Take a look…..

WHAT YOU WILL LEARN IN THIS CHAPTER

Use garbage collection as an example

Fixed input

- Capital
- One truck

Variable input

- Labor
- Workers on the truck

Output

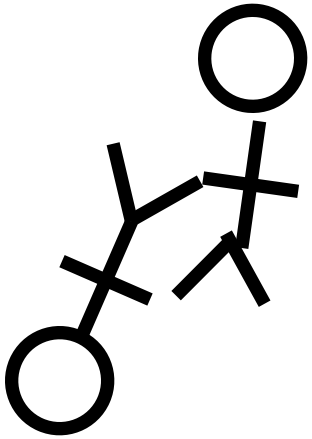
- Trash cans picked up

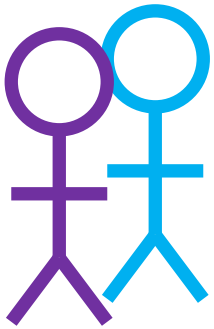
To Active Learning

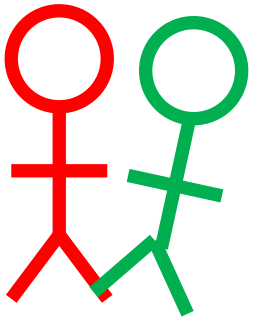
To Video

Take a look.....

WHAT YOU WILL LEARN IN THIS CHAPTER







To Active Learning

PRODUCTION AND COSTS

WHAT YOU WILL LEARN IN THIS CHAPTER

- The **production function,** the relationship between quantity of inputs and quantity of output
- Production is often subject to **diminishing returns to inputs** **(labor, capital)**
- The **various types of costs**: fixed cost and variable cost, **marginal and average cost** curves
- Technology of production can generate **increasing returns to scale**

The Production Function

A *production function* is the relationship between the quantity of inputs a firm uses and the quantity of output it produces.

$$\text{Output} = f\{\ \text{inputs}\ \}$$

A *fixed input* is an input that is fixed in quantity for a period and cannot be varied.

A *variable input* is an input of the firm that can vary at any time.

The *long run* is the period in which all inputs can be varied.

The *short run* is the period in which at least one input is fixed.

Back to Table of contents

Take a look.....

WHAT YOU WILL LEARN IN THIS CHAPTER

Quantity of labor (hours in surgery)	Quantity of capital (operating rooms)	Total product (number of surgeries)
30	0	0
30	1	15
30	2	25
30	3	32
30	4	35

1. Paul is a surgeon. The information in the table contains information about Paul's production function. It depicts Paul's:

a) short-run production function.

b) long-run production function.

2. The fixed input in Paul's production function for surgeries is the quantity of:

a) labor.

b) capital.

3. Paul's marginal product of capital from hiring a third operating room is:

a) 32 surgeries.

b) 25 surgeries.

c) 7 surgeries per operating room.

d) 3 surgeries per operating room.

To Active Learning

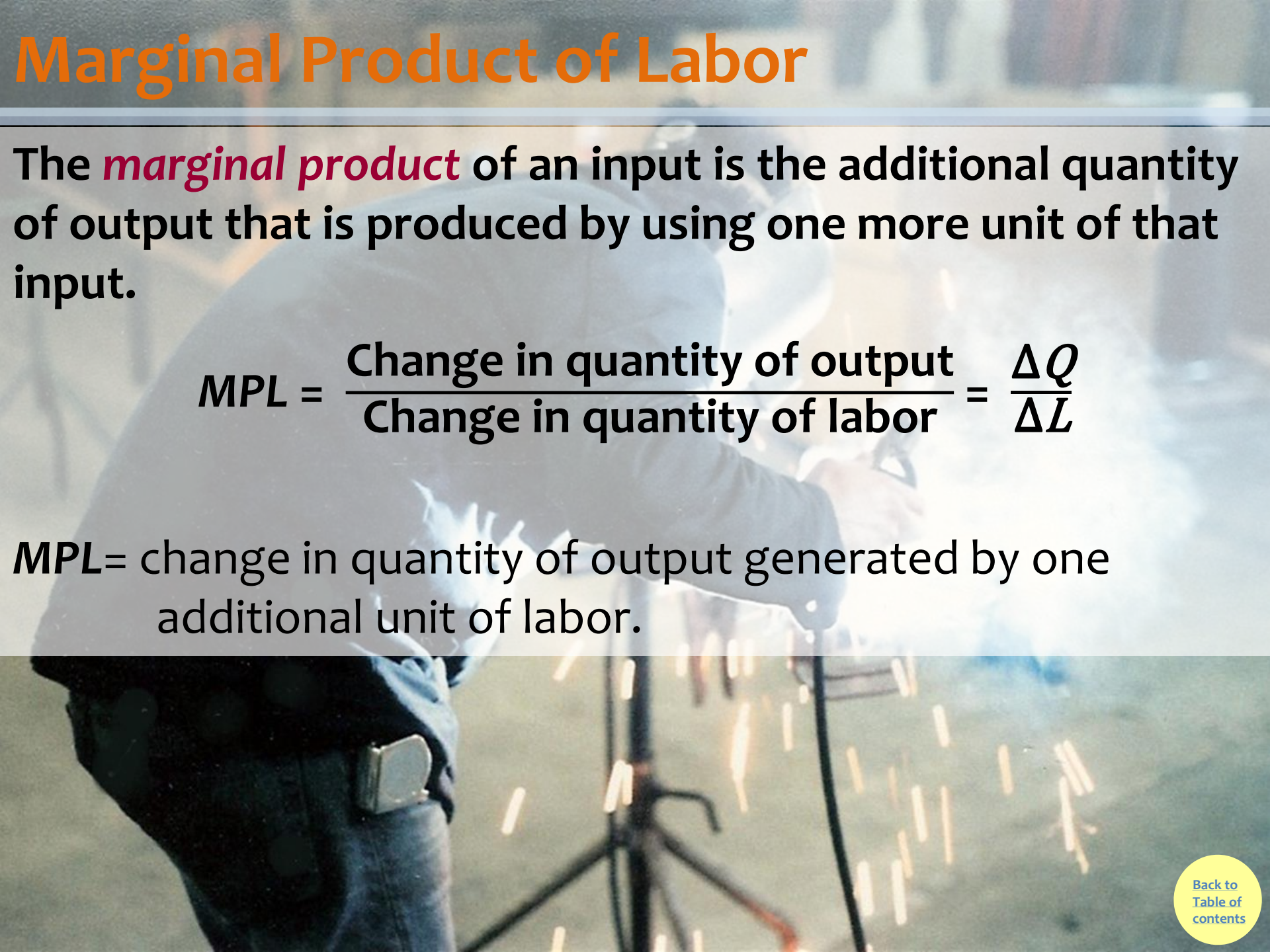
To Video

Marginal Product of Labor

The *marginal product* of an input is the additional quantity of output that is produced by using one more unit of that input.

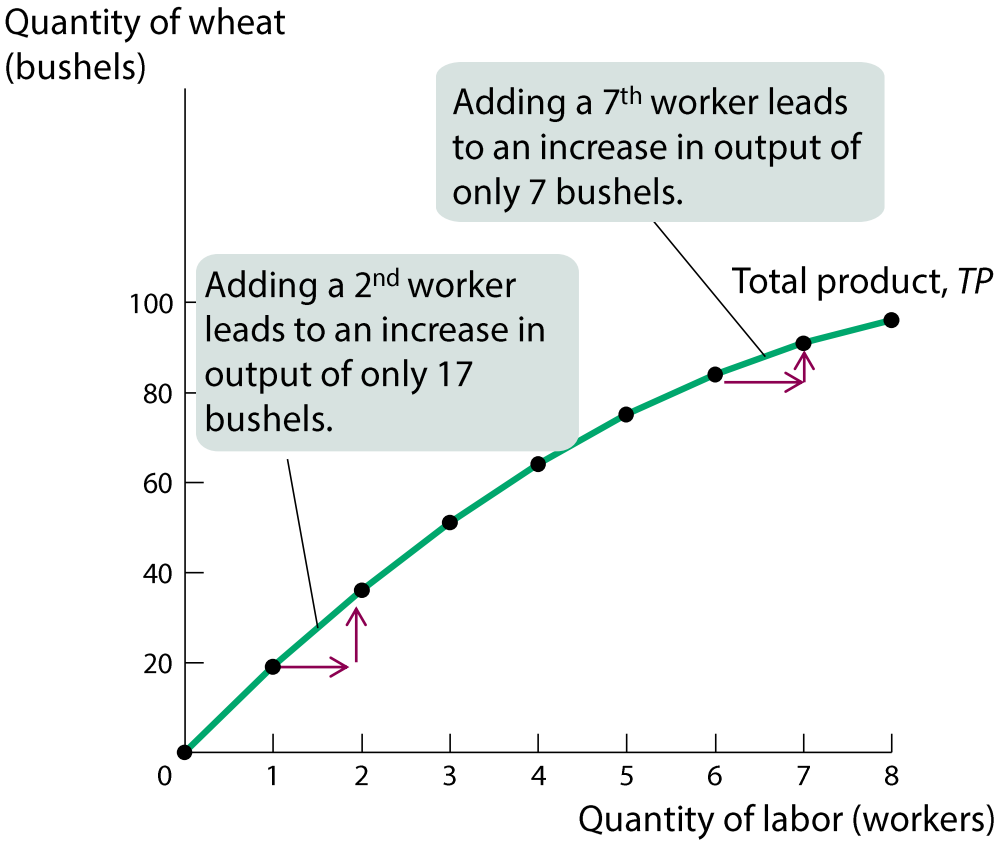
$$MPL = \frac{\text{Change in quantity of output}}{\text{Change in quantity of labor}} = \frac{\Delta Q}{\Delta L}$$

MPL= change in quantity of output generated by one additional unit of labor.



Back to Table of contents

Production Function and *TP* Curve



Quantity of labor (worker)	Quantity of wheat (bushels)	*MP* of labor $MPL = D_Q/D_L$ (bushels per worker)
0	**0**	
		19
1	**19**	
		17
2	**36**	
		15
3	**51**	
		13
4	**64**	
		11
5	**75**	
		9
6	**84**	
		7
7	**91**	
		5
8	**96**	

The relationship between inputs and output is positive, but not constant: marginal product of labor , MPL, changes along the production function.

In other words, MP_L is the slope of the TP curve

Back to Table of contents

Take a look.....

WHAT YOU WILL LEARN IN THIS CHAPTER

If one worker makes 14 baskets,

two workers make 34 baskets,

three workers make 45 baskets, and

four workers make 50 baskets, *which worker yielded the highest marginal product?*

a) The first worker

b) The second worker

c) The third worker

d) The fourth worker

Marginal product is the slope of the:

a) marginal cost curve.

b) total product curve.

c) long-run average total cost curve.

d) total cost curve.

Active Learning

To Video

COST Curves

A *fixed cost = FC* is a cost that does *not* depend on the quantity of output produced. It is the cost of the fixed input.

Whether Q=0, or Q=100, or Q=1000, the fixed cost is the same amount.

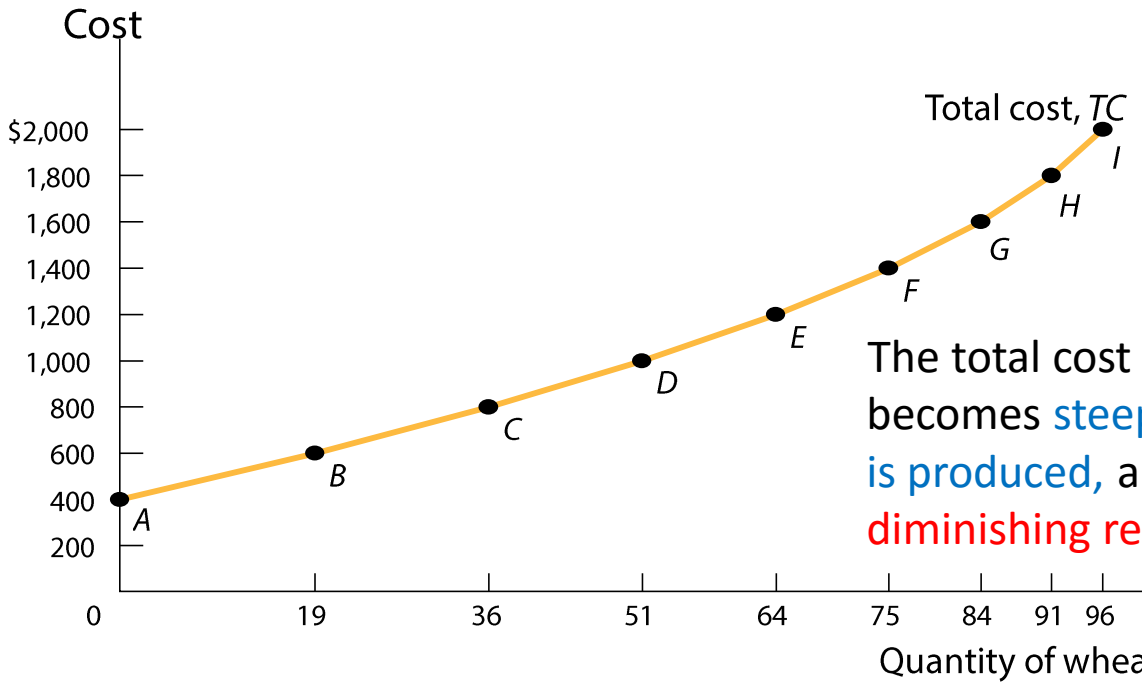
A *variable cost = VC* is a cost that depends on the quantity of output produced. It is the cost of the variable input.

The *total cost* of producing a given quantity of output is the sum of the fixed cost and the variable cost of producing that quantity of output.

$$TC = FC + VC$$

Back to Table of contents

Total Cost Curve



The total cost curve usually becomes steeper as more output is produced, a result of diminishing returns.

Point on graph	Quantity of labor (INPUT)	Quantity of wheat (OUTPUT)	Variable cost (*VC*)	Fixed Cost (*FC*)	Total cost (*TC* = *FC* + *VC*)
A	0	0	$0	$400	$**400**
B	1	19	200	400	**600**
C	2	36	400	400	**800**
D	3	51	600	400	**1,000**
E	4	64	800	400	**1,200**
F	5	75	1,000	400	**1,400**
G	6	84	1,200	400	**1,600**
H	7	91	1,400	400	**1,800**
I	8	96	1,600	400	**2,000**

Back to Table of contents

Various Costs of Selena's Gourmet Salsas

Quantity of salsa *Q* (cases)	Fixed cost *FC*	Variable cost *VC*	Total cost *TC = FC + VC*	Marginal cost of case *MC = ΔTC/ΔQ*
0	$108	$0	$108	
				$12
1	108	12	120	
				36
2	108	48	156	
				60
3	108	108	216	
				84
4	108	192	300	
				108
5	108	300	408	
				132
6	108	432	540	
				156
7	108	588	696	
				180
8	108	768	876	
				204
9	108	972	1,080	
				228
10	108	1,200	1,308	

(also check the change in VC)

Back to Table of contents

Let's try this: MPL and MC

Magnificent Blooms is a florist specializing in floral arrangements. Its fixed cost (space and equipment) is $100 per day. Each worker is paid $50 per day. The table below shows the production function.

a.Calculate the marginal product of each worker (MPL). What principle explains why the MPL (marginal product of labor) declines as the number of workers employed increases?

b.Calculate the marginal cost (MC). What principle explains why the MC increases as the number of arrangements increases?

Qty (labor)	Qty of floral arrangements	MPL	MC
0	0		
1	5		
2	9		
3	12		
4	14		
5	15		

Back to Table of contents

Average Cost

Average total cost(often referred to simply as **average cost**) = total cost divided by quantity of output produced.

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

Average fixed cost **= the fixed cost per unit of output.**

$$\mathbf{AFC = = \frac{FC}{Q} = \frac{\text{Fixed cost}}{Q \text{ of output}}}$$

Average variable cost **= the variable cost per unit of output.**

$$\mathbf{AVC = = \frac{VC}{Q} = \frac{\text{Variable cost}}{Q \text{ of output}}}$$

Back to Table of contents

Take a look.....

WHAT YOU WILL LEARN IN THIS CHAPTER

Average fixed cost = *TFC/Q.*

Average variable cost = *TVC/Q.*

Average total cost = *TC/Q.*

Example: Assume fixed cost, FC, is 100 and fill in the following table.

Q	*TVC*	*TC*	*AFC*	*AVC*	*ATC*
0	0				
1	30				
2	46				
3	80				

To Active Learning
To Next Active Learning
To Video

Average Costs for Selena's Gourmet Salsas

Quantity of salsa *Q* (cases)	Total cost *TC*	Average total cost of case *ATC = TC/Q*	Average fixed cost of case *AFC = FC/Q*	Average variable cost of case *AVC = VC/Q*
1	$120	$120.00	$108.00	$12.00
2	156	78.00	54.00	24.00
3	216	72.00	36.00	36.00
4	300	75.00	27.00	48.00
5	408	81.60	21.60	60.00
6	540	90.00	18.00	72.00
7	696	99.43	15.43	84.00
8	876	109.50	13.50	96.00
9	1,080	120.00	12.00	108.00
10	1,308	130.80	10.80	120.00

Back to Table of contents

Some "Effects"

Opposing effects on ATC :

1) *The spreading effect:* The larger the output, the more output over which fixed cost is spread, leading to lower average fixed cost.

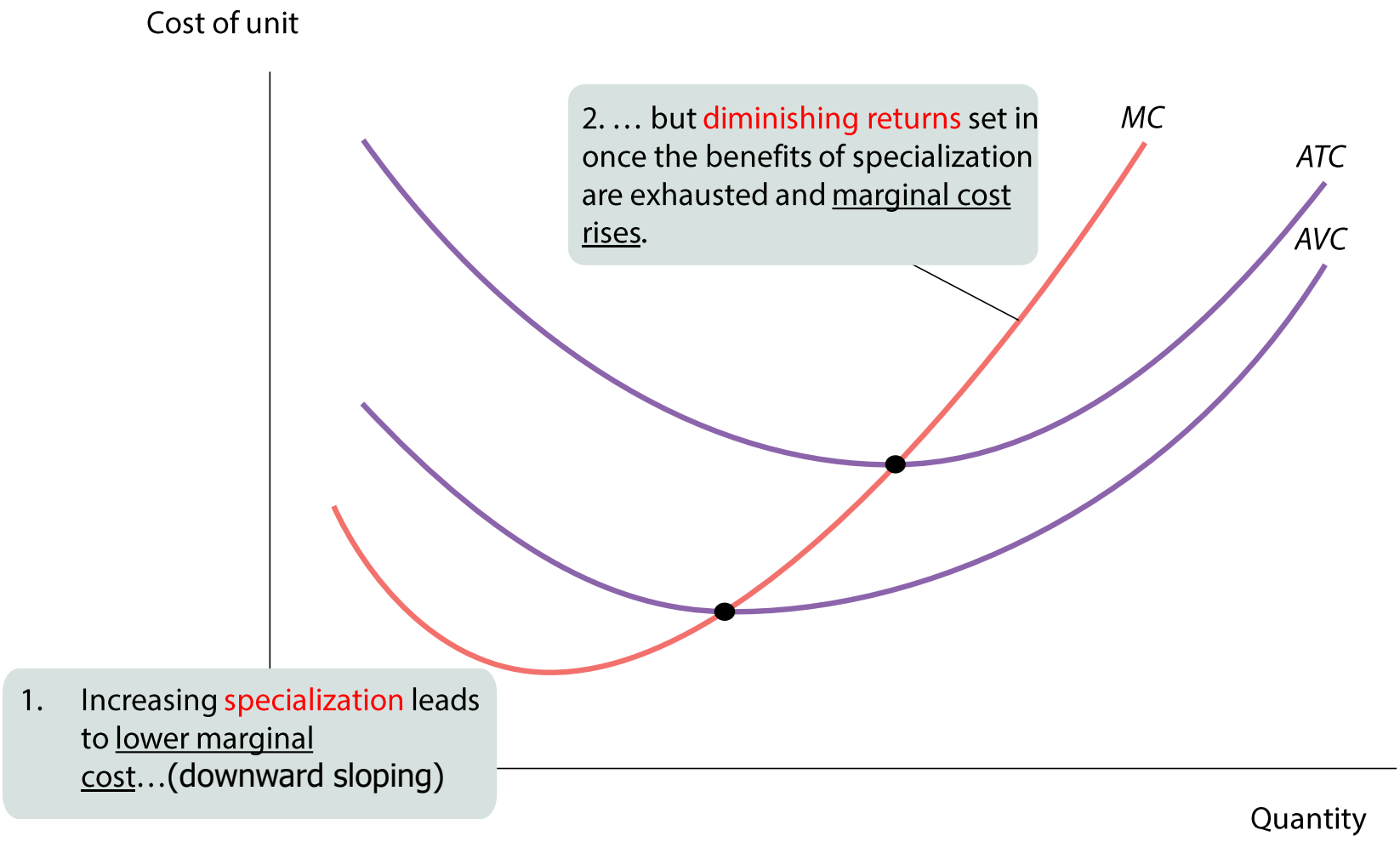
2) *The diminishing returns effect:* The larger the output, the more variable input required to produce additional units, which leads to higher average variable cost.

Additionally:

Specialization effect on MC: *As the firms learn to specialize and experience learning curve,* output, the additional cost to produce one more unit will be/might be lower, leading to lower Marginal cost.

Back to Table of contents

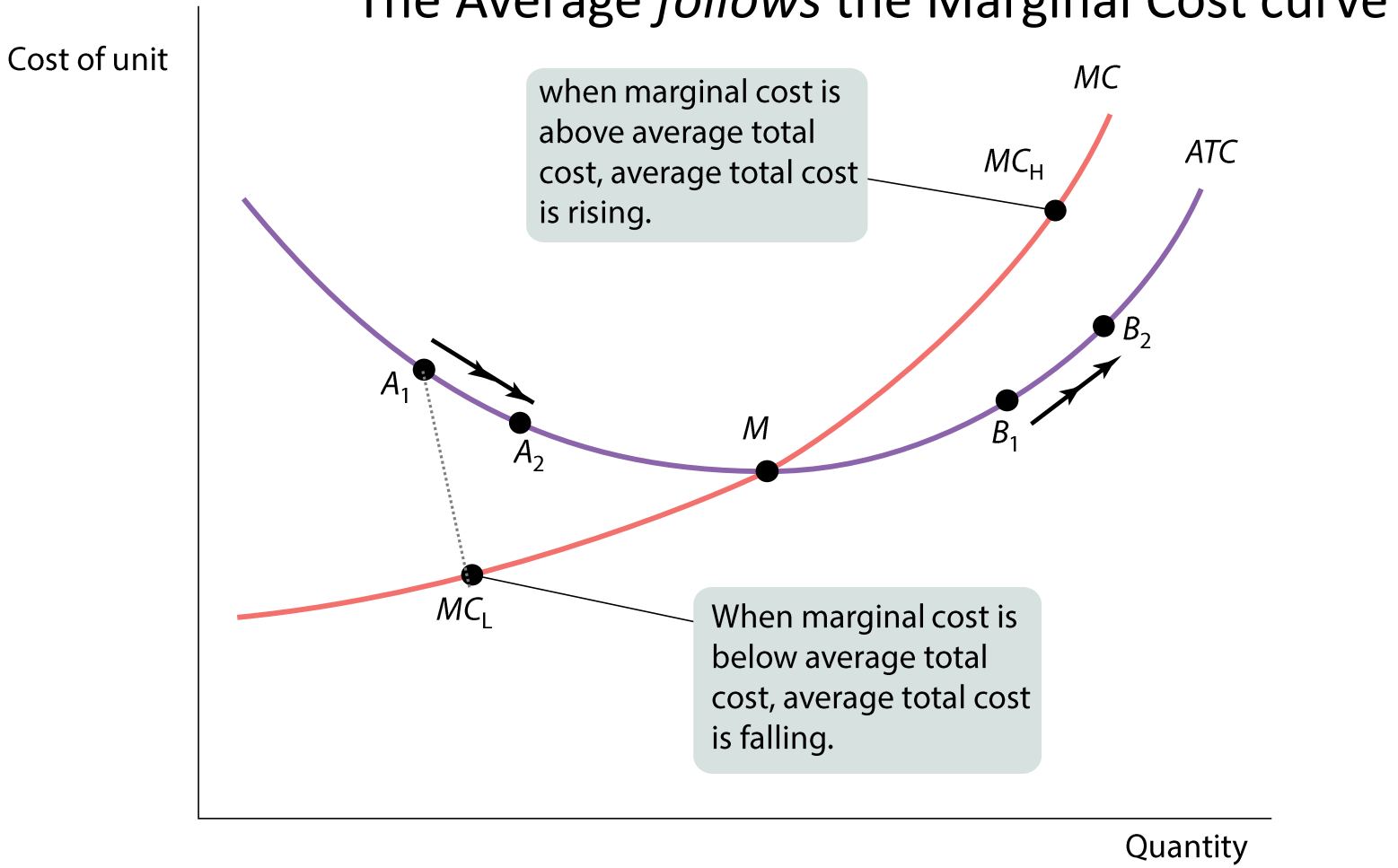
More Realistic Cost Curves



Back to Table of contents

The Relationship Between the *ATC* and *MC* Curves

The Average *follows* the Marginal Cost curve



Think in terms of your GPA (as your "average")

Back to Table of contents

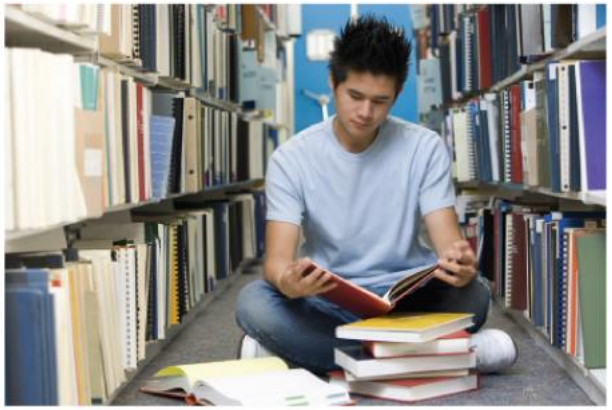
Margin and Average Relationship (MC and ATC): Class GPA

Think of this example:

- **Class GPA**

Suppose the class average grade on the economics exam is 85%

- **Smarty McGenius joins the class, gets 100% on the exam**
  - **The class average <u>rises</u>**
- **Lazy NoStudyson joins the class, gets 34% on the exam**
  - **The class average <u>falls</u>**



to Table of contents

MC and ATC: Sports Statistics

Suppose Lebron James has a scoring *average* of 30 points per game

- **If he has a game in which he scores 45 points**
  - **His average increases**
- **If he has a game in which he scores 12 points**
  - **His average decreases**

Once again:

- **The average follows the margin**

Back to Table of contents

Putting the Four Cost Curves Together

Note that:

1. **MC is upward sloping because of diminishing returns. (but downward sloping because of specialization)**
2. **AVC is also upward sloping but flatter than the MC curve.**
3. **Average fixed cost, AFC is downward sloping because of the spreading effect.**
4. **MC curve intersects the ATC curve from below, crossing it at its lowest point (the "minimum-cost" output).**

Back to Table of contents

Long Run Costs

Economies of scale

ATC *falls* when production expands

eg: Larger firm more efficient than a smaller firm

Diseconomies of scale

ATC *rises* when production expands

eg: Very large firm has to deal with additional management, coordination, logistical expenses

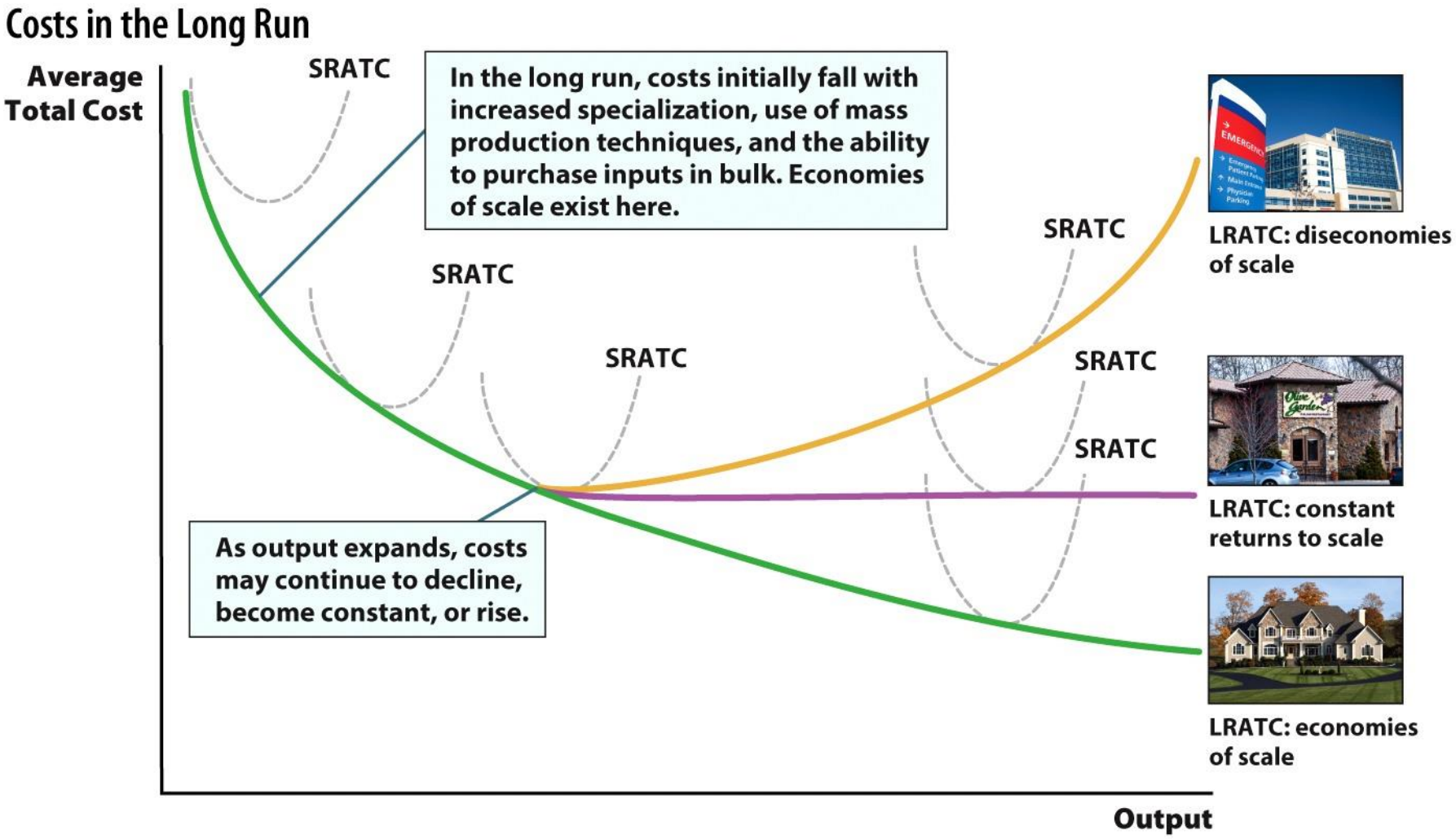
Constant returns to scale

ATC *doesn't change* when production expands

eg: Olive Garden builds another restaurant. Requires same K and L as previous restaurants. Output similar.

Back to Table of contents

Costs in the Long Run



SR and LR Cost Comparison

The short run cost curve and the long run cost curve are both U-shaped. However, they are U-shaped for different reasons!

SR-AC

- **U-shaped because of diminishing marginal product**
- **MPL falls, MC rises, and ATC follows MC**

LR-AC

- **U-shaped because of economies and diseconomies of scale**
- **Smaller firms can lower costs by growing, but if they get too big (and inefficient), costs can grow**

Back to Table of contents

In-Class Exercise:

1. Evaluate each statement.

If a statement is true, explain why.

If it is false, identify the mistake and try to correct it.

a. A decreasing marginal product tells us that marginal cost must be rising.
b. An increase in fixed cost increases the minimum-cost output.
c. An increase in fixed cost increases marginal cost
d. When marginal cost is above ATC, ATC must be falling.
e. When marginal cost is rising, ATC and AVC must be rising too.

Back to Table of contents

Let's try this:

You have the information below about a firm's costs. Complete the missing data. Then find the minimum value of ATC and AVC, and the minimum-cost output.

Qty	TC	MC	FC	VC	AFC	AVC	ATC
0	20	-					
1		20					
2		10					
3		16					
4		20					
5		24					

Back to Table of contents