Production

Goals

- Create a taxonomy, i.e., a categorization, of productive inputs
- Show a general pattern of production and why those patterns happen.
- Use a production function to derive common cost functions: AC, MC, AVC, AFC, etc.

Warning: Things will be getting mathy and graphy.

The Hot dog Stand

- Actual hot dog stand on the Santa Cruz Boardwalk in the 70s.
- Really small
- Very experimental person running it.

The Stand and Things in it

Inputs

- All the things, tongs, bottles, buns, kimchi, are *inputs*.
- Those divide into two groups:
  - *Fixed inputs*, Capital (K): Don't change when output changes. Are uncorrelated with output. (The building, tongs, steam trays, . . .)
  - *Variable inputs*, Labor (L): Change when output changes. Are correlated with output.(The buns, kimchi, mustard, people working,. . .)

We will bundle the variable inputs into one and call it labor minutes. "Labor" and "Capital" are convention.

Add People and Plot What is Made

Observe

- No variable inputs, no outputs.
- Add variable inputs and output goes up, but eventually falls.
- Each worker add more to output than the previous for a while.
  - Increasing *marginal product of labor*
  - For calc people $\frac{\partial^2}{\partial x^2} > 0$
- Each worker then adds more to output, but the increase of each new worker is less than the last.
  - Decreasing *marginal product of labor*
  - For calc people $\frac{\partial^2}{\partial x^2} < 0$
- Ignore the part where we make output go down. It is silly.

Why Increasing and Decreasing MP_L?

- Increasing MP_L, output increaseses and last added adds **more** than the previously added.
    - Less idle capital but labor in constant motion.
    - More specialization.
    - Learning by doing (Slightly off)
- Decreasing MP_L, output increases and last added adds **less** than the previously added.
    - No idle capital but labor not in constant motion.
    - No more gains from specialization on this scale.

Our Clean Idealized Production Function

Lets Turn this Into Costs

- Invert production function, $f(input) = output$ to get **inverse production** function, $f^{-1}(output) = input$.
- Multiply inverse production function by price of variable input, wages, w to produce **variable cost function**, $wf^{-1}(output) = winput = VC(output)$.
- Add cost of fixed inputs, r, to produce **total costs**, $VC(inputs) + rK = VC(output) + rK = VC(output) + FC = TC(Output)$

Inverting with Mirrors and Pipe cleaners

Multiply by Stretchering

Add by Sliding

Great, but We Need More

- Eventually we will find the output that maximizes profit.
- Calc people know that means take a derivative.
- Will do this graphically but we need more cost functions.

The Average Family

$$\frac{g(x)}{x} = \textit{Average G Function}$$

- Will put a variety of costs in for G.
- AFC: Average fixed cost
- AVC: Average variable cost
- AC or ATC: Average Cost or Average Total Cost

The Marginal

- For calc people, $\frac{\partial TC}{\partial q} = \frac{\partial TC}{\partial q} = MC(q)$
- For non-calc, the **additional** costs required to produce one more.

Cord from Origin Trick on AFC

Construct AVC

Construct AC

Construct MC

All the Average/Marginal at Once

Key Features

- AC generally like a smile but can have other shapes IRL
- Mark the min of AC
- MC looks like a Nike swoosh/fish hook that cuts min of AC.
- AVC is less than AC, is cut at min by MC, and gets closer and closer to AC as output increases. ***THIS IS THE HARD PART***
- Note hidden AFC, the vertical distance between AC and AVC.

A Few Rules

- FC is fixed
- $TC = VC + FC$
- $VC(0) = 0$
- $AC = AVC + AC = \frac{TC}{Q} = \frac{VC}{Q} + \frac{FC}{Q}$
- $MC(Q) = TC(Q+1) - TC(Q) = VC(Q+1) - VC(Q)$ The non-calc definition varies by textbook. Caution.

Try a Table