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.

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 increases 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**, $VC(inputs) + rK = VC(output) + rK = VC(output) + FC = TC(Output)$

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

- 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.

- 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.

Q	TC	VC	FC	AC	AFC	AVC	MC
0							3
1			2				
4	15						x

So now what?

At this level, economics has a specific modus operandi

- Figure out what the actor wants, the objective function.
- Figure out the constraints, costs, income, . . .
- Maximize (or minimize) the objective function subject to those constraints.

We will assume that the goal of the firm is profits, Π, which we define as revenue less costs.

Warning

- Costs are more expansive to an economist.
    - We include opportunity cost.
    - Imputed salary of owner that takes no salary.
    - Impute rent when firm owns property, even things like desks
- Because Costs are Different – Profits are different.
    - Net Income, profit to an accountant, is always more than economic profit.
    - We include costs they don't

$$Accounting\ Profit - Opportunity\ Costs = Economic\ Profit$$

Just because you have positive accounting profits, net income, does not mean you have positive economic profits

Profit

$$\Pi = Rev(q) - Cost(q)$$

- Positive profit
    - Greater than can be achieved elsewhere in the economy for the same risk.
    - Expect net entry soon
- Zero or Normal Profit
    - Equal to what can be achieved elsewhere for the same risk.
    - No net entry or exit
- Negative: Less
    - Net exit

Note that risk is built in. The higher the risk the more profit needed.

- A very safe 2% return may be positive economic profits.
- A very risky 15% return may be negative economic profits.

So what Does the Firm do?

Competitive firms observe a price and choose output to maximize profit.

- They can't control price and can only react.
- Profit, not maximum per unit.
- Calc people will see this as an optimization problem.

$$\max_q R(q) - C(q)$$

Profit Max Q with Total Cost and Total Revenue

Steps

- Find q^* where $MC = MR$
- Start at q^* go to AC and hang a left.
  - That is AC^*.
  - Box is Total Cost, $TC^* = AC^* q^*$
- Start at Start at q^* go to $AR = P = MR = D_{firm}$ and hang a left.
  - That is AR^*.
  - Box is Total Revenue, $TR^* = AR^* q^*$
- Little box on top is profit.

Weird sunglasses shows up when there is positive economic profits.

Negative Economic Profits

Negative Profits

- No Weird sunglasses thing but a funny triangle.
- Does not mean you go out of business or exit.
    - But you could make more in another industry.
- There is a shut-down condition
    - If AVC > AR, shut down
    - Not out of business.
- Why all stores are not 24/7.
    - The revenue from staying open (AR) is less than the costs of lights and labor (AVC).
    - Exit and Entry is a long term topic which we handle elsewhere.

$$\Pi = TR - FC - VC$$

When TR<VC you are better off just paying FC and let $TR = 0$ and $VC = 0$.

$$\Pi = (TR - VC) - FC < -FC$$

Play Time

- Which curves move when price changes?
- Which curves move when the rental rate, r, the price of fixed inputs changes?
- Which curves move when the wage rate, w, the price of the variable input changes?

Price?

- No cost curves change
- $q*$ changes and everything that follows after that.
- MC is the supply curve for the firm

Price Demo

Double the rental rate

Q	TC	VC	FC	AC	AFC	AVC	MC
0	2 (4)	0	2 (4)				1
1	3 (5)	1	2 (4)	$\frac{3}{1}$ ($\frac{5}{1}$)	$\frac{2}{1}$ ($\frac{4}{1}$)	$\frac{1}{1}$	×

- TC, FC, AC, AFC change
- MC, VC Don't

Diagram

- q^* does not change
- Revenue does not change
- Profits change

Double the rental rate

Q	TC	VC	FC	AC	AFC	AVC	MC
0	2	0	2				1 (2)
1	3 (4)	1 (2)	2	$\frac{3}{1}(\frac{4}{1})$	$\frac{2}{1}$	$\frac{1}{1}$ $(\frac{2}{1})$	x

- TC, VC, AC, AVC and MC change
- FC and AFC Don't

Diagram (TRICKY)

Note

- q^* does change
- Revenue changes
- Profits change

What You Learned So Far

- MC is the supply function for the firm.
- Wage changes moves MC the same way supply changes in S/D model
- Rental rate does not right now but will in next section, Long-run perfect competition.