Production, Cost, and the Perfect Competition Model

AP Microeconomics

The Production Function

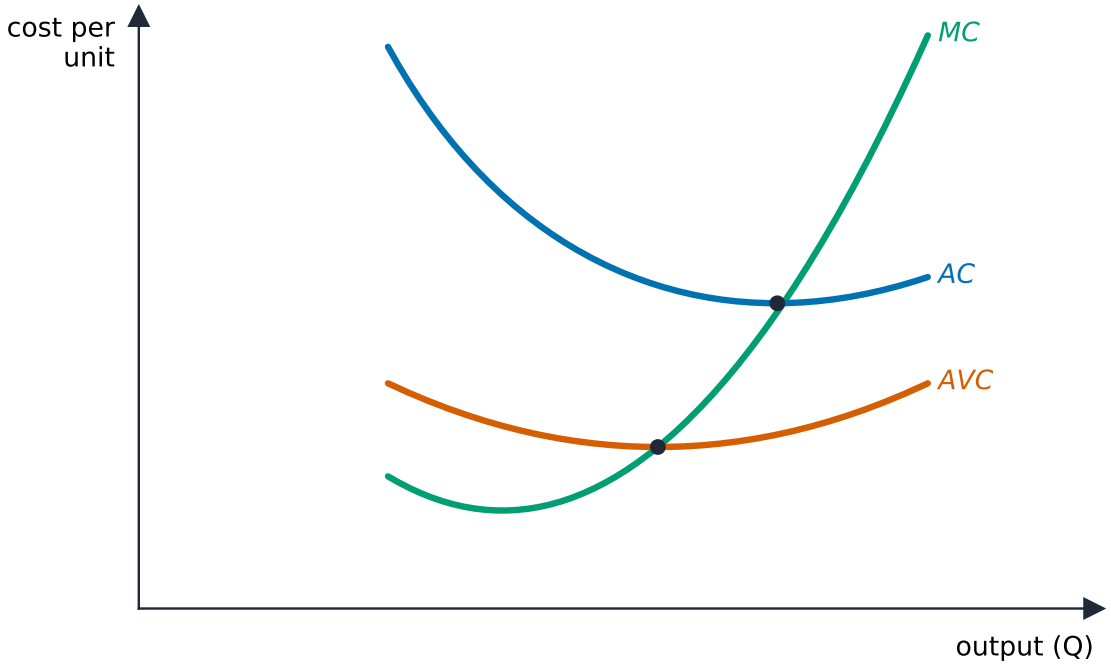
The **production function** 生产函数 links inputs to output. In the **short run** 短期 at least one input (usually **capital**) is **fixed** 固定; in the **long run** 长期 all inputs vary.

- **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.

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:

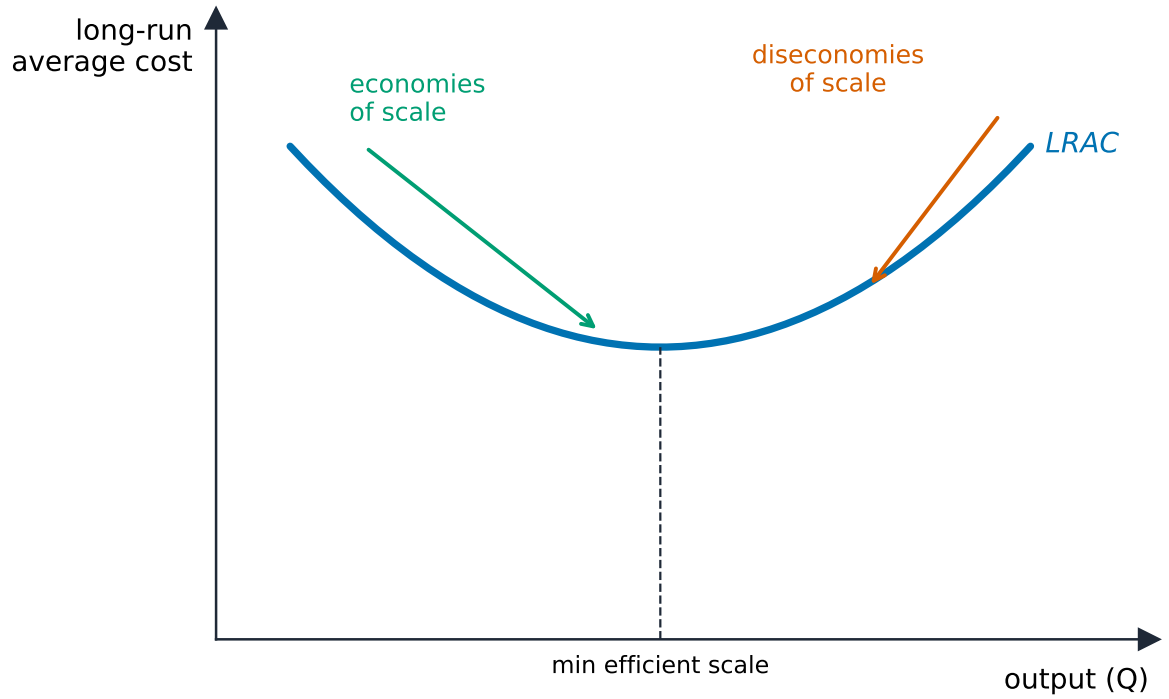
- **Average fixed cost** $AFC = FC/Q$ falls continuously (spreading fixed cost).
- **Average variable cost** $AVC = VC/Q$ and **average total cost** $ATC = TC/Q$ are **U-shaped**.
- **Marginal cost** 边际成本 $MC = \dfrac{\Delta TC}{\Delta Q}$ is the cost of one more unit.

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 $\dfrac{\Delta TC}{\Delta Q} = \dfrac{325 - 300}{1} = \$25$.

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.

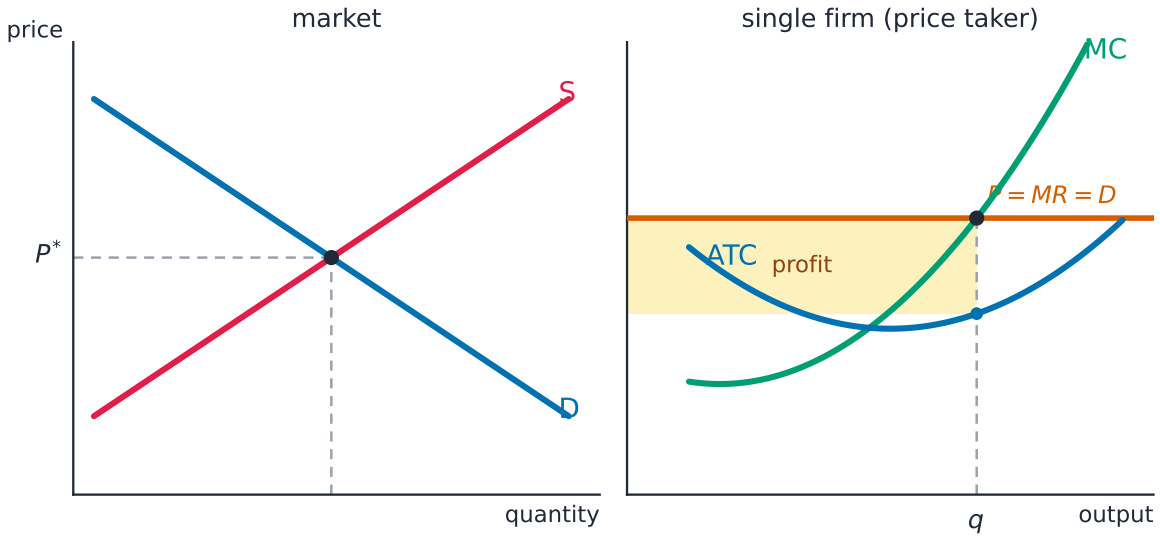
Deciding to Produce, Enter, or Exit

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

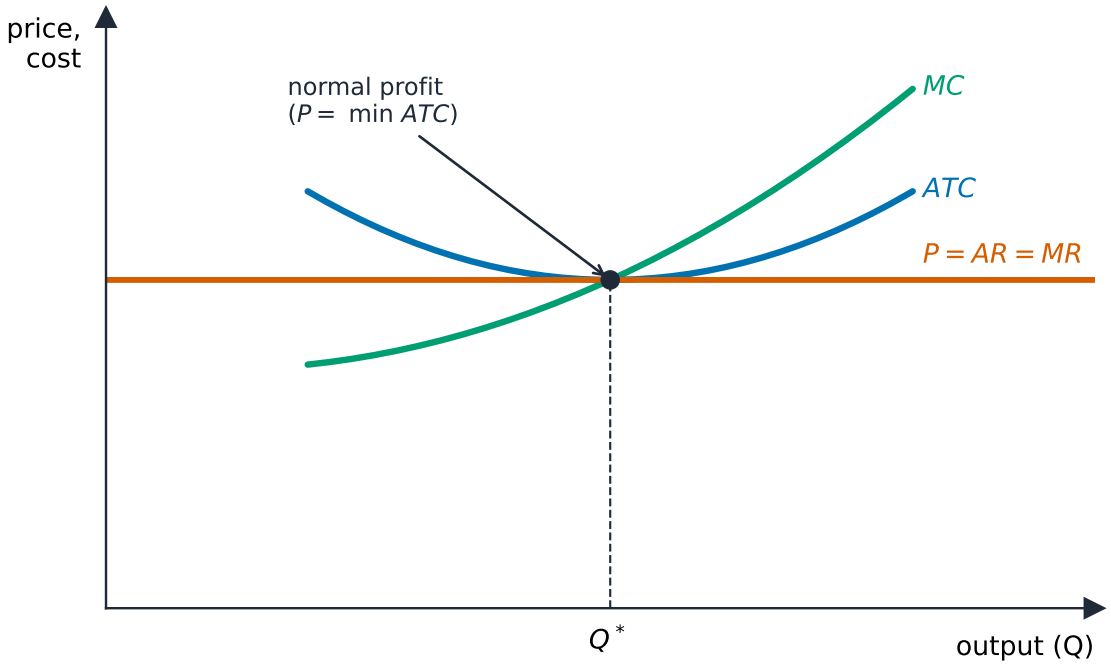
A **perfectly competitive** 完全竞争 market has many small firms, an identical (homogeneous) product, free entry and exit, and perfect information. Each firm is a **price taker** 价格接受者–too small to affect the price –so it faces a **horizontal** demand curve at the market price, and **price = marginal revenue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



short-run profit (P > ATC) attracts entry → market S shifts right → P falls to min ATC (long run)

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** 生产效率 (lowest-cost output) and **allocative efficiency** 配置效率 ($P = MC$, 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.