Twice the bakers, twice the bread?

One oven, more bakers: why output and costs curve the way they do.

1 Short run vs long run

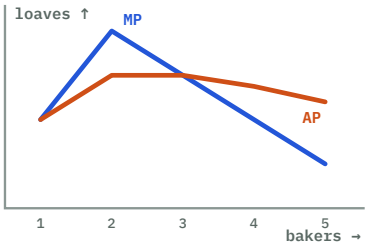
what can change?

- **Short run** → ≥ 1 input fixed (the oven) · only labor changes
- **Long run** → every input changes, even the number of ovens
- Hire a 5th baker / buy flour = short run · buy a 2nd oven = long run

2 Product of labor

bakers → loaves

- **Marginal product** (MP) = loaves the next baker adds → 20, 40, 30, 20, 10 · **total** = 20, 60, 90, 110, 120
- **Average product** (AP) = total ÷ bakers → 20, 30, 30, 27.5, 24
- MP up (2nd baker: specialize) → then down: **diminishing marginal returns** = fixed oven shared by more hands
- MP > AP ⇒ AP rises · MP < AP ⇒ AP falls · MP = AP ⇒ AP peaks (3 bakers: 30 = 30)
- Same MP can sit on both sides of the peak: 1st baker 20 (rising), 4th baker 20 (crowded)



3 Fixed, variable, total

the cost table

- **Fixed cost** (FC) → same at any output: oven $180/day
- **Variable cost** (VC) → grows with output: wages, $120 × bakers
- `TC = FC + VC` → 1 baker $300 · 2: $420 · 3: $540 · 4: $660 · 5: $780
- Wage $120 → $150 ⇒ VC and TC rise (4 bakers: $600 + $180 = **$780**) · FC unchanged

4 Average costs

per loaf

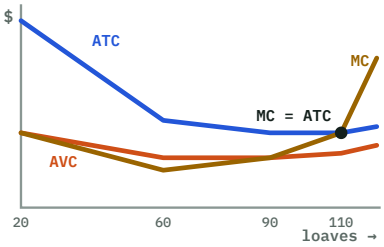
loaves	20	60	90	110	120
AFC	9.00	3.00	2.00	1.64	1.50
AVC	6.00	4.00	4.00	4.36	5.00
ATC	15.00	7.00	6.00	6.00	6.50

- `AFC = FC ÷ Q` · `AVC = VC ÷ Q` · `ATC = TC ÷ Q = AFC + AVC` (Q = loaves)
- AFC = average fixed cost · AVC = average variable cost · ATC = average total cost
- AFC always falls (same $180 spread wider) · ATC U-shaped: falls (spreading FC), then rises (crowding)
- Rent ↑ ($180 → $270) ⇒ only **ATC** shifts up (+ $270 ÷ Q: at 90 loaves $6 → $7) · AVC, MC stay put

5 Marginal cost

and the average rule

- `MC = ΔTC ÷ ΔQ` (Δ = change in) → 2nd → 3rd baker: $120 ÷ 30 = $4 · MC by baker: 6, 3, 4, 6, 12
- **Marginal–average rule** (like a test average) → MC < average ⇒ average falls · MC > average ⇒ average rises · MC = average ⇒ average at its **minimum**
- MC cuts AVC and ATC at their lowest points · AVC min = $4.00 (60–90 loaves) · ATC min = $6.00 (90–110 loaves) = **efficient scale**
- Above 110 loaves: MC $12 > ATC ⇒ ATC ↑ ($6.50 at 120)



6 Long run: scale

more ovens

- 1 oven: up to 120/day, lowest $6.00 · 2 ovens: up to 240, **$5.00** · 3 ovens: up to 350, $7.00
- **Economies of scale** → ATC falls as the firm grows (bulk buying, split jobs) · **diseconomies** → ATC rises (hard to manage)
- 240 loaves a day → 2 ovens, $5.00 a loaf

7 Economic profit

explicit + implicit

- **Explicit cost** = money out (wages, rent) · **implicit cost** = what the owner gives up (job $150 + savings in a bank $50 = $200)
- `Accounting profit = revenue − explicit` · `Economic profit = accounting − implicit`
- 3 bakers: 90 × $8 = $720 − $540 = $180 → − $200 = **− $20** (loss)
- 4 bakers: 110 × $8 = $880 − $660 = $220 → − $200 = **+ $20**
- Positive accounting profit can hide an economic loss