

Production, Cost, and the Perfect Competition Model

AP Microeconomics

The Production Function



A steel plant: production functions and costs shape how firms supply goods

The **production function** 生产函数 links inputs to output. In the **short run** 短期 at least one input (usually **capital**) is **fixed** 固定; in the **long run** 长期 all inputs vary.

- **Total product** 总产量 is the total output.
- **Marginal product** 边际产量 (MP) is the extra output from one more unit of a variable input (usually labor): $MP = \frac{\Delta \text{output}}{\Delta \text{labor}}$.
- **Average product** 平均产量 is output per worker.

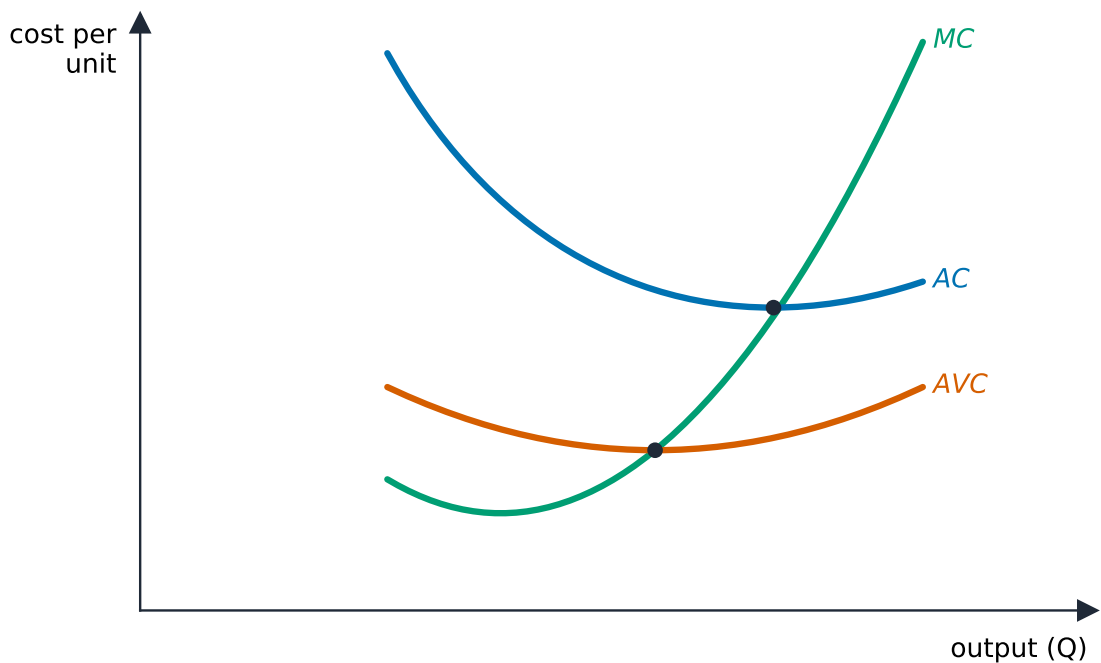
As you add workers to fixed capital, MP eventually falls – the **law of diminishing marginal returns** 边际收益递减法则. This shape of MP is what drives the shape of the cost curves below.



The production function turns inputs — labour and capital like this robot — into output

Short-Run Production Costs

Costs split into **fixed** and **variable**:



The short-run marginal, average, and average variable cost curves

- **Fixed cost** 固定成本 (FC) does not change with output (rent on the factory).
- **Variable cost** 可变成本 (VC) rises with output (materials, labor).
- **Total cost** 总成本 $TC = FC + VC$.

The **per-unit** costs matter most:

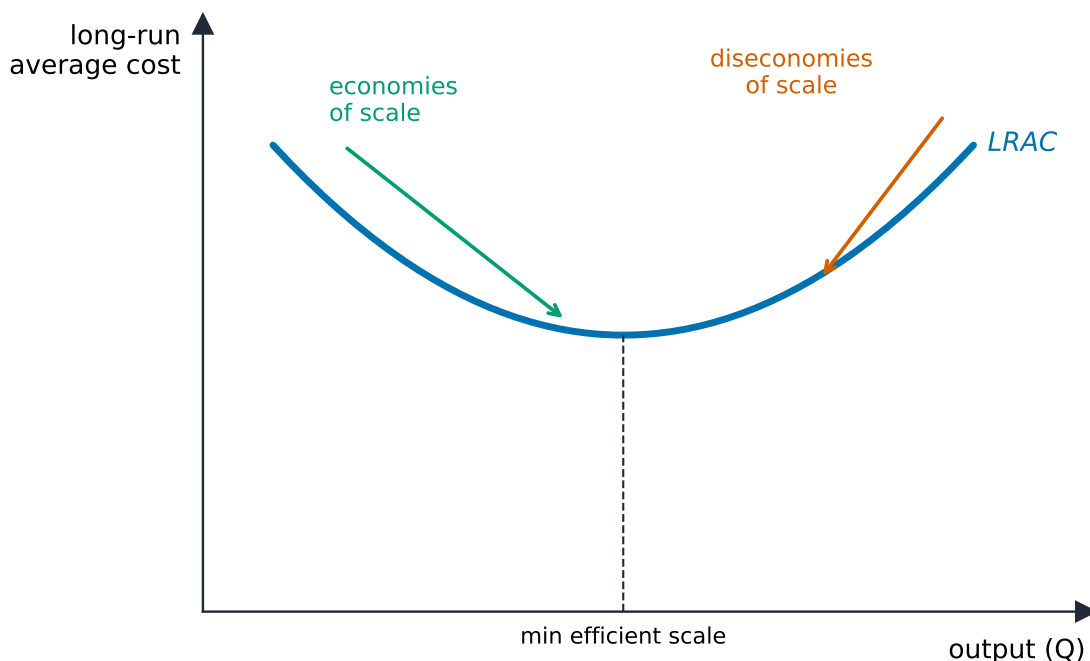
- **Average fixed cost** $AFC = FC/Q$ falls continuously (spreading fixed cost).
- **Average variable cost** $AVC = VC/Q$ and **average total cost** $ATC = TC/Q$ are **U-shaped**.
- **Marginal cost** 边际成本 $MC = \frac{\Delta TC}{\Delta Q}$ is the cost of one more unit.

Two key facts: **MC is the mirror image of MP** (when MP rises, MC falls, and vice versa), and **MC cuts both AVC and ATC at their minimum points** (when marginal is below average, the average falls; when above, it rises).

Worked example. A firm has fixed cost $FC = \$100$. At $Q = 10$ its total cost is \$300, so variable cost is \$200: then $ATC = \frac{300}{10} = \$30$, $AVC = \frac{200}{10} = \$20$, and $AFC = \frac{100}{10} = \$10$ (note $AFC + AVC = ATC$). If raising output to $Q = 11$ pushes total cost to \$325, the marginal cost of that 11th unit is $\frac{\Delta TC}{\Delta Q} = \frac{325 - 300}{1} = \25 .

Long-Run Production Costs

In the long run all inputs – including plant size – can change, so only the **long-run average total cost (LRATC)** curve matters. Its shape shows **returns to scale**:



Economies and diseconomies of scale on the long-run average cost curve

- **Economies of scale** 规模经济: LRATC falls as output grows (bulk buying, specialization).
- **Constant returns to scale**: LRATC flat.
- **Diseconomies of scale** 规模不经济: LRATC rises (a firm too big to manage well).

Exam skill: know that “diminishing returns” is a **short-run** idea (one fixed input) while “economies of scale” is a **long-run** idea (all inputs vary) – examiners test the distinction.

Types of Profit

Economists count **all** opportunity costs, including the owner’s:

- **Explicit costs** 显性成本 are out-of-pocket payments; **implicit costs** 隐性成本 are the opportunity costs of owner-supplied resources (forgone salary, forgone interest).

- **Accounting profit** 会计利润 = revenue – explicit costs.
- **Economic profit** 经济利润 = revenue – explicit – implicit costs.

Because economic profit subtracts more, it is smaller. **Zero economic profit** (a **normal profit** 正常利润) still means the owner is earning exactly the opportunity cost of their resources – a perfectly acceptable outcome.

Worked example. A shopkeeper takes in \$200,000 of revenue and pays \$120,000 in explicit costs, so **accounting profit** is \$80,000. But she gave up a \$70,000 salary elsewhere and \$5,000 of interest on the savings she invested – \$75,000 of **implicit costs**. Her **economic profit** is $80,000 - 75,000 = \$5,000$: still positive, so staying in business genuinely beats her next-best alternative.

Profit Maximization

Every firm, in every market structure, maximizes profit at the quantity where **marginal revenue equals marginal cost**:

$$MR = MC.$$

Produce each unit whose MR exceeds its MC; stop when they are equal. Producing less leaves profitable units unmade; producing more adds units that cost more than they earn.

Deciding to Produce, Enter, or Exit

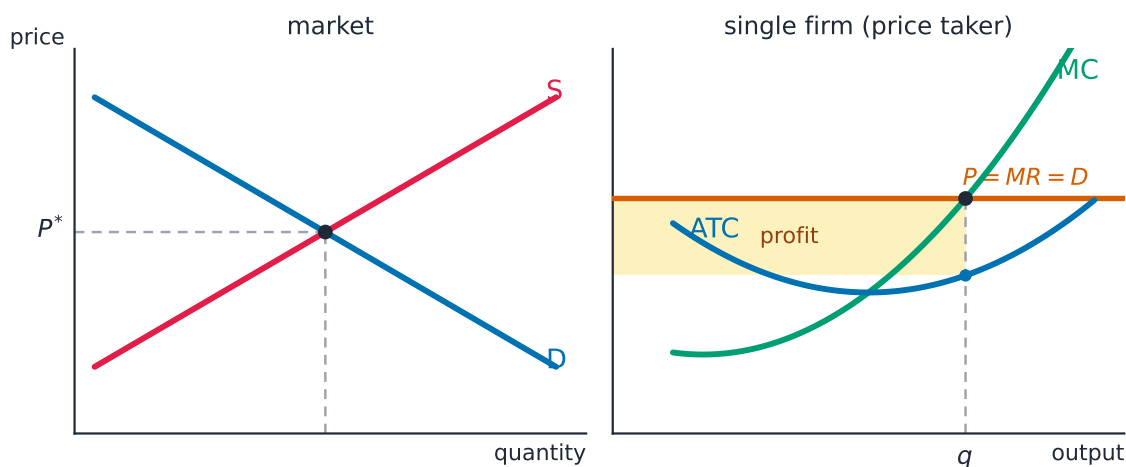
Even at $MR = MC$, a firm must check whether to operate:

- **Short run – the shutdown rule:** keep producing only if price covers **average variable cost** ($P \geq AVC$). If $P < AVC$, shut down and lose only fixed cost. So the firm's short-run supply curve is its **MC curve above minimum AVC**.
- **Profit check:** compare P to ATC at the profit-maximizing quantity – $P > ATC$ means economic profit, $P < ATC$ means a loss, $P = ATC$ means break-even.
- **Long run – entry and exit:** economic profits attract **entry** 进入; losses cause **exit** 退出. This continues until economic profit is zero.

Perfect Competition

A **perfectly competitive** 完全竞争 market has many small firms, an identical (homogeneous) product, free entry and exit, and perfect information. Each firm is a **price taker** 价格接受者 – too small to affect the price – so it faces a **horizontal** demand curve at the market price, and **price = marginal revenue = average revenue** ($P = MR = AR$).

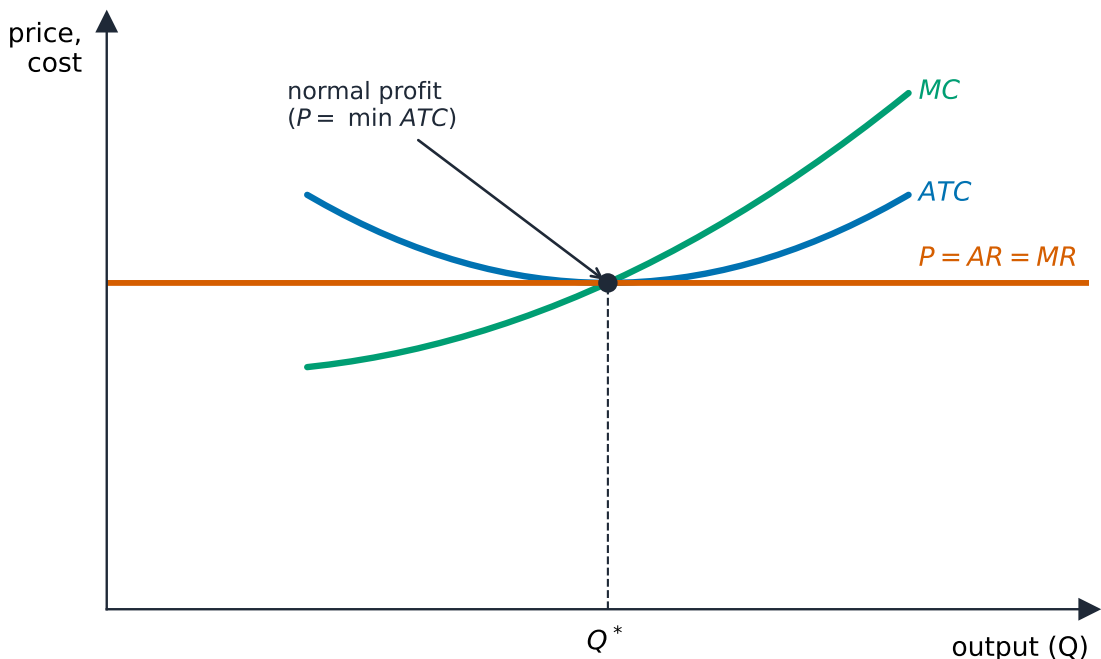
This is why economists prize perfect competition. In **long-run equilibrium** it is both **allocatively efficient** 配置效率 and **productively efficient** 生产效率. Allocative efficiency holds because the firm produces where $P = MC$: the price (society's marginal benefit from the last unit) equals its marginal cost, so exactly the right amount is made. Productive efficiency holds because free entry drives price down to the minimum of average total cost, so goods are made as cheaply as possible. The market price is itself a **signal** that communicates everyone's marginal costs and benefits.



short-run $P > ATC$ attracts entry $\Rightarrow S$ right $\Rightarrow P \rightarrow \min ATC$ (long-run zero profit)

The market sets the price; the price-taking firm produces where $MC = P$, here with short-run profit

The side-by-side panel is the graph the exam wants: the **market** (left) fixes the price P^* ; the **firm** (right) takes it as a horizontal line and produces where $MC = P$. When $P > ATC$ there is a short-run profit (the shaded box); that profit attracts entry, which shifts market supply right and pushes the price down.



A perfectly competitive firm makes only normal profit in the long run

- **Short run:** the firm can earn profit, break even, or take a loss, producing where $P = MC$.
- **Long run:** entry and exit drive the firm to **zero economic profit**, producing where $P = MC = ATC$ at **minimum ATC**. This double efficiency – **productive efficiency** (lowest-cost output) and **allocative efficiency** ($P = MC$, so the last unit's value equals its cost) – is the benchmark against which every other market structure is judged.

Exam skill: be able to draw the side-by-side market and single-firm graphs, show a short-run profit or loss, then show how entry/exit restores long-run equilibrium at minimum ATC.

Exam tips

- Know the cost curves: AFC falls, ATC/AVC are U-shaped, and **MC cuts ATC and AVC at their minimums**.
- Every firm maximises profit at $MR = MC$; check the shutdown rule ($P \geq AVC$ in the short run).
- Distinguish **accounting profit** (revenue – explicit costs) from **economic profit** (also minus implicit/opportunity costs); zero economic profit is normal.
- “Diminishing returns” is short-run (one fixed input); “economies of scale” is long-run (all inputs vary).

- In perfect competition $P = MR = AR$; entry/exit drive long-run economic profit to zero at minimum ATC.