



Microeconomics
HM207

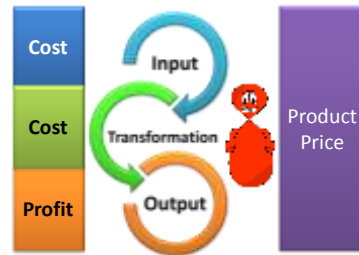
Production Theory & Cost

Topic 5: The Cost of Production



Production Theory

- study of the economic process of converting inputs into outputs



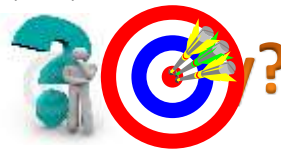
Firm and Household Decisions



- Firms **demand factors of production** in input markets
 - Raw materials
 - Machinery
 - Labour services
 - Capital goods
 - Land
- and **supply goods and services** in output markets.

Production Theory

- 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.



Production Theory

- **The Firm's Objective**
 - The economic goal of the firm is to maximize profits.



The Behavior of Profit-Maximizing Firms



- The three decisions that all firms must make include:

1.

How much output to supply

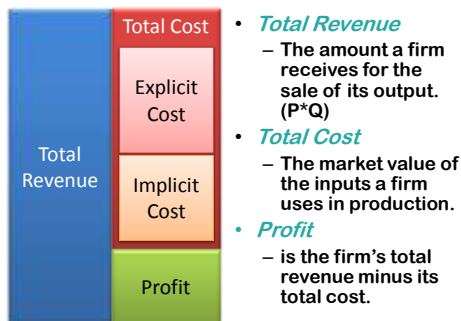
2.

Which production technology to use

3.

How much of each input to demand

Total Revenue, Total Cost, and Profit



The Firm's Costs

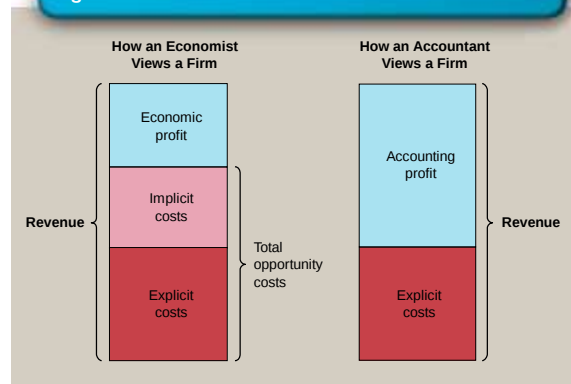


- A firm's **cost of production** includes all the opportunity costs of making its output of goods and services.
- **Explicit and Implicit Costs**
 - A firm's cost of production include explicit costs and implicit costs.
 - **Explicit** costs are input costs that require a direct outlay of money by the firm.
 - **Implicit** costs are input costs that do not require an outlay of money by the firm.

Economic Profit versus Accounting Profit

- Economists measure a firm's **economic profit** as total revenue minus total cost, including both explicit and implicit costs.
- Accountants measure the **accounting profit** as the firm's total revenue minus only the firm's explicit costs.

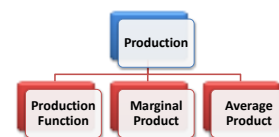
Figure 1 Economic versus Accountants



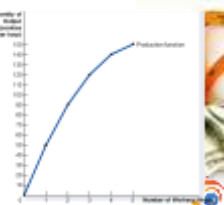
Economic Profit versus Accounting Profit

- When total revenue exceeds both explicit and implicit costs, the firm earns **economic profit**.
 - Economic profit is smaller than accounting profit.
- The **rate of return**, often referred to as the yield of the investment, is the annual flow of net income generated by an investment expressed as a percentage of the total investment.

PRODUCTION



- **The Production Function**
 - The **production function** shows the relationship between quantity of inputs used to make a good and the quantity of output of that good.
 - $Q = f(x_1, x_2, x_3, x_4 \dots)$
 - Where :
 - Q = Output quantity
 - x_n = factor of production

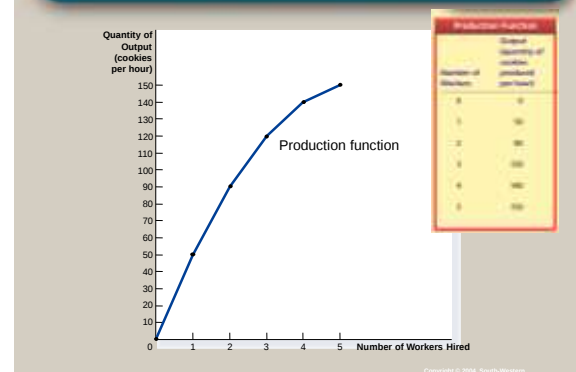


**Table 1 A Production Function and Total Cost:
Hungry Helen's Cookie Factory**

Production Function					
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	50	\$30	\$ 0	\$30
1	50	40	30	10	40
2	90	30	30	20	50
3	120	20	30	30	60
4	140	10	30	40	70
5	150	10	30	50	80

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Figure 2 Hungry Helen's Production Function



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The Production Function

• Marginal Product

- The **marginal product** of any input in the production process is the increase in output that arises from an additional unit of that input.

$$MP = \frac{\Delta Q}{\Delta X}$$

Where:

ΔQ = change in quantity of output
 ΔX = change in factor of production

Marginal Product		
Number of Workers	Output (quantity of cookies produced per hour)	Marginal Product of Labor
0	0	50
1	50	40
2	90	30
3	120	20
4	140	10
5	150	10

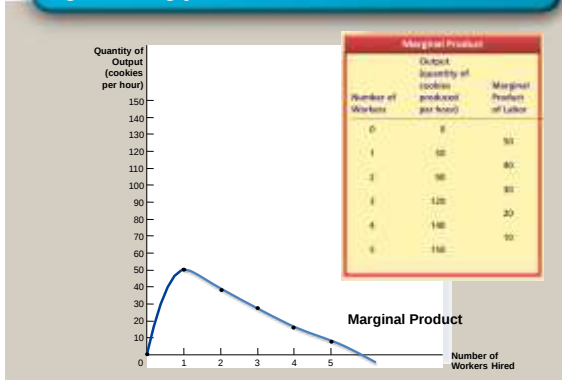
$$MP = \frac{50 - 0}{1 - 0} = 50$$

**Table 1 A Production Function and Total Cost:
Hungry Helen's Cookie Factory**

Marginal Product					
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)
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2	90	30	30	20	50
3	120	20	30	30	60
4	140	10	30	40	70
5	150	10	30	50	80

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Figure 2 Hungry Helen's Production Function

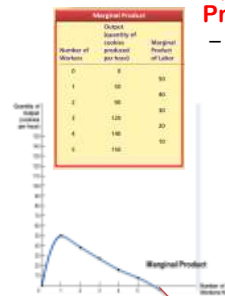


The Production Function

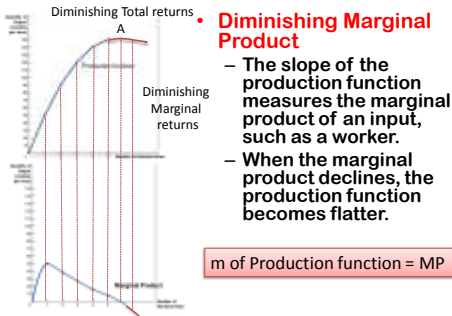
• Diminishing Marginal Product

- **Diminishing marginal product** is the property whereby the marginal product of an input declines as the quantity of the input increases.

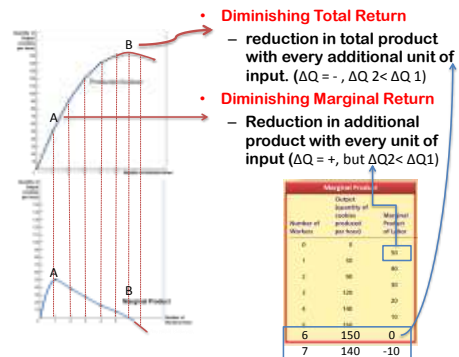
- Example: As more and more workers are hired at a firm, each additional worker contributes less and less to production because the firm has a limited amount of equipment.



The Production Function



The Production Function & Diminishing Returns

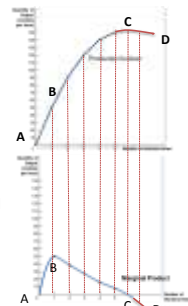


Law of Diminishing Returns

When variable factors of production are combined with fixed factors of production, total production will increase as the amount of the variable factor is increased. Initially, the increase in total output will be at an increasing rate. Eventually, the increase will be at a decreasing rate until a certain point of total production after which total production declines.

Law of Diminishing Returns

- When variable factors of production are combined with fixed factors of production, total production will increase as the amount of the variable factor is increased. **(A to C)**
- Initially, the increase in total output will be at an increasing rate. **(A to B)**
- Eventually, the increase will be at a decreasing rate. **(B to C)**
- Until a certain point of total production after which total production declines. **(C to D)**



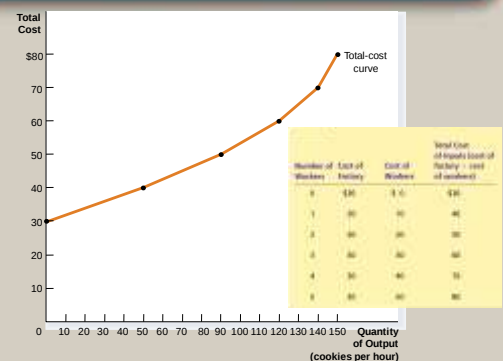
From the Production Function to the Total-Cost Curve

- The relationship between the quantity a firm can produce and its costs determines pricing decisions.



- The **total-cost curve** shows this relationship graphically.

Figure 3 Hungry Helen's Total-Cost Curve



THE VARIOUS MEASURES OF COST

- Costs of production may be divided into

- **fixed costs**

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

- **variable costs**

those costs that do vary with the quantity of output produced.

Number of Workers	Cost of Factory	Cost of Workers	Total Cost of Inputs (cost of factory + cost of workers)
0	\$10	\$ 0	\$10
1	10	10	40
2	10	20	50
3	10	30	60
4	10	40	70
5	10	50	80

Fixed and Variable Costs

- Total Costs
 - Total Fixed Costs (*TFC*)
 - Total Variable Costs (*TVC*)
 - Total Costs (*TC*)
 - $TC = TFC + TVC$

$$TFC = 30$$

$$TVC = vc(x) = 10x$$

$$TC = 10x + 30$$

Number of Workers	Cost of Factory	Cost of Workers	Total Cost of Inputs (cost of factory + cost of workers)
0	\$10	\$ 0	\$10
1	10	10	40
2	10	20	50
3	10	30	60
4	10	40	70
5	10	50	80

Various Measures of Cost



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Table 2 The Various Measures of Cost: Thirsty Thelma's Lemonade Stand

Quantity of Lemonade (glasses per hour)	Total Cost	Fixed Cost	Variable Cost	Average Fixed Cost	Average Variable Cost	Average Total Cost	Marginal Cost
0	\$2.00	\$1.00	\$0.00	—	—	—	\$0.30
1	3.30	1.00	0.30	\$3.00	\$0.30	\$3.30	0.50
2	3.80	1.00	0.80	1.50	0.40	1.90	0.70
3	4.50	1.00	1.50	1.00	0.50	1.50	0.90
4	5.40	1.00	2.40	0.75	0.60	1.35	1.10
5	6.50	1.00	3.50	0.60	0.70	1.30	1.30
6	7.80	1.00	4.80	0.50	0.80	1.30	1.50
7	9.30	1.00	6.30	0.43	0.90	1.33	1.70
8	11.00	1.00	8.00	0.38	1.00	1.38	1.90
9	12.90	1.00	9.90	0.33	1.10	1.43	2.10
10	15.00	1.00	12.00	0.30	1.20	1.50	—

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Measures of 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

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

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

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

Figure 4 Thirsty Thelma's Total-Cost Curves

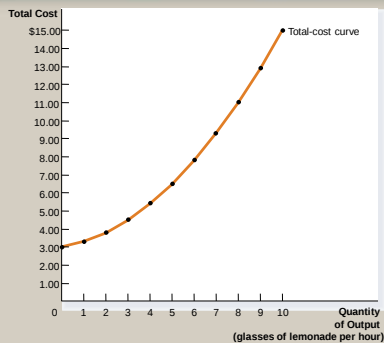


Figure 5 Thirsty Thelma's Average-Costs

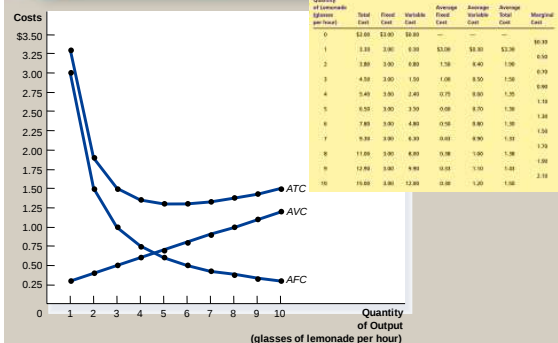


Table 2 The Various Measures of Cost: Thirsty Thelma's Lemonade Stand

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

Measures of Costs

• 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 Thirsty Thelma's Lemonade Stand

Quantity	Total Cost	Marginal Cost	Quantity	Total Cost	Marginal Cost
0	\$3.00	—	6	\$7.80	\$1.30
1	3.30	\$0.30	7	9.30	1.50
2	3.80	0.50	8	11.00	1.70
3	4.50	0.70	9	12.90	1.90
4	5.40	0.90	10	15.00	2.10
5	6.50	1.10			

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

Cost Curves and Their Shapes

- **Marginal cost rises with the amount of output produced.**
- This reflects the property of *diminishing marginal product*.

Figure 5 Marginal-Cost Curve

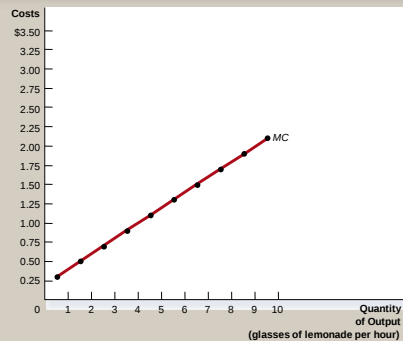
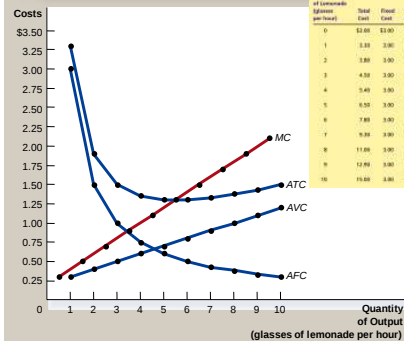


Figure 5 Thirsty Thelma's Average-Cost and Marginal-Cost Curves

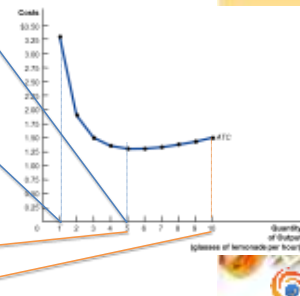


Cost Curves and Their Shapes

- The average **total-cost curve (ATC)** is **U-shaped**.

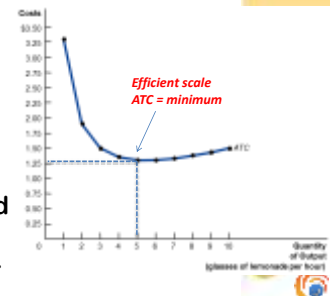
- At **very low levels** of output average total cost is high because fixed cost is spread over only a few units.

- ATC starts rising because average variable cost rises substantially.



Cost Curves and Their Shapes

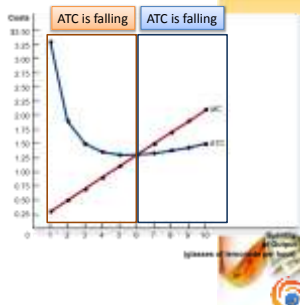
- The bottom of the U-shaped ATC curve occurs at the quantity that **minimizes average total cost**. This quantity is sometimes called the **efficient scale** of the firm.



Cost Curves and Their Shapes

- Relationship between Marginal Cost and Average Total Cost**

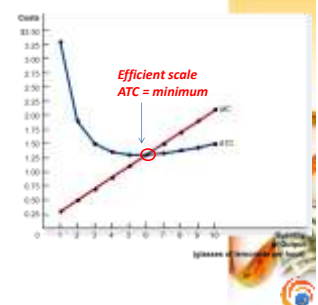
- Whenever marginal cost is less than average total cost, average total cost is falling.
- Whenever marginal cost is greater than average total cost, average total cost is rising.



Cost Curves and Their Shapes

- 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.



Typical Cost Curves

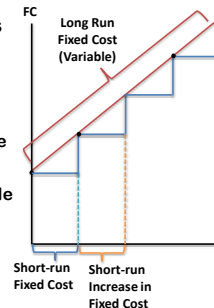
• Three Important Properties of Cost Curves

- 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.



COSTS IN THE SHORT RUN AND IN THE 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.



- In the long run, all inputs are variable

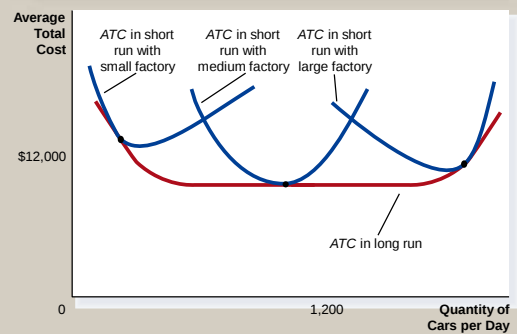


COSTS IN THE SHORT RUN AND IN THE LONG RUN

- 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.



Figure 7 Average Total Cost in the Short and Long Run

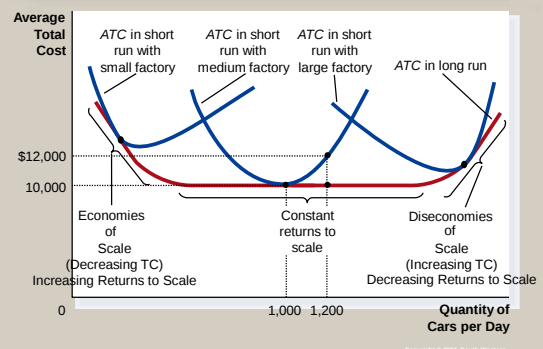


Economies and Diseconomies of Scale

- **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



Figure 7 Average Total Cost in the Short and Long Run





Next: Utility Analysis

Study for Tutorial



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