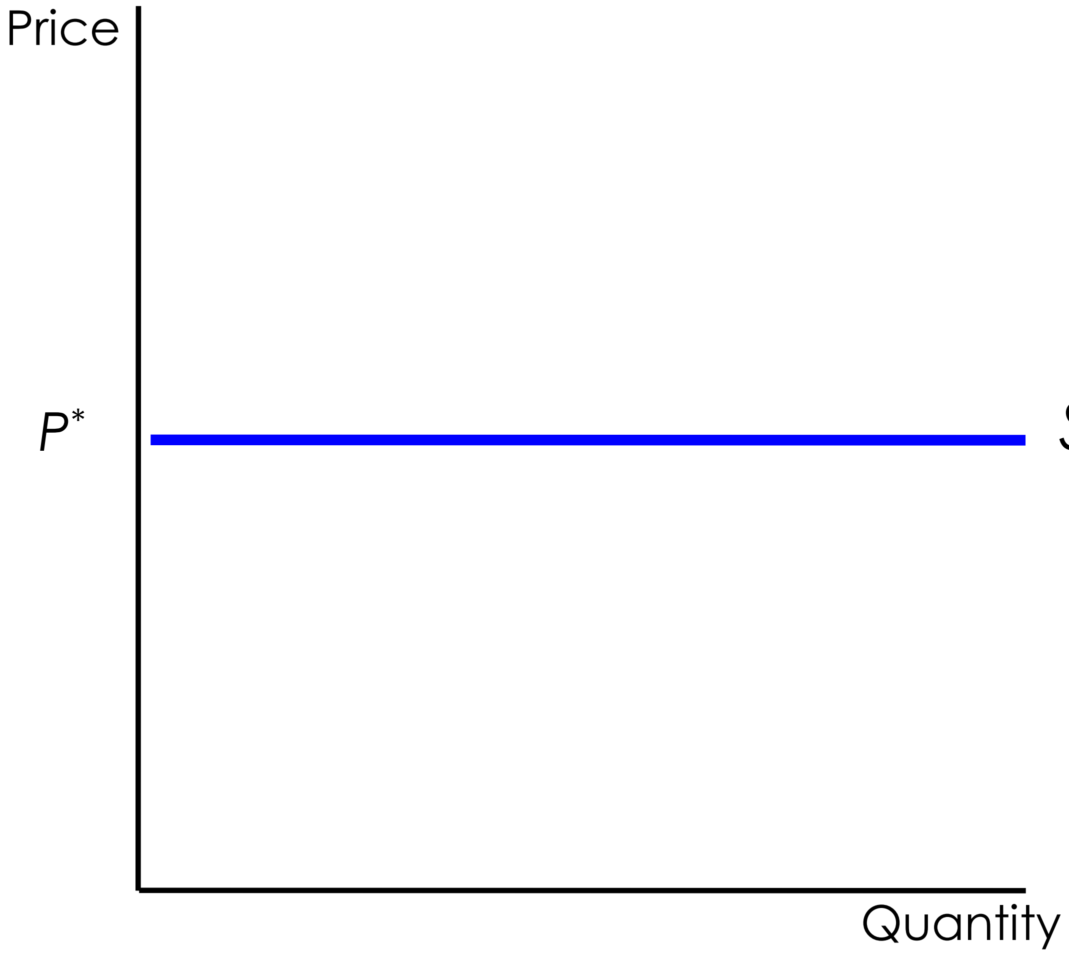
Consequence: In the very long run equilibrium,

P = min LAC, and $Q = N$ x MES,

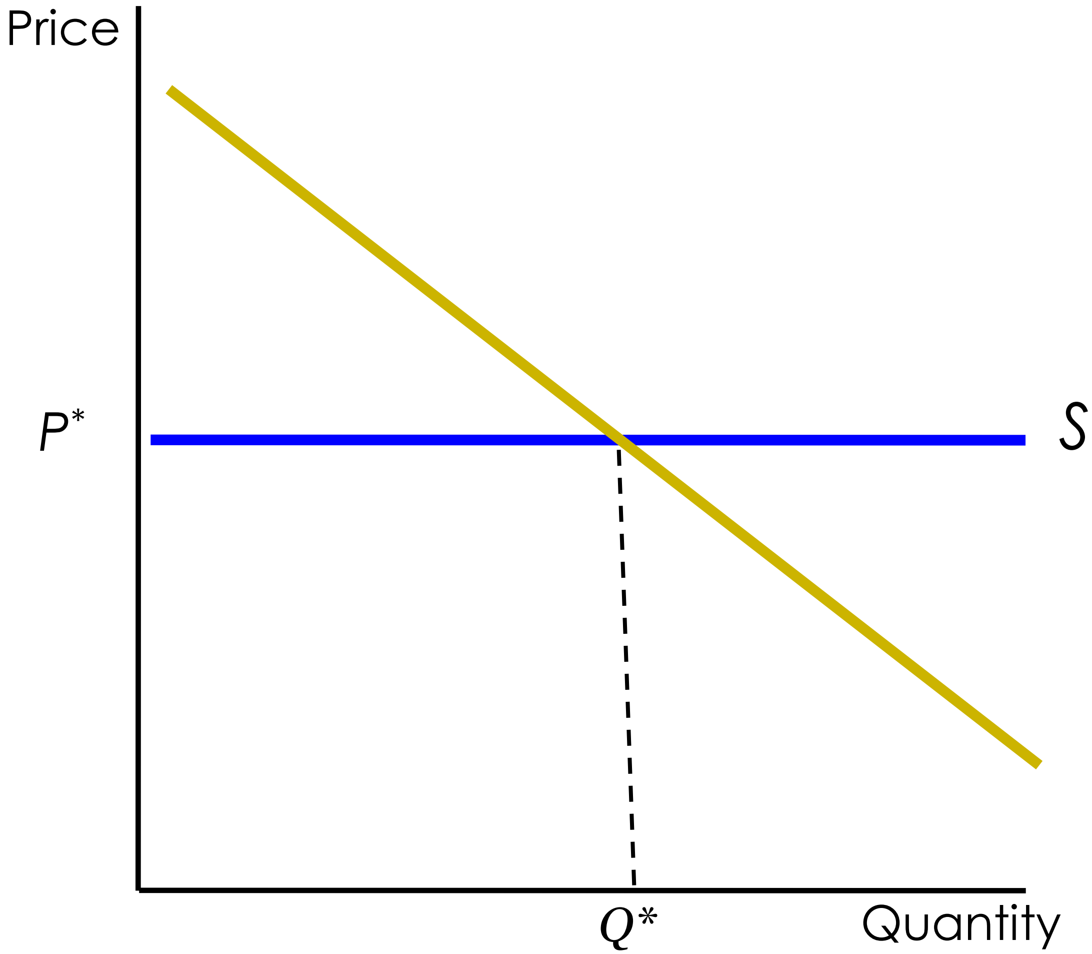
where N is the number of firms, and

MES = *minimum efficient scale* for each firm.

Supply in the very long run (constant-cost industry)



Long-run equilibrium (constant-cost industry)



Main results

- In the long run, firms will enter (exit) any industry with positive (negative) economic profits, thereby raising (lowering) equilibrium supply and lowering (raising) the equilibrium price.
- Thus, in the very long term equilibrium, *the economic profit must be zero*. (The *accounting* profit might be positive, but it is exactly equal to the *opportunity cost* of investing in this sector.)
- **Consequence:** In a constant-cost industry, the very long-run supply is *perfectly elastic* (i.e. a horizontal line).
- The very long-run price is equal to the lower bound for the profitability (the *minimum average long-term cost of production*).
- The total quantity produced at the very long-term equilibrium is equal to the aggregate demand at this price
- Each firm produces at the *minimum efficient scale* (**MES**).
- The *number of firms* is the quantity produced, divided by the MES.
- However, in an increasing/decreasing cost industry, the very long-run supply curve could be upwards/downwards sloping.