

UNIT 4

Cost and Revenue Curves

(6 Hrs) — Applied Economics (CAEC353), BCA III/VI

⚠ Please Take Care — This May Contain Errors

These notes were prepared from the course syllabus and may contain errors, omissions or over-simplifications — including in numerical examples, diagrams, and Nepal-specific facts and figures (which change over time). Please take care: cross-check every formula, number and definition with your prescribed textbook, class notes and the official syllabus before relying on it for study or examination.

4.1 Concept of Cost

Cost is the monetary value of the resources used to produce a good or service. Cost analysis is central to a firm's decisions on how much to produce and at what price, because $\text{profit} = \text{total revenue} - \text{total cost}$.

Concept	Meaning	Example
Actual (money / real) cost	Actual expenditure incurred by the firm on inputs — wages, raw materials, rent, electricity.	A software firm pays Rs. 10 lakh in salaries.
Opportunity cost	Value of the next best alternative forgone by using a resource in a particular use.	Owner uses own building for the business instead of renting it out for Rs. 50,000/month.
Explicit cost	Cash payments made to outsiders for hired inputs; recorded in accounts.	Wages, material purchases, interest on loans.
Implicit cost	Imputed value of the firm's own resources and the owner's services; not paid in cash.	Owner's own capital, own land, owner-manager's time.
Accounting cost	Explicit costs (+ depreciation) only.	What appears in the profit and loss statement.
Economic cost	Explicit + implicit costs (including normal profit).	Accounting cost + forgone returns of own resources.

Economic profit = TR – (explicit cost + implicit cost) = accounting profit – implicit cost.

Normal profit is the minimum reward needed to keep the entrepreneur in business; it is included in economic cost. Any profit above it is *supernormal (abnormal) profit*.

Example 4.1 — Accounting vs economic profit

Ram runs a computer shop from his own building. Yearly revenue Rs. 20 lakh; wages, electricity and materials paid Rs. 12 lakh. He could have rented out the building for Rs. 3 lakh a year and could have earned a salary of Rs. 4 lakh elsewhere.

Solution

Accounting profit = $20 - 12 = \text{Rs. 8 lakh}$.

Implicit costs = $3 + 4 = \text{Rs. 7 lakh} \rightarrow \text{Economic cost} = 12 + 7 = \text{Rs. 19 lakh}$.

Economic profit = $20 - 19 = \text{Rs. 1 lakh}$ (supernormal profit).

4.2 Short-Run Cost Curves

In the **short run** at least one factor (capital, plant) is fixed, so costs are divided into **fixed** and **variable** costs. In the **long run** all factors are variable and there are no fixed costs.

4.2.1 Total Costs

- **Total fixed cost (TFC):** does not change with output (rent, insurance, salaries of permanent staff); horizontal line; positive even at zero output.
- **Total variable cost (TVC):** changes with output (raw materials, power, wages of casual workers); starts from the origin; first rises at a decreasing rate then at an increasing rate (law of variable proportions) — an inverse-S shape.
- **Total cost (TC) = TFC + TVC:** has the same shape as TVC, shifted up by the amount of TFC.

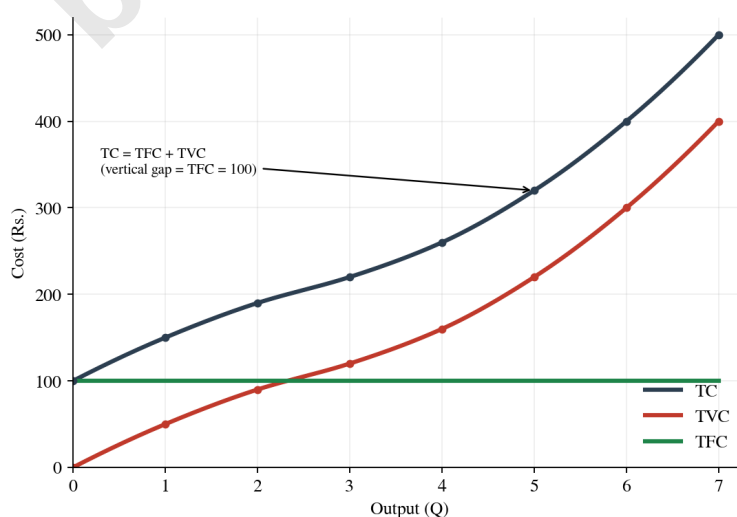


Figure 4.1 — Short-run total cost curves

4.2.2 Per-Unit Costs

Cost	Formula	Shape / behaviour
Average fixed cost (AFC)	$AFC = TFC / Q$	Falls continuously — rectangular hyperbola (spreading overhead).
Average variable cost (AVC)	$AVC = TVC / Q$	U-shaped: falls, reaches a minimum, then rises.
Average (total) cost (ATC/AC)	$ATC = TC / Q = AFC + AVC$	U-shaped; minimum comes later than AVC's minimum.
Marginal cost (MC)	$MC = \Delta TC / \Delta Q = \Delta TVC / \Delta Q$	U-shaped (initially falls then rises); independent of fixed cost.

Example 4.2 — Cost table (numerical exercise)

TFC = Rs. 100. TVC for $Q = 1 \dots 7$ is 50, 90, 120, 160, 220, 300, 400. Compute TC, AFC, AVC, ATC and MC.

Solution — Cost schedule

$TC = TFC + TVC$; $AFC = 100/Q$; $AVC = TVC/Q$; $ATC = TC/Q$; $MC = TC(n) - TC(n-1)$ (values rounded to two decimals).

Q	TFC	TVC	TC	AFC	AVC	ATC	MC
0	100	0	100	—	—	—	—
1	100	50	150	100.00	50.00	150.00	50
2	100	90	190	50.00	45.00	95.00	40
3	100	120	220	33.33	40.00	73.33	30
4	100	160	260	25.00	40.00	65.00	40
5	100	220	320	20.00	44.00	64.00	60
6	100	300	400	16.67	50.00	66.67	80
7	100	400	500	14.29	57.14	71.43	100

Observations: MC is lowest at $Q = 3$ (diminishing returns begin after that). MC equals AVC at its minimum ($Q = 4$, $AVC = 40$). ATC is lowest ($\approx$ Rs. 64) around $Q = 5$, where MC (60 at $Q=5$, 80 at $Q=6$) crosses it.

4.2.3 Shape of the Short-Run Cost Curves and Their Relationships

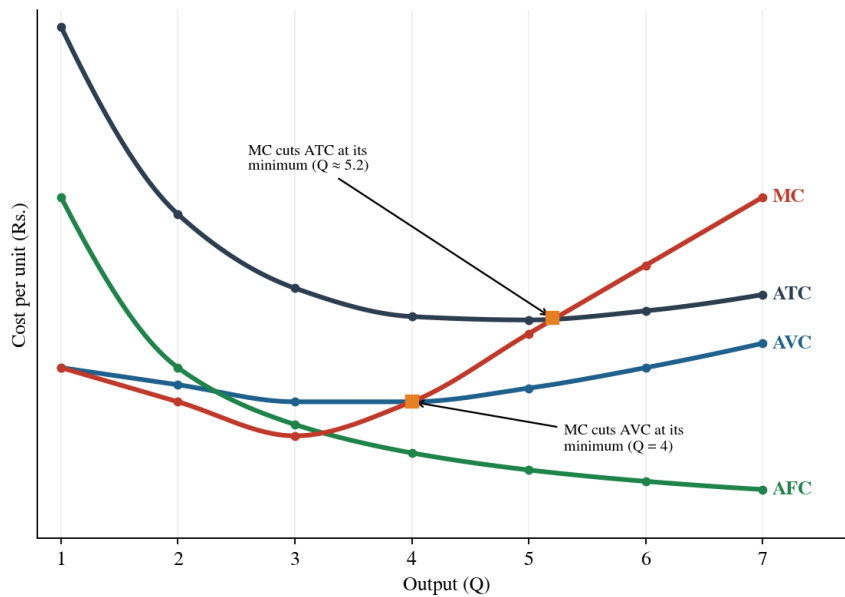


Figure 4.2 — Short-run average and marginal cost curves (from Example 4.2)

- **U-shape of AVC, ATC and MC** comes from the **law of variable proportions** (increasing then diminishing returns). When the marginal product of the variable factor rises, MC falls; when returns diminish, MC rises.
- **MC and AC:** if $MC < AC$, AC falls; if $MC > AC$, AC rises; MC cuts AC (and AVC) **at their minimum points**. MC rises faster because it reflects only the extra cost of the last unit.
- **AFC** falls continuously so the vertical gap between ATC and AVC ($= AFC$) narrows as output rises but never reaches zero; ATC and AVC never meet.
- The minimum of ATC occurs at a **larger output** than the minimum of AVC (because AFC is still falling).
- $TVC = \sum MC$ (the sum of marginal costs up to Q gives total variable cost; fixed cost does not affect MC).

4.3 Long-Run Cost Curves

4.3.1 Long-Run Total Cost (LTC)

The **LTC curve** shows the minimum total cost of producing each level of output when all inputs can be varied. It starts from the origin (no fixed cost in the long run) and is the **envelope** of the short-run total cost curves — it lies below or touches each STC curve.

4.3.2 Long-Run Average Cost (LAC) and Shape

LAC = LTC / Q. In the long run the firm can choose the plant size that gives the lowest AC for each output. The LAC curve is thus the **envelope (planning curve)** of an infinite number of short-run average cost curves, each drawn for one plant size; every SAC touches LAC at one point (tangent) and lies above it elsewhere. LAC is **U-shaped** but flatter than SAC.

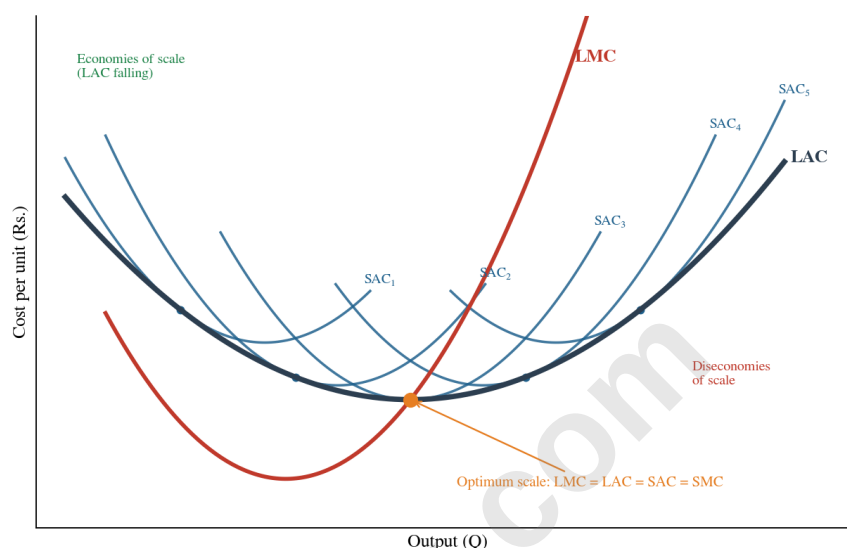


Figure 4.3 — LAC as the envelope of short-run average cost curves; LMC cuts LAC at its minimum

- **Falling LAC — economies of scale:** technical (specialisation, indivisibilities), managerial, marketing, financial and risk-bearing economies.
- **Minimum LAC** (optimum scale, constant returns) — where the firm uses its plant at the most efficient scale.
- **Rising LAC — diseconomies of scale:** managerial difficulties, coordination and communication problems, labour relations, resource scarcity.
- The U-shape of LAC is due to **returns to scale** (in contrast with the law of variable proportions that explains SAC).

4.3.3 Long-Run Marginal Cost (LMC)

LMC is the addition to long-run total cost from producing one more unit when all inputs are variable: $LMC = \Delta LTC / \Delta Q$. It is also U-shaped, is flatter than SMC, and **cuts the LAC curve at its minimum point**.

4.4 Relationship between SR and LR AC and MC Curves

- **SAC and LAC:** LAC is tangent to (and below or equal to) every SAC curve. A SAC touches LAC at the output for which that plant is optimal.

- **Tangency is not at the minimum of SAC** except at the minimum point of LAC. To the left of LAC's minimum, tangency occurs on the **falling** part of SAC (plant slightly under-utilised, i.e., excess capacity); to the right, on the **rising** part of SAC (over-utilisation).
- **SMC and LMC:** at the output where SAC touches LAC, **SMC = LMC** — because the SAC and LAC have the same slope there and equal total cost.
- **At the optimum scale:** $LMC = LAC = SMC = SAC$ (all four are equal at the minimum point of LAC).
- LMC is flatter than SMC because in the long run the firm can adjust all inputs.

Basis	Short-run	Long-run
Factors	At least one fixed	All variable
Cost types	Fixed and variable	Only variable (no fixed cost)
Reason for U-shape	Law of variable proportions	Returns to scale (economies/diseconomies)
Curves	SAC, SMC — steeper	LAC, LMC — flatter
Relationship	Many SACs, one for each plant	LAC is the envelope of all SACs

4.5 Concept of Revenue

- **Total revenue (TR)** = $P \times Q$, the total sales receipts.
- **Average revenue (AR)** = $TR / Q = P$; the AR curve is the firm's **demand curve**.
- **Marginal revenue (MR)** = $\Delta TR / \Delta Q$; the addition to TR from selling one more unit.

4.5.1 Revenue Curves under Perfect and Imperfect Competition

Perfect competition: the firm is a price-taker; it can sell any quantity at the market price, so **AR = MR = P** — a horizontal line (perfectly elastic demand); TR is an upward-sloping straight line through the origin.

Imperfect competition (monopoly, monopolistic competition, oligopoly): to sell more the firm must lower price, so the AR curve slopes downward and **MR < AR** lies below AR. For a straight-line AR curve, the MR curve is also straight, with the same vertical intercept and **twice the slope** — it bisects the horizontal distance between the AR curve and the vertical axis. TR rises, reaches a maximum where $MR = 0$, then falls as MR turns negative.

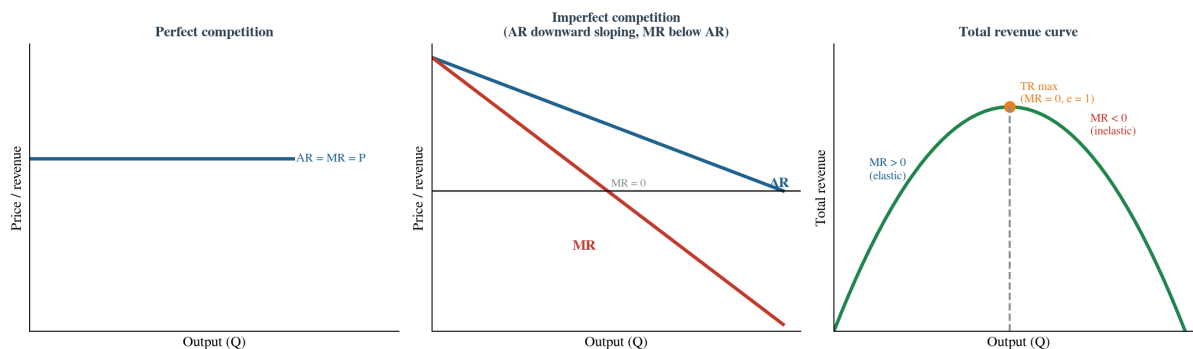


Figure 4.4 — Revenue curves under perfect and imperfect competition

4.5.2 Relationship between AR and MR

$MR = AR \times (1 - 1/e)$ where e is price elasticity of demand (absolute value). Thus:

Elasticity	MR	TR
$e > 1$	$MR > 0$	TR rises as output rises
$e = 1$	$MR = 0$	TR is maximum
$e < 1$	$MR < 0$	TR falls as output rises

- If AR is falling, MR is less than AR; if AR is constant, $MR = AR$; if AR is rising, $MR > AR$.
- A profit-maximising monopolist never operates where $MR < 0$, i.e., on the inelastic part of AR.

Example 4.3 — Revenue schedule

The demand (AR) function of a firm is $P = 10 - Q$. Prepare a table of TR, AR and MR for $Q = 1 \dots 9$.

Solution

$TR = P \times Q = Q(10 - Q)$; $MR = TR(n) - TR(n-1)$. Analytically, $MR = d(TR)/dQ = 10 - 2Q$ (twice the slope of AR).

Q	P = AR	TR	MR
1	9	9	9
2	8	16	7
3	7	21	5
4	6	24	3
5	5	25	1

Q	P = AR	TR	MR
6	4	24	-1
7	3	21	-3
8	2	16	-5
9	1	9	-7

TR is maximum (25) at $Q = 5$ where $MR \approx 0$ (the continuous formula gives $MR = 0$ exactly at $Q = 5$, $P = 5$, $e = 1$).

4.6 Numerical Exercise Using Excel

Task	Cell / Formula (columns: A = Q, B = TVC, C = TC, D = AFC, E = AVC, F = ATC, G = MC; TFC = 100 typed in \$J\$1)
Total cost	C2: =\$J\$1+B2
Average fixed cost	D2: =\$J\$1/A2
Average variable cost	E2: =B2/A2
Average total cost	F2: =C2/A2 (or =D2+E2)
Marginal cost	G2: =C2-\$J\$1 (first unit, since TC at $Q = 0$ equals TFC); G3: =C3-C2, then fill down
Minimum ATC and its output	=MIN(F2:F8) and =INDEX(A2:A8,MATCH(MIN(F2:F8),F2:F8,0))
Revenue (new sheet, $P = 10 - Q$)	A = Q, B: =10-A2 (price = AR); C: =A2*B2 (TR); D3: =C3-C2 (MR)
Charts	Select Q and cost columns → Insert → Scatter with Smooth Lines to draw the U-shaped curves; check MC crossing ATC and AVC at their minima.

Note: Keep TFC in a separate cell and use absolute references (\$F\$1) so the formula can be filled down without changing.

Key Takeaways — Unit 4

- ✓ Economic cost = explicit + implicit costs; economic profit = accounting profit – implicit cost.
- ✓ SR costs: $TC = TFC + TVC$; AFC falls, AVC/ATC/MC are U-shaped (law of variable proportions); MC cuts AVC and ATC at their minimum points.
- ✓ LR curves: LAC (envelope of SACs, planning curve) is U-shaped due to returns to scale; LMC cuts LAC at its minimum; $SMC = LMC$ where SAC is tangent to LAC.
- ✓ Revenue: $TR = P \times Q$, $AR = P$, $MR = \Delta TR / \Delta Q$. Under perfect competition $AR = MR = P$ (horizontal); under imperfect competition AR slopes down and $MR < AR$.

✓ $MR = AR(1 - 1/e)$: TR is maximum where $MR = 0$ and $e = 1$.

— *End of Unit 4* —

Reminder: these notes may contain errors — verify with your textbook and syllabus.

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