FREE EDITION · NOTES + 3 SAMPLE MCQS

CUET · ECONOMICS · CLASS XII · CODE 309

# Production and Costs

CUET unit: Producer Behaviour and Supply

By **UniDrill** · NCERT-grounded study material

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# 📌 Snapshot

- A firm transforms inputs (labour, capital) into output via a **production function** `q = f(L, K)` that gives the maximum output for any input combination (NCERT §3.1).
- The **short run** has at least one fixed factor; the **long run** has all factors variable — the basis for separating variable-proportions analysis from returns-to-scale analysis (NCERT §3.2, §3.6).
- Three product measures (TP, AP, MP) and the **Law of Variable Proportions / Diminishing Marginal Product** give inverse-U-shaped MP and AP curves, with MP cutting AP from above at AP's maximum (NCERT §3.3–§3.5).
- The short-run cost structure (TFC, TVC, TC, AFC, AVC, SAC, SMC): AFC is a rectangular hyperbola; SMC, AVC and SAC are all U-shaped; SMC cuts both AVC and SAC from below at their minima (NCERT §3.7.1).
- Connects returns to scale (IRS, CRS, DRS) to the U-shape of LRAC and the position of LRMC, which cuts LRAC from below at its minimum (NCERT §3.7.2).

# 📖 Detailed Notes

## 2.1 Core concepts

- **Production** is the process by which inputs (labour, machines, land, raw materials) are transformed into output, carried out by producers or firms; production is assumed instantaneous, and "production" and "supply" are used synonymously (NCERT §3 intro, p. 36).
- **Cost, revenue, profit:** to acquire inputs a firm pays the cost of production; selling output earns revenue; profit = revenue – cost; the firm's objective is maximum profit (NCERT §3 intro, p. 36).
- **Production function** `q = f(L, K)` gives the maximum output q for given inputs L and K — it deals only with the efficient use of inputs, and is defined for a given technology; improved technology means a new production function (NCERT §3.1, pp. 37–38).
- **Factors of production** are the inputs a firm uses; analysis here is restricted to two factors — labour (L) and capital (K) (NCERT §3.1, p. 37).

- **Isoquant** is the set of all input combinations that yield the same maximum output level; when marginal products are positive, isoquants are negatively sloped (NCERT §3.1 box "Isoquant", p. 38).
- **Short run** = at least one factor (here capital) cannot be varied and remains the fixed factor; the other is the variable factor. **Long run** = all factors can be varied; there is no fixed factor. The distinction is not defined in calendar terms but by whether all inputs can be varied (NCERT §3.2, pp. 38–39).
- **Total Product (TP):** the relationship between a variable input and output when all other inputs are held constant; also called total return or total physical product of the variable input (NCERT §3.3.1, p. 39).
- **Average Product:** `APL = TPL / L` — output per unit of variable input (NCERT §3.3.2, eq. 3.2, p. 39).
- **Marginal Product:** `MPL = ΔTPL / ΔL` — change in output per unit change in input, holding other inputs constant; MP is undefined at zero level of input; total product equals the sum of marginal products of every preceding unit (NCERT §3.3.3, eq. 3.3–3.4, pp. 39–40).
- **Law of Variable Proportions / Diminishing Marginal Product:** as a variable input is increased (holding the other fixed), MP first rises, then falls — because factor proportions first become more suitable for production, then the process becomes "too crowded" with the variable input (NCERT §3.4, pp. 40–41).
- **Shapes of TP, MP, AP curves:** TP is positively sloped; MP curve is inverse-U-shaped; AP curve is also inverse-U-shaped; **MP cuts AP from above at AP's maximum** — when AP rises, MP > AP; when AP falls, MP < AP (NCERT §3.5, pp. 41–42, Fig. 3.1, Fig. 3.2).
- **Returns to scale (long run, both factors scaled by t > 1):** CRS if `f(tx1, tx2) = t·f(x1,x2)`; IRS if `f(tx1, tx2) > t·f(x1,x2)`; DRS if `f(tx1, tx2) < t·f(x1,x2)`. If doubling all inputs doubles output → CRS; more than doubles → IRS; less than doubles → DRS (NCERT §3.6, pp. 42–43).
- **Cost function** gives the least cost of producing each level of output, given factor prices and technology — for every output level the firm chooses the least-cost input combination (NCERT §3.7, p. 43).
- **Short-run costs:** `TC = TVC + TFC` (eq. 3.6); `SAC = TC/q` (eq. 3.7); `AVC = TVC/q` (eq. 3.8); `AFC = TFC/q` (eq. 3.9); `SAC = AVC + AFC` (eq. 3.10); `SMC = ΔTC/Δq` (eq. 3.11). At zero output, SAC, AVC, AFC and SMC are all undefined; only TFC equals a positive constant and TVC = 0 (NCERT §3.7.1, pp. 43–45, Table 3.3).
- **Shapes of short-run cost curves:** TFC is a horizontal straight line; AFC is a rectangular hyperbola (AFC × q = TFC, constant); SMC, AVC, and SAC are all **U-shaped**; SMC cuts AVC from below at AVC's minimum; SMC cuts SAC from below at SAC's minimum; minimum of SAC lies to the right of minimum of AVC because AFC keeps falling even after AVC starts rising (NCERT §3.7.1, pp. 45–48, Fig. 3.3–3.8).

- **Long-run costs:** all inputs variable → no fixed cost; TC = TVC in the long run; `LRAC = TC/q` (eq. 3.13); `LRMC = (TC at q1) − (TC at q1 − 1)` (eq. 3.14) (NCERT §3.7.2, pp. 48–49).
- **Shapes of long-run cost curves and link to returns to scale:** IRS → LRAC falls; CRS → LRAC constant; DRS → LRAC rises. A typical firm shows IRS, then CRS, then DRS, so LRAC is **U-shaped**; LRMC is also U-shaped and **cuts LRAC from below at LRAC's minimum** (NCERT §3.7.2, p. 49, Fig. 3.9).
- **Cobb-Douglas:** for `q = x1^α · x2^β`, scaling inputs by t gives output scaled by t^($\alpha+\beta$); so $\alpha+\beta = 1 \Rightarrow$ CRS, $\alpha+\beta > 1 \Rightarrow$ IRS, $\alpha+\beta < 1 \Rightarrow$ DRS (NCERT §3.7 box "Cobb-Douglas Production Function", p. 43).

## 2.2 Definitions to memorise

| Term | Definition | Page |
|---|---|---|
| Production function | Relationship giving the maximum output q for various input combinations (L, K), for a given technology | 37 |
| Isoquant | Set of all input combinations that yield the same maximum output level | 38 |
| Short run | Period in which at least one factor of production cannot be varied (remains fixed) | 38 |
| Long run | Period in which all factors of production can be varied; no fixed factor | 39 |
| Total Product (TP) | Relationship between a variable input and output, holding all other inputs constant | 39 |
| Average Product (AP) | Output per unit of variable input: APL = TPL/L | 39 |
| Marginal Product (MP) | Change in output per unit change in input, others held constant: MPL = $\Delta$TPL/$\Delta$L | 39 |
| Law of Variable Proportions | MP of a variable input first rises with employment, then falls beyond a certain level | 41 |
| Constant Returns to Scale (CRS) | Proportional increase in all inputs results in same proportional increase in output | 42 |
| Increasing Returns to Scale (IRS) | Proportional increase in inputs results in a larger proportional increase in output | 42 |
| Decreasing Returns to Scale (DRS) | Proportional increase in inputs results in a smaller proportional increase in output | 42 |
| Cost function | Least cost of producing each level of output, given factor prices and technology | 43 |
| TFC | Cost incurred to employ fixed inputs; constant for all output levels in the short run | 43 |
| TVC | | 44 |

| Term | Definition | Page |
|---|---|---|
| | Cost incurred to employ variable inputs; rises as output rises | |
| TC | Total cost: TC = TVC + TFC | 44 |
| SAC, AVC, AFC | TC/q, TVC/q, TFC/q respectively; SAC = AVC + AFC | 44 |
| SMC | Short-run marginal cost: $\Delta TC/\Delta q$ (equivalently $\Delta TVC/\Delta q$ since TFC is constant) | 44 |
| LRAC, LRMC | Long-run average cost = TC/q; Long-run marginal cost = TC(q1) − TC(q1−1) | 48–49 |

## 2.3 Diagrams / processes to remember

- **Fig. 3.1 — Total Product curve:** positively sloped curve in the L–output plane; with L units of labour, the firm produces at most q1 (p. 41).
- **Fig. 3.2 — AP and MP curves:** both inverse-U-shaped; MP cuts AP from above at AP's maximum (point L on horizontal axis); to the left of L, MP > AP and AP is rising; to the right of L, MP < AP and AP is falling (p. 42).
- **Fig. 3.3 — TFC, TVC, TC curves:** TFC is a horizontal line at c1; TC is the vertical sum of TFC and TVC (p. 45).
- **Fig. 3.4 — AFC curve:** rectangular hyperbola; area of rectangle OFCq1 = TFC (p. 46).
- **Fig. 3.5 — TFC curve geometry:** slope of ∠AOq0 (tan $\theta$) gives AFC at q0 (p. 46).
- **Fig. 3.6 — AVC curve:** U-shaped; area of rectangle OVBq0 = TVC at q0 (p. 47).
- **Fig. 3.7 — TVC curve geometry:** slope of ∠EOq0 (tan $\theta$) gives AVC at q0 (p. 47).
- **Fig. 3.8 — SMC, AVC, SAC curves:** all U-shaped; SMC cuts AVC at P (minimum of AVC) and SAC at S (minimum of SAC); q1 < q2, so AVC reaches its minimum before SAC does (p. 48).
- **Fig. 3.9 — LRAC and LRMC curves:** both U-shaped; LRMC cuts LRAC from below at LRAC's minimum (p. 49).
- **Table 3.1 — Production function:** L on rows (0–6), K on columns (0–6), entries are q; with L = K = 0 output is 0; with L = 1, K = 1, q = 1; with L = K = 2, q = 10 (p. 37).
- **Table 3.2 — TP, MP, AP schedule with K fixed at 4:** TP rises from 0 to 57 as L goes 0 to 6; MP rises to 16 (at L = 3), then falls; AP peaks at 13.33 (at L = 3) (p. 40).
- **Table 3.3 — Cost schedule:** TFC fixed at Rs 20; minimum AVC = 6.5 at q = 6; minimum SAC = 9.57 at q = 7; SMC at q = 5 equals (53 − 49)/1 = 4 (p. 45).

## 2.5 Key formulas

| Formula | Meaning | NCERT page |
|---|---|---|
| q = f(L, K) | Production function (two-factor) | 37 |
| TP? = Σ MPᵢ (i = 1 ⋯ n) | Total Product as sum of marginal products | 39 |
| MP? = TP? − TP?₋₁ | Marginal Product of nth unit | 40 |
| AP? = TP? ÷ n | Average Product per unit of variable factor | 40 |
| MP = AP at AP maximum | MP cuts AP from above at AP's peak | 41 |
| TC = TFC + TVC | Total Cost decomposition | 50 |
| AFC = TFC ÷ q | Average Fixed Cost — rectangular hyperbola | 51 |
| AVC = TVC ÷ q | Average Variable Cost — U-shaped | 51 |
| SAC = AFC + AVC = TC ÷ q | Short-run Average Cost | 51 |
| SMC = ΔTC ÷ Δq | Short-run Marginal Cost | 51 |
| SMC cuts SAC and AVC at their minima from below | Cost-curve geometry | 52 |
| LRAC U-shaped: IRS → CRS → DRS | Long-run shape via returns to scale | 55 |
| LRMC cuts LRAC at its minimum from below | Long-run cost geometry | 55 |
| Profit = TR − TC | Producer's objective | 36 |
| Cobb-Douglas q = x₁^α · x₂^β; α + β > 1 ⇒ IRS, = 1 ⇒ CRS, < 1 ⇒ DRS | Returns-to-scale test | 43 |

## 2.4 Common confusions / NTA trap points

- **MP-AP relationship.** Students confuse "MP = AP" (AP at its maximum) with "MP = 0" (TP at its maximum). NCERT says MP cuts AP at AP's maximum from above (p. 42).
- **Law of Variable Proportions vs Returns to Scale.** Variable proportions is a short-run phenomenon (one factor fixed); returns to scale is a long-run phenomenon (all factors scaled proportionally). NCERT explicitly contrasts these in §3.6 (p. 42).
- **AFC curve.** AFC is a rectangular hyperbola — it falls continuously toward zero but never touches the axis; AFC × q is always equal to TFC (p. 46). Students wrongly say AFC is U-shaped or horizontal.

- **Position of minimum AVC vs minimum SAC.** Minimum SAC lies to the right of minimum AVC because, after AVC begins to rise, AFC is still falling and initially dominates (p. 48).
- **At q = 0.** TFC > 0 but TVC = 0, TC = TFC, and AFC/AVC/SAC/SMC are all undefined (Table 3.3, p. 45). A common trap is to take SAC = TFC at q = 0.
- **Cobb-Douglas test.** For $q = x1^{\alpha} \cdot x2^{\beta}$, the returns-to-scale verdict depends on $(\alpha + \beta)$ — not on $\alpha$ and $\beta$ individually (p. 43).

## 🎯 Practice MCQs

## 📊 PYQ Alignment

This chapter is one of the most heavily examined in CUET Economics — the U-shaped cost curves, MP-AP relationship, returns to scale (IRS/CRS/DRS), and short-run cost identities (TC = TVC + TFC, SAC = AVC + AFC, SMC = $\Delta TC/\Delta q$) typically generate 10–12 MCQs per cycle. Past papers favour numerical questions from NCERT Tables 3.2 and 3.3 (computing MP, AP, SMC, AVC, SAC), match-the-following on cost formulae, and statement-based questions on the MP-AP / SMC-AVC / SMC-SAC intersection properties.