BUEC 311: Producer Behaviour, Part 2

Outline Conceptualizing Costs Measuring Costs Long and short run costs The Learning Curve Multiple goods and returns to scope

BUEC 311: Business Economics, Organization and Management
Producer Behaviour, Part 2

Fall 2020

Outline

1. Conceptualizing costs.

2. Common measures of costs.

3. Costs in the short run and long run.

4. The learning curve.

5. The costs of producing multiple goods.

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Conceptualizing Costs

- Previously, we examined how output changes in response to changes in inputs, technology, etc.

- But the technical relationship between inputs and outputs defined by the production process is only one determinant of how firms choose what to produce.

- We also need to account for the cost of inputs.

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Explicit and Implicit Costs

- Financial accounting statements correctly measure costs for tax purposes and to meet other legal requirements.

- To make sound managerial decisions, good managers need more information.

- We need to think about both *explicit* and *implicit* costs.
  - Explicit costs are direct, out-of-pocket payments for labor, capital, energy and materials.
  - Implicit costs reflect forgone opportunities rather than explicit, current expenditure.

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Opportunity Costs

- The *opportunity cost* of a resource is the value of the best alternative use of that resource.

Example (Opportunity costs)

Taylor owns and manages a consulting firm. The firm's monthly revenue is $55k, and monthly costs are $46k, which includes a $2k per month salary for Taylor. Taylor also collects the firm's profits each month. Alternatively Taylor could work for another firm and receive $12k per month. Given this, is Taylor using her labor effectively? Why or why not?

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Trumpian Opportunity Costs

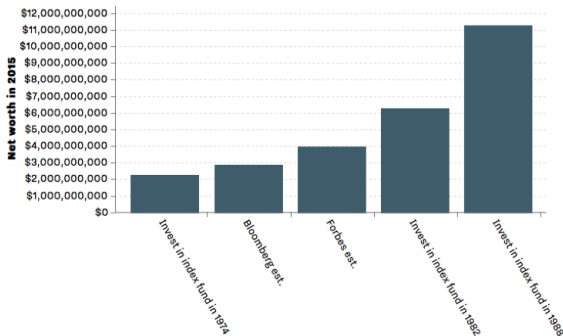**How rich Donald Trump would've been if he'd just put his money in the S&P 500**

Figure: The opportunity cost of being Donald?

Opportunity Costs

- The opportunity cost for inputs that can be bought and used in the same period can be determined from the market.
  - E.g: Labor services, energy, and materials.

- It is more difficult to determine the opportunity costs of inputs that are *durable*.
  - Durable inputs are useable for a long period, perhaps for many years.
  - E.g: Capital, such as land, buildings, and equipment.

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Durable Input Costs

- Two issues with durable inputs:
    1. How do we allocate the initial purchase cost over time?
    2. What do we do if the value of the input changes over time?

- Accountant may expense input or amortize it over the life of the input following standard accounting rules.

- The decision to operate the input is independent of the expense/amortize decision; it depends on the opportunity cost of the input.

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Durable Input Costs

Example (Opportunity Costs and Durable Inputs)

Consider the case of Tony, who is deciding on whether or not to operate a welding truck. Operating the truck earns the company $2k per month, but the truck depreciates at a value of $1k per month.

1. First, suppose that Tony can rent the truck to Kelly's Welding Company at a rate of $2.25k per month. Should Tony operate the truck?

2. Next, suppose that there is no rental market for trucks. Should Tony operate the truck?

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Sunk Costs

- Some costs that appear in financial accounts are not relevant for managerial decisions.

- These are *sunk costs*: past expenditures that cannot be recovered.

- Sunk costs should be ignored by managers when making decisions.

Sunk Costs

Example (Sunk Costs)

A.T. & Love is a real estate developer that invested $10 million to purchase an apartment building with the intent to renovate the building and turn the apartments into luxury condos. The renovation is expected to cost an additional $2.5 million. However, since the initial purchase, a recession has hit, meaning demand for luxury condos has dried up. Gerald, one of A.T. & Love's executives, suggests the company invest in the renovations anyway, given that "We've already spent $10 million on this thing - we might as well spend the additional $2.5 to finish it up." Do you agree with Gerald's reasoning? Why or why not?

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Key Cost Measures

- Three key cost measures for making decisions based on the opportunity cost of inputs:
    1. Fixed Cost (F): A cost that does not vary with the level of output.
        - Includes expenditures on land, office space, and other overhead.
        - Often sunk, but not always.

    2. Variable Cost (VC): A cost that changes as output changes.
        - Refers to the cost of *variable inputs*.

    3. Total Cost (C): The sum of fixed and variable costs.
- Industry-specific names may be different, e.g. sustaining capital costs.

$$C = F + VC$$

Average Costs

- Corresponding average cost measures:
  1. Average Fixed Cost (AFC): $AFC = F/q$
     - Falls as output rises because the fixed cost is spread over more units.

  2. Average Variable Cost (AVC): $AVC = VC/q$
     - Can rise or fall with increases in output.

  3. Average Cost (AC): $AC = AFC + AVC$
     - Also referred to as average total cost.
     - May increase or decrease with increases in output.

Marginal Cost

- Another important cost concept: *Marginal Costs*

- Marginal Costs (MC) are the amount by which a firm's cost changes if the firm produces one more unit.

$$MC = \Delta C / \Delta q$$

- Marginal costs are also equal to the change in variable costs from a one-unit increase in output:

$$MC = \Delta VC / \Delta q$$

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Cost Example: Ben's Pizza Shop

- As an example, consider Ben's Pizza shop.

- Ben is interested in understanding how his costs change as he sells more pizzas.
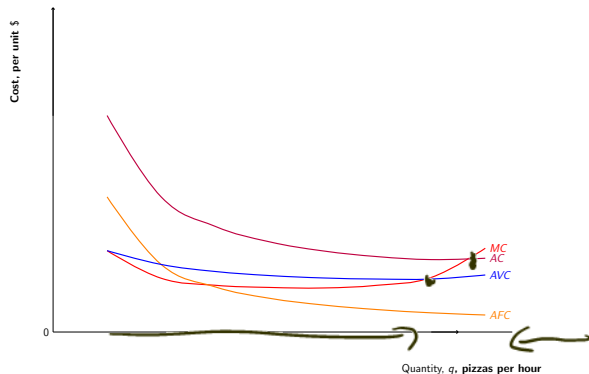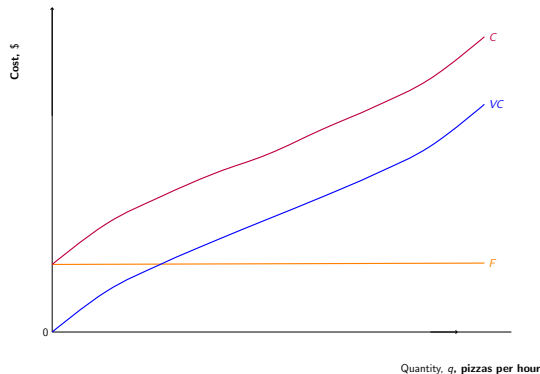
Cost Example: Ben's Pizza Shop

q	F	VC	C	MC	AFC = F/q	AVC = VC/q	AC = C/q
0	5	0.00	5.00				
1	5	3.01	8.01	3.01	5.00	3.01	8.01
2	5	5.00	10.00	1.99	2.50	2.50	5.00
3	5	6.73	11.73	1.73	1.67	2.24	3.91
4	5	8.37	13.37	1.65	1.25	2.09	3.34
5	5	10.00	15.00	1.63	1.00	2.00	3.00
6	5	11.73	16.73	1.73	0.83	1.96	2.79
7	5	13.75	18.75	2.02	0.71	1.96	2.68
8	5	16.85	21.85	3.10	0.63	2.11	2.73

Cost Example: Ben's Pizza Shop

- We can also illustrate the relationship between different cost measures and output graphically using cost curves.

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Cost Example: Ben's Pizza Shop

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Long run costs

- In the short run, the production function determines the shape of a firm's cost curves for given input prices.

- Why? Consider a firm with a production function of capital and labour, with capital fixed in the short run.

  - In the short run, diminishing marginal returns to labor determine the shape of the production function.

  - Moreover, labor is the only variable input, so $VC = wL$.

  - This means that as output increases, variable costs increase more than proportionally.

    - Diminishing marginal returns mean more labor is needed to produce one more unit of output.

Diminishing Marginal Returns

- Diminishing marginal returns determine the shape of the marginal cost curve.

- Recall that $MC = \Delta VC/\Delta q$, and note that with a fixed capital stock, the change in variable cost must be the change in the cost of labor. That is:

$$MC = \Delta VC/\Delta q = w[\Delta L/\Delta q]$$

- But also, $MP_L = \Delta q/\Delta L$, meaning:

$$MC = w/MP_L$$

- This means marginal costs and the marginal product of labor are inversely related; MC falls as MP_L increases and vice-versa.

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Diminishing Marginal Returns

- Diminishing marginal returns also determine the shape of the average cost curve.

- Recall $AVC = VC/q$, and note that in the short run labor is the only variable input, so $VC = wL$. Hence, in the short run:

$$AVC = wL/q$$

- But also, $AP_L = q/L$, so:

$$AVC = w/AP_L$$

- This means that average costs and the average product of labor are inversely related; AVC falls as AP_L increase and vice versa.

Diminishing Marginal Returns

- To summarize, in the short run:

  1. The costs associated with fixed inputs are fixed, while the costs from inputs that can be adjusted are variable.

  2. For a given set of input prices, the shapes of the variable cost curves and the marginal cost curve are determined by the production function.

  3. Where there are diminishing marginal returns, the variable cost and cost curves become relatively steep as output increases, so the average cost, average variable cost, and marginal cost curves rise with output.

  4. The average cost and average variable cost curves fall when marginal cost is below them and rise when marginal cost is above them, so the marginal cost cuts both these average cost curves at their minimum points.

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Long Run Costs

- In the long run, firms adjust all of their inputs so that the cost of production is as low as possible.
  - Firms can adjust plant size, design, build new machines, and otherwise adjust inputs that were fixed in the short run.
  - Fixed costs are *avoidable* in the long run.
    - These costs are no longer sunk, as in the short run.

Long Run Costs

- In the long run, the firm's problem becomes one of choosing between bundles of inputs.

- <u>Recall</u>: In the long run, the firm can choose to produce a given quantity of output from many different *technically efficient* combinations of inputs.

- So the question becomes:
  - Which technically efficient combination of inputs should the firm choose?

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Cost Minimization

- <u>Goal</u>: Choose the combination of inputs that is *economically efficient*.

- <u>Getting there</u>: Need information about the firm's production process, and information about the cost of production.

Cost Minimization

- Suppose capital and labor are the only inputs used by the firm. In this case, the firm's total costs are given by:

$$C = wL + rK$$

  where w is the wage rate, and r is the rental rate on capital.

- The *isocost line* is all of the combinations of labor and capital that have the same total cost, $\bar{C}$:

$$\bar{C} = wL + rK$$

Cost Minimization

- Consider the case of Axel, who is opening a new ice cream shop.

- Given that capital and labor are variable, Axel can choose between many possible input combinations.

- Suppose that Axel has \$150 to spend on inputs, labor costs 25 dollars per day ($w = \$25$), and capital costs 25 dollars per day ($r = \$25$).

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Cost Minimization

Bundle	L	K	wL	rK	$wL + rK$
a	6	0	$150	$0	$150
b	5	1	$125	$25	$150
c	4	2	$100	$50	$150
d	3	3	$75	$75	$150
e	2	4	$50	$100	$150
f	1	5	$25	$125	$150
g	0	6	$0	$150	$150

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Cost Minimization

- We can also present the same information graphically by rewriting the isocost line as:

$$K = \frac{\bar{C}}{r} - \frac{w}{r}L$$

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Cost Minimization

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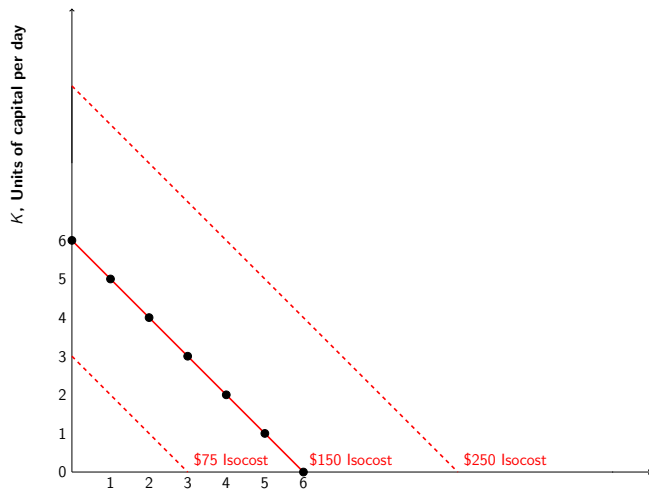
Isocost lines

- Three key properties of isocost lines:
  1. The point at which the isocost line hits the capital and labor axes depends on the firm's cost and on the price of inputs.
  2. Isocost lines that are farther from the origin have higher costs than those closer to the origin.
 3. The slope of each isocost line is the same, and is given by:

$$\frac{\Delta K}{\Delta L} = -\frac{w}{r}$$

This is the rate at which the firm can trade capital for labor in input markets.

Cost Minimization

- We can determine the economically efficient level of production for a firm by using the information contained in an isoquant and the information contained in an isocost line.
  - Isoquant $\implies$ how technology allows the firm to trade off labor and capital to produce output.
  - Isocost $\implies$ how the firm is able to trade off labor and capital in the market.

- The economically efficient outcome occurs when these trade-offs are the same.
  - This minimizes the cost of production.
  - Occurs when the firm chooses the combination of inputs that is on the lowest isocost line that touches the isoquant with the desired level of produciton.
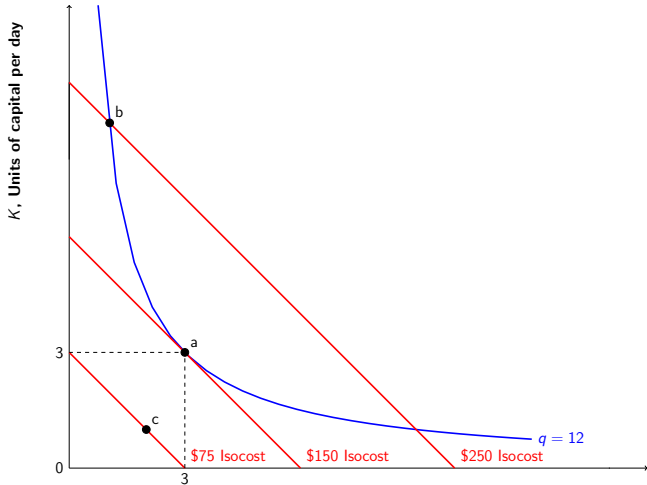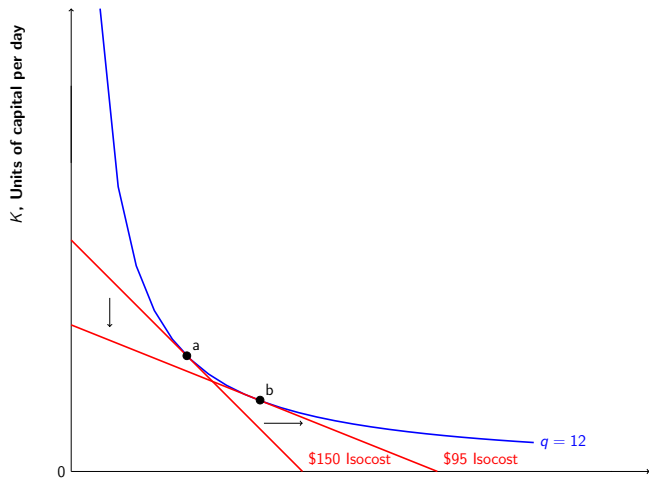
Cost Minimization

Cost Minimization

- There are three equivalent rules for minimizing costs in the long run:
  1. The Lowest Isocost Rule
     - The firm minimizes its cost by using the combination of inputs on the isoquant that is on the lowest isocost line that touches the isoquant.

  2. The Tangency Rule: $MRTS = -w/r$
     - At the minimum-cost bundle, x, the isoquant is tangent to the isocost line. The slope of the isoquant (MRTS) and the slope of the isocost are equal.

  3. The Last-Dollar Rule: $MP_L/w = MP_K/r$
     - Cost is minimized if inputs are chosen so that the last dollar spent on labor adds as much extra output as the last dollar spent on capital. Thus, spending one more dollar on labor at x gets the firm as much extra output as spending the same amount on capital.

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Cost minimization when input prices change

- Key question: How should a firm change its behavior if the cost of one of its inputs changes?

- As an example, consider the effects of a change in the price of labor on Axel's choice of inputs given that he is producing $q = 12$.

- Specifically, suppose that the cost of labor falls from \$25 to \$10.

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Cost minimization when input prices change

Cost minimization when input prices change

- As in the short-run, the shape of the long-run cost curve depends on the shape of the production function.

- However, unlike the short run, where key determinant was diminishing marginal returns, in the long run, the key determinant is returns to scale.

Long Run Average Costs

- The Long-Run Average Cost (LRAC) curve must be U-shaped if a production function has:
    - increasing returns to scale at low levels of output,
    - constant returns to scale at intermediate levels of output, and
    - decreasing returns to scale at high levels of output.

- The shape of the LRAC curve can have different shapes depending on whether the production process exhibits economies of scale or diseconomies of scale.
    - *Economies of scale* occur if average costs fall as output expands.
    - *Diseconomies of scale* occur if average costs rise as output expands.
    - There are *no economies of scale* if average costs do not change with output.

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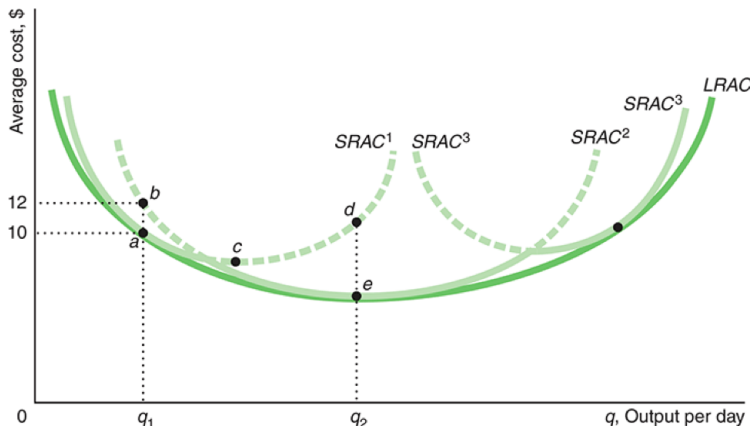
Long Run Average Costs

- The shape of the LRAC curve also depends on market structure.
  - In perfectly competitive markets, firms typically have U-shaped LRAC curves.

  - In non-competitive markets, curves may be U-shaped, L-shaped, everywhere downward sloping, everywhere upward sloping or have other shapes.

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Long Run Average Costs

- It is important to note that the short-run and long-run average cost curves are related.

- Specifically, long-run average costs are always equal to or below short-run average costs.

- Why is this?

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Long Run Average Costs

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Cost declines

- A firm's costs may fall over time because of increasing returns to scale, technological progress, and learning by doing.

- Learning by doing refers to the productive skills and knowledge that workers and managers gain from experience.
  - Workers add speed via practice.
  - Managers learn how to organize production more efficiently, assign tasks based on worker's skills, and reduce inventory costs.
  - Engineers optimize product designs with experimentation.

- Learning by doing tends to cause the average cost of production to fall over time as output increases.
  - The effect is particularly strong with new products.

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The Learning Curve

- We can illustrate the relationship between average costs and cumulative output (the total number of units that have been produced since a product was introduced) with the <u>learning curve</u>.
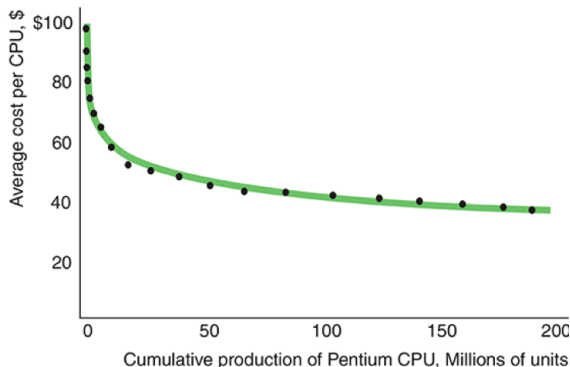
Moore's Law

Figure: Learning by Doing in Computer Chip Production

Learning-by-doing and economies of scale

- It is important to note that the effects of learning by doing can interact with economies of scale.

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Learning-by-doing and economies of scale
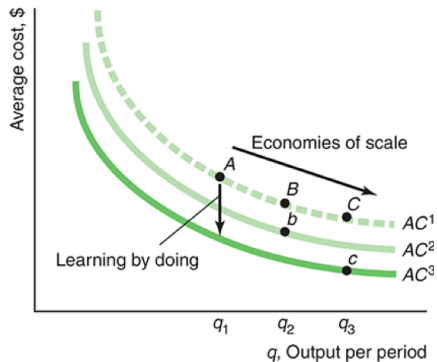
Figure: Learning by Doing with Economies of Scale

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The Cost of Producing Multiple Goods

- If a firm produces two or more goods that are linked by a single input, the cost of one good may depend on the output level of another good.
  - E.g. Cattle, oil refining.

- Firm costs exhibit economies of scope if it is less expensive to produce goods jointly than separately.
  - It is less expensive to produce beef and hides together, so there are economies of scope.
  - It is less expensive to produce gasoline, diesel, bunker fuel, etc. together, so there are economies of scope.

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The Cost of Producing Multiple Goods

- For a production process with two outputs, the degree of scope is given by:

$$SC = \frac{[C(q_1, 0) + C(0, q_2) - C(q_1, q_2)]}{C(q_1, q_2)}$$

  where the costs of only producing q_1, of only producing q_2 and of producing both goods are given by $C(q_1, 0)$, $C(0, q_2)$, and $C(q_1, q_2)$.

- SC measures the percentage change in costs from producing goods jointly vs separately.
  - If $SC > 0$ it is cheaper to produce goods jointly, meaning there are economies of scope.
  - If $SC < 0$ it is cheaper to produce goods separately, meaning there are diseconomies of scope.

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Part 2: Takeaways

1. Good management decisions are based on opportunity cost.

2. In the short run, the relationship between costs and output is determined by fixed costs and diminishing marginal returns.

3. Costs are minimized in the long run by using the last dollar rule.

4. In the long run, the relationship between costs and output is determined by returns to scale.

5. Costs may also be influenced by learning by doing and economies of scope.