Lecture # 14 – Costs of Production

I. Which Costs Matter?

- Having defined production, the next step in the firm's problem is cost minimization. To begin, we discuss which costs economists are concerned with.
- Economic costs vs. accounting costs
    - Accounting costs focus on explicit costs (e.g. wages, rent, cost of materials...)
    - Economic costs also include opportunity costs.
        - Opportunity cost -- the cost of forgone opportunities.
    - Economic costs ignore sunk costs.
        - Sunk costs -- expenditures that have been made and cannot be recovered.
            - Since sunk costs cannot be changed, they should not influence the firm's decision.

II. Costs in the Short Run

A. Definitions

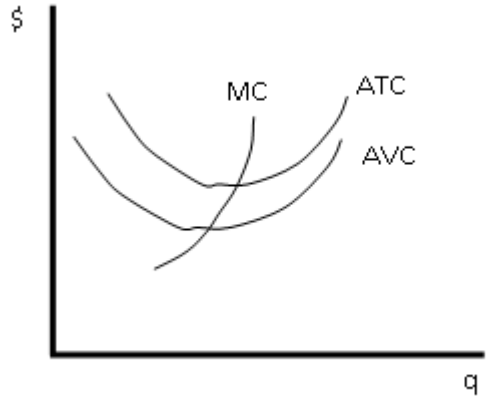
- Total cost (TC) -- the total amount a firm spends to produce a given level of output (Q).
    - Can be divided into:
        - Fixed cost (FC) -- a cost that does not change as the quantity of output changes.
        - Variable cost (VC) -- a cost that does change as the level of output changes.
- Marginal cost (MC) -- the increase in cost that results from producing one extra unit of output.
    - Marginal cost is equal to changes in variable cost.
- Average cost (AC) -- the cost per unit of output.

B. Cost Curves

- The chart below contains the numbers from the example in class:

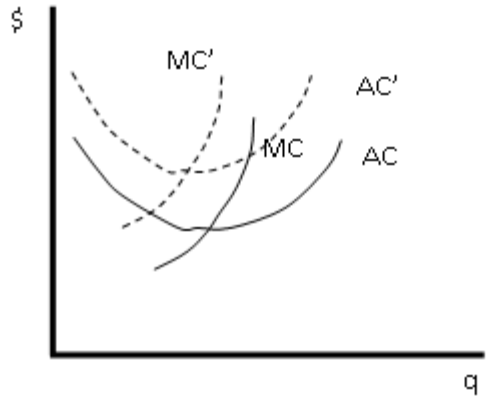
Output	Fixed Cost	Variable Cost	Total Cost	Marginal Cost	Average Fixed Cost	Average Variable Cost	Average Total Cost
Q	**FC**	**VC**	**TC**	**MC**	**AFC**	**AVC**	**ATC**
0	48	0	48	--	--	--	--
1	48	25	73	25	48	25	73
2	48	46	94	21	24.0	23.0	47.0
3	48	66	114	20	16.0	22.0	38.0
4	48	82	130	16	12.0	20.5	32.5
5	48	100	148	18	9.6	20.0	29.6
6	48	120	168	**20**	8.0	**20.0**	28.0
7	48	141	189	21	6.9	20.1	27.0
8	48	168	216	**27**	6.0	21.0	**27.0**
9	48	198	246	30	5.3	22.0	27.3
10	48	230	278	32	4.8	23.0	27.8
11	48	272	320	42	4.4	24.7	29.1
12	48	321	369	49	4.0	26.8	30.8

- Key features of cost curves:
    - AC & MC are U-shaped curves.

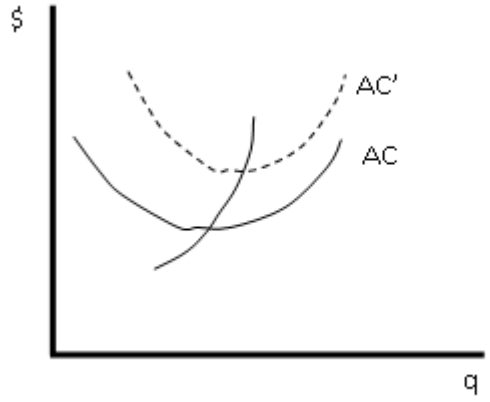


    - MC intersects the average cost curves at the minimum of each average cost curve.

- Shifting the curves
    - Things that affect variable costs shift both the AC and MC curves.
        - Example: a tax on labor.



- Things that affect fixed costs only shift the AC curve.
  - Example: increase rent on a factory



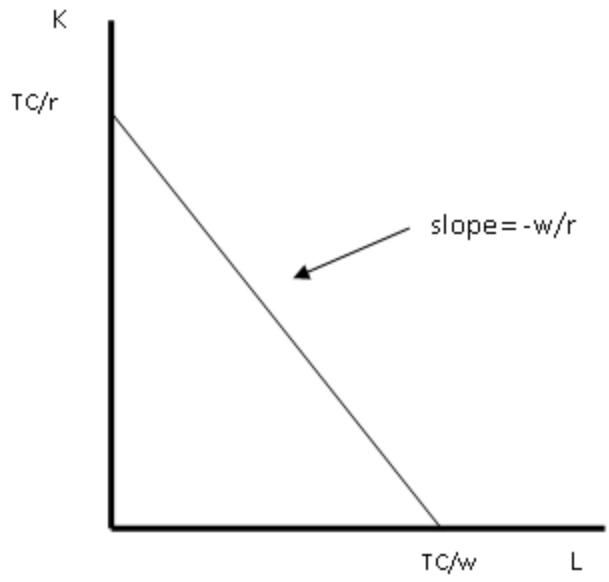
- Finally, note that the shape of the cost curves relate to the average product and marginal product curves.
  - When MP of labor is rising, MC falls, and vice versa.
    - Algebraically: $MC = w/MP_L$
  - When AP of labor is rising, average variable costs (AVC) fall, and vice versa.
    - Algebraically, $AVC = VC/q = wL/q = w\mathbf{(L/q)} = w/AP_L$
    - Note that the relationship between AP and AC is not exact, because AC also includes fixed costs.
  - Example:
    - wage = $25/day
    - price of capital (r) = $100/day

K	L	q	MP_L	TFC	TVC	TC	MC
1	0	0		100	0	100	--
1	1	4	4	100	25	125	25/4=6.25
1	2	10	6	100	50	150	25/6=4.167
1	3	13	3	100	75	175	25/3=8.33
1	4	15	2	100	100	200	25/2=12.25
1	5	16	1	100	125	225	25/1=25

III. Costs in the Long Run

A. Isocost Lines

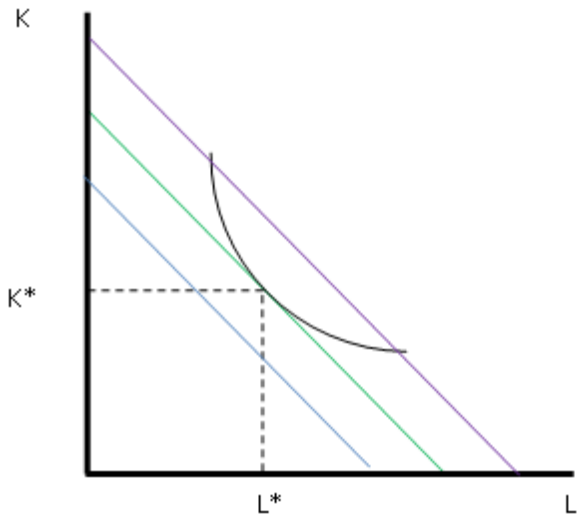
- Isocost line -- a line representing all possible combinations of inputs that can be purchased for a given total cost.
    - slope = -w/r



    - Costs increase as the isocost line shifts out.
    - An isocost line is similar to the budget constraint from consumer theory.

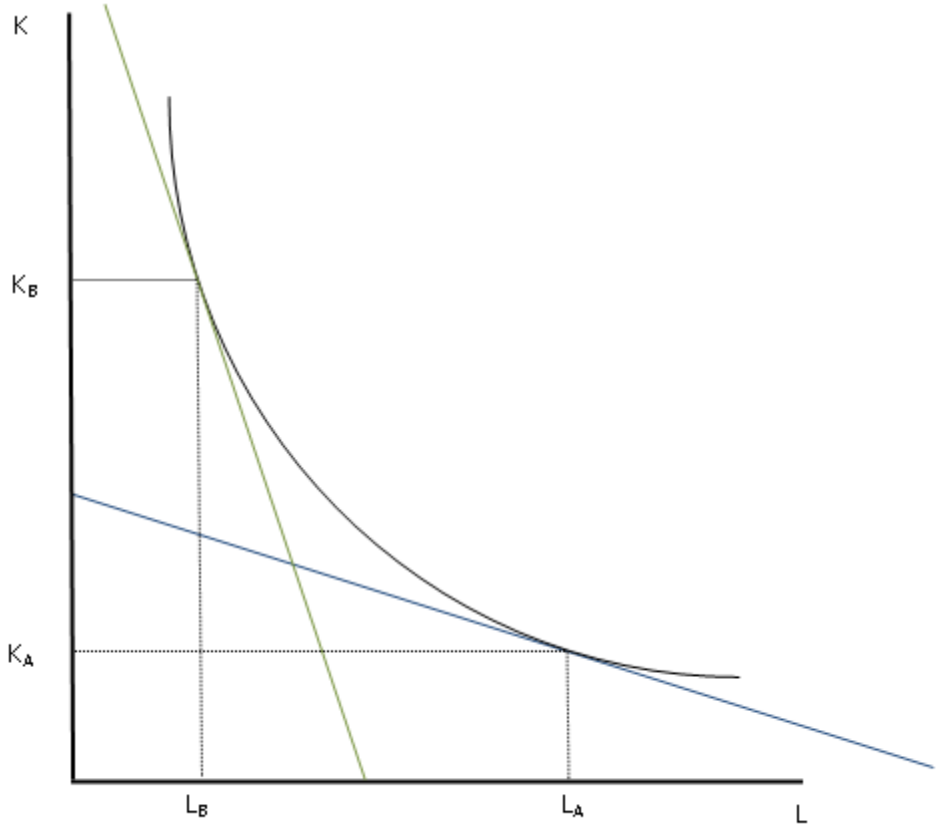
B. Minimizing Costs

- Goal: To find the combination of inputs that produces a given level of quantity at the lowest possible cost.
- Occurs where an isocost line is tangent to the isoquant.
    - Consider the three isocost lines below. Our goal is to minimize the cost of producing the quantity represented by the isoquant.
        - The purple line allows us to produce the desired quantity. However, we would spend too much.
        - The blue line does not spend enough. It is not possible to produce the desired quantity.
        - The green line is the lowest possible isocost line touching the isoquant. This is the cheapest way to produce this output.



- At this point, $MP_L/MP_K = w/r$, or:
- $MP_L/w = MP_K/r$
    - The marginal product per dollar spent on each input is equal!
    - Intuition: Each dollar of input added to production adds an equivalent amount of output.
        - Suppose they are not. For example, the marginal product per dollar of labor is two, and the marginal product per dollar of capital is one. If you spend one less dollar on capital, you lose one unit of output. If that dollar is spent on labor, you get two additional units of output. Thus, there is a net gain of one unit of output for the same cost as before.

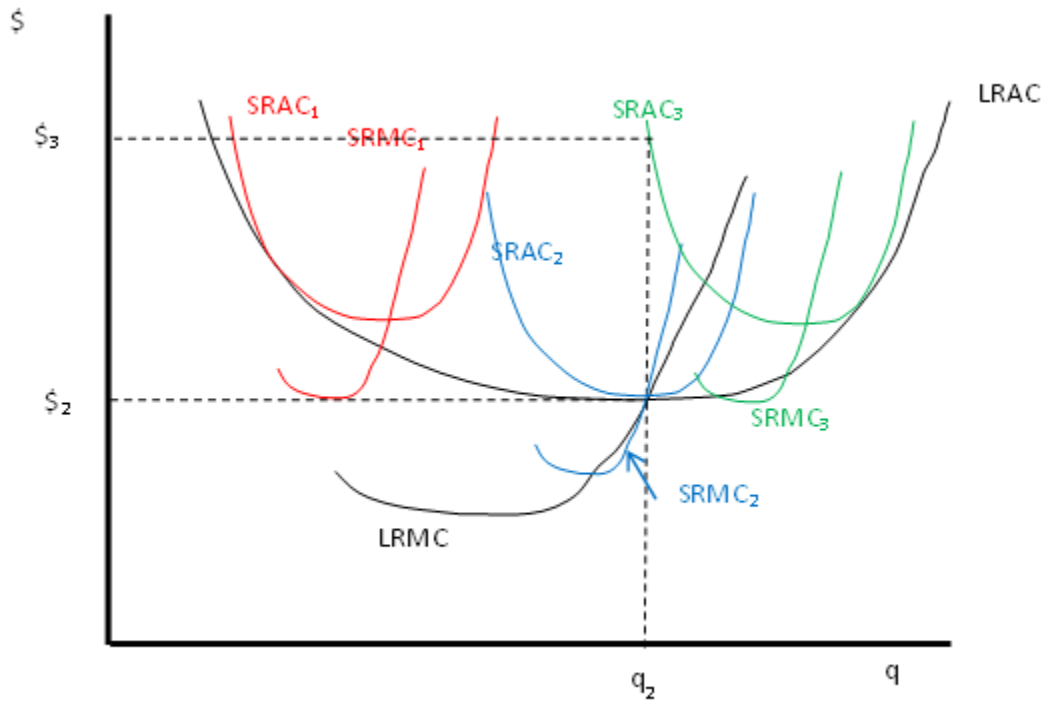
- Note: if the price of an input changes, the slope of the isocost line changes. However, cost minimization requires that we stay on the same isoquant.
    - As a result, the firm uses less of the input whose price has increased, and more of the other.
    - In the example below, the firm staarts with K_A and L_A. Costs are shown by the blue isocost line.
    - As the cost of labor increases, the isocost line becomes steeper (similar to when it rotated in when working with budget constraints).
        - At this point, the firm uses more capital (K_B) and less labor (L_B).
        - Note as well that the intercept on the K axis is higher. Since the price of capital hasn't changed, this must mean that total costs are higher with the green isocost line.



IV. Economies of Scale

- The long run total cost curve follows from cost minimization.
    - By varying the level of output (that is, looking at different isoquants), cost minimization tells us the cheapest possible way to produce any given level of output.
- The shape of the long run total cost curve is determined by economies of scale.
    - Recall that returns to scale kept inputs in the same proportion (e.g. double inputs => double output).
    - However, in the long run, the proportion of inputs can change. Thus, we look at changes in cost.
- Economies of scale -- when you can double output for less than double the cost.
- Diseconomies of scale -- when you double output and costs more than double.
- Economies of scale help determine the shape of the long run AC curve
    - MC < AC (AC falling) => economies of scale
    - MC > AC (AC rising) => diseconomies of scale
- U-shaped AC curves are typical for competitive markets.
    - In these industries, it makes since to have several small firms to avoid diseconomies of scale.
- Monopolies are often the result of economies of scale.
    - When average costs fall as output increases, it makes since to have one firm produce the output.

- Finally, note that short run total cost is always greater than or equal to long run total cost
    - In this example, the black curves represent long run average and marginal costs.
    - The colored lines represent three different short run cost curves. Each set can be thought of, for example, as pertaining to a different size factory.
        - For each set of short run cost curves, there is one point where SRAC = LRAC.
        - At this quantity, the size factory represented by these curves is ideal.
        - At all other points, you would prefer a different size factory (e.g. you would adjust your fixed inputs if you could).
            - For example, suppose you currently have a large factory, represented by the green curves, and are producing q_2 units of output.
            - With these cost curves, your average cost will be $\$_3$.
            - However, you would prefer the smaller factory represented by the blue cost curves.
            - In the long run, you could switch to this size, and average costs would fall to $\$_2$.



        - *Intuition*: There are fewer constraints in the long run. You can always replicate what you did in the short run in the long run, so there is no reason for you do worse. Since you have more flexibility, however, you can do better.