Production and Cost in the Short-Run

EE211

What are Firms?

Organization of Firms

Firms come in six basic types:

1. Single proprietorships
2. Ordinary partnerships
3. Limited partnerships
4. Corporations
5. State-owned enterprises
6. Non-profit organizations

Some firms are multinational enterprises (MNEs), which operate in more than one country.

Financing of Firms

Firms use financial capital -- equity and debt.

A firm acquires funds from its owners in return for stocks, shares, or equity. Profits may be distributed as dividends, or may be retained.

A firm's creditors are lenders -- using debt instruments (loans, bonds and securities in money markets).

Goals of Firms

Economists usually make two key assumptions about firms:

1. All firms are assumed to be profit-maximizers
2. Each firm is assumed to be a single, consistent, decision-making unit

Based on these assumptions, economists can predict the behavior of firms in various situations.

Production, Costs, and Profits

Firms use four types of inputs for production:

Intermediate products e.g. the car firm that are outputs from some other firm such as steel, spark plugs, electricity

Inputs provided directly by nature such as land

Inputs provided directly by people, such as labor services

Inputs provided by the services of physical capital (machines)

Production Function

The production function relates inputs to outputs. It describes the technological relationship between the inputs that a firm uses and the output that it produces.

In simple functional notation we have:

$$Q = f(L,K)$$

Remember that production is a flow: it is a number of units per period of time.

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., opportunity cost of the owner's time, opportunity cost of owner's capital

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.

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.

Economic Profits

Economic profit is sometimes called pure profit.

Economic Profit is the difference between revenues received from the sale of output and the opportunity cost of the inputs used to make the output.

If economic profit is positive, then the owner's capital is earning more than it could in its next best alternative use.

Negative economic profits are called economic losses.

Opportunity cost of owner's time

Example, an entrepreneur who opens a restaurant may pay herself only $1000 per month while she is building her business, even though she could earn $4000 per month in her next best alternative job. An implicit cost to her firm of 3000 per month that would be missed by the accountant who measures only the explicit cost of her wage at 1000 per month.

Opportunity cost of owner's capital

- Determine what the owners could earn by lending this amount to someone else in a riskless loan (e.g. a government bond) – It is an opportunity cost since the firm could close down operations, lend out its money and earn a__ percent return
- Determine what the firm could earn in addition to this amount by lending its money to another firm where risk of default was equal to the firm's own risk of loss.

Profits and Resource allocation

- Economists are interested in how profits affect resource allocation
- When resources are valued by the opportunity cost principle, their costs show how much these resources would earn if used in their best alternative uses.
- If the revenue of all the firms in some industry exceed opportunity cost, the firms in that industry will be earning pure or economic profits. Hence, the owners of factors of production will want to move resources into the industry, because the earnings potentially available to them are greater there than in alternative uses.

- Economic profits and losses play a crucial signaling role in the workings of a free-market system
- Economic profits in an industry are the signal that resources can profitably be moved into the industry. Losses are the signal that the resources can profitably be moved elsewhere. Only if there are zero economic profits is there no incentive for resources to move into or out of an industry

Profit-Maximizing Output

A firm's (economic) profit is equal to total revenues minus total (economic) costs:

$$\pi = TR - TC$$

Time Horizons for Decision Making

The short run is a period of time in which some of the firm's factors of production are fixed

- typically capital is fixed in the short run

Fixed factor – An input whose quantity cannot be changed in the short run.

Variable factor – An input whose quantity can be changed over the time period under consideration.

The Long Run

The long run is the length of time over which all of the firm's factors of production can be varied, but its technology is fixed.

The very long run is the length of time over which all the firm's factors of production and its technological possibilities can change.

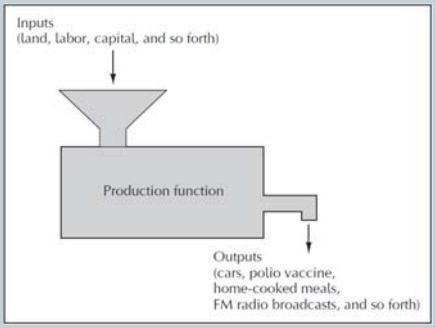
The Production Function

- ***Production function:*** the relationship that describes how inputs like capital and labor are transformed into output.
- Mathematically,

$$Q = F(K, L)$$

K = Capital
L = Labor

The Production Function



Production in the short run

Total, Average, and Marginal Products

Total product (***TP***) is the total amount of output that is produced during a given period of time.

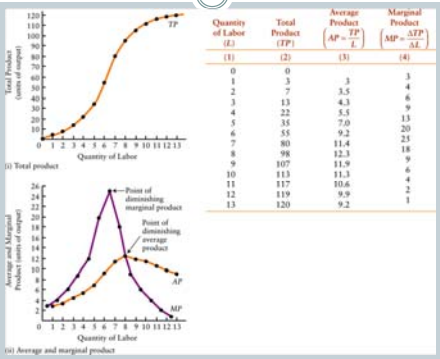
Average product (***AP***) is the total product divided by the number of units of the variable factor used to produce it (usually thought of as labor):

$$AP = TP / L$$

- Marginal product (MP) is the change in total product resulting from the use of one additional unit of labor

$$MP = \frac{\Delta TP}{\Delta L}$$

Total, Average, and Marginal Products in the Short Run



Quantity of Labor (*L*)	Total Product (*TP*)	Average Product $\left(AP = \frac{TP}{L}\right)$	Marginal Product $\left(MP = \frac{\Delta TP}{\Delta L}\right)$
(1)	(2)	(3)	(4)
0	0		
1	3	3	3
2	7	3.5	4
3	13	4.3	6
4	22	5.5	9
5	35	7.0	13
6	55	9.2	20
7	80	11.4	25
8	98	12.3	18
9	107	11.9	9
10	113	11.3	6
11	117	10.6	4
12	119	9.9	2
13	120	9.2	1

Diminishing Marginal Product

The law of diminishing returns:

As more workers are added to a production process, each can specialize on one task, and the workers' marginal product initially rises.

But if there is a fixed amount of physical capital, eventually the marginal product is likely to fall.

The Average–Marginal Relationship

If an additional worker's output raises the average product, the ***MP*** must exceed ***AP***.

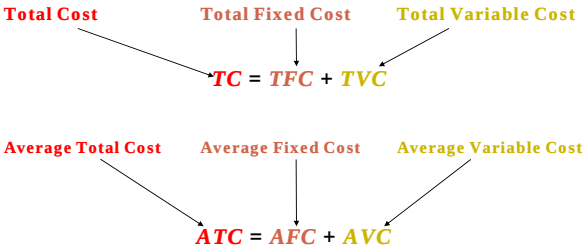
Similarly, if the marginal worker's output reduces the average product, the ***MP*** must be less than the ***AP***.

The ***AP*** curve slopes upward as long as the ***MP*** curve is above it (and ***AP*** slopes downward when ***MP*** is below it).

It follows that the ***MP*** curve must intersect the ***AP*** curve at its maximum point.`

Costs in the Short Run

Defining Short-Run Costs



Average Cost

Average total cost, often referred to simply as **average cost**, is total cost divided by quantity of output produced.

ATC = TC/Q = (Total Cost) / (Quantity of Output)

A **U-shaped average** total cost curve falls at low levels of output, then rises at higher levels.

Average fixed cost is the fixed cost per unit of output.

AFC = FC/Q = (Fixed Cost) / (Quantity of Output)

Average variable cost is the variable cost per unit of output.

AVC = VC/Q= (Variable Cost) / (Quantity of Output)

Average Total Cost Curve

Increasing output, therefore, has two opposing effects on average total cost—the "***spreading effect***" and the "***diminishing returns effect***":

- ***The spreading effect***: the larger the output, the greater the quantity of output over which fixed cost is spread , leading to lower the average fixed cost.
- ***The diminishing returns effect***: the larger the output , the greater the amount of variable input required to produce additional units leading to higher average variable cost.

Costs in the Short Run

Marginal cost (***MC***) is the increase in total cost resulting from increasing the output by one unit.

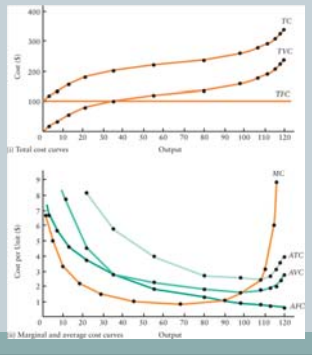
$$MC = \frac{\Delta TC}{\Delta Q}$$

Because fixed costs do not vary with output, the only part of ***TC*** that changes is the variable cost.

Short-Run Costs: Fixed Capital and Variable Labor

Inputs		Output	Total Costs			Average Costs			Marginal Cost
Capital (K)	Labor (L)	(Q)	Fixed (TFC)	Variable (TVC)	Total (TC)	Fixed (AFC)	Variable (AVC)	Total (ATC)	(MC)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
10	0	0	$100	0	$100	—	—	—	
10	1	3	100	20	120	$33.33	$6.67	$40.00	$6.67
10	2	7	100	40	140	14.29	5.71	20.00	5.00
10	3	13	100	60	160	7.69	4.62	12.31	3.33
10	4	22	100	80	180	4.55	3.64	8.18	2.22
10	5	35	100	100	200	2.86	2.86	5.71	1.54
10	6	55	100	120	220	1.82	2.18	4.00	1.00
10	7	80	100	140	240	1.25	1.75	3.00	0.80
10	8	98	100	160	260	1.02	1.63	2.65	1.11
10	9	107	100	180	280	0.93	1.68	2.62	2.22
10	10	113	100	200	300	0.88	1.77	2.65	3.33
10	11	117	100	220	320	0.85	1.88	2.74	5.00
10	12	119	100	240	340	0.84	2.02	2.86	10.00
10	13	120	100	260	360	0.83	2.17	3.00	20.00

Total, Average, and Marginal Cost Curves



ATC = AVC + AFC

(a vertical summation)

AFC declines steadily as output rises — this is called spreading the overhead.

Short-Run Cost Curves

- The TVC rises at a decreasing rate until output is approximately 60 units.
- The TFC does not vary as the level of output changes
- The shape of TC comes from the shape of TVC.
- The MC curve cuts the ATC curve and the AVC curve at their lowest points.
- The ATC curve slopes downward whenever the MC curve is below it; it slopes upward whenever the MC curve is above it.

- The AFC curve is steadily declining as output rises – spreading overhead
- The AVC curve declines as output rises, reaching a minimum at approximately 100 units of output. As output increases above this level, AVC rises
- The ATC curve declines initially as output increases, reaches a minimum, and then rises as output further increases – "U-shaped" ATC curve

Why U-Shaped Cost Curves?

Since labor input adds directly to cost- the relationship between labor input and output (AP and MP curves) is closely linked to the relationship between output and cost (AVC and MC curves)

The relationship between the AP and AVC curves

- The AP curve shows that as the amount of labor input increases, the average product of labor rises, reaches a maximum, and then eventually falls
- Each additional worker adds the same amount to cost but a different amount to output. When output per worker (AP) is rising, the variable cost per unit of output (AVC) is falling, and when output per worker (AP) is falling, average variable cost (AVC) is rising
- AVC is at its minimum when AP reaches its maximum

Eventually diminishing average product of the variable factor implies eventually increasing average variable cost

The relationship between the MP and MC curves

Since each unit of labor adds the same amount to cost but has a different marginal product, it follows that when MP is rising MC is falling, and when MP is falling MC is rising.

The MC curve reaches it minimum when the MP curve reaches its maximum

Eventually diminishing marginal product of the variable factor implies eventually increasing marginal costs

General Principles

The minimum-cost output is the quantity of output at which average total cost is lowest- the bottom of the U-shaped average total cost curve.

- At the minimum-cost output, average total cost is ***equal to*** marginal cost.
- At output less than the minimum-cost output, marginal cost is ***less than*** average total cost and average total cost is falling.
- And at output greater than the minimum-cost output, marginal cost is ***greater than*** average total cost and average total cost is rising.

Capacity

The level of output that corresponds to the minimum short-run ***ATC*** is the capacity of the firm.

Capacity is the largest output that can be produced without encountering rising average cost per unit.

A firm that is producing at an output less than the point of minimum ***ATC*** is said to have excess capacity.

Changes in Factor Prices

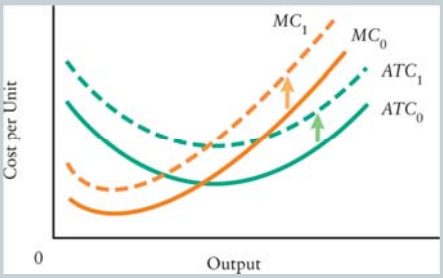
Consider a change in the wage, the price of a unit of labor services.

An increase in the wage increases variable costs, leaves fixed costs unaffected, and therefore increases the firm's total costs.

An increase in the price of the variable factor will also increase the firm's marginal costs.

An increase in the price of the variable factor will therefore cause an upward shift in the firm's ATC and MC curves

An Increase in Variable Input Prices



Sources:

- Lipsey, Ragan, and Storer (2008)
- Frank, R.H. (2010)