



Presentation to accompany
Principles of Microeconomics, Fourth Edition
N. Gregory Mankiw

Lecture 8

Today...

- Firm Behavior – Costs of Production
 - fixed, variable cost
 - marginal, average, total cost
 - short run, long run
- Midterm

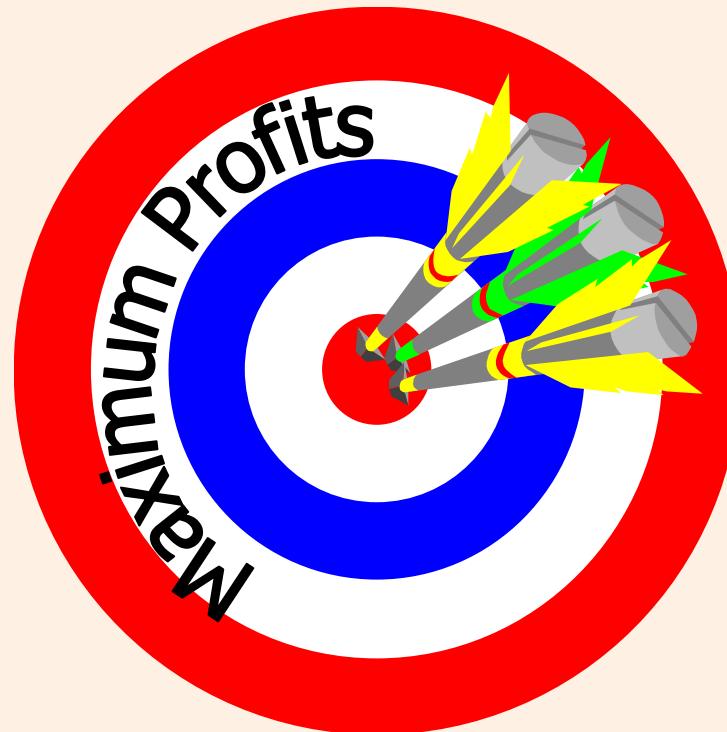
Cost of Production

According to the Law of Supply:

- Firms are willing to produce and sell a greater quantity of a good when the price of the good is high
- This results in a supply curve that slopes upward

Cost of Production

- The firm's objective
 - the economic goal of the firm is to maximize profits



Cost, Revenue, Profit

Total Revenue

The amount a firm receives for the sale of its output

Total Cost

The market value of the inputs a firm uses in production

Profit = Total Revenue - Total Cost

Cost of Production

A firm's **cost of production** includes all the opportunity costs of making its output of goods and services

Explicit and Implicit Costs

A firm's cost of production include explicit costs and implicit costs

- **Explicit costs** are input costs that require a direct outlay of money by the firm
- **Implicit costs** are input costs that do not require an outlay of money by the firm
- When total revenue exceeds both explicit and implicit costs, the firm earns economic profit

Production and Cost

Production and Costs

The Production Function

shows the relationship between quantity of inputs used to make a good and the quantity of output of that good

Marginal Product

of any input in the production process is the increase in output that arises from an additional unit of that input

Production and Cost

Diminishing Marginal Product

is the property whereby the marginal product of an input declines as the quantity of the input increases

Example: As more and more workers are hired at a firm, each additional worker contributes less and less to production because the firm has a limited amount of equipment

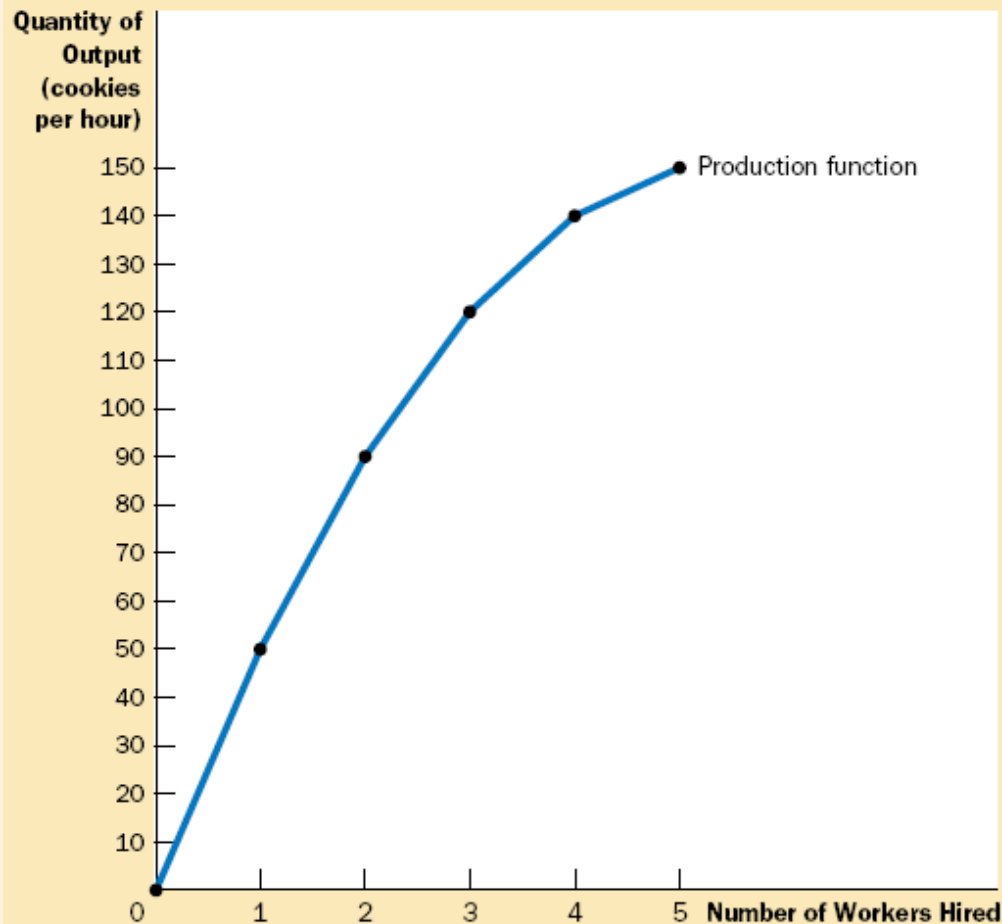
Production and Cost

Output – Total Cost

NUMBER OF WORKERS	OUTPUT (QUANTITY OF COOKIES PRODUCED PER HOUR)	MARGINAL PRODUCT OF LABOR	COST OF FACTORY	COST OF WORKERS	TOTAL COST OF INPUTS (COST OF FACTORY + COST OF WORKERS)
0	0		\$30	\$ 0	\$30
1	50	50	30	10	40
2	90	40	30	20	50
3	120	30	30	30	60
4	140	20	30	40	70
5	150	10	30	50	80

Production and Cost

Production function:



Production and Cost

Diminishing Marginal Product

- The slope of the production function measures the marginal product of an input, such as a worker
- When the marginal product declines, the production function becomes flatter

Production and Cost

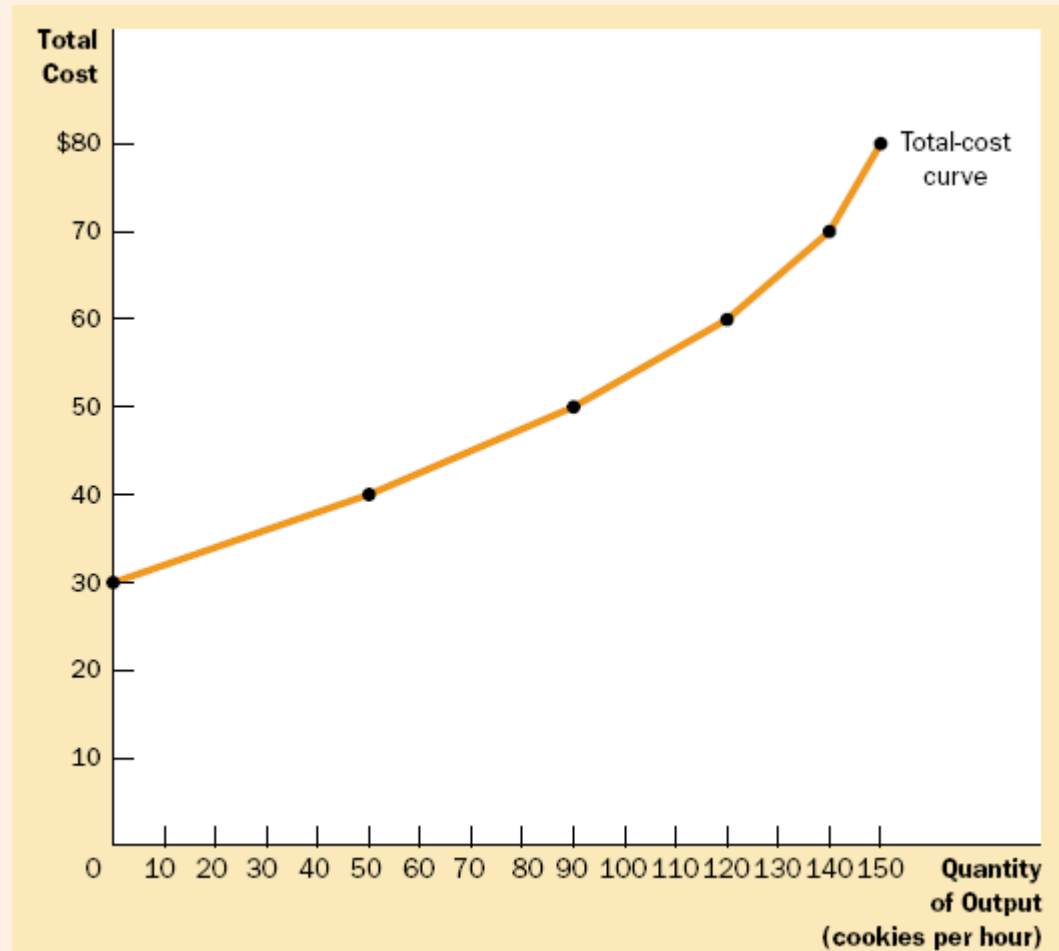
- The relationship between the quantity a firm can produce and its costs determines pricing decisions
- The **total-cost curve** shows this relationship graphically

Production and Cost

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5	150	10	30	50	80

Production and Cost

Output – Total Cost



Fixed and Variable Costs

Various Measures of Cost:

Costs of production may be divided into *fixed costs* and *variable costs*

Fixed costs are those costs that do not vary with the quantity of output produced

Variable costs are those costs that do vary with the quantity of output produced

Fixed and Variable Costs

Total Costs:

Total Fixed Costs (TFC)

Total Variable Costs (TVC)

Total Costs (TC)

$$TC = TFC + TVC$$

Fixed and Variable Costs

QUANTITY OF LEMONADE (GLASSES PER HOUR)	TOTAL COST	FIXED COST	VARIABLE COST	AVERAGE FIXED COST	AVERAGE VARIABLE COST	AVERAGE TOTAL COST	MARGINAL COST
0	\$ 3.00	\$3.00	\$ 0.00	—	—	—	
1	3.30	3.00	0.30	\$3.00	\$0.30	\$3.30	\$0.30
2	3.80	3.00	0.80	1.50	0.40	1.90	0.50
3	4.50	3.00	1.50	1.00	0.50	1.50	0.70
4	5.40	3.00	2.40	0.75	0.60	1.35	0.90
5	6.50	3.00	3.50	0.60	0.70	1.30	1.10
6	7.80	3.00	4.80	0.50	0.80	1.30	1.30
7	9.30	3.00	6.30	0.43	0.90	1.33	1.50
8	11.00	3.00	8.00	0.38	1.00	1.38	1.70
9	12.90	3.00	9.90	0.33	1.10	1.43	1.90
10	15.00	3.00	12.00	0.30	1.20	1.50	2.10

Average Costs

Average Costs:

- Average costs can be determined by dividing the firm's costs by the quantity of output it produces
- The average cost is the cost of each typical unit of product

Average Costs

Average Fixed Costs (*AFC*)

Average Variable Costs (*AVC*)

Average Total Costs (*ATC*)

$$ATC = AFC + AVC$$

Average Costs

$$AFC = \frac{\text{Fixed cost}}{\text{Quantity}} = \frac{FC}{Q}$$

$$AVC = \frac{\text{Variable cost}}{\text{Quantity}} = \frac{VC}{Q}$$

$$ATC = \frac{\text{Total cost}}{\text{Quantity}} = \frac{TC}{Q}$$

Average Costs

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Marginal Cost

Marginal Cost (MC)

- measures the increase in total cost that arises from an extra unit of production
- Marginal cost helps answer the following question:
How much does it cost to produce an additional unit of output?

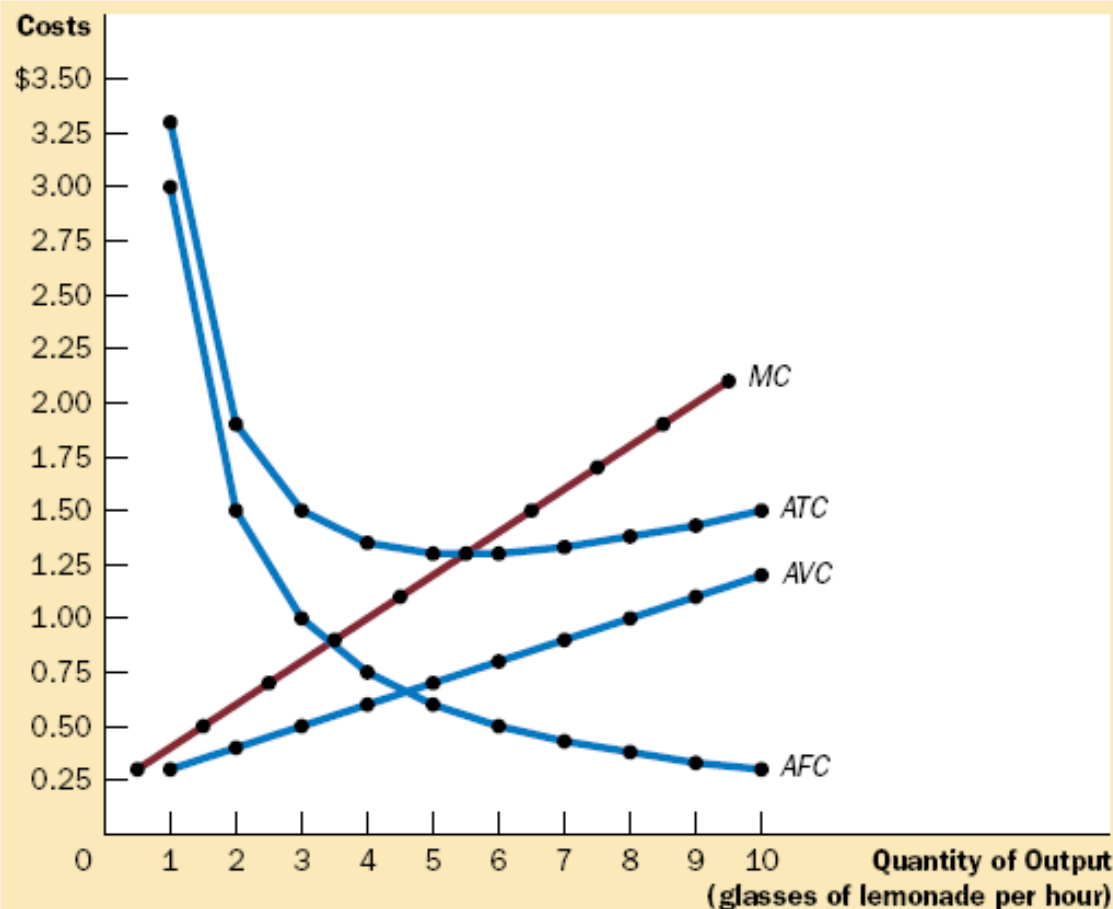
$$MC = \frac{(\text{change in total cost})}{(\text{change in quantity})} = \frac{\Delta TC}{\Delta Q}$$

Marginal Cost

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Cost Curves

ATC, AVC, AFC, MC



MC - ATC

Marginal cost rises with the amount of output produced

This reflects the property of *diminishing marginal product*

The average total-cost curve is *U-shaped*

- At very low levels of output average total cost is high because fixed cost is spread over only a few units
- Average total cost declines as output increases
- Average total cost starts rising because average variable cost rises substantially

MC - ATC

The bottom of the U-shaped *ATC* curve occurs at the quantity that *minimizes average total cost*

This quantity is sometimes called the *efficient scale* of the firm

MC - ATC

Relationship Between Marginal Cost and Average Total Cost

- Whenever marginal cost is less than average total cost, average total cost is falling
- Whenever marginal cost is greater than average total cost, average total cost is rising

MC - ATC

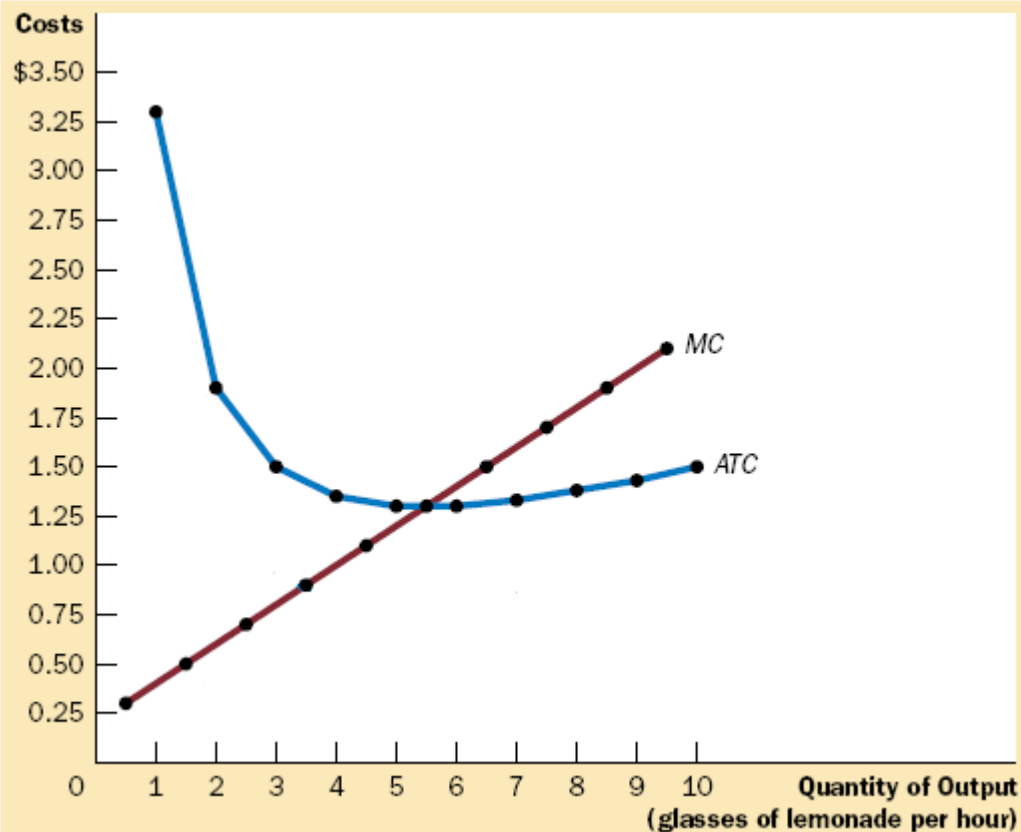
Relationship Between Marginal Cost and Average Total Cost

- The marginal-cost curve crosses the average-total-cost curve at the efficient scale

Efficient scale is the quantity that minimizes average total cost

MC - ATC

Relationship Between Marginal Cost and Average Total Cost



Cost Curves

Three Important Properties of Cost Curves

- Marginal cost eventually rises with the quantity of output
- The average-total-cost curve is U-shaped
- The marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost

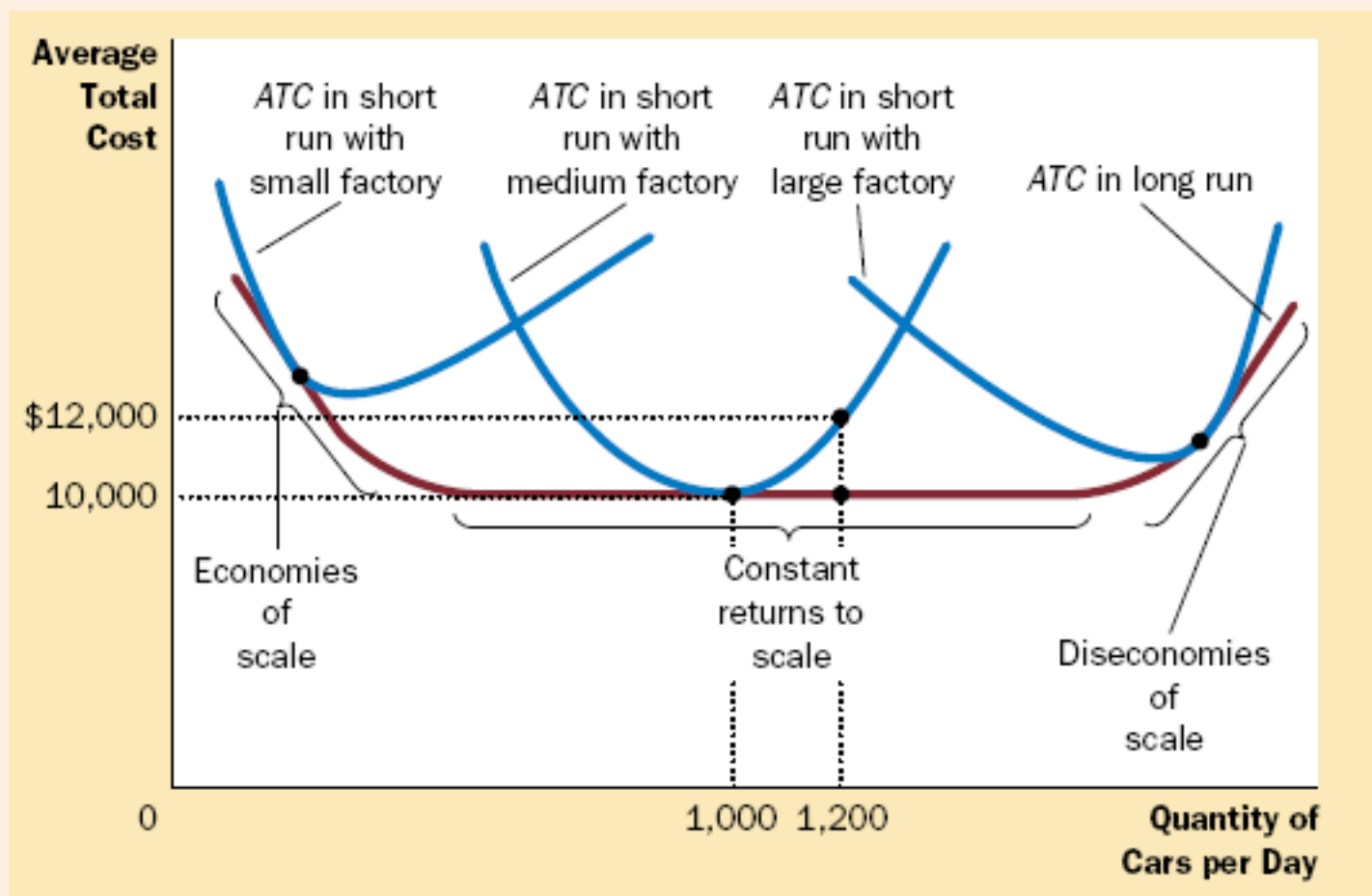
Short Run – Long Run

For many firms, the division of total costs between fixed and variable costs depends on the time horizon being considered

- In the short run, some costs are fixed
- In the long run, fixed costs become variable costs
- Because many costs are fixed in the short run but variable in the long run, a firm's long-run cost curves differ from its short-run cost curves

Short Run - Long Run

Short Run vs Long Run



Short Run – Long Run

Economies of scale refer to the property whereby long-run average total cost falls as the quantity of output increases

Diseconomies of scale refer to the property whereby long-run average total cost rises as the quantity of output increases

Constant returns to scale refers to the property whereby long-run average total cost stays the same as the quantity of output increases

Summary I

- The goal of firms is to maximize profit, which equals total revenue minus total cost
- When analyzing a firm's behavior, it is important to include all the opportunity costs of production
- Some opportunity costs are explicit while other opportunity costs are implicit

Summary II

- A firm's costs reflect its production process
- A typical firm's production function gets flatter as the quantity of input increases, displaying the property of diminishing marginal product
- A firm's total costs are divided between fixed and variable costs. Fixed costs do not change when the firm alters the quantity of output produced; variable costs do change as the firm alters quantity of output produced

Summary III

- Average total cost is total cost divided by the quantity of output
- Marginal cost is the amount by which total cost would rise if output were increased by one unit
- The marginal cost always rises with the quantity of output
- Average cost first falls as output increases and then rises

Summary IV

- The average-total-cost curve is U-shaped
- The marginal-cost curve always crosses the average-total-cost curve at the minimum of ATC
- A firm's costs often depend on the time horizon being considered
- In particular, many costs are fixed in the short run but variable in the long run

Midterm

Histogram:

