

Principles of Economics

Chapter 13:

The Costs of Production



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The Cost of Production

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In This Chapter

- ▶ What is a **production function**? What is **marginal product**? How are they related?
- ▶ What are the various **costs**? How are they related to each other and to output?
- ▶ How are costs different in the **short run** vs. **long run**?
- ▶ What are “**economies of scale**”?

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Active Learning 1: Brainstorming Costs

You run Foxconn Electronics Inc. (鴻海富士康)

- A. List three different **costs** they have.
- B. List three different **business decisions** that are affected by these costs.
- C. How would your answers change if you instead run **台北農產運銷公司?**



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Total Revenue, Total Cost, and Profit

- ▶ Assumption:
 - ▶ The goal of a firm is to maximize profit
- ▶ Total Revenue, $TR = P \times Q$
 - ▶ The amount a firm receives for the sale of its output
- ▶ Total Cost, TC
 - ▶ The market value of the inputs a firm uses in production
- ▶ Profit = $TR - TC$

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Example: Jelani's Gelato Shop

Jelani owns a small gelato shop on campus. She can make 15,000 pints of gelato a year, and sell them at NT\$50 each. If Jelani's total costs are NT\$650,000 a year, how much profit the shop brings in one year?

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Explicit and Implicit Costs

- ▶ "The cost of something is what you give up to get it."
- ▶ **Explicit** Costs
 - ▶ Input costs that require an outlay of money by the firm (paying wages to workers)
- ▶ **Implicit** Costs
 - ▶ Input costs that do not require an outlay of money by the firm (opportunity cost of the owner's time)
- ▶ Total Cost = **Explicit** + **Implicit** Costs

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Example: Costs for Jelani's Gelato Shop

Jelani owns a small gelato shop on campus.

Jelani pays NT\$200,000 for raw materials and NT\$120,000 in rent per year.

Jelani can work at a local coffee shop for NT\$250,000 a year.

Identify/calculate **explicit** and **implicit** costs.

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Example: The Cost of Capital for Jelani

Jelani invested NT\$800,000 in factory and equipment to start the business last year: NT\$300,000 from savings and borrowed NT\$500,000 (interest 10% for saving and borrowing).

Identify and calculate the **explicit** and **implicit** costs.

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Economic Profit vs. Accounting Profit

- ▶ Accounting profit
 - ▶ Total revenue minus total explicit costs
- ▶ Economic profit
 - ▶ Total revenue minus total costs (explicit and implicit costs)
- ▶ Accounting profit ignores implicit costs, so it's higher than economic profit.

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Example: Profit for Jelani's Gelato Shop

Jelani owns a small gelato shop on campus.

She makes 15,000 pints of gelato a year, and sell them at NT\$50 each. Jelani pays NT\$200,000 a year for raw materials, and NT\$120,000 in rent.

Jelani can work at a local coffee shop for NT\$250,000 a year. Jelani invested NT\$800,000 in factory and equipment to start the business last year: NT\$300,000 from savings and borrowed NT\$500,000 (interest rate is 10% for saving and borrowing). Calculate Jelani's accounting and economic profit.

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Example: [Solutions]

Total Revenue $TR = \$50 \times 15,000 = \text{NT\$}750,000$

▶ Explicit Costs =

=

▶ Implicit Costs =

=

▶ Accounting Profit =

=

▶ Economic Profit =

=

= Accounting Profit – Implicit Cost

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Active Learning 1: Economic vs. Accounting Profit

The equilibrium rent on office space has just increased by NT\$5,000/month.

Determine the effects on accounting profit and economic profit if:

- A. You rent your office space (you pay NT\$5,000/month more)
- B. You own your office space

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Active Learning 1: Answers

▶ The rent on office space increases by NT\$5,000/mo.

A. You rent your office space

▶

▶

B. You own your office space

▶

▶

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Production and Costs

▶ Assumption:

▶ Production in the Short Run

▶ Factory size is **fixed**

▶ To increase production: Hire more workers

▶ Production Function: Relationship between

▶ Quantity of **inputs** used to make a good

▶ And the quantity of **output** of that good

▶ Gets flatter as production rises

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Example: Xavier's Popcorn Truck

- ▶ Xavier has a popcorn truck (fixed resource) that he takes to fairs and sporting events.
- ▶ He can hire as many workers as he wants
 - ▶ The quantity of output produced varies with the number of workers
 - ▶ If Xavier hires only 1 worker, his truck will produce 30 buckets of popcorn per hour
 - ▶ If Xavier hires 5 workers, his truck will produce 100 buckets of popcorn per hour

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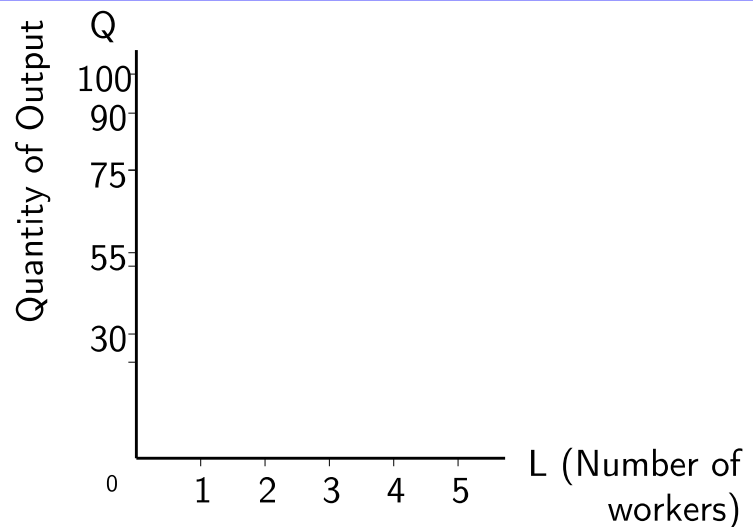
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Example: Xavier's Popcorn Production Function

L workers	Q buckets
0	0
1	30
2	55
3	75
4	90
5	100



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Marginal Product

- ▶ Marginal Product
 - ▶ Increase in output that arises from an additional unit of input
 - ▶ Other inputs constant
 - ▶ Slope of the production function
- ▶ Marginal Product of Labor, $MPL = \Delta Q / \Delta L$
 - ▶ If Xavier hires one more worker, his output rises by the marginal product of labor.

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Example: Xavier's Total and Marginal Product

	L workers	Q buckets		MPL buckets
	0	0		
$\Delta L = 1$	1	30	$\Delta Q = 30$	30
$\Delta L = 1$	2	55	$\Delta Q = 25$	25
$\Delta L = 1$	3	75	$\Delta Q = 20$	20
$\Delta L = 1$	4	90	$\Delta Q = 15$	15
$\Delta L = 1$	5	100	$\Delta Q = 10$	10

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Diminishing MPL

- ▶ Diminishing Marginal Product
 - ▶ Marginal product of an input declines as the quantity of the input increases
 - ▶ Production function gets flatter as more inputs are being used
 - ▶ The slope of the production function decreases
- “Rational people think at the margin”
- ▶ Hiring one extra worker
 - ▶ Increases output by MPL
 - ▶ Increases costs by the wage paid

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Example: Xavier's Popcorn Truck Costs

- ▶ Xavier must pay NT\$2,000 per hour for the truck, regardless of how much popcorn he produces
- ▶ The market wage for popcorn makers is NT\$500 per hour
- ▶ So, Xavier's costs are related to how much popcorn the truck produces

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Example: Solutions

L workers	Q buckets	Cost of the truck	Cost of labor	Total Cost
0	0			
1	30			
2	55			
3	75			
4	90			
5	100			

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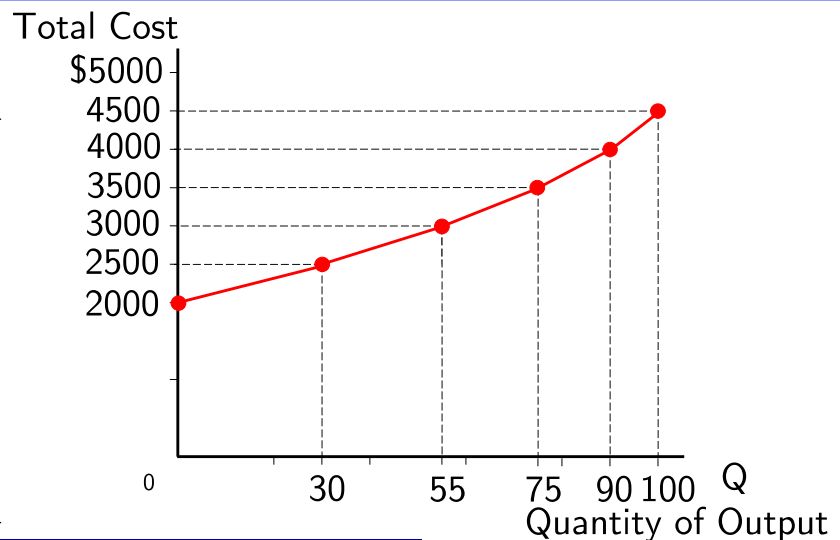
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Example: Xavier's Total Cost Curve

Q buckets	Total Cost
0	\$2,000
30	\$2,500
55	\$3,000
75	\$3,500
90	\$4,000
100	\$4,500



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Active Learning 2: Diminishing MPL

# of workers	Output	MPL
0	0	
1	45	
2	85	
3	115	
4	135	
5	145	

A. What is the marginal product of the second worker?

B. What is the marginal product of the fourth worker?

C. Does this production function exhibit diminishing marginal returns?

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The Various Measures of Cost

- ▶ Total Cost, $TC = FC + VC$
 - ▶ Total cost of producing a given amount of output
- ▶ Fixed Costs, FC
 - ▶ Do not vary with the quantity of output produced
 - ▶ Incur even if production is zero
- ▶ Variable Costs, VC
 - ▶ Vary with the quantity of output produced

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Example: Angel's Knitted Scarves Business

Q	FC	VC	TC
0	18	0	18
1	18	15	33
2	18	25	43
3	18	30	48
4	18	32	50
5	18	36	54
6	18	44	62
7	18	58	76
8	18	78	96
9	18	104	122
10	18	136	154

Angel loves to knit scarves:

- ▶ Angel paid \$18 for two pairs of knitting needles
- ▶ To produce more scarves, Angel needs more yarn and more workers

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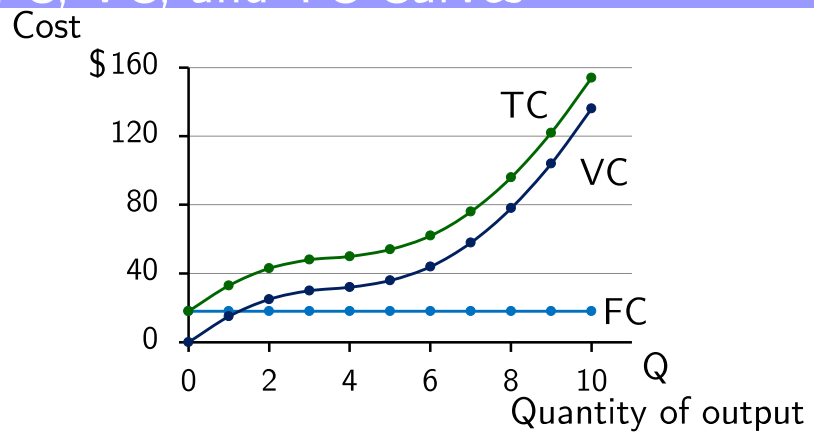
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Example: Angel's FC, VC, and TC Curves

Q	FC	VC	TC
0	18	0	18
1	18	15	33
2	18	25	43
3	18	30	48
4	18	32	50
5	18	36	54
6	18	44	62
7	18	58	76
8	18	78	96
9	18	104	122
10	18	136	154



The TC and VC curves are parallel

The FC curve is a horizontal line

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Average and Marginal Cost

- ▶ Average Fixed Cost, $AFC = FC / Q$
- ▶ Average Variable Cost, $AVC = VC / Q$
- ▶ Average Total Cost,

$$ATC = TC / Q = AFC + AVC$$
 - ▶ The cost of the typical unit produced
 - ▶ Total cost divided by the quantity of output
- ▶ Marginal Cost, $MC = \Delta TC / \Delta Q$
 - ▶ The increase in total cost that arises from an extra unit of production

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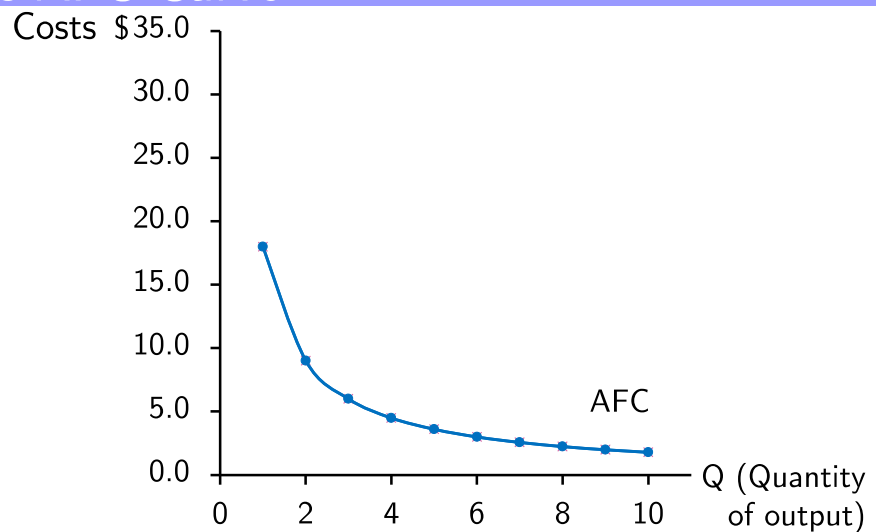
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Example: Angel's AFC Curve

Q	FC	AFC
0	18	-
1	18	18.0
2	18	9.0
3	18	6.0
4	18	4.5
5	18	3.6
6	18	3.0
7	18	2.6
8	18	2.3
9	18	2.0
10	18	1.8



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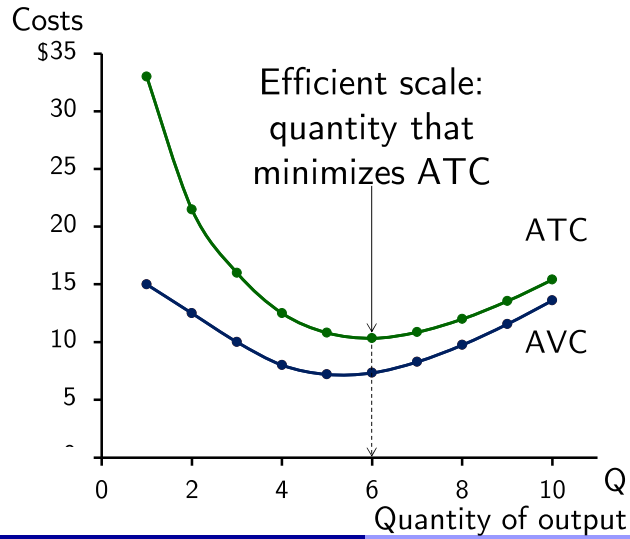
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Example: Angel's AVC and ATC Curves

Q	VC	TC	AVC	ATC
0	\$0	\$18	-	-
1	15	33	15.0	33.0
2	25	43	12.5	21.5
3	30	48	10.0	16.0
4	32	50	8.0	12.5
5	36	54	7.2	10.8
6	44	62	7.3	10.3
7	58	76	8.3	10.9
8	78	96	9.8	12.0
9	104	122	11.6	13.6
10	136	154	13.6	15.4



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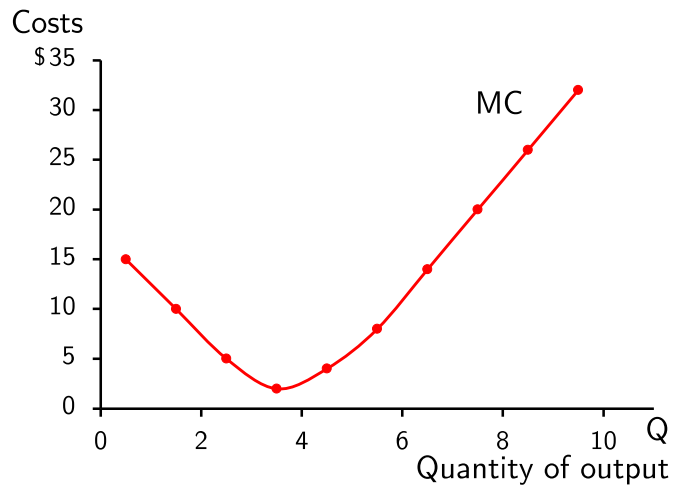
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Example: Angel's Marginal Cost Curve

Q	TC	MC
0	\$18	
1	33	\$15.0
2	43	10.0
3	48	5.0
4	50	2.0
5	54	4.0
6	62	8.0
7	76	14.0
8	96	20.0
9	122	26.0
10	154	32.0



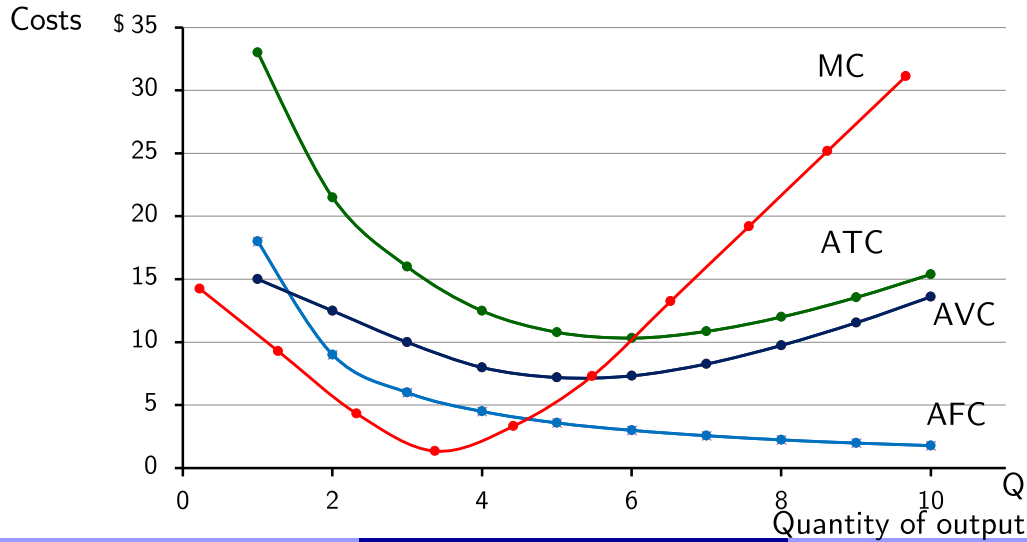
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Example: Angel's Knitting Cost Curves



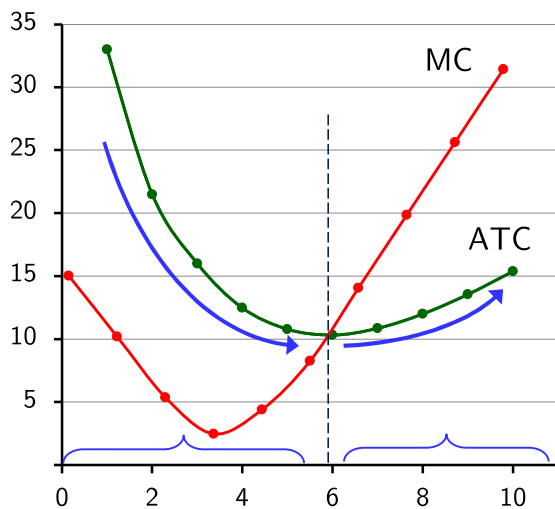
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Example: Angel's ATC and MC Curves



- ▶ When $MC < ATC$, ATC is falling.
- ▶ When $MC > ATC$, ATC is rising.
- ▶ The MC curve crosses the ATC curve at the ATC curve's minimum.

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Active Learning 3: Calculating Costs

Fill in the blank spaces of this table.

Q	VC	TC	AFC	AVC	ATC	MC
0		\$50	n/a	n/a	n/a	
1	10			\$10	\$60.00	\$10
2	30	80				30
3			16.67	20	36.67	
4	100	150	12.50		37.50	
5	150			30		60
6	210	260	8.33	35	43.33	

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Costs in the Short Run and Long Run

- ▶ Short Run, **SR**:
 - ▶ Some inputs are fixed (e.g., factories, land)
 - ▶ The costs of these inputs are **FC**
- ▶ Long Run, **LR**:
 - ▶ All inputs are variable (e.g., firms can build more factories or sell existing ones)
- ▶ In the Long Run
 - ▶ **ATC** at any **Q** is the cost per unit using the most efficient mix of inputs for that **Q** (e.g., factory size with lowest **ATC**)

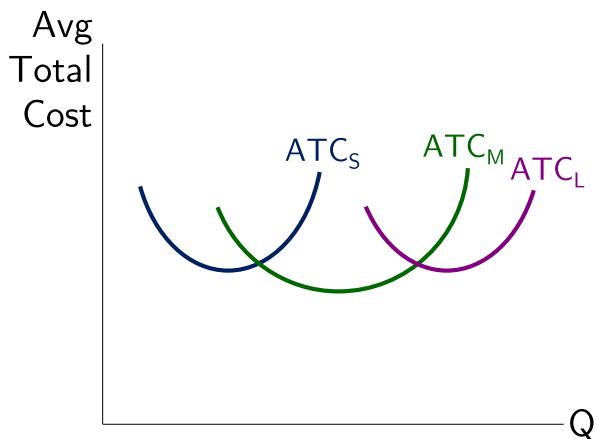
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LRATC with 3 Factory Sizes



► Firm can choose from three factory sizes: S, M, L.

Each size has its own **SRATC** curve.

► The firm can change to a different factory size in the long run, but not in the short run.

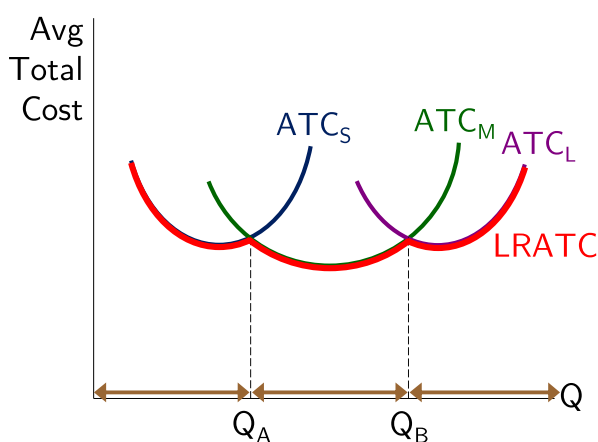
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LRATC with 3 Factory Sizes



To produce less than Q_A , firm will choose size S in the long run.

To produce between Q_A and Q_B , firm will choose size M in the long run.

To produce more than Q_B , firm will choose size L in the long run.

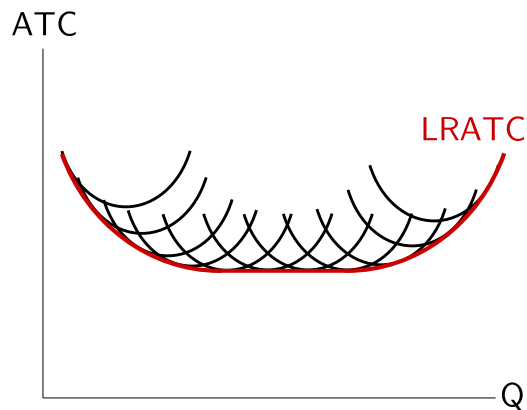
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A Typical LRATC Curve



- ▶ In the real world, factories come in many sizes, each with its own **SRATC** curve.
- ▶ So a typical **LRATC** curve looks like this:

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Costs in Short and Long Run

- ▶ Economies of Scale
 - ▶ Long-run average total cost falls as the quantity of output increases
 - ▶ Increasing specialization among workers
 - ▶ More common when Q is low
- ▶ Constant Returns to Scale
 - ▶ Long-run average total cost stays the same as the quantity of output changes

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Costs in Short and Long Run

- ▶ Diseconomies of Scale
 - ▶ Long-run average total cost rises as the quantity of output increases
 - ▶ Increasing coordination problems in large organizations.
 - ▶ E.g., management becomes stretched, can't control costs.
 - ▶ More common when Q is high.

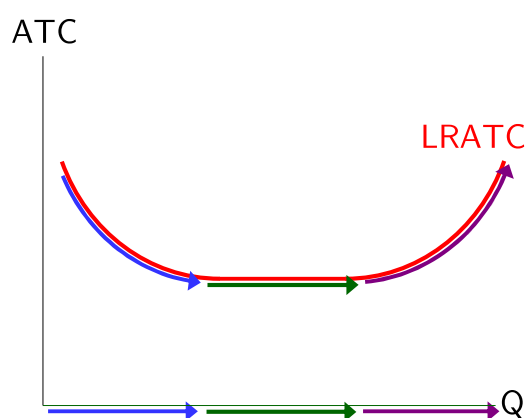
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Economies and Diseconomies of Scale



- ▶ Economies of Scale:
ATC falls as Q increases.
- ▶ Constant Returns to Scale:
ATC stays the same as Q increases.
- ▶ Diseconomies of Scale:
ATC rises as Q increases.

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Think-Pair-Share

Your Neighbor Has a Backyard Garden and Grows...

fresh fruit and vegetables to be sold at a local “farmer’s market.” He comments, “I hired a college student who was on summer vacation to help me this summer and my production more than doubled. Next summer, I think I’ll hire three helpers and my output should go up more than three- or fourfold.”

- A. What can explain why the production more than doubled when your neighbor hired a helper?
- B. Will production increase three- or fourfold if your neighbor hires 3 helpers next summer?

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Chapter In A Nutshell

- ▶ 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.
 - ▶ **Explicit**: wages a firm pays its workers
 - ▶ **Implicit**: wages the firm owner gives up by working at the firm rather than taking another job

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Chapter In A Nutshell

- ▶ **Economic Profit** takes both explicit and implicit costs into account, whereas **Accounting Profit** considers only explicit costs.
- ▶ A firm's costs reflect its production process.
 - ▶ **Diminishing Marginal Product**: Production Function gets flatter as Q of an input increases
 - ▶ **Total-cost Curve** gets steeper as the quantity produced rises.

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Chapter In A Nutshell

- ▶ Firm's total costs = fixed costs + variable costs.
 - ▶ **Fixed Costs**: do not change when the firm alters the quantity of output produced.
 - ▶ **Variable Costs**: change when the firm alters the quantity of output produced.
- ▶ **Average Total Cost** is total cost divided by the quantity of output.
- ▶ **Marginal Cost** is the amount by which total cost rises if output increases by 1 unit.

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Chapter In A Nutshell

- ▶ Graph average total cost and marginal cost.
 - ▶ Marginal cost rises with the quantity of output.
 - ▶ Average total cost first falls as output increases and then rises as output increases further.
 - ▶ The MC curve always crosses the ATC curve at the **minimum of ATC**

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Chapter In A Nutshell

- ▶ A firm's costs often depend on the time horizon considered.
 - ▶ In particular, many costs are fixed in the **short run** but variable in the **long run**.
 - ▶ As a result, when the firm changes its level of production, average total cost may rise more in the short run than in the long run.

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Chapter 13: The Cost of Production

- ▶ Opportunity Cost (Explicit / Implicit)
 - ▶ Accounting Profit vs. Economic Profit
- ▶ Marginal Product
 - ▶ $MC, TC = FC + VC, ATC = AFC + AVC$
- ▶ Economies of Scale (for LR)

- ▶ Homework: Mankiw, Ch.13,
Problem 2, 4, 5, 7-9

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Chapter 13: The Cost of Production

- ▶ Challenge Questions (Past Finals)
 - ▶ 2007 - Part 1
 - ▶ 2008 - Essay C
 - ▶ 2012 - Part I
 - ▶ 2013 - Part I (both A and B)
 - ▶ 2014 - Essay A1-A4
 - ▶ 2015 - Essay B1-B6
 - ▶ 2017 - Essay D5-D6

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The Big Picture

- ▶ Chapter 13: The Cost of Production
- ▶ Then, we will look at firm's revenue
 - ▶ But revenue depends on market structure
- 1. Competitive market (chapter 14)
- 2. Monopoly (chapter 15)
- 3. Monopolistic Competition (chapter 16)
- 4. Oligopoly (chapter 17)
 - ▶ Are there other types of markets? Yes, see more advance courses in IO and firm competition