UNIT 8 THE COST OF PORDUCTION

Structure

8.0 OBJECTIVES

After going through this unit, you should be able to:

- state the various concepts of costs like private cost, social cost, money cost, sunk cost, economic cost, accounting cost etc.;

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- differentiate between short-run and long-run cost functions;
- know the difference between fixed cost and variable cost and the nature of total cost curve;
- explain the concept of average fixed cost, average variable cost, average total cost and marginal cost and nature of these curves;
- discuss the relationship between marginal cost curve and average cost curve;
- appreciate the difference between short-run and long-run cost curves; and
- describe the relationship between long-run marginal cost and short-run marginal cost.

8.1 INTRODUCTION

The decision of a firm regarding production of a good depends on two factors: First, the demand for the good, and second, the cost of production of the good. Accordingly, the concept of cost of production is basic to the understanding of the price theory and requires a thorough discussion. A price taker firm wishes to maximise its profits will be able to do so if it is able to minimise its costs. Obviously a firm is interested in minimising what economists call the *private cost*. The concept of *social cost* that is being often referred to in the context of social welfare is not relevant for the theory of firm. However, it is necessary to understand the distinction between the concepts of the private cost and the social cost. In economic analysis, we often distinguish between *money cost* and the *opportunity cost*. From analytical point of view both the concepts are relevant and thus must be understood carefully. The concept of money cost may be interpreted from the point of view of an accountant or an economist. The two approaches differ on the treatment of implicit costs.

After settling these conceptual issues in the theory of costs, one has to analyse the nature of costs in both the short-run and the long-run. In the short-run since we have some fixed inputs and some other inputs are variable, one has to draw the distinction between the *fixed costs* and the *variable costs*. However, in the long-run because the amounts of all the inputs can be varied, all costs are considered together. Finally, the theory of costs attempts to explain as to how cost changes occur in response to changes in the size of production. In the last two units we have discussed the theory of production at some length. This discussion should help us to understand that the cost changes depend largely on how changes in production take place as a result of changes in the amounts of inputs.

8.2 THE CONCEPTS OF COSTS

8.2.1 Private Costs and Social Costs

In microeconomic theory, the concepts of both private cost and social cost are used. The firm, in its attempt to attain the goal of profit maximisation, is guided entirely by the private cost considerations. In its decision making, it ignores all those costs which it may be imposing on others while carrying out its production programme. However, in welfare studies, together with the

firm's both explicit and implicit costs, all such costs are taken into account which are external to the 'narrow economy' of the firm.

Private costs: Every firm requires various inputs to produce a good. In order to secure a command over these inputs, the firm has to pay some price for each of these inputs. In common parlance, the amount of money so paid is known as cost. Economists, however, include in the private cost not only the expenditure incurred by the producer on purchasing (or hiring) of factors of production (or inputs) from the market, but also the imputed cost of all those services which the producer himself provides. The private cost of production of any output may thus be defined as either the purchase or the imputed value of all productive services used in producing the output and is equivalent to the total monetary sacrifice of the firm made to secure it.

Generally, economists include the following expenditures in the cost: (i) cost of the raw materials, (ii) wages of the labourers, (iii) interest payments on capital loans, (iv) rent of the land and the buildings, (v) repairing costs of machines and depreciation, (vi) tax payments to the government and local bodies, (vii) imputed wage payment to the producer for the work performed by him, (viii) imputed interest payment for the capital invested by the producer himself, (ix) rent of land and buildings owned by the producer himself and (x) normal profits of the firm.

This shows that three types of expenditures are included in the private cost: (i) the purchase price of the factors of production employed in the production process, (ii) imputed price of the resources provided by the producer himself, and (iii) normal profits.

Social costs: Social costs differ from private costs on account of two reasons:

First, externalities are not included in private costs. For example, a factory located in the residential area by polluting the atmosphere will expose the residents of the colony to various ailments and will thereby raise their medical expenditures. Though these costs are quite relevant from the point of view of the society, they will never be considered by the firm as part of its costs.

Secondly, market prices of goods may not reflect their social value and thus there may be divergence between private and social costs. The imposition of government taxes, subsidies, and controls of various kinds distort free market prices. Further, prices of factors of production may overstate or understate the opportunity cost of using those factors. In heavily populated countries where widespread disguised unemployment is to be found in the agricultural sector, the industrial wage often exceeds the opportunity cost of the labour which is drawn from the agricultural sector. In computing the social costs, adjusted market prices for goods and factors of production are used. While the adjusted prices for factors of production are called shadow prices, the adjusted prices for goods are termed as social prices.

8.2.2 Money Cost: Explicit and Implicit Costs

The concept of the money cost in contrast to the concept of opportunity cost is simple.

The money cost of production of any output is considered to be equivalent to the total monetary sacrifice made to obtain that output.

Thus, costs are not sacrificed alternatives but monetary payments. This conception of money cost is rather narrow and is used for accounting purposes. From the point of view of the economists, this concept of cost is not very relevant. Since economists wish to study as to how costs affect output choices, employment decisions, and the like, costs should include imputed value of all the inputs provided by the producer himself in addition to outright money expenses. Hence, costs can be classified as explicit costs and implicit costs. Explicit costs arise from transactions between the firm and other parties in which the former purchases inputs or services of inputs for carrying out the production. These costs are usually the costs shown in the accounting statements and include wage payments, raw materials costs, interest on loans, payments for insurance, electricity and so on. Implicit costs are the costs associated with the use of the firm's own resources. Since these resources will bring return if employed elsewhere, their imputed values constitute the implicit costs. Implicit costs are however difficult to measure. Economists nonetheless assert that they must be taken into account in analysing the activities of a firm.

8.2.3 Real Costs

The concept of real cost was developed by Alfred Marshall. In his opinion, a worker suffers discomfort while he renders his services for productive purposes. Similarly, a person makes some sacrifice when he saves his income and lends it to investors who use it for carrying out production. These discomforts and sacrifices are in the nature of real costs of production. In Marshall's own words, "The exertions of all the different kinds of labour that are directly or indirectly involved in making it; together with the abstinences or rather the waitings required, for saving the capital used in making it; all these efforts and sacrifices together will be called the real costs of the production of the commodity."

The concept of real cost is, however, based on subjectivity and cannot be used for precise measurement of production cost. It is this reason why modern economists do not consider it to be of much relevance in the price theory. They admit that most of the labour involves hard work and is definitely unpleasant. It, therefore, has a heavy real cost. In contrast, the real cost of simple and less arduous work is generally low. But this fact is not at all relevant from the point of view of price determination in a free enterprise economy. Moreover, to modern economists, savings do not involve any sacrifice. Hence, these economists regard the concept of real cost as inappropriate.

8.2.4 Sunk Cost and Incremental Cost

In economics and business decision-making, a sunk cost is a cost that has already been incurred and cannot be recovered. Sunk costs (also known as retrospective costs) are sometimes contrasted with prospective costs, which are future costs that may be incurred or changed if an action is taken. In traditional microeconomic theory, only prospective (future) costs are relevant for decision making. Since sunk costs have already been incurred and cannot be recovered, therefore they should not influence the rational decision-maker's choices.

An incremental cost is the increase in total costs resulting from an increase in production or other activity. For instance, if a company's total costs increase from Rs. 5.6 lakh to Rs. 6.0 lakh as a result of increasing its machine hours from 7,000 to 8,000, the incremental cost of the 1,000 machine hours is Rs. 40,000.

8.2.5 Economic Cost and Accounting Cost

Economists and accountants view costs from different angles. Accountants are concerned with the firm's financial statement and tend to take a retrospective look at the firm's finances because they have to keep track of assets and liabilities and evaluate past performance. Accounting cost includes depreciation expenses for capital equipment at rates allowed by the tax authorities.

Economists, on the other hand, are concerned with what cost is expected to be in the future, and with how the firm might be able to rearrange its resources to lower its cost and improve its profitability. Thus, they take a forward looking view and must therefore be concerned with opportunity costs.

As stated earlier, there is a difference regarding the treatment of explicit and implicit costs as well. Both, the economists and the accountants consider explicit costs (like payment of wages and salaries, cost of raw material, property rentals, etc.) because these involve direct payments by a company to other firms and individuals that it does business with. However, while economists also take into account the implicit costs, accountants ignore them. For example, consider the owner of a retail store who manages his own retail store but does not pay any salary to himself. Since no monetary transaction has taken place, accountant will not include it in the accounting cost. However, the economist will include this implicit cost in total cost as the retail store owner could have earned a competitive salary by working elsewhere (that is, the implicit cost of the owner will be his opportunity cost).

The treatment of depreciation is also different. When estimating the future profitability of a business, an economist is concerned with the capital cost of plant and machinery. This involves not only the explicit cost of buying and the running of the machinery, but also the cost associated with wear and tear. On the other hand, accountants use depreciation rates on different assets as allowed under the tax laws in their cost and profit calculations. These depreciation rates need not reflect the actual wear and tear of the equipment, which is likely to vary asset by asset.

The above discussion shows that there are some important differences in the methods of calculating costs as used by the economists and the accountants. Accordingly, the calculation of profit will also differ. To illustrate, consider a retail store owner who has invested Rs. 1,00,000 as equity in a store and inventory. His monthly sales revenue is Rs. 2,60,000. After deduction of cost of goods sold, salaries of hired labour, and depreciation of equipment and buildings, the accounting profit to the store owner is Rs. 25,000 (see Table 8.1).

Table 8.1: Accounting income statement for the Retail-Store Owner

Sales		Rs. 2,60,000
Cost of goods sold	Rs. 1,80,000	
Salaries	30,000	
Depreciation expense	25,000	Rs. 2,35,000
Accounting profit		Rs. 25,000

In Table 8.2 we consider the economic statement of profit of the same store. The cost of goods sold and salaries remain the same. Let us suppose that the market values of the equipment and building in fact declined by Rs. 25,000 over the current year and that the depreciation charge, therefore, reflects the opportunity costs of these resources. Thus, depreciation expense is taken to be Rs. 25,000 as in Table 8.1. However, the economist will add two items relating to the implicit cost in the cost of production. Suppose that the owner-manager could earn Rs. 25,000 per month as a departmental manager in a large store and that this is his best opportunity for salary. Then we would add Rs. 25,000 as the imputed salary of the owner-manager to the cost of production. Similarly, the owner-manager has Rs.1,00,000 equity in the store and inventory – a sum he could have easily invested elsewhere. Let us suppose that he could have earned 10 per cent interest on this amount had he invested it elsewhere. Thus, imputed interest cost on equity will be Rs. 10,000. Thus, as can be seen from Table 8.2, the total economic costs, or the opportunity costs of all resources used in the production process will add up to Rs. 2,70,000. This implies an economic loss of Rs.11,000 to the owner-manager of the store against the accounting profit of Rs. 25,000 depicted in Table 8.1.

Table 8.2: Economic statement of profit to the Retail-Store Owner

	Rs.	Rs.
Sale		2,60,000
Cost of goods sold	1, 80,000	
Salaries	30,000	
Depreciation expense	25,000	
Imputed salary to owner-manager	25,000	
Imputed interest cost on equity	10,000	2,70,000
Economic Profit		-10,0000

In addition to the above differences in the calculation of profits by the economists and the accountants, it is also important to point out that while for economists, profits and losses are the driving force, business accounting does not stop here. Business accounts also include the balance sheet, which is a picture of financial conditions on a particular date. This statement records what a firm is worth at a given point of time. On one side of the balance sheet are recorded the 'assets' and on the other side are recorded the 'liabilities' and 'net worth'. A balance sheet must always balance because net worth is a residual defined as assets minus liabilities.

The business accounting concepts can be summarised as follows:

1) **The income statement shows the flow of sales, cost, and revenue over the year or accounting period. It measures the flow of money into and out of the firm over a specified period of time.**

2) **The balance sheet indicates an instantaneous financial picture or snapshot. It is like a measure of the stock of water in a lake. The major items are assets, liabilities and net worth**.

8.2.6 Historical Cost and Replacement Cost

The historical cost is the cost that was actually incurred at the time of the purchase of an asset. As against this, replacement cost is the cost that will have to be incurred now to replace that asset (i.e., replacement cost is the current cost of the new asset of the same type).

These two costs differ because of changes in prices over a period of time. Naturally, if prices remain unchanged over time, both the costs will be the same. But this seldom happens. Accordingly, historical cost and replacement cost of an asset always differ. If the price rises over a period of time, replacement cost will be higher than the historical cost. On the other hand, if the price of the asset declines over a period of time, replacement cost will be lower than the historical cost.

Because of the requirements of tax laws and the laws governing financial reporting to shareholders, accountants generally express many costs in terms of the actual or historic costs paid for the resources used in the production process in accordance with the convention of financial accounts. However, both economists and accountants agree on the fact that for decision making purposes, it is not the historical cost that is relevant but the replacement cost. This is due to the reason that for all decision making purposes, it is the 'current' (or the replacement) cost that is important and not the cost that was incurred some years earlier at the time of the purchase of the asset.

Check Your Progress 1

1) Indicate the following statements as true (T) or false (F):

   i) Externalities are not a part of private cost ( )

   ii) Implicit costs are the costs associated with the use of firm's own resource ( )

   iii) Retrospective costs are relevant for decision making ( )

   iv) Accountants tend to take a retrospective look at the firm's finances ( )

   v) Economists are concerned with opportunity costs ( )

   vi) The historical cost is the current cost of the new asset of the same type ( )

2) Explain the difference between explicit cost and implicit cost.

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3) Distinguish between private cost and social cost.

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4) What is the difference between sunk cost and incremental cost?

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5) Explain the difference between economic cost and accounting cost.

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8.3 COST FUNCTIONS: SHORT-RUN AND LONG-RUN

The relationship between product and costs is known as the cost function.

There are two elements in determining the cost function of a firm. First, the production of the firm, and second, the prices paid by the firm for the factors used.

In practice, production functions can be of various types. At times, one factor of production is variable and other factors fixed. It is also possible for some factors to be variable. On account of this reason, cost function can also be of various types. In economics, generally two types of cost functions are considered under the price theory:

i) The short-run cost function, and

ii) The long-run cost function.

Cost functions can be illustrated in diagrammatic forms as cost curves.

8.3.1 Cost Function and the Time Element

To understand the theory of cost, it is necessary to be clear about the meaning of short-run and long-run. In common usage, these terms may be used for weeks, months and years but for the economist they indicate conditions of production and have no reference to the calendar year. Even then, the concept of time does creep in indirectly when the terms short-run and long-run are discussed.

Generally, economists regard that period of time as short-run in which some factors of production are fixed (at least one factor is fixed) and the firm depends only on the variable factors of production to increase the level of output. If the firm does not employ the variable factors at all, the output will be zero in the short-run. However, the maximum quantity of output that can be produced depends upon the quantity of the fixed factors of production. In the long-run, all factors are variable and the quantity of the output can be increased to any limit. For example, in a manufacturing industry the plants, machinery, building of the factory, etc. are fixed resources in the short-run while the raw materials, labour, power, etc. are variable. Therefore, to increase the amount of output in this period, it will become necessary to employ more units of the variable resources in conjunction with the fixed resources. Obviously, the

maximum output that can be obtained in this period will depend to a great extent upon the total quantity of the fixed resources of production.

8.3.2 Long-Run Cost Function

In the long-run, total cost is a multivariable function which implies that total cost is determined by many factors. The long-run cost function may be written as

$$C = f(Q, T, P_f)$$

Where, C = total cost of production

Q = output

T = technology

P_f = prices of the relevant factors of production.

Graphically, the long-run cost function is shown on two dimensional diagram as C=f(Q), ceteris paribus. With the assumption that the technology and the prices of relevant factors of production remain constant, the long-run cost function may be written as

$$C = f(Q, \overline{T}, \overline{P}_f \text{ or } C = f(Q)$$

However, the technology and the factor prices need not remain constant. When these factors change, their effect on cost is shown by a shift of the cost curve. It is this reason why the factors other than output are known as shift factors. Theoretically there is no difference between the various factors which determine the costs, and the distinction we have drawn above between the output level and other factors determining costs can sometimes be misleading. However, for showing costs on two dimensional diagrams this distinction has to be made.

8.3.3 Short-Run Cost Function

In the short-run, in addition to output level, technology and factor prices, the fixed factors such as capital equipment, land, etc. also determine costs of production. Therefore, the short-run cost function is written as

$$C = f(Q, \overline{T}, \overline{P}_f, \overline{K})$$

Where, $\overline{K}$ indicates fixed factors. In the discussion on the production function, it has been stated that in the short-run certain factors like capital equipment, land, factory building and top managerial staff remain constant. $\overline{K}$ underlines the fact of the constancy of the fixed factors. Since the amount of fixed factors does not change in the short-run under any circumstances, $\overline{K}$ is not a shift factor like technology and factor prices.

8.4 THEORY OF COST IN THE SHORT-RUN

The short-run costs of a firm are divided into fixed and variable costs. Therefore,

$$TC = TFC + TVC$$

where, TC = total cost

TFC = total fixed cost

TVC = total variable cost

8.4.1 Fixed Cost

Fixed cost is also known as supplementary cost. While engaging in productive activity, the producer always has to incur some expenditure which remains fixed whatever the level of production, so much so that even if the producer stops production altogether, these costs have to be incurred.

This is known as fixed cost of production. Interest paid by the producer on the capital borrowed for purchasing plant and machinery, rent of the factory building, depreciation of the machinery, the wages of foremen and organisers, etc. are all fixed costs. These costs remain fixed even when the level of output is varied. Even if the producer decides to close down production, he has to bear these costs since the factory rent, wages of managers, interest on capital, etc. have to be paid. This discussion makes it clear that larger the level of production in a firm, the lower will be the per unit fixed cost (or average fixed cost).

8.4.2 Variable Cost

The cost which keeps on changing with the changes in the quantity of output produced is known as variable cost.

For instance, raw material has to be used in the process of production in a manufacturing industry, labour has to be employed for running machines, and energy (electricity) has to be arranged. Generally expenditure on these inputs increases or decreases due to changes in the level of production. It is important to remember in this context that when the producer abandons production in the short run, these costs also vanish completely. In fact, it is due to this direct relationship between expenditure on such inputs and the level of production that these expenditures are known as variable costs.

The concepts of total cost, total variable cost and total fixed cost in the short-run can be easily followed with the help of Table 8.3.

Table 8.3 : Short-Run Costs of a Hypothetical Firm

Output (Unit)	Total Fixed Cost (Rupees)	Total Variable Cost (Rupees)	Total Cost (Rupees)
0	240	0	240
1	240	120	360
2	240	160	400
3	240	180	420
4	240	212	452
5	240	280	520
6	240	420	660

8.4.3 Total Fixed Cost

Total fixed cost is the total expenditure by the firm on fixed inputs.

From Table 8.3, it is clear that the total fixed cost of the firm remains constant at Rs. 240 irrespective of the level of output. In our illustration, output varies from 1 unit to 6 units, but the total fixed cost remains 240 in each case. Even when the firm stops production altogether, implying that output is at zero level, the total fixed cost remains unchanged. The firm's total fixed cost function is shown in Fig. 8.1.

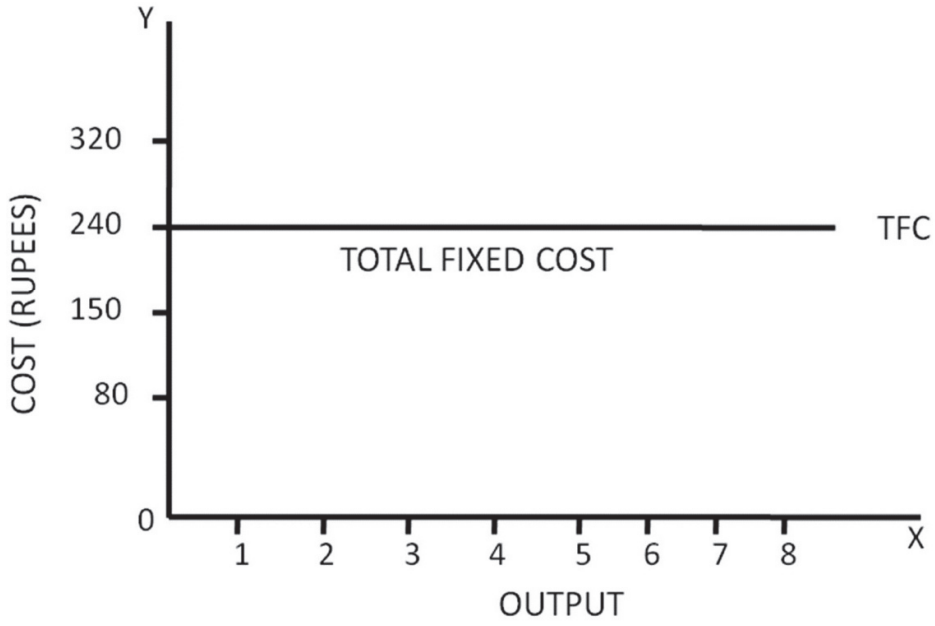

Fig. 8.1 : Total Fixed Cost curve is parallel to X axis as total fixed cost remains the same for all levels of output

8.4.4 Total Variable Cost

Total variable cost is firm's total expenditure on variable inputs used to carry out production.

Since higher output levels require greater utilisation of variable inputs, they mean higher total variable cost. Table 8.3 shows that the total variable cost of the firm increases as its output increases. However, when the firm stops its production altogether, it does not require any variable input and, therefore, its total variable cost is zero. Fig. 8.2 shows the firm's total variable cost function. Notice one peculiar feature of TVC – initially it rises sharply, then, there is a moderation in its rate of rise and ultimately it resumes rising at a faster pace.

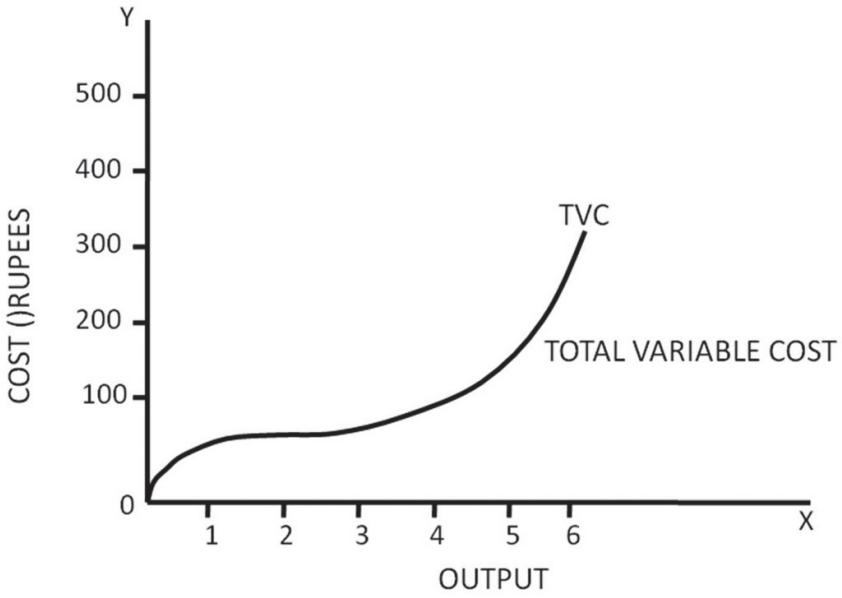

Fig. 8.2 : Total Variable Cost Curve rises from left to right

8.4.5 Total Cost

Total cost is the sum of total fixed cost and total variable cost.

Thus, to obtain the firm's total cost at a given output, we have only to add its total fixed cost and its total variable cost at that output. The result is shown in Table 8.3 and the total cost function is shown in Fig. 8.3. Since the total cost function and the total variable cost function differ by only the amount of total fixed cost which is constant, they have the same shape.

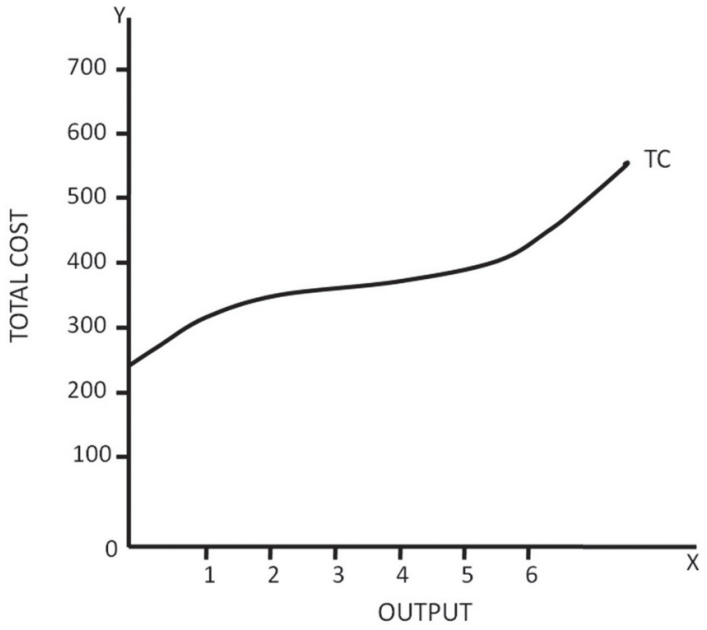

Fig. 8.3: Total Cost curve is obtained by adding the total fixed cost to total variable cost

In Fig. 8.4, all the three cost functions discussed above (total fixed cost function, total variable cost function and total cost function) have been shown together. Cost functions, when depicted graphically, are often called cost curves.

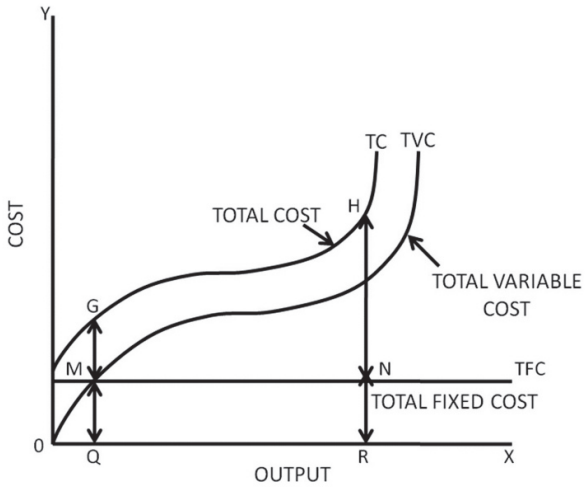

Fig. 8.4 : Total Fixed Cost, Total Variable Cost and Total Cost

In Fig. 8.4, TFC is the total fixed cost curve. Since it is parallel to X-axis, it indicates that whatever be the level of output the total fixed cost remains the same (i.e., it does not change in response to a change in the level of production). TC is total cost curve. It indicates the sum of total fixed cost and total variable cost for the various output levels. If the level of production is to be raised, the use of variable inputs will have to be increased and this will push up the costs. The rising total cost curve TC from left to right (the positive slope of TC curve) indicates this fact. The vertical distance between the total cost curve TC and the total fixed cost curve TFC indicates total variable cost. For example, if the firm wishes to produce OQ units of output, the total variable cost will be GQ – MQ = GM and if the level of output is OR, the total variable cost will be HR – NR = HN. The total variable cost has been depicted by the curve TVC in Fig. 8.4. This is parallel to the total cost curve TC and the vertical distance between the two curves (TC and TVC) indicates total fixed cost.

Check Your Progress 2

1) Indicate the following statements as true (T) or false (F):
   i) Cost function explains the relationship between product and costs ( )
   ii) In the long run all factors are variable ( )
   iii) Fixed cost is also known as supplementary cost ( )
   iv) Total variable cost is the total expenditure by the firm for fixed input ( )
2) Define and distinguish between long run cost function and short run cost function.

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3) Distinguish between fixed cost and variable cost.

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4) Define total fixed cost and total variable cost and trace the nature of the total cost curve.

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8.5 SHORT-RUN COST CURVES

To find out the per unit profit, the firm has to compare the per unit cost (or average cost) with per unit price. Therefore, it is necessary for us to understand the concepts of average fixed cost, average variable cost and average total cost.

8.5.1 Average Fixed Cost

Generally, all those firms whose total costs of production include a significant proportion of fixed costs try to increase the level of production to such an extent that per unit fixed cost which is often known as average fixed cost, is reduced substantially. To find out the average fixed cost, total fixed cost has to be divided by the output.

In the form of a formula,

$$AFC = \frac{TFC}{Q}$$

where, AFC is the average fixed cost

TFC is the total fixed cost

Q is the output

Table 8.4: Average Fixed Cost, Average Variable Cost and Average Total Cost of the Firm

Output (Units)	Average Fixed Cost TFC ÷ Q	Average Variable Cost TVC ÷ Q	Average Total Cost TC ÷ Q
1	240 ÷ 1=240	120 ÷ 1=120	360 ÷ 1=360
2	240 ÷ 2=120	160 ÷ 2=80	400 ÷ 2=200
3	240 ÷ 3=80	180 ÷ 3=60	420 ÷ 3=140
4	240 ÷ 4=60	212 ÷ 4=53	452 ÷ 4=113
5	240 ÷ 5=48	280 ÷ 5=56	520 ÷ 5=104
6	240 ÷ 6=40	420 ÷ 6=70	660 ÷ 6=110

A mere look at Table 8.4 will show how the average fixed cost declines with a rise in the level of output. When the firm produces only 1 unit, average fixed cost is Rs. 240. As the ouput is expanded, there is a sharp decline in average fixed cost and it is as low as Rs. 40 when 6 units of the commodity are produced.

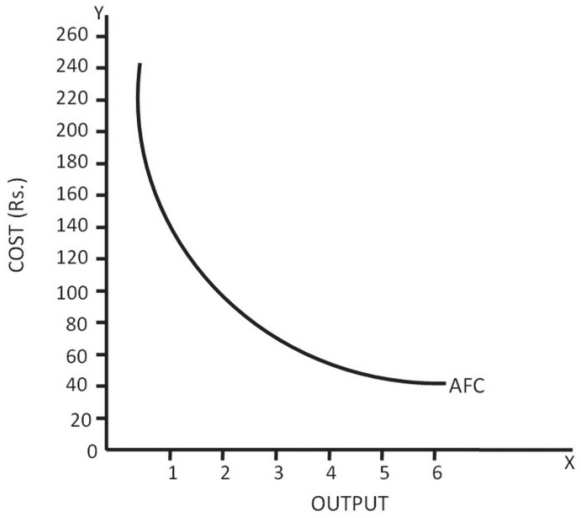

Fig. 8.5: Average Fixed Cost curve is a rectangular hyperbole

The fact that average fixed cost must decline with increases in output can be easily understood with the help of average fixed cost curve in Fig. 8.5. In this figure, when output is 1 unit, the average fixed cost is Rs. 240. When the output is increased to 3 units and then to 6 units, average fixed cost declines first to Rs. 80 and then to Rs. 40.

The average fixed cost curve (AFC) is a rectangular hyperbole because multiplication of average fixed cost with the quantity of output produced always yields a fixed value (the area under the curve is always same and is equal to the total fixed cost).

8.5.2 Average Variable Cost

To obtain the average variable cost, we divide the total variable cost by the output. In the form of formula:

$$AVC = \frac{TVC}{Q}$$

where, AVC = the average variable cost

TVC = the total variable cost

and Q = the output.

In fact, the average variable cost curve (AVC) gives us the same information in money terms that we obtain from the average product curve of the variable factor in physical terms.

With an increase in the amount of variable factor, the efficiency in production increases (resulting in an increase in average product) and the average variable

cost declines. If average productivity remains constant, average variable cost will also remain constant. If it declines, average variable cost increases.

Thus, average variable cost curve is the reciprocal of the average variable (factor) product curve.

After having understood the relationship between average variable factor productivity and average cost, it is easy to understand the nature of the AVC curve. While discussing the laws of production, we had stated that if other factors are kept constant and only the quantity of one factor is increased, then initially the tendency of increasing returns is observed. Later on, it is followed by constant returns and diminishing returns in that order. This means that in the initial stages, average variable cost declines and, after reaching a minimum point, starts increasing. This increase is due to the operation of the law of diminishing returns. From Table 8.4 we learn that at the output level of 1 unit the firm's average variable cost is Rs. 120. It declines when output is increased and is Rs. 53 when 4 units of the commodity are produced. Thereafter, it increases and is Rs. 70 when output level is raised to 6 units. The average variable cost curve is thus U-shaped as in Fig. 8.6.

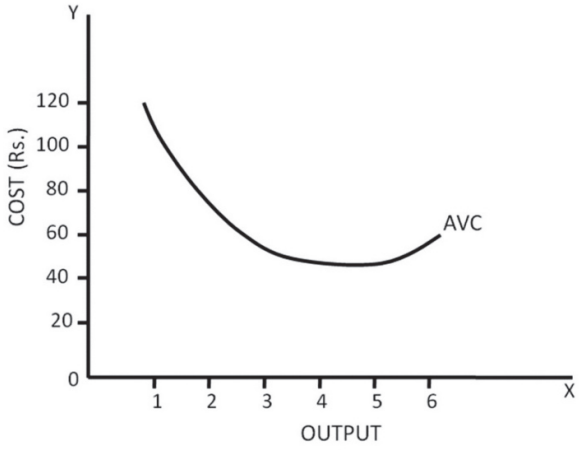

Fig. 8.6: Average variable cost curve is a U-shaped curve

8.5.3 Average Total Cost

The average total cost is also known as average cost. To find out average cost, we divide total cost (which is the sum of total fixed cost and total variable cost) by the output. In the form of a formula:

$$\text{AC or ATC} = \frac{\mathbf{TC}}{\mathbf{Q}} = \frac{\mathbf{TFC}}{\mathbf{Q}} + \frac{\mathbf{TVF}}{\mathbf{Q}}$$

The modern economists are generally agreed that in all areas of economic activity, average total cost declines initially. The reasons are the same which lead to increasing returns in the initial stages. Average cost declines initially because some of the resources are indivisible and there are possibilities of specialisation in the production process. As long as the indivisible factors are not fully utilised, the average total cost falls and when expansion in output leads to a stage where the indivisible resources are fully utilised, an optimum proportion is established between the factors of production. Output obtained at this point is the optimum output. Here, the average total cost is minimum. If the output is expanded beyond this point (which denotes an optimum combination of resources) by increasing the amount of variable inputs, then total production increases at a diminishing rate. This leads to a rise in average

total cost. This shows why the average total cost curve is U-shaped as shown in Fig. 8.7. The illustration given in Table 8.4 also makes this point abundantly clear.

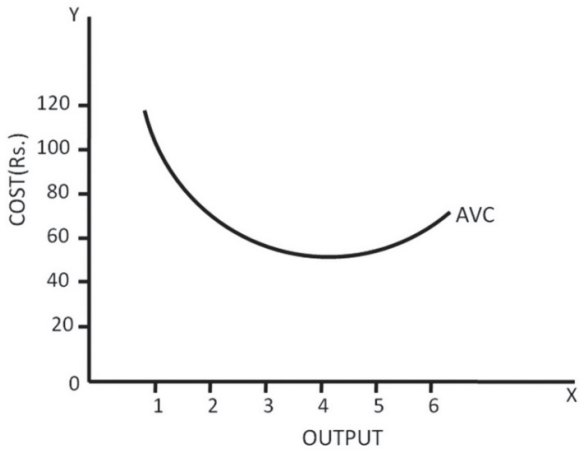

Fig. 8.7: Average Total Cost curve is obtained by dividing total cost by the output

We can understand the shape of average total cost curve ATC better with the help of average variable cost curve AVC and average fixed cost curve AFC drawn in Fig. 8.8. Since the ATC curve is obtained by vertically summing up the AVC and AFC curves, when both AVC and AFC curves slope downward, the ATC curve also slopes downwards. The point R on the AVC curve shows the minimum average variable cost. After this point, the average variable cost starts increasing and thus the AVC curve is sloping upward. However, the fall in the average fixed cost more than compensates for the rise in average variable cost. Hence, the ATC curve slopes downward. Since at point T on the AVC curve the rate of increase of the average variable cost is the same as the rate at which the average fixed cost falls corresponding to this level of output, average total cost is minimum at this output level. As the level of output increases beyond this point, the average variable cost rises far more rapidly than the rate at which average fixed cost falls. Therefore, the ATC curve slopes upward.

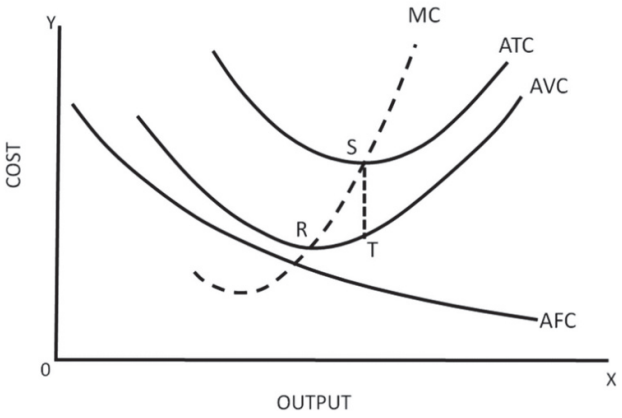

Fig. 8.8: Average total cost is the vertical sum of AFC and AVC

8.5.4 Marginal Cost

The marginal cost is the increase in the total cost owing to a small increase in output.

In symbols,

$$MC = \frac{\Delta TC}{\Delta Q} \text{ or } \frac{\Delta TVC}{\Delta Q}$$

where, MC is marginal cost

ΔTC is change in total cost associated with a small change in output

ΔTVC is change in total variable cost associated with a small change in output

ΔQ is small change in output

The concept of marginal cost can be understood with the help of an example. In Table 8.5, the total cost of producing 2 units of output is Rs. 400 and the total cost of producing 2 + l or 3 units of output is Rs. 420. Therefore, marginal cost is Rs. 20 which is Rs. 420 – Rs. 400.

Table 8.5: Calculation of Marginal Cost

Output Units	Total Cost (Rs.)	Total Variable Cost (Rs.)	Marginal Cost (Rs.)
0	240	0	-
1	360	120	120
2	400	160	40
3	420	180	20
4	452	212	32
5	520	280	68
6	660	420	140

Since fixed cost remains unchanged in the short run, marginal cost can also be defined as the increase in total variable cost consequent upon a small increase in output. From Table 8.5, we learn that the variable cost of producing 2 units is Rs. 160 and that of 3 units Rs. 180. The marginal cost, thus, will be Rs. 180 – Rs. 160 = Rs. 20.

The marginal cost (MC) curve as it would be clear from Fig. 8.9 is U-shaped. This implies that the marginal cost curve MC first slopes downward and then at the point where marginal cost is minimum, it starts sloping upward because marginal cost after decreasing with increases in output at low output levels, increases with further increases in output. The shape of marginal cost curve is in fact attributable to the law of variable proportions. According to the law of variable proportions, the marginal product of the variable input rises at low output levels and then falls with the expansion in output. Hence, the marginal cost curve will first fall and then rise. There are two important points to remember about the marginal cost curve:

i) The MC curve reaches its minimum point before the ATC and the AVC curves reach their minimum points; and

ii) When the MC curves rises, it cuts the AVC and the ATC curves at their minimum points.

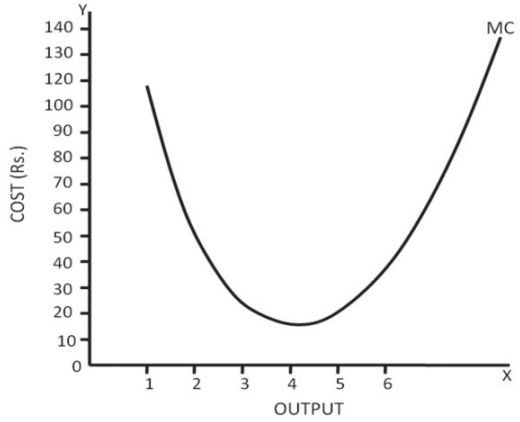

Fig. 8.9 : Marginal Cost Curve is a U-shaped Curve

8.5.5 Relationship between Marginal Cost and Average Cost

There is a close relationship between the marginal cost (MC) curve and the average total cost (ATC) and average variable cost (AVC) curves. We shall explain the relationship only between the MC curve and the ATC curve, but the relationship between the MC curve and the AVC curve can be explained along the same lines of reasoning.

Fig. 8.10 shows the MC curve together with the ATC curve and the AVC curve. The relationship between the ATC curve and the MC curve is as follows:

1) **When the MC curve is below the AC curve (which means marginal cost is less than average cost), the latter falls.**
2) **When the MC curve is above the AC curve (which means marginal cost is more than average cost), the latter rises.**
3) **The MC curve intersects the AC curve at its minimum point.**

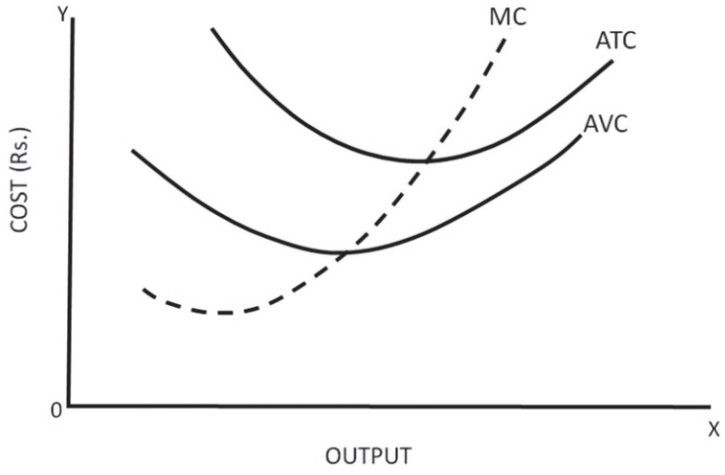

Fig. 8.10 : MC curve intersects both AVC curve and ATC curve at their minimum points

The reason for the above stated relationship between the MC curve and the ATC curve is simple. So long as the MC curve lies below the ATC curve, it pulls the latter downwards; when the MC curve rises above the ATC curve, it pulls the latter upwards. Consequently, marginal cost and average total cost are equal where the MC curve intersects the ATC curve. Further when output is small, marginal cost remains lower than average total cost; but when output is expanded, marginal cost exceeds average total cost. Thus, it is natural that the MC curve intersects the ATC curve at its minimum point.

Another important feature of the relationship between MC and AC curves is that MC is affected only by variable costs. Fixed costs do not affect marginal costs. This can be proved algebraically as follows:

$$MC_N = TC_N - TC_{N-1}$$

$$= (TFC_N + TVC_N) - (TFC_{N-1} + TVC_{N-1})$$

Since, TFC_N will always be equal to TFC_{N-1} we can also state as follows:

$$MC_N = TFC_N + TVC_N - TFC_{N-1} - TVC_{N-1}$$

$$= TVC_N - TVC_{N-1}$$

This proves that MC is affected only by TVC and not by TFC.

Check Your Progress 3

1) Indicate the following statement as true (T) or false (F):

   i) Average fixed cost curve is a rectangular hyperbole ( )

   ii) Average variable cost curve is the reciprocal of the average variable factor productivity curve ( )

   iii) The average total cost curve has inverted U shape ( )

   iv) When the MC curve is below the AC curve, the latter rises ( )

2) What is average cost? What is the nature of the average total cost curve?

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3) Define and distinguish between average cost and marginal cost.

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4) Explain the relation between the average cost and the marginal cost. How is it possible that the marginal cost continues to rise while average cost declines?

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5) The following table gives information on total cost, total fixed cost and total variable cost for a firm for different levels of output:

Output ⟶	0	1	2	3	4	5	6
TFC (Rs.)	120	120	120	120	120	120	120
TVC Rs.)	0	60	80	90	105	140	210
TC (Rs.)	120	180	200	210	225	260	330

Find (i) AFC (ii) AVC (iii) AC and (iv) MC.

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8.6 LONG-RUN COST CURVES

In the long-run, all factors are variable. Due to the absence of fixed factors in the production function, all costs of production are variable in the long-run and therefore there is no need to distinguish between fixed and variable costs as is done in the short-run. In the long-run, to increase the level of production, all factors have to be increased and this results in an expansion of scale.

In the short-run, the production capacity of the firm depends upon the size of the plant. Generally, there are many options before a firm. According to the circumstance, it can choose any plant out of the large and small plants available to it. Let us suppose that a firm has three options and corresponding to them, the short-run average total cost (SATC) curves are as given in Fig. 8.11. We shall call the smallest plant as A, the medium size plant as B, and the large size plant as C. The short-run average total cost curves corresponding to these plants are designated $SATC_a$, $SATC_b$ and $SATC_c$.

The firm decides about the size of plant keeping the market considerations in view. If the demand is small, the firm will use plant A for purposes of production but in doing so it will have to incur a higher average total cost. If the firm has to produce OQ_2 quantity of output, it has two options open before it: firstly, it can employ plant A. The optimum level of output that can be produced with the help of this plant is itself OQ_2. Secondly, it can opt for plant B. If it does so, the capacity of plant B will not be fully utilised nevertheless per unit cost of production will be lower than the cost of production the firm will have to incur if it opts for producing OQ_2 amount of output with the help of plant A (even though OQ_2 is the optimum level of output that can be produced on plant A). This is due to the tendency of 'increasing returns to scale'. Not that plant C is larger in size than plant B yet, the curve $SATC_c$ is higher than the $SATC_b$ curve. If the firm opts for plant C in this case, the average total cost will increase due to the operation of 'diminishing returns to scale'.

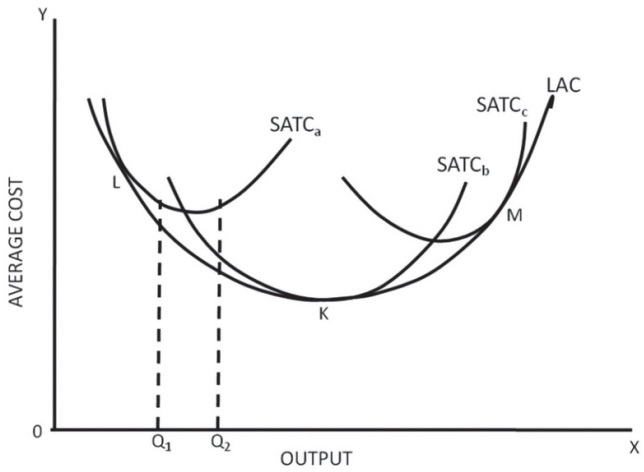

Fig. 8.11 : Long-run average cost curve envelopes short-run average total cost curves

Theoretically speaking, the long-run average cost (LAC) curve touches the short-run average total cost (SATC) curves on their minimum points. Geometrically this is possible only under those circumstances when the tendency of constant returns to scale prevails. It is due to the fact that initially increasing returns to scale and after some time diminishing returns to scale prevail in the production process that the LAC curve touches the lowest SATC curve at its minimum point. In the phase of increasing returns to scale when average total cost is falling, the LAC curve touches the SATC curves to the left of the minimum points of the SATC curves and in the phase of diminishing returns towards the right of minimum points of these curves. In Fig. 8.11, the curve LAC touches the $SATC_b$ curve at its minimum point K, the $SATC_a$ curve towards the left of its minimum point (at L) and the SAT C_c curve towards the right of its minimum point (at M).

In Economics, we say that the long-run average cost curve (LAC) 'envelopes' the short-run average total cost (SATC) curves.

8.6.1 Long Period Economic Efficiency

The behaviour of the firm which seems to be efficient in the short-run may be found to be inefficient in the long-run. To understand this let us consider Fig. 8.12. Let us suppose that the firm is producing OQ_1 quantity of output. If, due to an increase in demand, the firm wishes to increase output by Q_1Q_2, plant cannot be changed in the short-run and only variable factors will be increased. Thus, the firm will advance on the curve $SATC_1$. As a result, the efficiency of the variable resources will improve and per unit production cost will decline from BQ_1 to JQ_2. In the short-run the level of efficiency cannot improve further because this is the optimum level of production that can be achieved with the help of the plant available to the firm. However, in the long-run to produce the level of output OQ_2, the use of plant of such a small size is inefficient. If the firm uses a plant of a larger size, it will benefit from the increasing returns that would thus become available. As a result, the per unit cost will fall and come down to the level KQ_2. Though the full capacity of this plant will not be fully utilised, even then it would be more efficient as compared to the earlier plant.

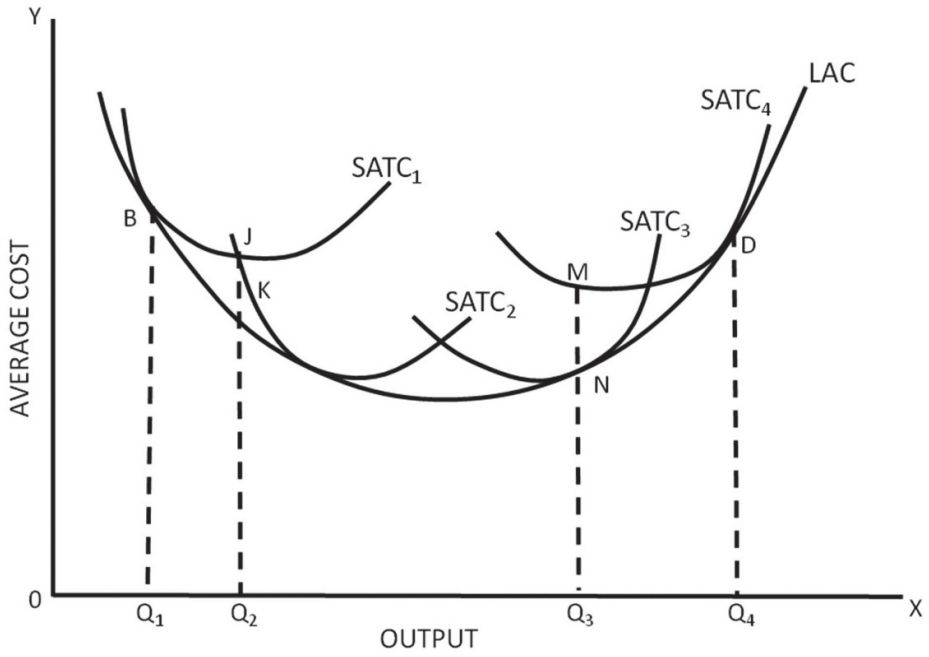

Fig. 8.12: Explanation of long-run economic efficiency

In a similar way when an expansion in scale leads to diseconomies or diminishing returns to scale emerge, it will be in the interest of the firm to reduce the level of production. If the firm is producing the output OQ_4 in Fig. 8.12, it will not be a right strategy from the point of view of maximising profits. The firm can cut down production by Q_3Q_4 in the short-run and this will enable it to reduce the average total cost from DQ_4 to MQ_3. This will result in optimum use of the plant. However, in the long-run, this position will not be satisfactory as the firm can reduce the average cost to the level NQ_3 by reducing the size of the plant. Since $NQ_3 < MQ_3$, the position which was optimum for the firm in the short-run becomes inefficient in the long-run. It is clear that when the firm uses plant of a relatively small size, it produces output much larger than is technologically optimum yet the cost remains low because it becomes possible to reduce the diseconomies of the large plant.

8.6.2 The Long-Run Average Cost Curve

We have explained in detail above that the short-run average total cost curve is U-shaped. Let us now discuss the shape of long-run average cost curve. There is general agreement that the long-run average cost falls initially due to economies of scale. But whether it falls to a certain point and then becomes constant or rises again, cannot be conclusively said.

In traditional analysis, the long-run average cost (LAC) curve is assumed to be U-shaped (as in Fig. 8.12). The shape of the long-run average cost curve is based on the assumption that ultimately the tendency of diminishing returns operates in the production process. If this belief of the economists is correct that every producer wishes to maximise profits and conditions of production are perfectly competitive, then it is true that the LAC curve must ultimately rise to the right.

8.6.3 Long-Run Marginal Cost Curve

After having understood the meaning of short-run marginal cost, it is not difficult to understand what long-run marginal cost is. Long-run marginal cost designates the change in total cost consequent upon a small change in total output when the firm has ample time to accomplish the output changes by making the appropriate adjustments in the quantities of all resources used, including those that constitute its plant. As can be seen, this definition of long-run marginal cost is practically the same as the definition of short-run marginal cost given by us earlier. The only difference between the two is that whereas in the short-run the existing plant will continue to be used for affecting an increase in output, in the long-run the plant itself will be changed.

As far as the relationship between the long-run marginal cost curve and long-run average cost curve is concerned, it is precisely the same as exists between the short-run marginal cost curve and the short-run average total cost curve. This would be clear from a mere glance at Fig. 8.13.

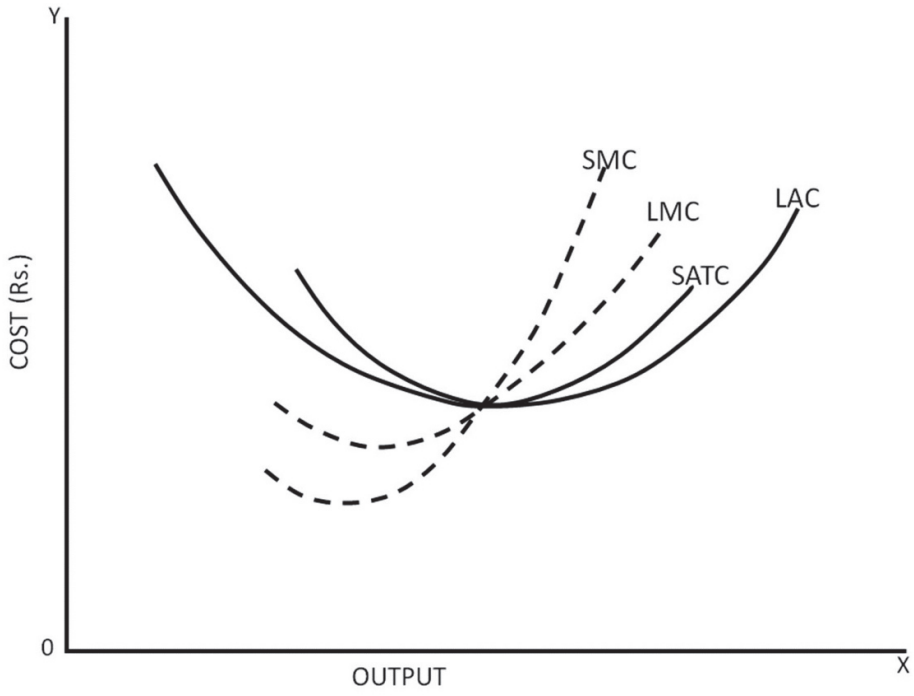

Fig. 8.13: Long-run marginal and average cost curves

8.6.4 Relationship between Long-Run Marginal Cost and Short-Run Marginal Cost

When to produce a certain given level of output, a firm sets up the most efficient plant, its short-run marginal cost (SMC) becomes equal to its long-run marginal cost (LMC). Let us explain this with the help of Fig. 8.14. In this figure, the given quantity of output is OQ_1. This output can be produced at lowest unit cost with the help of plant A. The short-run average cost curve of the firm when it produces with the help of plant A is given by SAC. Short-run average cost curves corresponding to other plants have not been drawn in Fig. 8.14. It is clear from the figure that at OQ_1 level of output, SMC and LMC are equal. However, we must see why they should be equal.

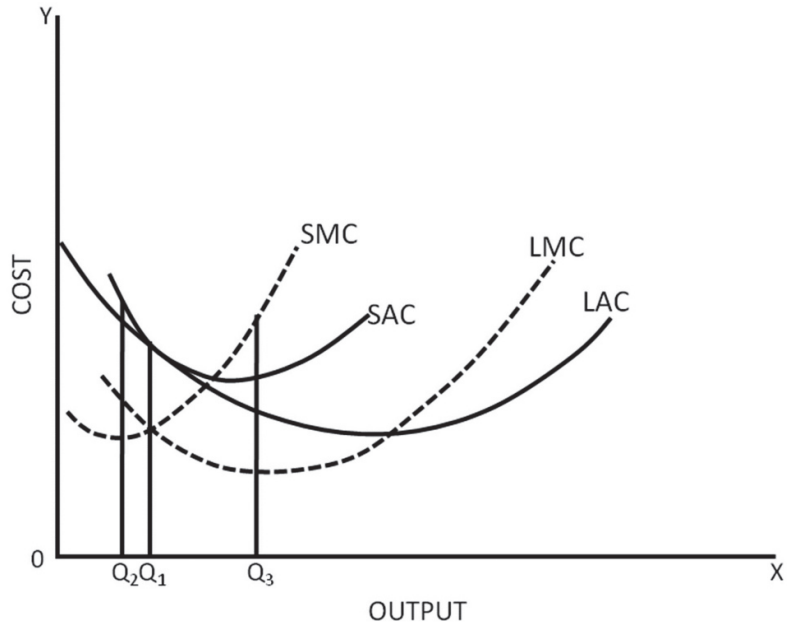

Fig. 8.14: Equality of SMC and LMC on use of an optimum size plant

To find out why SMC and LMC must be equal at the level of output OQ_1, let us consider the implications of a small change in the output by a small amount. For instance, let us take the level of output OQ_2. At this output level, short-run average cost will be greater than long-run average cost (SAC > LAC). In other words, short-run total cost is greater than long-run total cost (STC > LTC). When output rises from the level OQ_2 to the level OQ_1 the short run total cost becomes equal to the long-run total cost. If the level of output is raised to OQ_3 then since SAC is greater than LAC at this output, STC will also be greater than LTC. In other words, when output level is raised beyond OQ_1, we find that SMC exceeds LMC. Actually as we move from OQ_2 to OQ_1, we find that rate of decline in SMC is declining. In fact, beyond OQ_1, it stands rising. On the other hand, LMC keeps falling over the entire range. Therefore, between OQ_1 and OQ_3 SAC is rising and LAC is falling.

On practical considerations, the equality of short-run marginal cost and the long-run marginal cost is very significant for a firm. If the firm has to increase the level of output only by a very small amount whether it continues to employ the existing plant and changes only the quantity of the variable resources or makes a small change in the size of the plant, the results are the same. Therefore, from the point of view of the firm, both the methods are equally correct.

Check Your Progress 4

1) Indicate the following statements as True (T) or False (F):

   i) There is no need to distinguish between fixed costs and variable costs in the long-run. ( )

   ii) Long-run average cost curve envelopes the short-run average total cost curves. ( )

   iii) Long-run marginal cost curve cuts the long-run average cost curve from below at the latter's lowest point. ( )

2) Discuss the nature of the long-run average cost curve.

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3) Discuss the concept of long period economic efficiency.

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4) What is the relationship between long-run marginal cost curve and long-run average cost curve.

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5) Discuss the relationship between long-run marginal cost and short-run marginal cost.

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8.7 LET US SUM UP

In this unit, we start with a discussion of the various concepts of cost like private cost, social cost, and economic cost and accounting cost. This is followed by a discussion of short-run and long-run cost functions. We then proceed to define the distinction between fixed cost and variable cost. We note that total fixed cost curve is a straight line while the total variable cost curve and the total cost curve rise upwards to the right. We then turn to a discussion of short-run cost curves .We note that the nature of the average fixed cost curve is that of a rectangular hyperbola. When average variable cost curve is added to the average fixed cost curve, we get the average cost curve. This is followed by a discussion of the marginal cost and the nature of the marginal cost curve. The marginal cost curve cuts the average cost curve from below at the latter's minimum point.

8.8 REFERENCES

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2) Dominick Salvatore, *Principles of Microeconomics* (Oxford University Presss, Fifth Edition, 2010). Chapter 8, Section 8.1, 8.2, 8.3, 8.4 and 8.5.

3) A. Kountsoyiannis, *Modern Microeconomics* (The Macmillion Press Ltd., Second edition, 1982), Chapter 4.

4) John P. Gould and Edward P. Lazear, *Microeconomic Theory* (All India Traveller Bookseller, Sixth edition, 1996). Chapter 8.

5) Ahuja H.L., *Advanced Economc Theory* (S.Chand & Company Ltd., New Delhi 2001), Chapter 20 Page 396-439.

8.9 ANSWERS OR HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) (T) ; ii) (T) ; iii) (F) ; iv) (T) ; v) (T) ; vi) (F) .

2) See Sub-section 8.2.2 of Section 8.2.

3) See Sub-section 8.2.1 of Section 8.2.

4) See Sub-section 8.2.4 of Section 8.2.

5) See Sub-section 8.2.5 of Section 8.2.

Check Your Progress 2

1) (T) ; ii) (T) ; iii) (T) ; iv) (F)

2) See Section 8.3

3) See Sub-section 8.4.1 and 8.4.2 of Section 8.4

4) See Sub-section 8.4.3, 8.4.4 and 8.4.5 of Section 8.4

Check Your Progress 3

1) (T) ; ii) (T) ; iii) (F) ; iv) (F)

2) See Sub-section 8.5.3 of Section 8.5

3) See Sub-sections 8.5 .3 and 8.5.4 of Section 8.5

4) See Sub-section 8.5.5 of Section 8.5

5) (I)AFC = $\frac{TFC}{Q}$ (ii) AVC = $\frac{TVC}{Q}$ (iii) AC = $\frac{TC}{Q}$ (iv) MC = $\frac{\Delta(TC)}{\Delta Q}$

Check Your Progress 4

1) (i) T (ii) T (iii) T

2) See section 8.6

3) See Sub-section 8.6.1 of Section 8.6

4) See Sub-sections 8.6.2 and 8.6.3 of Section 8.6

5) See Sub-section 8.6.4 of Section 8.6