



# *Production and Cost in the Firm*

**Cost and Profit**

**Production in the Short Run**

**Cost in the Short Run**

**Cost in the Long Run**



## *Producer's Behavior:*

*Producers maximize Profits*

- ⊕ **Assumes that producers try to maximize profit**
  - ⊗ **provides the motivation for their behavior**
  
- ⊕ **They must make plans while confronting uncertainty about**
  - ⊗ **Consumer demand**
  - ⊗ **Resource availability**
  - ⊗ **Intentions of other firms in the industry**



## *How Producers Hire Resources*

- **To hire resources, producers must pay at least their opportunity costs**
  - ❖ For most resources, the cash payments approximate their opportunity cost
  - ❖ Some resources are owned by the firm or the firm's owners
    - No direct cash payments
  - ❖ *Whether hired in resource markets or owned by the firm, all resources have an opportunity cost*

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## *Explicit and Implicit Costs*

- ***Explicit costs***
  - ❖ Actual cash payments for resources
  - ❖ Like wages, rent, taxes, etc.
  
- ***Implicit costs***
  - ❖ Opportunity costs of using resources owned by the firm or provided by the firm's owners
  - ❖ No cash payment and no entry in the firm's accounting statement,
- **Accounting statement records revenues, explicit costs, and accounting profits of a firm**

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## Alternative Measures of Profit

- Accounting profit doesn't consider implicit cost.
- A particular example is given to clarify
  - Accounting profit
  - Economic profit : Consider implicit cost
- Wanda Wheeler
  - Current Salary: 50000
  - Start her own business
    - Withdraws \$20,000 from her savings,
    - Hires and assistant: Salary: \$21000
    - Uses garage: Rent: \$1,000

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## Accounts of Wheeler Dealer 2001

Total revenue		\$105,000
Less explicit costs:		
Assistant's salary	-21,000	
Material and equipment	-20,000	
Equals accounting profit		\$64,000
Less implicit costs:		
Wanda's forgone salary	50,000	
Forgone interest on savings	-1,000	
Forgone garage rental	-1,200	
Equals economic profit		\$11,800

- *Accounting profit equals total revenue minus explicit costs*
  - Determine a firm's taxable income
- However, this ignores the opportunity cost of Wanda's own resources
  - Her forgone salary of \$50,000
  - Annual interest of \$1,000 from the savings used to start the business
  - Rental income of \$1,200
- *Economic profit equals total revenue minus all costs, both explicit and implicit*
  - Accounting profit of \$64,000 less implicit costs of \$52,200 → economic profit of \$11,800

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## *Normal Profit*

- The accounting profit required to induce the firm's owners to employ their own resources
  
- Normal profit:
  - The accounting profit = Opportunity cost of the resources of the firm's owner.
- Accounting profit = \$64,000
  - Normal profits = \$50,000 + \$1,200 + \$1,000 = \$52,200
  - \$11,800 is an economic profit

*Any profit in excess of normal profit*

*The owner will continue the business if this profit  $\geq 0$*  7



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## *Fixed and Variable Resources*

- Resources can be divided into two categories
  - *Variable resources* can be varied quickly to change the output rate: Ex: 麵包廠:麵粉
  - *Fixed resources* are those resources which cannot be easily changed Ex:麵包廠:麵包機
  
- This provides us the distinction between the short run and the long run
  - *Short run* → at least one resource is fixed
  - *Long run* → all resources are variable

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## *Short Run and Long Run*

- Output can be changed in the short run by adjusting variable resources
  
- However, the size, or scale of the firm is fixed in the short run
  
- In the long run, all resources can vary
  
- The length of the short and long run differs from industry to industry
  - 晶圓廠 vs. 麵包廠

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## Law of Diminishing Marginal Returns

- ◆ We now focus on the short-run link between resource use and the rate of output
- ◆ 考慮一個搬家公司
  - ▣ Fixed resources: 倉庫, 卡車
  - ▣ The only variable resource is labor
- ◆ See next slide

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## Short-Run Relationship

- ◆ Relationship between the amount of resources employed and total product is called the firm's *production function*.

Units of Labor and Tons of Furniture Moved

Units of the Variable Resource (worker-days)	Total Product (tons moved per day)	Marginal Product (tons moved per day)
0	0	-
1	2	2
2	5	3
3	9	4
4	12	3
5	14	2
6	15	1
7	15	0
8	14	-1

*Increase marginal return (scale of economics)* →

*Marginal return eventually decreases*

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## Law of Diminishing Marginal Returns

- ✦ As more of a variable resource is combined with a given amount of a fixed resource, marginal product eventually declines
- ✦ The most important feature of production in the short run → dictates the shape of the production function and the cost curves

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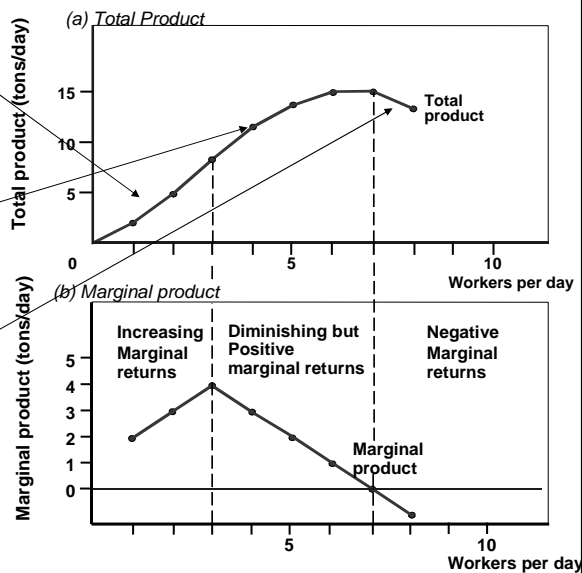


## Total and Marginal Product

Total product is increasing at an increasing rate.

Total product increase but at a decreasing rate.

Marginal product turns negative, total product starts to fall.



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## *Costs in the Short Run*

- **Two kinds of costs in the short run**
- **Fixed costs (土地, 店面)**
  - pay for fixed resources
  - do not vary when output varies
    - Assumed fixed cost to be \$200
- **Variable cost (勞力)**
  - the cost of variable resources
  - Vary with the amount of labor employed
    - The firm can hire labor at \$100 per worker day
    - variable cost equals \$100 times the number of workers

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## Short-Run Cost Data

Tons Moved per Day (q) (1)	Fixed cost (FC) (2)	Workers per Day (3)	Variable Cost (VC) (4)	Total Cost TC=FC+VC (5)	Marginal Cost MC= $\Delta$ TC/ $\Delta$ q (6)
\$0	\$200	0	\$0	\$200	-
2	200	1	100	300	50.00
5	200	2	200	400	33.33
9	200	3	300	500	25.00
12	200	4	400	600	33.33
14	200	5	500	700	50.00
15	200	6	600	800	100.00

*Marginal cost is simply the change in total cost divided by the change in output  $\rightarrow MC = \Delta TC / \Delta q$   
Changes in MC reflect changes in marginal productivity of the variable resource employed*

*Marginal productivity =  $MC/100$*

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## Marginal Cost and Marginal Productivity

- **When the firm experiences increasing marginal returns**
  - ❏ marginal product is increasing
  - ❏ the marginal cost decreases
  
- **When the firm experiences diminishing marginal returns**
  - ❏ marginal product begins to decline
  - ❏ the marginal cost of output increases
  
- **See next slide**

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## Total and Marginal Cost Curves

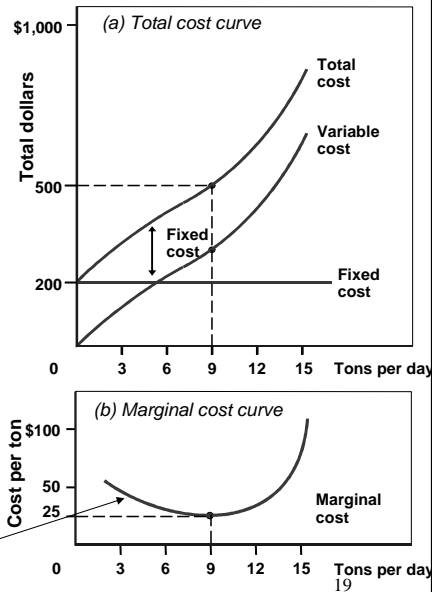
The fixed cost curve is a horizontal line at \$200.

The variable cost curve starts at zero, then increases slowly then sharply.

The total cost curve sums the variable and fixed cost curves.

Marginal cost declines until the 9<sup>th</sup> unit of output and then increases reflecting labor's increasing and then diminishing marginal returns.

The slope of the total cost curve at each rate of output equals the marginal cost at that rate of output.



## Summary

- The total cost curve can be divided into two sections, based on what happens to marginal cost
- Increasing marginal returns from labor,
  - ❖ marginal cost declines
  - ❖ total cost curve: concave increasing
- Diminishing marginal returns from labor,
  - ❖ marginal cost increases
  - ❖ total cost curve: convex increasing



## *Summary*

- **Marginal cost is the key to economic decisions made by firms**
- **The firm in the short run has no control over its fixed cost, but, by varying output, the firm can alter its variable cost and hence its total cost**
- **Marginal cost indicates how much total cost will increase if one more unity is produced**

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## *Average Cost in the Short Run*

- **The average cost per unit of output is another of the useful cost measures**
- **There are average cost measures corresponding to total cost, fixed cost and variable cost**
- **See next slide**

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## Short Run Cost Data

Tons Moved per Day (q) (1)	Variable Cost (VC) (2)	Total Cost TC=FC+VC (3)	Marginal Cost MC= $\Delta$ TC/ $\Delta$ q (4)	Average Variable Cost AVC=VC/q (5) =(2) / (1)	Average Total Cost ATC=TC /q (6)=(3) / (1)
0	\$0	\$200	\$0.00	-	$\infty$
2	100	300	50.00	\$50.00	\$150.00
5	200	400	33.33	40.00	80.00
9	300	500	25.00	33.33	55.55
12	400	600	33.33	33.33	50.00
14	500	700	50.00	35.71	50.00
15	600	800	100.00	40.00	53.33

- Average variable cost,  $AVC = VC / q$
- Average total cost,  $ATC = TC / q$
- Both average variable cost and average total cost first decline as output expands, then increase

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## The Relationship between Marginal and Average Cost

- When marginal cost is less than average cost it pulls average cost down
- When marginal cost is higher than average cost it pulls average cost up
- See next slide

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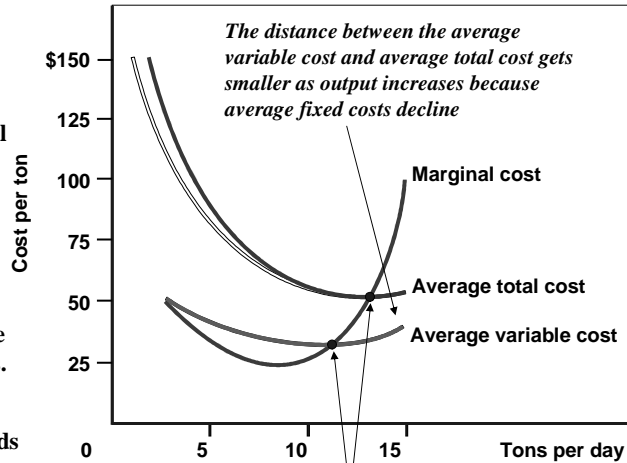
## Average and Marginal Cost Curves

Increasing marginal returns:  
Marginal cost declines

Law of decreasing marginal return:  
Marginal cost eventually increases

As long as marginal cost is below average cost, average cost falls as output expands.

Where marginal cost exceeds average cost, marginal cost pulls up the average.



The distance between the average variable cost and average total cost gets smaller as output increases because average fixed costs decline

Notice also that the rising marginal cost curve intersects both the average variable cost and average total cost curves at their minimums.

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## *Costs in the Long Run*

- ⊕ *In the long run, all inputs that are under the firm's control can be varied*
  - *There are no fixed costs*
- ⊕ *The long run is best thought of as a **planning horizon***
- ⊕ *In the long run, the choice of input combinations is flexible, but that flexibility is available only to firms that have not yet decided their plans*
- ⊕ *Firms plan for the long run, but they produce in the short run*

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## *Long-Run Average Cost Curve*

- ⊕ *Suppose that a firm must choose among only three possible sizes*
  - *Small*
  - *Medium*
  - *Large*
- ⊕ *Next slide presets this simple case*

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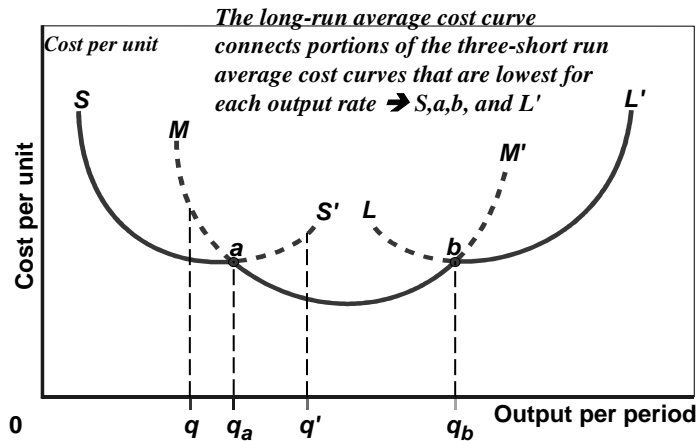


## Short-Run Cost Curves and the Long-Run Planning Curve

The size for the new firm depends on how much the firm wants to produce.

If  $q$  is the desired output  $\rightarrow$  Small size.

$q'$   $\rightarrow$  the medium size ensures lowest cost.



For any output less than  $q_a$  average cost is the lowest when the size is small.

For output rates between  $q_a$  and  $q_b$ ,  $\rightarrow$  medium

Output exceeds  $q_b$ , the large size

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## Long-Run Average Cost Curve

- Suppose there are many possible plan sizes
- In next slide,
  - ▣ Short-run average total cost curves shown in pink
  - ▣ Long-run average cost curve in red,
    - Formed by connecting the points on the various short-run average cost curves that represent the lowest per-unit cost for each rate of output

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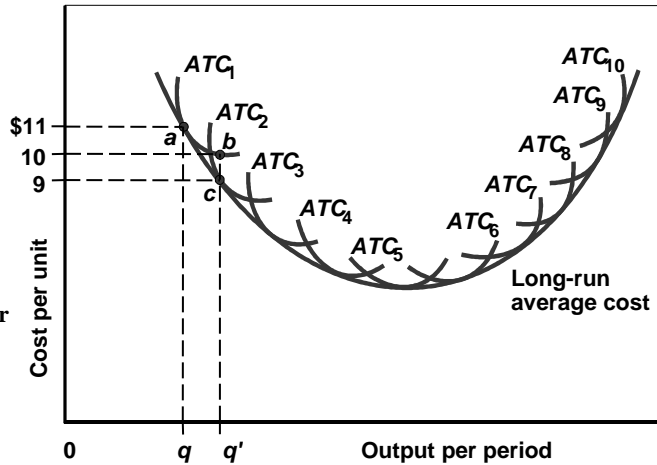


### Family of Short-Run Cost Curves Forming a Firm's Long-Run Planning Curve

Each of the short-run average cost curves is tangent to the long-run average cost curve.

These points of tangency represent the least-cost way of producing each particular rate of output.

An example is given in next slide.



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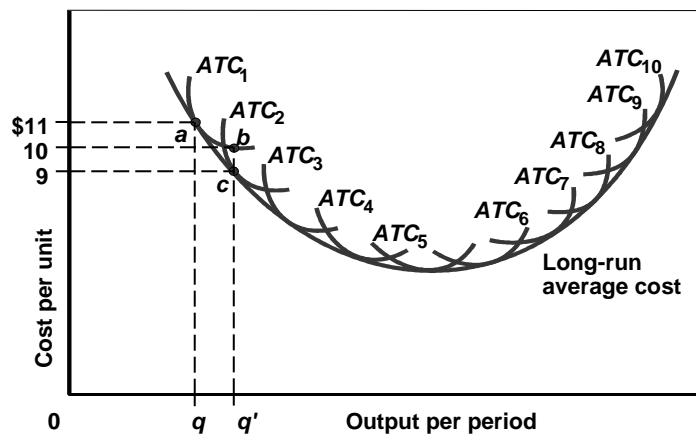


### Family of Many Short-Run Cost Curves Forming a Firm's Long-Run Planning Curve

$ATC_1$  is tangent at point  $a$   
→ the least-cost way of producing output rate  $q$  is with the plant size associated with  $ATC_1$

To produce  $q'$ ,  $ATC_1$  has a higher average cost:  $b$

$ATC_2$  has a lower average cost:  $c$



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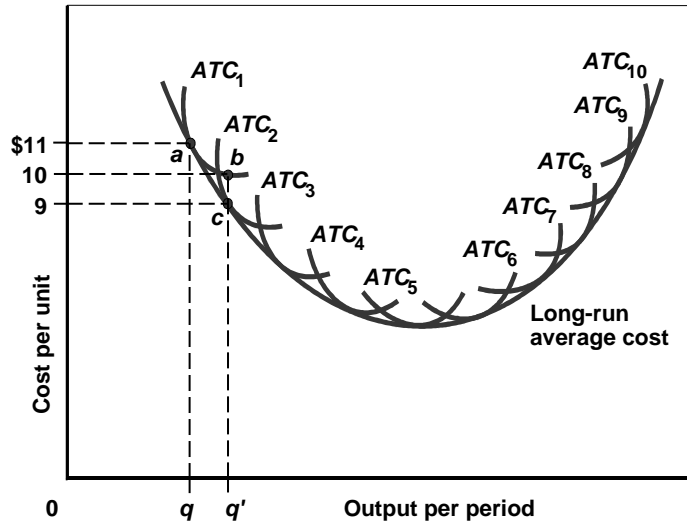


## Family of Many Short-Run Cost Curves Forming a Firm's Long-Run Planning Curve

In the short run, the plant associated with  $ATC_1$   
Produce  $q' \rightarrow AC=10$

In the long run, the size of plant change  
 $\rightarrow ATC_2$

The average cost of producing  $q'$  would be minimized at \$9 per unit at point  $c$



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## Economies of Scale

- The long-run average curve is *U*-shaped
- The U-shape here is a result of
  - economies of scale
  - diseconomies of scale
- Economies of scale imply that long-run average costs decline as output expands
- Diseconomies of scale imply that long-run average costs increase as output increases

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## *Economies of Scale*

- **A larger output**
  - often allows for more efficient machines and workers a greater degree of specialization
  - Production techniques such as the assembly line can be utilized
- **As the scale of the firm increases, capital substitutes for labor and complex machines substitute for simpler machines (Ex:工廠自動化)**

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## 分析:自然獨占 (楊澤泉)

- 所謂自然壟斷，指的是一種產業，因生產的「規模經濟」特別顯著，以致長期平均成本線 **LAC** 隨產量不斷下降。針對自然壟斷的經營管理問題，有兩種解決方法。一種是由政府對自然壟斷的企業做某種程度的干預，另一種方式則是將有自然壟斷性質的企業由政府自行經營。後一種方式即是公營事業，郵政、電力、自來水、交通等公用事業皆具有此特性。

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## *Diseconomies of Scale*

- **Diseconomies of scale, eventually take over**
  - ▣ long-run average cost eventually increase as output expands
  
- **The task of coordinating all inputs increases**
  
- **Additional layers of management are needed to monitor production**
  - ▣ communications may get mangled

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## *Constant Long-Run Average Costs*

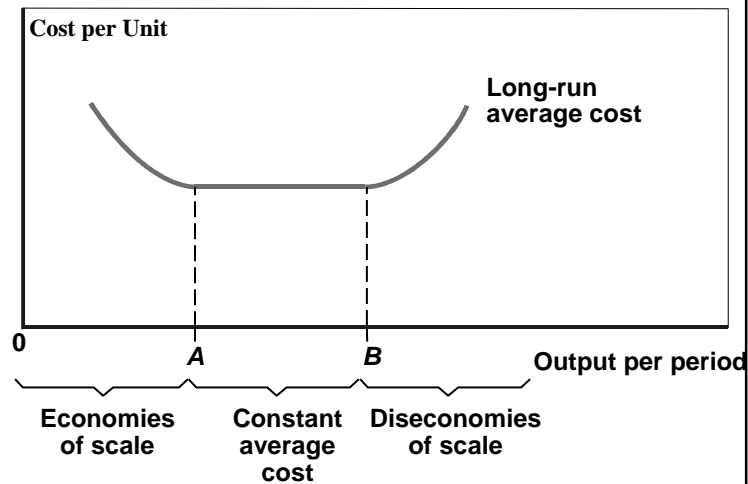
- **It is possible for average cost to neither increase nor decrease with changes in firm size**
  
- **In these situations, the firm experiences constant long-run average costs**
  
- **Next slide presents a firm's long run average cost curve, which is divided into three segments:**
  - ▣ Economics of scale
  - ▣ Constant average cost
  - ▣ Diseconomies of scale

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## A Firm's Long-Run Average Cost Curve

The minimum efficient scale, which is the lowest output at which long-run average cost is a minimum. At output A.



From output A to rate B, average cost is constant. Beyond output rate B, diseconomies of scale increase long-run average cost.

*Jump to appendix*

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## 課堂報告

- 請解釋何謂“Law of Diminishing Marginal Returns”
- 請解釋何謂explicit cost, implicit cost, economic profit 和accounting profit
- 請說明何謂 in the short run和in the long run
- 請解釋何謂average variable cost, average total cost,和marginal cost,並說明這三條曲線的關係(in the short run)
- 請說明如何使用short run average total cost曲線產生long run average total cost曲線
- 請解釋何謂 Economies of scale 和 diseconomies of scale

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## *Homework*

- ④ 2. 請分析下列何者為 explicit cost和 implicit cost
  - ❏ Ex: payment for labor purchased in the labor market → Explicit cost
- ④ 18. 請計算表格中的 Average cost, total cost ..., 並回答問題
- ④ 20. 請計算表格中的 AVC, ATC, MC 並說明這三者之間的關係