Does the second oven double the bread?

Sofia bakes 40 loaves an hour with 2 bakers and 2 ovens. In the long run she can change both inputs: what does doubling everything give, which mixes bake the same bread, and which mix is cheapest at today's prices?

1 Short run, long run

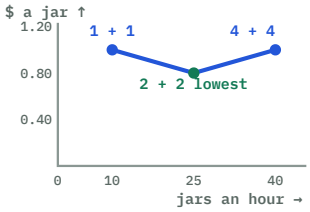
Micro 1, Lesson 5

- **Inputs** = what a firm uses to make output · bakers, ovens · **short run** ⇒ one input stuck (1 oven) · **long run** ⇒ every input can change
- One oven, more bakers ⇒ 1 → **20** loaves · 4 → **40** · 9 → **60** ⇒ extra loaves per extra baker: 1 → 4 ≈ **7** · 4 → 9 ⇒ `20 ÷ 5 = 4`
- **Diminishing returns** = **one** input grows, the others stay ⇒ each extra unit adds less (crowded kitchen)

2 Returns to scale

every input × 2

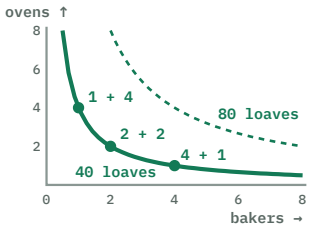
- **Returns to scale** = output when **every** input is multiplied by the same number ⇒ more than double **increasing** · exactly double **constant** · less **decreasing**
- Sofia (made-up table) ⇒ 1 + 1 → 20 · 2 + 2 → 40 · 3 + 3 → 60 · 4 + 4 → **80** ⇒ **constant** ⇒ flat cost per loaf
- Practice · Mateo's jam, cook $5 + pot $5 ⇒ 1 + 1 → 10 · 2 + 2 → **25** (> 20, increasing) · 4 + 4 → **40** (< 50, decreasing) ⇒ a jar `$1.00 → $0.80 → $1.00` ⇒ U of **long-run average cost** (cost per unit, every input free)
- Increasing ⇒ split jobs, closer stops (delivery), wider pipe · decreasing ⇒ an input that did not grow (lake, field) is really the short run
- Adam **Smith**, Scottish, **1776** ⇒ pin factory: 10 workers, one small job each ≈ **48,000** pins a day · Charles **Cobb** & Paul **Douglas**, American, **1928** ⇒ US factories 1899-1922: labor ≈ ¾, capital ≈ ¼, sum 1 ⇒ ≈ constant



3 Isoquant

same bread, other mix

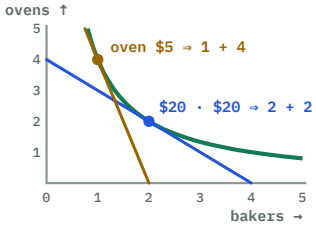
- **Isoquant** = curve of every input mix with the **same output** ("iso" = equal) ⇒ 40 loaves: `1 + 4` · `2 + 2` · `4 + 1` (bakers + ovens)
- Bends ⇒ fewer ovens need ever more bakers: 4 → 2 ovens costs +1 baker · 2 → 1 oven costs +2 bakers
- = the **indifference curve** of Lesson 1, drawn for bread instead of points · higher curve ⇒ more bread (80 loaves: 2 + 8 · 4 + 4 · 8 + 2 · 16 + 1)



4 Cheapest mix

isocost touches isoquant

- **Isocost line** = every mix with the same total cost · `cost = wage × bakers + rent × ovens` · slope = `wage ÷ rent`
- **Cheapest mix** ⇒ lowest isocost line that still **just touches** the isoquant (same slope there) ⇒ last $1 on bakers adds as much bread as last $1 on ovens
- Baker $20 · oven $20 ⇒ **2 + 2 = $80** (others $100) · oven **$5** ⇒ **1 + 4 = $40** (2 + 2 $50 · 4 + 1 $85) · oven $10 ⇒ 1 + 4 and 2 + 2 tie at $60
- **Substitution between inputs** ⇒ the cheaper input gets used more · practice: baker $10, oven $40 ⇒ **4 + 1 = $80** · baker $80 ⇒ **1 + 4 = $160** (keep 2 + 2: $200)
- Chain ⇒ wage ↑ → line steeper → mix slides to fewer bakers → cost ↑ by **less** than the wage · both prices +10% ⇒ `20 ÷ 10 = 22 ÷ 11` ⇒ **same mix**



5 Cost curves

idea 5 of 11

- Cost of each output = cost of its cheapest mix ⇒ **long-run cost curve** · Sofia $20 · $20 ⇒ 40 loaves $80 · 80 loaves $160 ⇒ **$2 a loaf** both
- Practice · festival 80 loaves ⇒ long run 4 + 4 **$160** ($2.00) · short run, ovens stuck at 2 ⇒ 8 + 2 **$200** (**$2.50**) ⇒ long-run cost never above short-run
- **Economies of scale** = cost per unit falls as output grows ⇒ from **increasing** returns, not from size alone
- **Eleven ideas behind the curves** · `1 · A demand curve is a chain of best bundles` `2 · A price change is two effects: substitution and income` `3 · Selling what you own is the same choice` `4 · Risk has a price: the risk premium` `5 · Cost curves come from the cheapest mix of inputs` · next at university: Cobb–Douglas exponents, the **cost function**

Watch out: diminishing returns (one input grows) ≠ **decreasing returns to scale** (all grow) · Sofia has both · bigger is cheaper per unit **only** with increasing returns · the mix follows `wage ÷ rent`, not each price alone