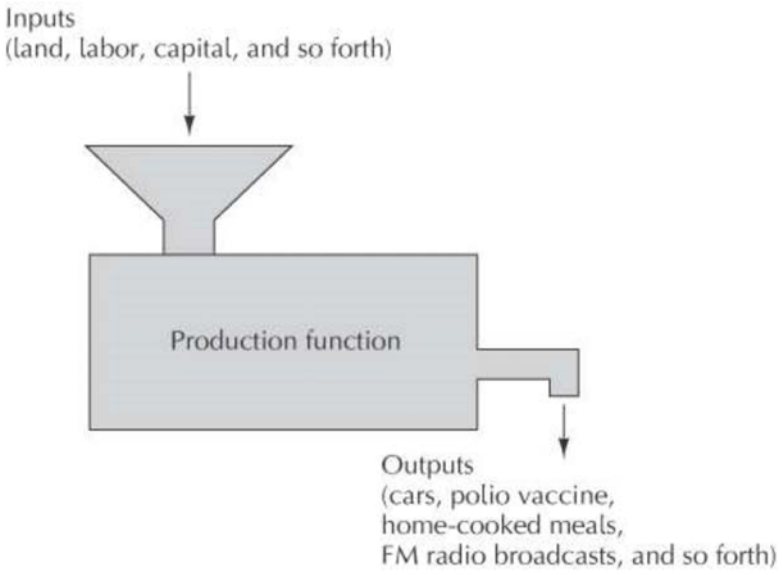
Production and Costs



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Objective of a firm

Objective of a firm

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

Profit (π) = **Total revenue (TR)** – **Total cost (TC)**

the amount a firm receives from the sale of its output

the market value of the inputs a firm uses in production

$$\max_{q} \pi(q) = TR(q) - TC(q)$$

3

Short Run Vs. Long Run

SR ⇒ period of time that at least one factor input cannot be varied.

LR ⇒ period of time that all factor inputs can be varied

4

Production Function in the Short Run

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.

$$Q = F(L, \overline{K})$$

where Q = quantity of outputs produced (#units / time period)

L = quantity of labor or workers employed. (#units / time period) — number of workers or number of working hrs

K = quantity of capital rented. (#units / time period).

- K is treated as "a fixed input."
- L is treated as "a variable input."

- Total product (TP) = Total outputs produced per time period.

- Average Product (AP) = $\frac{TP}{L}$ or = $\frac{Q}{L}$ → outputs, → workers
  [output per worker].

Ex: $Q_1 = 1000$ cookies/day

$L_1 = 10$ workers/day

$AP_L = \frac{Q_1}{L_1} = \frac{1000}{10} \frac{\text{cookies/day}}{\text{workers/day}} = 100$ cookies/worker

+7

On average, each worker produces 100 cookies/day

$Q_2 = 1200$ cookies/day

$L_2 = 11$ workers/day

$AP_L = \frac{Q_2}{L_2} = \frac{1200}{11} = 109.09$ cookies/day

on avg, each worker produces 109 cookies/day.

Since AP_L when $L=11$ > AP_L when $L=10$, labor becomes more productive.

- Marginal Product (MP) is the increase in output arising from an additional unit of that input, holding all other inputs constant.

$$MP_L = \frac{\Delta Q}{\Delta L} = \frac{Q_2 - Q_1}{L_2 - L_1}$$

marginal product of labor

7

Table 6.1 Total Product, Marginal Product, and Average Product of Labor with Fixed Capital

$Q = F(L, \bar{K})$ — variable input; fixed input

Capital, K	Labor, L	Output, Total Product of Labor, Q	Marginal Product of Labor, $MP_L = \Delta Q/\Delta L$	Average Product of Labor, $AP_L = Q/L$
8	0	0		
8	1	5	5	5
8	2	18	13	9
8	3	36	18	12
8	4	56	20	14
8	5	75	19	15
8	6	92	17	15.33
8	7	98	6	14
8	8	104	6	13
8	9	108	4	12
8	10	110	2	11
8	11	110	0	10
8	12	108	−2	9
8	13	104	−4	8

MP > AP → AP ↑
MP = AP → AP max
MP < AP → AP ↓

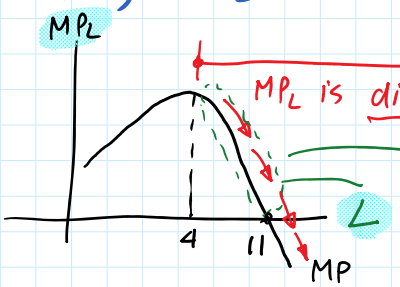
6–8

observation #1 Given K fixed, when $L = 0$, $Q = 0$.

observation #2 When L rises, Q or TP rises first, reaches its peak, and then falls...

observation #3 (on MP) MP_L rises first, hits its peak (here when $L = 4$ workers), and falls afterwards. $MP_L = 0$ at $L = 11$.

When $L > 11$, MP_L becomes negative.

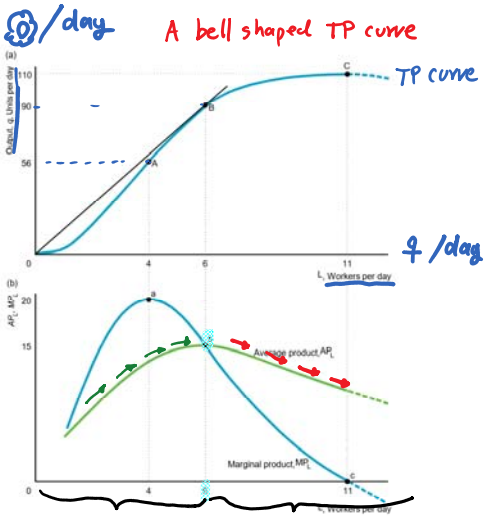


observation #4 (on AP_L): AP_L first increases, hits its peak, and eventually falls.

In other words, output per worker rises and then falls.

(☺/☹)

Figure 6.1 Production Relationships with Variable Labor



6–9

Observation #5 (on AP_L and MP_L)

From $L=0$ to $L=6$, $MP_L > AP_L$ and AP_L is rising.

At $L=6$, $MP_L = AP_L$ (=15) & AP_L is at max (=15)

From $L>6$, $MP_L < AP_L$ and AP_L is falling.

"AVERAGE & MARGINAL RELATIONSHIP"
PRODUCT PRODUCT

EXAMPLE

N_1 = 50 students

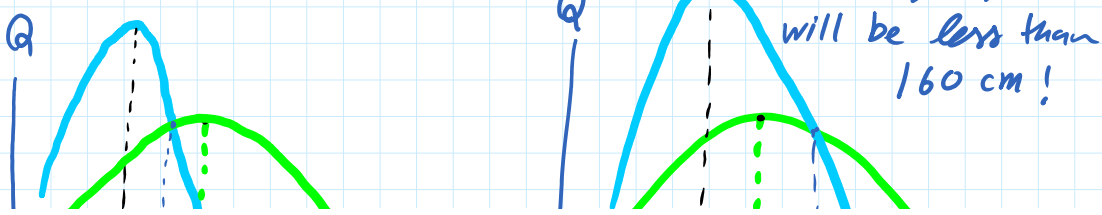
Average height = 160 cm.

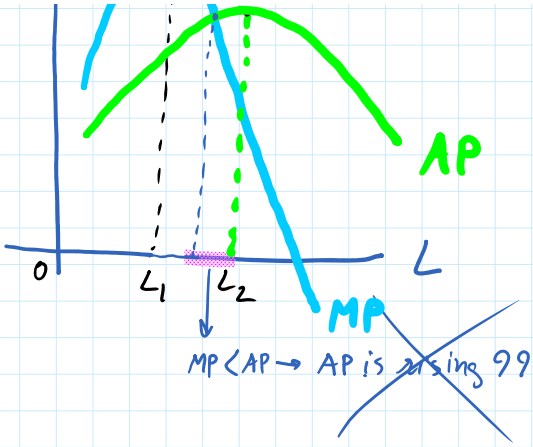
N_2 = 50 + Dutch guy w/ 200 cm height

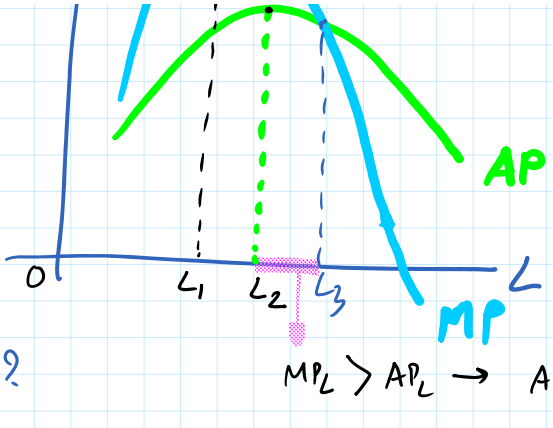
New avg height > 160

N_2 = 50 + Doraemon w/ 120 cm

New avg height will be less than 160 cm!

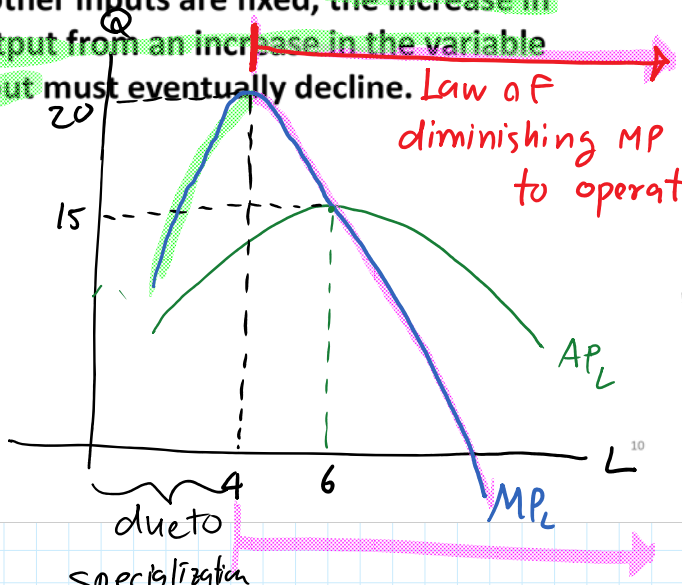



AP
0
L_1
L_2
L
MP
MP < AP → AP is ~~rising~~ ???


AP
0
L_1
L_2
L_3
L
MP
$MP_L > AP_L$ → AP is ~~falling~~ ???

Law of diminishing marginal returns

- If other inputs are fixed, the increase in output from an increase in the variable input must eventually decline.



MP_L

Law of diminishing MP starts to operate ...

due to specialization & division of labor, MP_L ↑

Reason for this:

mismatch or imbalance between the use of L and the amount of Fixed input K.

Why can't all the world's people be fed from the amount of grain grown in a single flowerpot?

The law of diminishing returns suggests that no matter how much labor, fertilizer, water, seed, capital equipment, and other inputs were used, only a limited amount of grain could be grown in a single flowerpot. With the land input fixed at such a low level, increases in other inputs would quickly cease to have any effect on total output.

11

Costs in the Short Run

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
- **Total costs** = Explicit costs + Implicit costs
- 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.

13

- Forgone salary you could have earned
- Forgone rent you could have earned
- forgone interest on deposits

Explicit vs. Implicit Costs: An Example

You need $100,000 to start your business.
The interest rate is 5%.

- Case 1: borrow $100,000
  - explicit cost = $5000 interest on loan
- Case 2: use $40,000 of your savings, borrow the other $60,000
  - explicit cost = $3000 (5%) interest on the loan
  - implicit cost = $2000 (5%) *foregone* interest you could have earned on your $40,000.

In both cases, total (exp + imp) costs are $5000.

14

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.

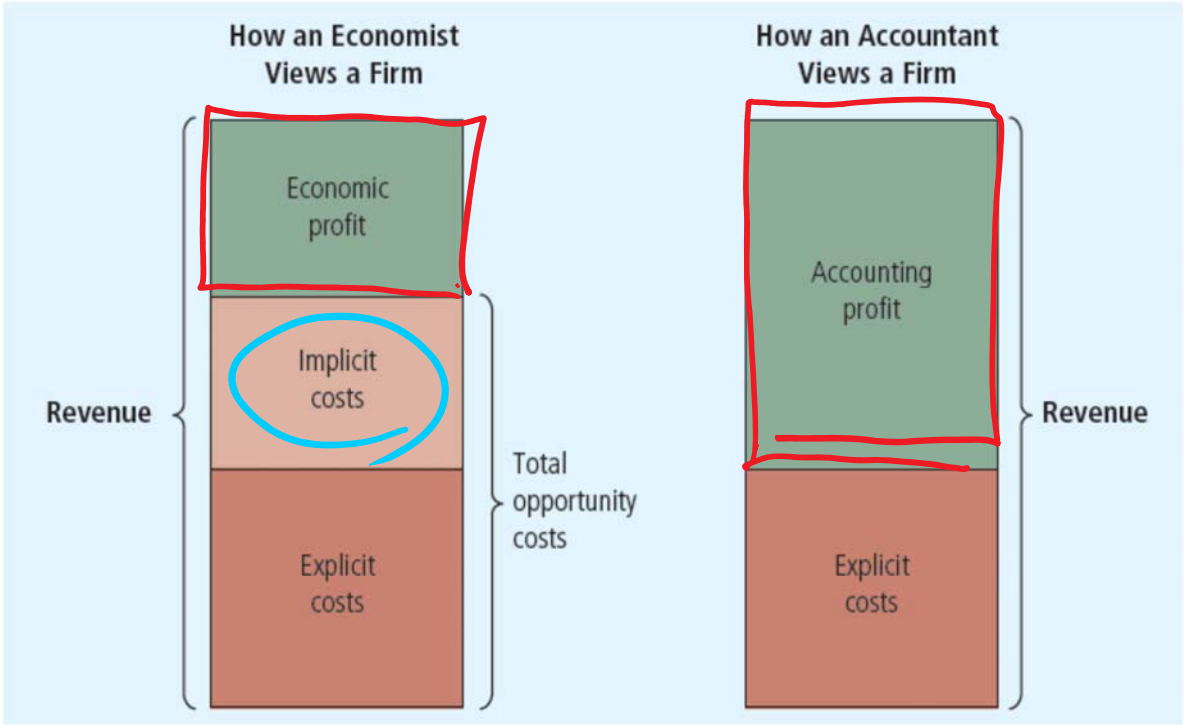
15

$\Rightarrow \pi^{AC'} = TR - \text{EXPLICIT COST}$

$\Rightarrow \pi^{EC} = TR - \text{EXPLICIT COST} - \text{IMPLICIT COST}$

when IMPLICIT COST $\neq 0$, $\pi^{EC'} < \pi^{AC'}$.

$\pi^{EC} < \pi^{AC}$



Economists include all opportunity costs when analyzing a firm, whereas accountants measure only explicit costs. Therefore, economic profit is smaller than accounting profit.

1
6

ACTIVE LEARNING 2:
Economic profit vs. accounting profit

The equilibrium rent on office space has just increased by $500/month.

Compare 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 $500/month.

a. You rent your office space.
Explicit costs increase $500/month.
Accounting profit & economic profit each fall $500/month.

b. You own your office space.
Explicit costs do not change,
so accounting profit does not change.
Implicit costs increase $500/month (opp. cost of using your space instead of renting it),
so economic profit falls by $500/month.

18

π^{AC} = TR − EXPLICIT COST

π^{EC} = TR − EXPLICIT COST − IMPLICIT COST

π^{AC} = TR − explicit cost

π^{EC} = TR − explicit cost − implicit cost

↑ by $500/mo

Total Costs (TC),
Total fixed cost (TFC or FC)
Total variable costs (TVC or VC)

TC = TFC + TVC

or TC = FC + VC

FC = costs that do not vary w/ outputs you produce.

VC = costs that do vary w/ outputs you produce.

19

Average total cost (Atc or AC)
Average fixed cost (AFC)
Average variable cost (AVC)

From $TC = FC + VC$ — (1)

Dividing (1) throughout by Q gives

$$\frac{TC}{Q} = \frac{FC}{Q} + \frac{VC}{Q}$$

$$AC = AFC + AVC \quad \text{— (2)}$$

variable cost per unit of output

Fixed cost per unit of output

average cost
or cost per unit of output
or unit cost

in business term

20

AC, AFC, AVC → unit is Baht/piece

Baht/unit

Baht/ 🐵

Marginal cost (MC)

MC = extra cost we incur when we produce an extra unit of output.

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{TC_{NEW} - TC_{OLD}}{Q_{NEW} - Q_{OLD}} \quad \text{(1)}$$

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{\Delta (FC + VC)}{\Delta Q} = \frac{\Delta FC + \Delta VC}{\Delta Q} = \frac{\Delta FC}{\Delta Q}^{0} + \frac{\Delta VC}{\Delta Q}$$

$$MC = \frac{\Delta VC}{\Delta Q} \quad \text{(2)}$$

21

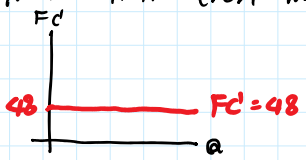
Variation of Short-Run Cost with Output

Output, q	Fixed Cost, FC	Variable Cost, VC	Total Cost, TC	Marginal Cost, MC	Average Fixed Cost, $AFC = FC/q$	Average Variable Cost, $AVC = VC/q$	Average Cost, $AC = C/q$
0	48	0	48				
1	48	25	73	25	48	25	73
2	48	46	94	21	24	23	47
3	48	66	114	20	16	22	38
4	48	82	130	16	12	20.5	32.5
5	48	100	148	18	9.6	20	29.6
6	48	120	168	20	8	20	28
7	48	141	189	21	6.9	20.1	27
8	48	168	216	27	6	21	27
9	48	198	246	30	5.3	22	27.3
10	48	230	278	32	4.8	23	27.8
11	48	272	320	42	4.4	24.7	29.1
12	48	321	369	49	4.0	26.8	30.8

7-22

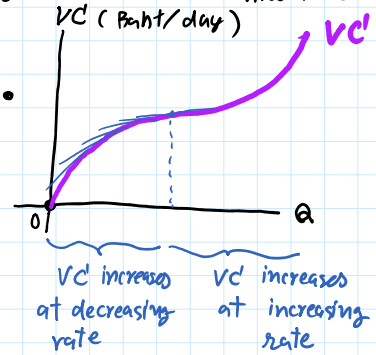
Fact#1 (on FC')

- $FC' = 48$. It does not change when Q changes.
- Notice that even when $Q = 0$, $FC' = 48$.

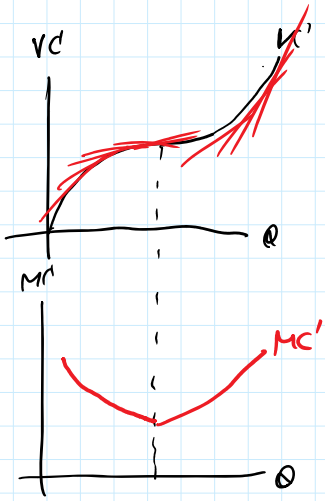


Fact#2 (on VC')

- When the Firm produces more Q, the Firm pays more VC'!
  i.e., $Q\uparrow \rightarrow VC'\uparrow$
- Notice that when $Q = 0$, $VC' = 0$.



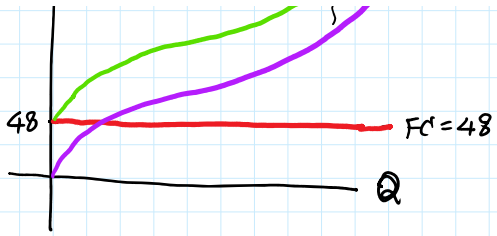
- When Q↑, VC'↑
- slope of $VC' = \frac{\Delta VC'}{\Delta Q} = MC'$



Fact#3 (on TC')

- When Q↑, TC'↑
- As $TC' = FC' + VC'$, TC' increases at decreasing rate first and then increases at increasing rate.

Notice that slope of $TC' = \frac{\Delta TC'}{\Delta Q}$



Notice that slope of TC = $\frac{\Delta TC}{\Delta Q}$

which is equal to MC !!!

So slope of TC is MC as well.

Grand conclusion : **slope of VC = slope of TC = MC**

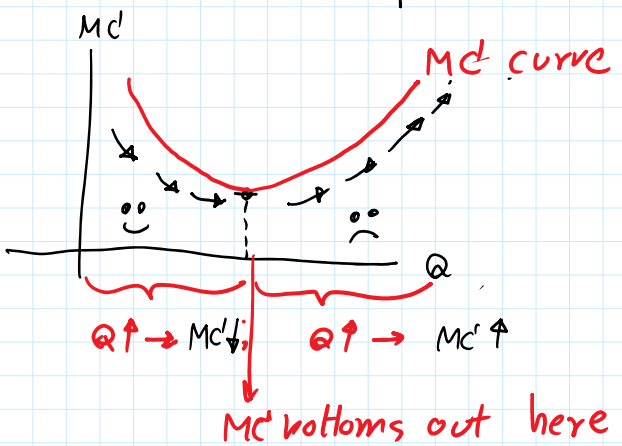
Fact#4 (on MC) :

- $MC = \frac{\Delta TC}{\Delta Q}$ or $MC = \frac{\Delta \cdot VC}{\Delta Q}$

  $\frac{\Delta TC}{\Delta Q}$ ↑ slope of TC curve

  $\frac{\Delta \cdot VC}{\Delta Q}$ ↑ slope of MC curve.

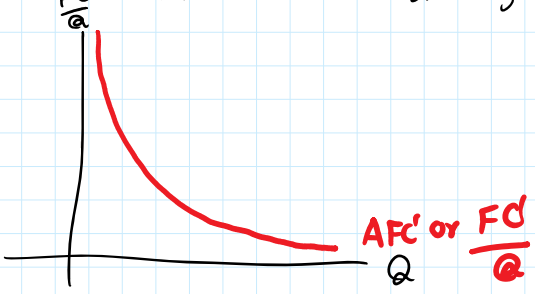
- MC is U-shaped : as Q↑, MC falls first, bottoms out, and then rises.



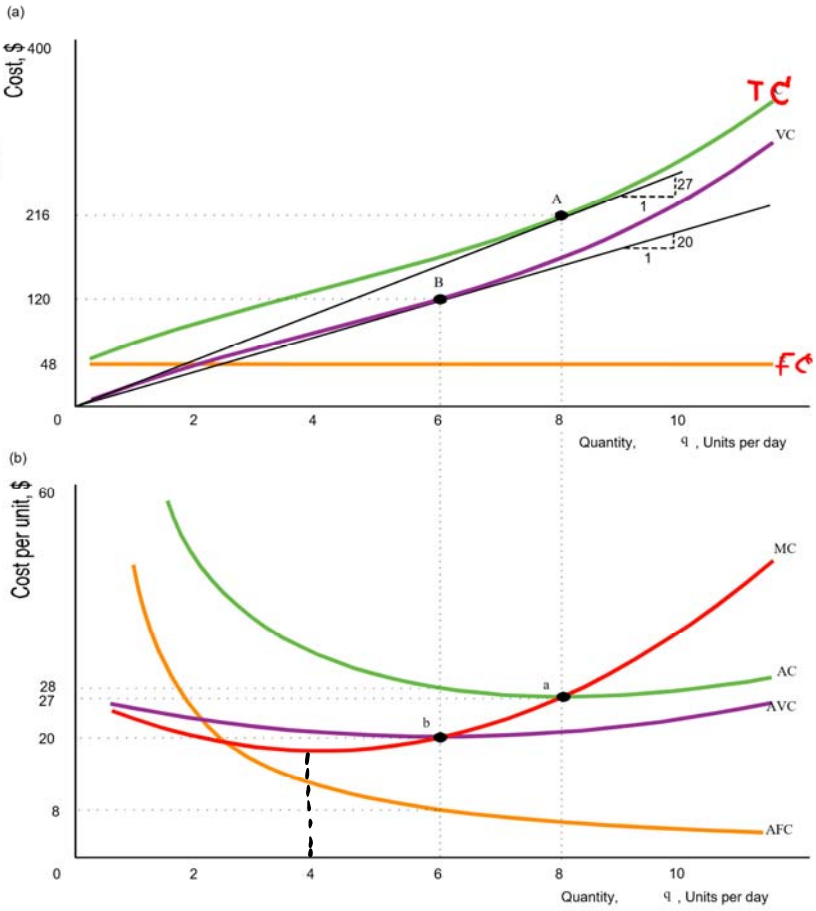
Fact#5 (on AFC)

- $AFC = \frac{FC}{Q}$ [fixed cost per unit of cookie)

- As Q↑, $\frac{FC}{Q}$ falls sharply at the begining and falls slowly at large amount of Q.



Short-Run Cost Curves



7–23

Facts about TC, FC, VC