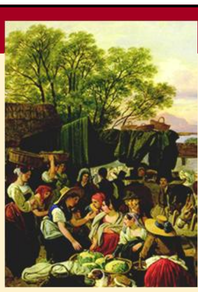
N. Gregory Mankiw

Principles of
Economics
Sixth Edition



The Costs of Production

Premium PowerPoint Slides by Ron Cronovich

Modified by Joseph Tao-yi Wang

Ten Principles of Taiwanese Economics

- No, we are NOT teaching Mankiw's Chapter 12.
  - You need not know the US tax system. But,
- You should understand how normal Taiwanese (or 鄉民 on PTT) view economic issues…
- So, several professors and I came up with the Ten Principles of Taiwanese Economics…
- See if you can you figure out:
  1. Why Taiwanese people believe in them, and
  2. Why they are misleading.

Ten Principles of Taiwanese Economics

1. Prices should be determined by cost.
2. Wages should be determined by effort.
3. The Taiwanese government is financed by Mars.
4. When market failures occur, blame the government.
5. Economists are to be blamed for government failures.

Ten Principles of Taiwanese Economics

6. The government should provide generous pensions to all (starting from its own employees).
7. Many industries are too sacred to be commercialized.
8. Education is just a signal, not human capital.
9. A weak currency is the driving force of economic growth.
10. Information should be withheld to prevent panics.

1. Prices should be determined by cost.

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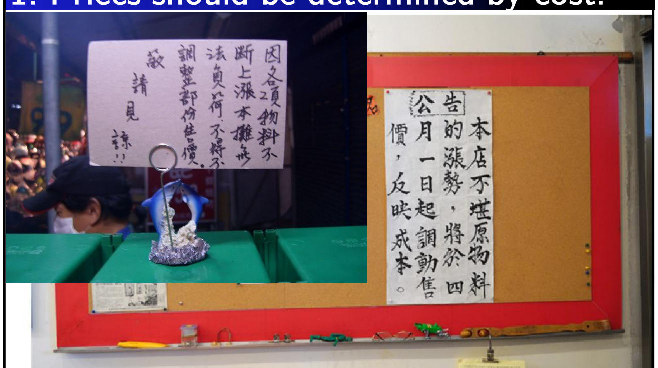
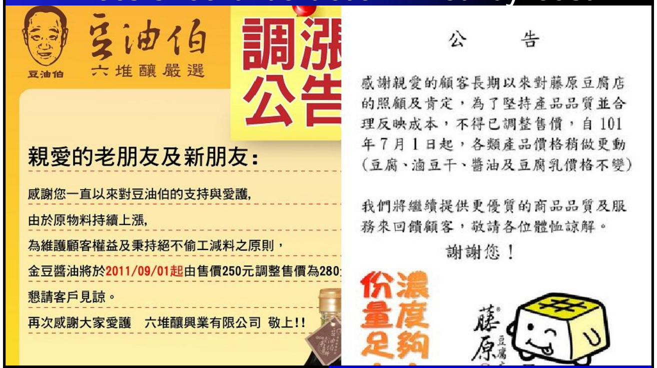


1. Prices should be determined by cost.



2. Wages should be determined by effort.

- College graduates earn 22k?
  - Surplus → Low salary?!

2. Wages should be determined by effort.

- But US Companies in Taiwan still can't find enough high-skilled workers!
  - 華視新聞：薪資遠勝22k 台灣技術人才短缺
  - Restatement of Principle #1, but for labor markets

3. The Taiwanese government is financed by Mars.

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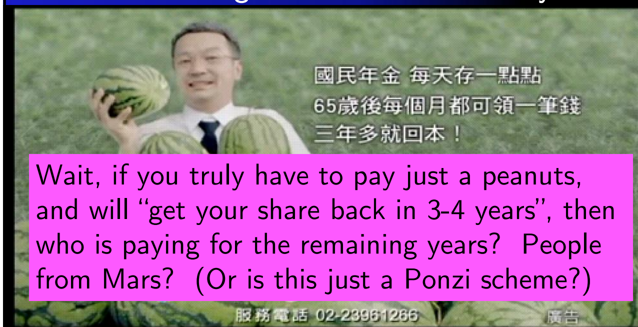
勞保局 國民年金理財篇 (國台語版)

3. The Taiwanese government is financed by Mars.



Wait, if you truly have to pay just a peanuts, and will "get your share back in 3-4 years", then who is paying for the remaining years? People from Mars? (Or is this just a Ponzi scheme?)

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The Costs of Production

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ACTIVE LEARNING 1

Brainstorming costs

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

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

In this chapter, look for the answers to these questions:

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

Total Revenue, Total Cost, Profit

- We assume that the firm's goal is to maximize profit.

Profit = Total revenue – Total cost

Total revenue: the amount a firm receives from the sale of its output

Total cost: the market value of the inputs a firm uses in production

Costs: Explicit vs. Implicit

- **Explicit costs** require an outlay of money, e.g., paying wages to workers.
- **Implicit costs** do not require a cash outlay, e.g., the opportunity cost of the owner's time.
- Remember one of the Ten Principles:
  The cost of something is what you give up to get it.
- This is true whether the costs are implicit or explicit. Both matter for firms' decisions.

Explicit vs. Implicit Costs: An Example

You need $1,000,000 to start your business. The interest rate is 5%.

- Case 1: borrow $1,000,000
  - explicit cost = $50,000 interest on loan
- Case 2: use $400,000 of your savings, borrow the other $600,000
  - explicit cost = $30,000 (5%) interest on the loan
  - implicit cost = $20,000 (5%) *foregone* interest you could have earned on your $400,000.

In both cases, total (exp + imp) costs are $50,000.

Economic Profit vs. Accounting Profit

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

ACTIVE LEARNING 2

Economic profit vs. accounting profit

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

Determine the effects on accounting profit and economic profit if

a. you rent your office space

b. you own your office space

ACTIVE LEARNING 2

Answers

The rent on office space increases $5,000/month.

a. You rent your office space.
Explicit costs increase $5,000/month.
Accounting profit & economic profit each fall $5,000/month.

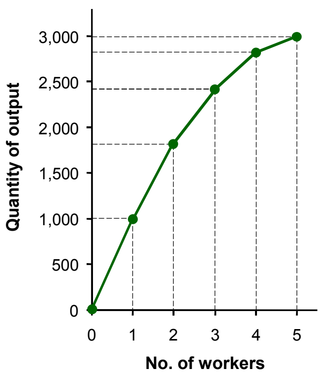
b. You own your office space.
Explicit costs do not change, so accounting profit does not change.
Implicit costs increase $5,000/month (opp. cost of using your space instead of renting it), so economic profit falls by $5,000/month.

The Production Function

- A **production function** shows the relationship between the quantity of inputs used to produce a good and the quantity of output of that good.
- It can be represented by a table, equation, or graph.
- Example 1:
  - Farmer Jack grows vegetables.
  - He has 5 acres of land.
  - He can hire as many workers as he wants.

EXAMPLE 1: Farmer Jack's Production Function

L (no. of workers)	*Q* (bushels of veggie)
0	0
1	1000
2	1800
3	2400
4	2800
5	3000



Marginal Product

- If Jack hires one more worker, his output rises by the *marginal product of labor.*
- The **marginal product** of any input is the increase in output arising from an additional unit of that input, holding all other inputs constant.
- Notation:
  Δ (delta) = "change in…"

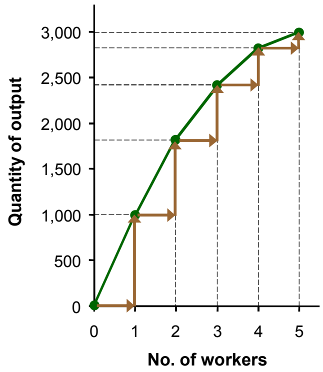
  Examples:
  ΔQ = change in output, ΔL = change in labor
- Marginal product of labor (*MPL*) = $\dfrac{\Delta Q}{\Delta L}$

EXAMPLE 1: Total & Marginal Product

	L (no. of workers)	*Q* (bushels of veggie)		*MPL*
	0	0		
$\Delta L = 1$			$\Delta Q = 1000$	1000
	1	1000		
$\Delta L = 1$			$\Delta Q = 800$	800
	2	1800		
$\Delta L = 1$			$\Delta Q = 600$	600
	3	2400		
$\Delta L = 1$			$\Delta Q = 400$	400
	4	2800		
$\Delta L = 1$			$\Delta Q = 200$	200
	5	3000		

EXAMPLE 1: MPL = Slope of Prod Function

L (no. of workers)	*Q* (bushels of veggie)	*MPL*
0	0	
		1000
1	1000	
		800
2	1800	
		600
3	2400	
		400
4	2800	
		200
5	3000	



Why MPL Is Important

- Recall one of the Ten Principles:
  Rational people think at the margin.
- When Farmer Jack hires an extra worker,
  - his costs rise by the wage he pays the worker
  - his output rises by *MPL*
- Comparing them helps Jack decide whether he should hire the worker.

Why MPL Diminishes

- Farmer Jack's output rises by a smaller and smaller amount for each additional worker. Why?
- As Jack adds workers, the average worker has less land to work with and will be less productive.
- In general, *MPL* diminishes as ***L*** rises whether the fixed input is land or capital (equipment, machines, etc.).
- **Diminishing marginal product**:
  the marginal product of an input declines as the quantity of the input increases (other things equal)

EXAMPLE 1: Farmer Jack's Costs

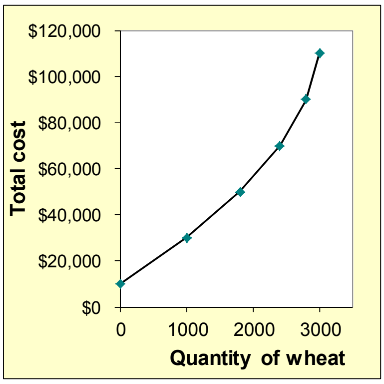
- Farmer Jack must pay $10,000 per month for the land, regardless of how much veggie he grows.
- The market wage for a farm worker is $20,000 per month.
- So Farmer Jack's costs are related to how much veggie he produces….

EXAMPLE 1: Farmer Jack's Costs

L (no. of workers)	*Q* (bushels of veggie)	Cost of land	Cost of labor	Total Cost
0	0	$10,000	$0	$10,000
1	1000	$10,000	$20,000	$30,000
2	1800	$10,000	$40,000	$50,000
3	2400	$10,000	$60,000	$70,000
4	2800	$10,000	$80,000	$90,000
5	3000	$10,000	$100,000	$110,000

EXAMPLE 1: Farmer Jack's Total Cost Curve

Q (bushels of veggie)	Total Cost
0	$10,000
1000	$30,000
1800	$50,000
2400	$70,000
2800	$90,000
3000	$110,000



Marginal Cost

- **Marginal Cost** (*MC*) is the increase in Total Cost from producing one more unit:

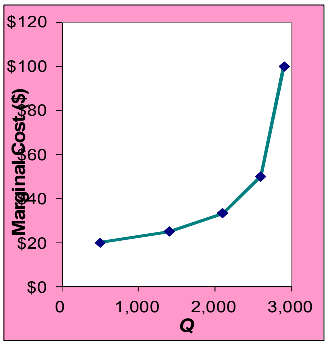
$$MC = \frac{\Delta TC}{\Delta Q}$$

EXAMPLE 1: Total and Marginal Cost

	Q (bushels of veggie)	Total Cost		Marginal Cost (*MC*)
	0	$10,000		
Δ***Q*** = 1000			Δ**TC** = $20,000	$20.0
	1000	$30,000		
Δ***Q*** = 800			Δ**TC** = $20,000	$25.0
	1800	$50,000		
Δ***Q*** = 600			Δ**TC** = $20,000	$33.3
	2400	$70,000		
Δ***Q*** = 400			Δ**TC** = $20,000	$50.0
	2800	$90,000		
Δ***Q*** = 200			Δ**TC** = $20,000	$100.0
	3000	$110,000		

EXAMPLE 1: The Marginal Cost Curve

Q (bushels of veggie)	*TC*	*MC*
0	$10,000	
		$20.0
1000	$30,000	
		$25.0
1800	$50,000	
		$33.3
2400	$70,000	
		$50.0
2800	$90,000	
		$100.0
3000	$110,000	



Why MC Is Important

- Farmer Jack is rational and wants to maximize his profit. To increase profit, should he produce more or less vegetables?
- To find the answer, Farmer Jack needs to "think at the margin."
- If the cost of additional veggie (*MC*) is less than the revenue he would get from selling it, then Jack's profits rise if he produces more.

Fixed and Variable Costs

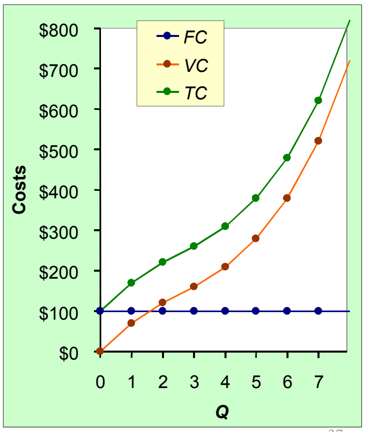
- **Fixed costs (*FC*)** do not vary with the quantity of output produced.
  - For Farmer Jack, *FC* = $10,000 for his land
  - Other examples: cost of equipment, loan payments, rent
- **Variable costs (*VC*)** vary with the quantity produced.
  - For Farmer Jack, *VC* = wages he pays workers
  - Other example: cost of materials
- **Total cost (*TC*)** = *FC* + *VC*

EXAMPLE 2

- Our second example is more general, applies to any type of firm producing any good with any types of inputs.

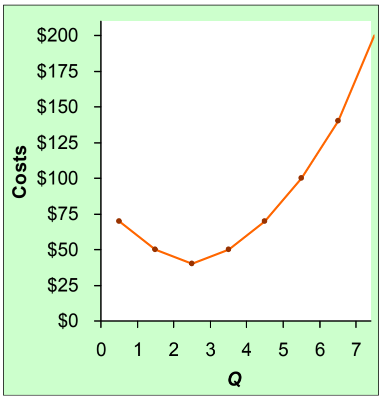
EXAMPLE 2: Costs

Q	*FC*	*VC*	*TC*
0	$100	$0	$100
1	100	70	170
2	100	120	220
3	100	160	260
4	100	210	310
5	100	280	380
6	100	380	480
7	100	520	620



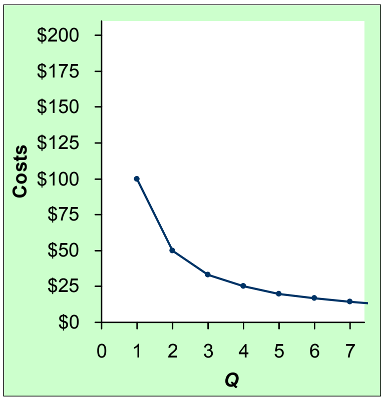
EXAMPLE 2: Marginal Cost

Q	*TC*	*MC*
0	$100	
		$70
1	170	
		50
2	220	
		40
3	260	
		50
4	310	
		70
5	380	
		100
6	480	
		140
7	620	



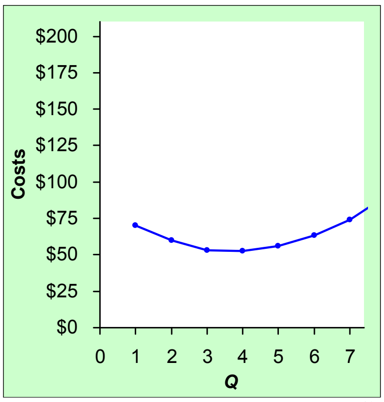
EXAMPLE 2: Average Fixed Cost

Q	*FC*	*AFC*
0	$100	n/a
1	100	$100
2	100	50
3	100	33.33
4	100	25
5	100	20
6	100	16.67
7	100	14.29



EXAMPLE 2: Average Variable Cost

Q	*VC*	*AVC*
0	$0	n/a
1	70	$70
2	120	60
3	160	53.33
4	210	52.50
5	280	56.00
6	380	63.33
7	520	74.29



EXAMPLE 2: Average Total Cost

Q	*TC*	*ATC*	*AFC*	*AVC*
0	$100	n/a	n/a	n/a
1	170	$170	$100	$70
2	220	110	50	60
3	260	86.67	33.33	53.33
4	310	77.50	25	52.50
5	380	76	20	56.00
6	480	80	16.67	63.33
7	620	88.57	14.29	74.29

Average total cost (*ATC*) equals total cost divided by the quantity of output:

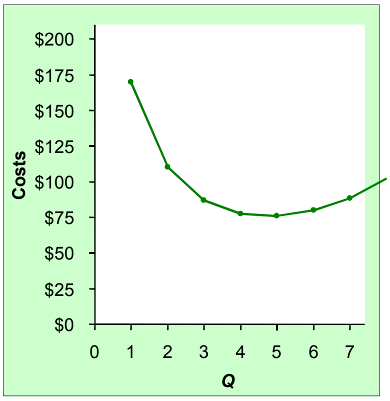
ATC = *TC*/***Q***

Also,

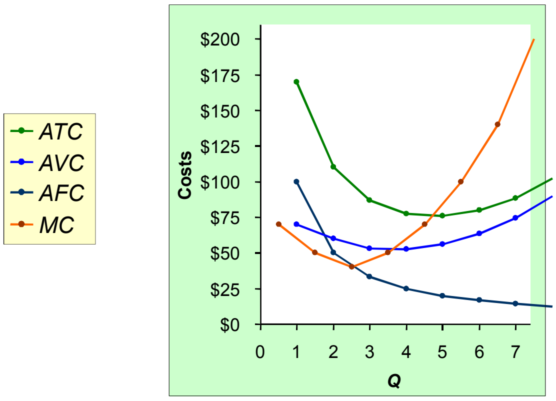
ATC = *AFC* + *AVC*

EXAMPLE 2: Average Total Cost

Q	*TC*	*ATC*
0	$100	n/a
1	170	$170
2	220	110
3	260	86.67
4	310	77.50
5	380	76
6	480	80
7	620	88.57



EXAMPLE 2: The Various Cost Curves Together



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				
3			16.67	20	36.67	30
4	100	150	12.50		37.50	
5	150			30		
6	210	260	8.33	35	43.33	60

ACTIVE LEARNING 3

Answers

First, deduce *FC* = $50 and use *FC* + *VC* = *TC*.

Q	*VC*	*TC*	*AFC*	*AVC*	*ATC*	*MC*
0	$0	$50	*n/a*	*n/a*	*n/a*	
1	10	60	$50.00	$10	$60.00	$10
2	30	80	25.00	15	40.00	20
3	60	110	16.67	20	36.67	30
4	100	150	12.50	25	37.50	40
5	150	200	10.00	30	40.00	50
6	210	260	8.33	35	43.33	60

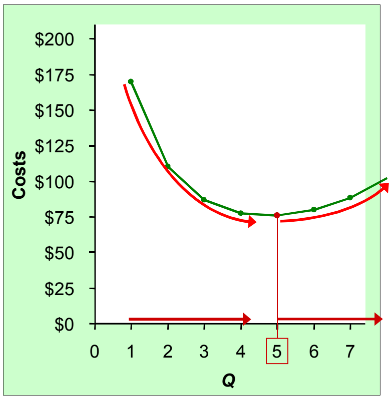
EXAMPLE 2: Why ATC Is Usually U-Shaped

As ***Q*** rises:

Initially, falling *AFC* pulls *ATC* down.

Eventually, rising *AVC* pulls *ATC* up.

Efficient scale: The quantity that minimizes ATC.

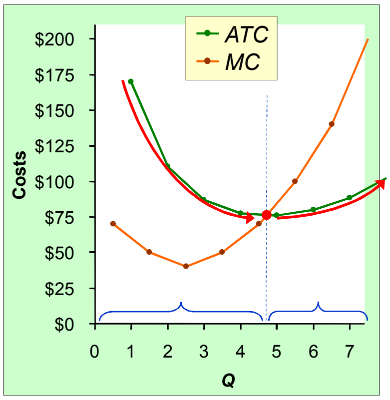


EXAMPLE 2: ATC and MC

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.



Costs in the Short Run & Long Run

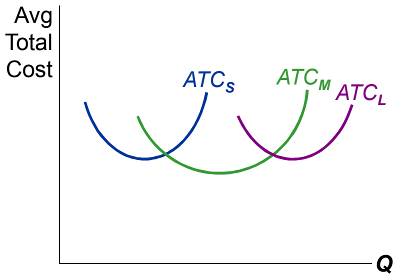
- Short run:
  Some inputs are fixed (e.g., factories, land).
  The costs of these inputs are *FC*.
- Long run:
  All inputs are variable
  (e.g., firms can build more factories,
  or sell existing ones).
- In the long run, *ATC* at any ***Q*** is cost per unit using the most efficient mix of inputs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

EXAMPLE 3: 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.

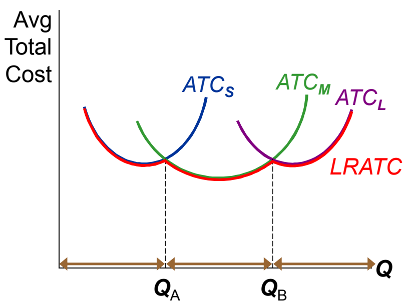


EXAMPLE 3: LRATC with 3 factory sizes

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.

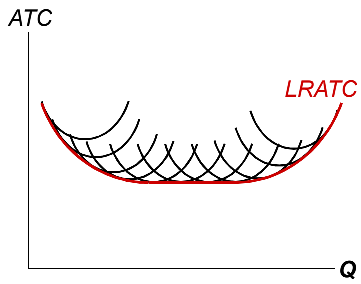
To produce more than Q_B, firm will choose size **L** in the long run.



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:

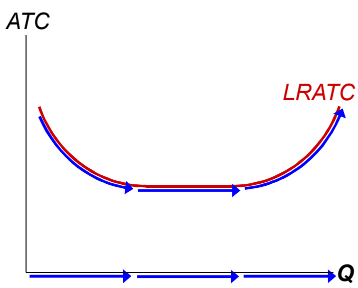


How ATC Changes as the Scale of Production Changes

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.



How ATC Changes as the Scale of Production Changes

- Economies of scale occur when increasing production allows greater specialization: workers more efficient when focusing on a narrow task.
  - More common when ***Q*** is low.
- Diseconomies of scale are due to coordination problems in large organizations.
  E.g., management becomes stretched, can't control costs.
  - More common when ***Q*** is high.

CONCLUSION

- Costs are critically important to many business decisions, including production, pricing, and hiring.
- This chapter has introduced the various cost concepts.
- The following chapters will show how firms use these concepts to maximize profits in various market structures.

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SUMMARY

- Implicit costs do not involve a cash outlay, yet are just as important as explicit costs to firms' decisions.
- Accounting profit is revenue minus explicit costs. Economic profit is revenue minus total (explicit + implicit) costs.
- The production function shows the relationship between output and inputs.

SUMMARY

- The marginal product of labor is the increase in output from a one-unit increase in labor, holding other inputs constant. The marginal products of other inputs are defined similarly.
- Marginal product usually diminishes as the input increases. Thus, as output rises, the production function becomes flatter, and the total cost curve becomes steeper.
- Variable costs vary with output; fixed costs do not.

SUMMARY

- Marginal cost is the increase in total cost from an extra unit of production. The *MC* curve is usually upward-sloping.
- Average variable cost is variable cost divided by output.
- Average fixed cost is fixed cost divided by output. *AFC* always falls as output increases.
- Average total cost (sometimes called "cost per unit") is total cost divided by the quantity of output. The *ATC* curve is usually U-shaped.

SUMMARY

- The *MC* curve intersects the *ATC* curve at minimum average total cost.
  When *MC* < *ATC*, *ATC* falls as *Q* rises.
  When *MC* > *ATC*, *ATC* rises as *Q* rises.
- In the long run, all costs are variable.
- Economies of scale: *ATC* falls as *Q* rises.
  Diseconomies of scale: *ATC* rises as *Q* rises.
  Constant returns to scale: *ATC* remains constant as *Q* rises.

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, pp. 275-277, Problem 1, 3, 6, 7, 9, 12.

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The Complete Data for Example 2

Q	*FC*	*VC*	*TC*	*AFC*	*AVC*	*ATC*	*MC*
0	$100	$0	$100	n/a	n/a	n/a	
1	100	70	170	$100	$70	$170	$70
2	100	120	220	50	60	110	50
3	100	160	260	33.33	53.33	86.67	40
4	100	210	310	25	52.50	77.50	50
5	100	280	380	20	56.00	76	70
6	100	380	480	16.67	63.33	80	100
7	100	520	620	14.29	74.29	88.57	140
8	100	720	820	12.50	90	102.50	200