

INSTITUTE OF ENGINEERING, JIWAJI UNIVERSITY



THOERY OF COST UNIT-IV BE 8sem (EL-8103) Electronics

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THEORY OF COST

1. INTRODUCTION

What is Cost?

To an economist, the cost of producing any good or service is its opportunity cost. In everyday living, all man-made choices have alternatives. Therefore the opportunity cost of obtaining a commodity is the foregone utility which could have been derived from the forgone alternatives.

Cost is best described as a sacrifice made in order to get something. In business, cost is usually a monetary valuation of all efforts, materials, resources, time and utilities consumed, risk incurred and opportunities forgone in production and delivery of goods and services. More explicitly, the costs attached to resources that a firm uses to produce its product are divided into explicit costs and implicit costs. All expenses are costs but not all costs are expenses. Those costs incurred in the acquisition of income-generating assets are not considered as expenses. The theory of costs is better categorized under the traditional and modern theory of cost.

The objectives of this TOPIC are to

a. Define correctly the following concepts: total, average and marginal costs.

- b. Differentiate between the following: accounting and economic costs, real and nominal cost, private and social cost, sunk and incremental cost.
- c. Appreciate the necessity of proper identification of costs in business decision-making.
- d. Illustrate the total, average and marginal cost curves for both the short run and the long run scenario.
- e. Elucidate on the determinants of each of internal and external economics of scale.
- f. Appreciate the reasons for the L-shape of the long run average cost curve.

1.1 TYPES OF COSTS

Costs can be categorized into seven types:

1) **Accounting and economic costs:** Accounting cost (money or explicit) is the total monetary expenses incurred by a firm in producing a commodity and this is what an entrepreneur takes into consideration in making payments for various items including factors of production (wages and salaries of labour), purchase of raw materials, expenditures on machine, including on capital goods, rents on buildings, interest on capital borrowed, expenditure on power, light, fuel, advertisement, etc. Money costs are known also as explicit costs that an accountant records in the firm's books of account. Explicit costs are the payments to outside suppliers of inputs.

To the economists, the cost of any good or service is the totality of all sacrifices made to bring the good or service into existence. Therefore, the “economic cost” (opportunity cost of production) is made up of both the explicit and the implicit cost. Implicit cost, are the imputed value of the entrepreneur’s own resources and services. According to Salvatore, “implicit costs are the value of owned inputs used by the firm in its production process”. These include the salary of the owner-manager who is content with having normal profits but does not receive any salary, the estimated rent of the building (if it belongs to the entrepreneur), etc. While explicit cost is monetarily valued, implicit cost is the forgone alternative or opportunity cost which the accounting cost didn't take note of.

2) **Production cost:** In the production process, many fixed and variable factors (inputs) usually capital equipments are used. They are being employed at various prices. The expenditures incurred on them are the total costs of production of a firm. Such costs are divided into two: total variable cost and total fixed costs.

3) **Real costs:** It tells us what lies behind money cost, since money cost are expenses of production from the point of view of the producer. Thus, according to Marshall, the efforts and sacrifices made by various members of the society in producing a commodity are the real costs of production. The efforts and sacrifices made by business men to save and invest, workers foregoing leisure, and by the landlords in the use of land, all these constitute real cost.

4) **Opportunity cost:** This is the cost of the resources foregone, in order to get or obtain another. The opportunity cost of anything is the next best alternative that could be produced instead by the same factors or by

an equivalent group of factors, costing the same amount of money. E.g. the real cost of labour is what it could get in some alternative employment. Opportunity cost includes both explicit and implicit cost.

5) **Private and social cost:** Private costs are the costs incurred by a firm in producing a commodity or service. It includes both implicit and explicit cost. However, the production activities of a firm may lead to economic benefit or harm for others. For instance, production of commodities like steel, rubber and chemical pollute the environment which leads to social costs. The society suffers some inconveniences as a result of the production exercise embarked upon by the firm.

6) **Sunk costs:** This refers to all the costs that have been incurred and definitely not recoverable or changeable whether the particular project or business goes on or not. For instance, if a road project already commissioned is abandoned or not, the money has already been spent and there is no way of recovering it. This cost is undiscoverable if not considered in economic decision making.

7) **Incremental cost:** This is the change in cost owing to a new decision. For example, a firm may decide to buy its equipment instead of leasing it and because of this the expenditure made in the production process will alter. If cost increases because of the change, the incremental cost will be positive. If the new decision does not alter the overall cost, then, the incremental cost will be negative.

1.2 COST FUNCTIONS

Cost functions are derived functions. They are derived from the production function which describes the available efficient methods of

production at any given period of time. Cost function expresses a functional relationship between total cost and factors that determine it. Usually, the factors that determine total cost of production (C) of a firm are the output (Q), level of technology (T), the prices of factors (Pf), and the fixed factors (K). Economic theory distinguishes between short-run costs and long-run costs.

The short run is a period in the production process, which is too short for a firm to vary all its factors of production. Short-run costs are the cost over a period during which some factors of production (usually capital equipment and management) are fixed. It is the cost at which the firm operates in any one period, where one or more factors of production are in fixed quantity. On the other hand, the long-run costs are costs over a period long enough to permit a change in all factors of production. The long-run costs are planning costs or ex ante costs, in that they present the optimal possibilities for expansion of the output and thus help the entrepreneurs to plan their future activities. In the long-run, there are no fixed factors of production and hence, no fixed costs. In the long-run, all factors are variable, all costs are also variable.

Symbolically, we may write the long-run cost function as:

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

and short-run cost function as;

$$C = f (Q,T,Pf,K)$$

Where C is total cost, Q is output, T is technology, Pf is prices of factor inputs, and K is fixed factors of production.

Graphically, costs are shown on two-dimensional diagrams. Such curves imply that cost is a function of output, i.e. $C = f(Q)$, ceteris paribus. The clause ceteris paribus implies that all other factors which determine costs are held constant. If these factors do change, their effect on costs is shown graphically by a shift of the cost curve. This is the reason why determinants of cost, other than output, are called shift factors. Mathematically, there is no difference between the various determinants of costs. The distinction between movements along the cost curve (when output changes) and shifts of the curve (when the other determinants change) is convenient only pedagogically, because it allows the use of two-dimensional diagrams. But it can be misleading when studying the determinants of costs. It is important to remember that if the cost curve shifts, this does not imply that the cost function is indeterminate.

The factor *technology* is itself a multidimensional factor, determined by the physical quantities of factor inputs, the quality of the factor inputs, the efficiency of the entrepreneur, both in organizing the physical side of the production (technical efficiency of the entrepreneur), and in making the correct economic choice of techniques (economic efficiency of the entrepreneur). Thus any change in these determinants (e.g. the introduction of a better method of organization of production, the application of an educational programme to the existing labour) will shift the production function, and hence will result in a shift of the cost curve. Similarly, the improvement of raw materials, or the improvement in the use of some raw materials will lead to a shift of the cost function.

1.2.1 ASSUMPTIONS OF THE COST- FUNCTION

In order to simplify the cost-analysis, certain assumptions are made:

1. Firms produce a single homogeneous good (X) with the help of certain factors of production.
2. Some of these factors are employed in fixed quantities, whatever the level of output of the firm in the short-run. So they are assumed to be given.
3. The remaining factors are variable whose supply is assumed to be known and available at fixed market prices.
4. The technology which is used for the production of the good is assumed to be known and fixed.
5. It is also assumed that the firm adjusts the employment of variable factors in such a manner that a given output(X) of the good 'X' is obtained at the minimum total cost, C.

Given the cost functions, we discuss the traditional and modern theories of costs.

1.3 TRADITIONAL THEORY OF COSTS

The traditional theory of costs analyses the behavior of cost curves in the short-run and long-run and arrives at the conclusion that both the short-run and long-run cost curves are U-shaped but the long-run cost curves are flatter than short-run cost curves.

1.3.1 SHORT-RUN COSTS OF THE TRADITIONAL THEORY

In the traditional theory of the firm, in the short run, there are variable inputs and at least one fixed input. This suggests that short run costs are divided into fixed costs and variable costs. Thus, there are three concepts of total cost in the short run: Total fixed costs (TFC), total variable costs (TVC), and total costs (TC).

$$TC = TFC + TVC$$

1. **Total Fixed Cost:** These are costs of production that do not change (vary) with the level of output, and they are incurred whether the firm is producing or not. They are independent of the level of output and it is the sum of all costs incurred by the firm for fixed inputs, and it is always the same at any level of output. It includes; (a) salaries of administrative staff (b) depreciation (wear and tear) of machinery (c) expenses for building depreciation and repairs (d) expenses for land maintenance and depreciation (if any). Another element that may be treated in the same way as fixed costs is the normal profit, which a lump sum including a percentage return on is fixed capital and allowance for risk.

Total Fixed Cost (TFC) is graphically denoted by a straight line parallel to the output axis.

Figure 1.1: Total Fixed Cost

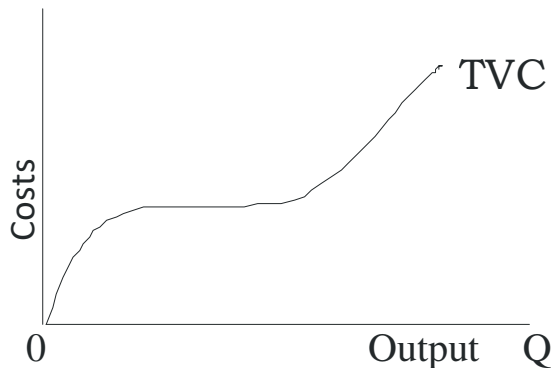


2. **Total Variable Cost:** These are costs of production that change directly with output. They rise when output increases and fall when output declines. They include (a) the raw materials (b) the cost of direct labour (c) the running expenses of fixed capital, such as fuel, ordinary repairs and routine maintenance. It is the total cost incurred by the firm for variable inputs.

$$TVC = f(Q)$$

In the traditional theory of the firm, the total variable cost (TVC) has an inverse-S-shape, graphically shown below, and it reflects the law of variable proportions.

Figure 1.2: Total Variable Cost



3. **Total Cost:** The firm's short run total cost is the sum of the total fixed cost (TFC) and total variable cost (TVC) at any given level of output. Total cost also varies with the level of the firm's output.

$$TC = TFC + TVC \quad 2$$

$$TC = f(Q) \quad 3$$

From Equation 2, it follows that:

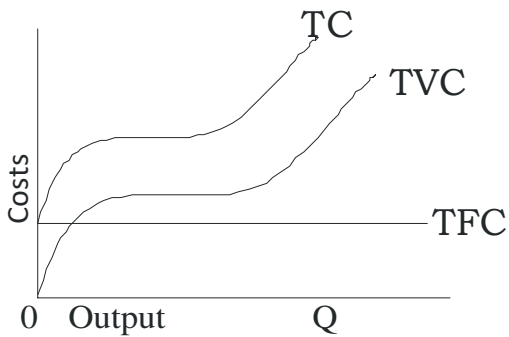
$$TFC = TC - TVC \quad 4$$

$$TVC = TC - TFC \quad 5$$

According to the law of variable proportions, at the initial stage of production with a given plant, as more of the variable factor(s) is employed; its productivity increases and the average variable cost fall. This continues until the optimal combination of the fixed and variable factors is reached. Beyond this point, as increased quantities of the variable factor(s) are

combined with the fixed factor(s) the productivity of the variable factor(s) decline (and the AVC rises). By adding the TFC and TVC we obtain the TC of the firm.

Figure 1.3: Total Cost



1.3.2 OTHER COST CONCEPTS

From the Total-Cost curves we obtain Average-Cost curves.

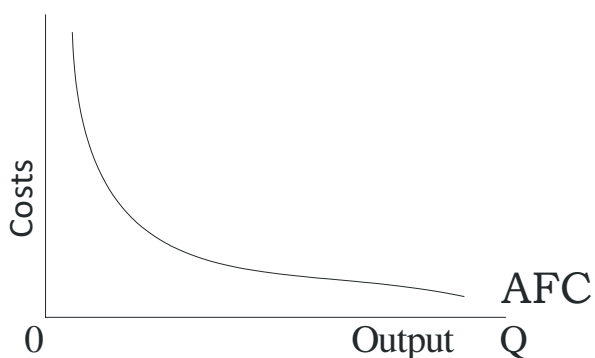
- a. **Average Fixed Cost (AFC):** The AFC at any given level of output is total fixed cost divided by output. In symbol, this becomes:

$$AFC = \frac{TFC}{Q} > 0$$

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Graphically, the AFC is a rectangular hyperbola, showing at all its points the same magnitude, that is, the level of TFC.

Figure 1.4: Average Fixed Cost



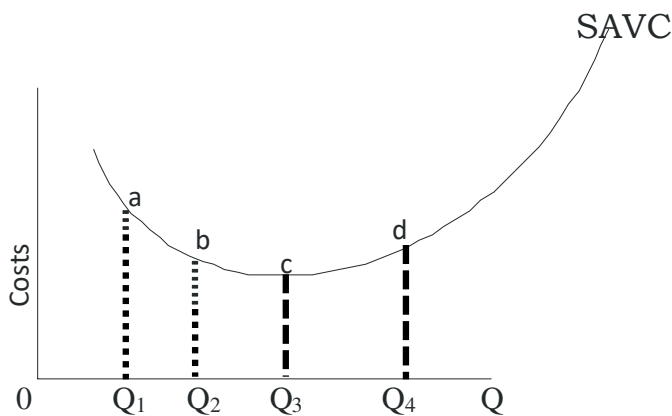
b. **Average Variable Cost (AVC):** The average variable cost at any given level of output is total variable cost divided by output. In symbol, it becomes:

$$AVC = \frac{TVC}{Q} \dots\dots\dots 7$$

The SAVC curve falls initially as the productivity of the variable factor(s) increases, reaches a minimum when the plant is operated optimally (with optimal combination of fixed and variable factors), and rises beyond that point, due to law of diminishing returns.

Thus, the SAVC curve is therefore U-shaped as seen below:

Figure 1.5: Short-run Average variable Cost



c. **Average Total Cost (ATC):** In the short-run analysis, average cost is more important than total cost. The units of output that a firm produces do not cost the same to the firm, but must be sold at the same price.

Therefore, the firm must know the per-unit cost or the average cost. Thus, the short-run average cost of a firm is the average fixed costs, the average variable cost and average total costs. The short run average total cost (SAC) at any given output level is obtained by simply dividing total cost by the output level:

$$SAC = \frac{STC}{Q} \dots\dots\dots 8$$

Since $STC = TFC + TVC$

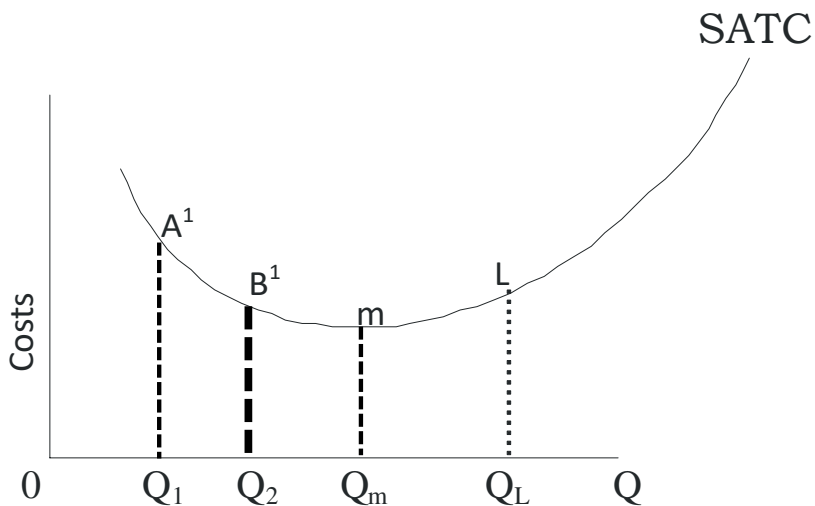
Then, $SAC = \frac{TFC + TVC}{Q}$

$$SAC = \frac{TFC}{Q} + \frac{TVC}{Q}$$

$$SAC = AFC + AVC \dots\dots\dots 9$$

Graphically, the ATC curve is derived in the same way as the SAVC. The shape of the ATC is similar to that of AVC (both being U-shaped). Initially, the ATC declines, it reaches a minimum at the optimal operation of the plant (Q_m) and subsequently rises again, as seen in Figure 1.6.

Figure 1.6: short-run Average Total cost



From Equation 9 we know that the SAC can be alternatively defined as the sum of AFC and AVC. Therefore,

$$AFC = SAC - AVC \quad 10$$

and

$$AVC = SAC - AFC \quad 11$$

The U-shape of both the AVC and the ATC reflects the law of variable proportions or law of diminishing returns to the variable factor(s) of production.

d. **Short run Marginal Cost (SMC):** Marginal Cost is the addition to total cost resulting from the production of an additional unit of output. The short-run marginal cost is defined as a change in total cost (TC) which results from a unit change in output. Mathematically, the Marginal Cost is the first derivative of the TC function. Marginal Cost is the addition to Total Cost by producing an additional unit of output.

Therefore, if

$$MC = SMC = \frac{\Delta TC}{\Delta Q} \text{ or } \frac{\Delta C}{\Delta Q} \dots\dots\dots 12$$

$$\text{Or } SMC = \frac{\Delta TVC + \Delta TFC}{Q}$$

*But since it is zero (fixed costs being fixed)

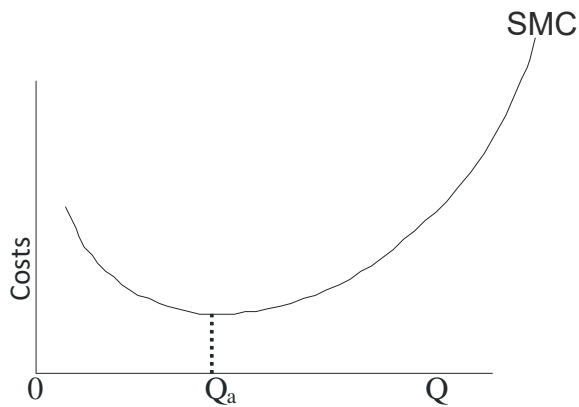
$$SMC = \frac{\Delta TVC}{\Delta Q} \dots\dots\dots 13$$

However, to derive the marginal cost from a total cost function, we find the derivative of total cost (TC) with respect to output (Q):

$$SMC = \frac{dTC}{dQ} > 0 \dots\dots\dots 14$$

Graphically, the MC is the slope of the TC curve (which of course is the same at any point as the slope of the TVC). The slope of a curve at any one of its points is the slope of the tangent at that point.

Figure 1.7: Short-run Marginal Cost SMC



Thus, the SMC curve is also U-shaped, as seen above. Therefore, the traditional theory of costs postulates that in the short-run, the costs curves (AVC, ATC and MC) are U-shaped reflecting the law of variable proportions. In the short-run with a fixed plant there is a phase of increasing productivity (falling unit costs) and the phase of decreasing productivity (increasing unit costs) of the variable factor(s). Between these two phases of plant operation there is a single point at which unit costs are at a minimum. When this point on the SATC is reached the plant is utilized optimally, that is, with optimal combination (proportions) of fixed and variable factors.

1.3.3 RELATIONSHIP BETWEEN SHORT-RUN COST CURVES.

The data on Table 1.1 gives a short run cost schedules for a hypothetical firm.

Table 1.1: Short run cost schedules for a firm (hypothetical data)

Output per week (a)	TFC (N) (b)	TVC (N) (c)	TC (N) (d)	AFC (N) (e) b, a	AVC (N) (f) c, a	SAC (N) (g) d, a	SMC (N) (g) Dd, Da
0	2000	0	2000	0	0	0	0
100	2000	800	2800	20	8.0	28.0	8.0
260	2000	1600	3600	7.7	6.2	13.8	5.0
400	2000	2400	4400	5.0	6.0	11.0	5.7
520	2000	3000	5000	3.8	5.8	9.6	6.7
620	2000	3800	5800	3.2	6.1	9.4	8.0
680	2000	4600	6600	2.9	6.8	9.7	13.3
720	2000	5400	7400	2.8	7.5	10.3	20.0
750	2000	6000	8000	2.7	8.0	10.7	26.7
760	2000	6800	8800	2.6	8.9	11.6	80.0
760	2000	7600	9600	2.6	10.0	12.6	∞

Note that in some cases, the AFC, and AVC do not add up exactly to the SAC. This is due to the fact that figures are rounded up. Table 1.1 reveals two important information which must be emphasized; to give an insight into management strategies for profit maximization, or loss minimization.

a.) When output is zero, TFC and TC are equal to each other. This implies that a firm incurs a loss which is equal to the TFC if nothing is

produced after the firm's plant has been installed. Such a loss will likely be in terms of rent on factory building, if not owned by the firm, interest on money borrowed from the bank, and wear and tear (depreciation) of fixed assets as a result of being neglected or exposed to unfavorable weather conditions.

b.) Average fixed cost (AFC) falls as output (Q) is increased. This occurs because TFC is the same at any level of output. Therefore, the larger the output level, the more these overhead costs are spread out.

1.3.4 THE RELATIONSHIP BETWEEN ATC AND AVC

The AVC is a part of the ATC, given

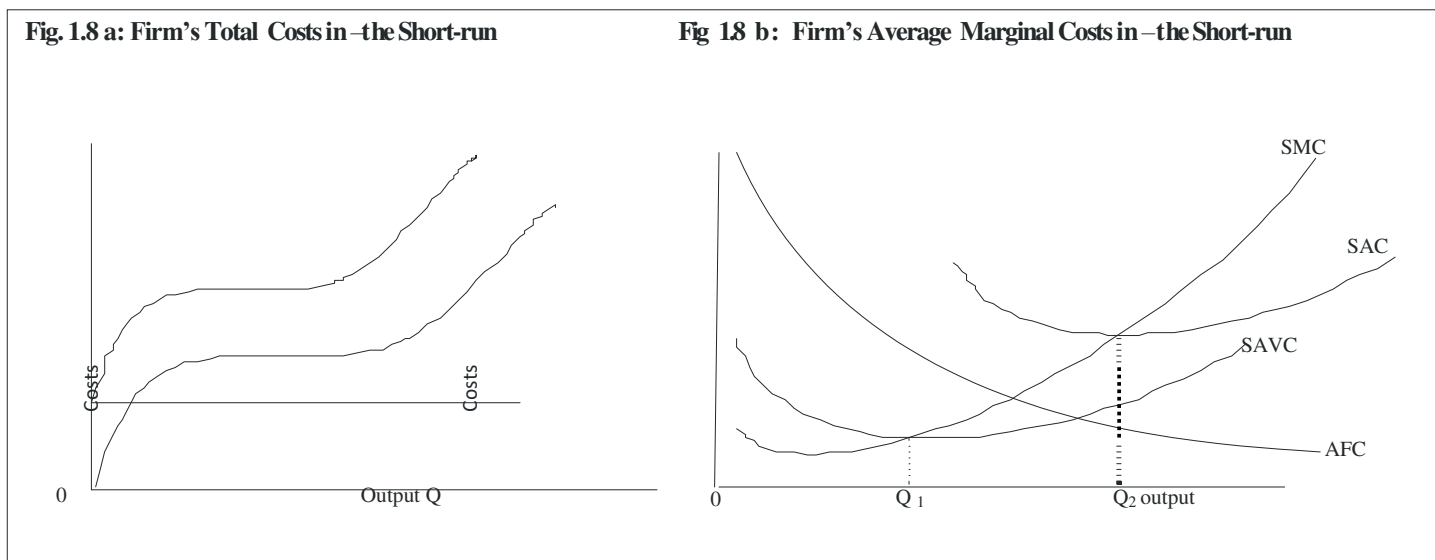
$$ATC = AFC + AVC.$$

Both AVC and ATC are U-shaped, reflecting the law of variable proportions. However, the minimum point of the ATC occurs to the right of the minimum point of AVC in the figures above due to the fact that ATC includes AFC and the AVC falls continuously with increases in output. After AVC has reached its lowest point and starts rising, its rise is over a certain range, set off by the fall in the AFC, so that ATC continues to fall (over that range) despite the increase in AVC. Thus, the rise in AVC eventually becomes greater than the fall in the AFC so that the ATC starts increasing. The AVC approaches the ATC asymptotically as X increases.

In Figure 1.8b, the minimum AVC is reached at Q1 while the ATC is at its minimum at Q2. Between Q1 and Q2 the fall in AFC more than offsets the rise in AVC so that the ATC continues to fall. Beyond Q2 the increase in AVC is not offset by the fall in AFC so that ATC rises.

1.3.5 RELATIONSHIP BETWEEN MC AND ATC

The MC cuts the ATC and the AVC at their lowest points. Recall that MC is the change in Total Cost (TC)



for producing an extra unit of output. Assume that we start from a level of n units of output. If we increase the output by one unit the MC is the change in TC resulting from the production of the $(n+1)$ th unit.

The AC at each level of output is found by dividing TC by Q .

Thus, the AC at the level of Q_n is

$$AC_n = \frac{TC_n}{Q_n} \dots\dots\dots 15$$

and the AC at the level Q_{n+1} is

$$AC_{n+1} = \frac{TC_{n+1}}{Q_{n+1}} \dots\dots\dots 16$$

Clearly,

$$TC_{n+1} = TC_n + MC \dots\dots\dots 17$$

Thus, if the MC of $(n+1)$ th unit is less than AC_n (i.e. the AC of the previous 'n' units) the AC_{n+1} will be smaller than AC_n . If the MC of the $(n+1)$ th is higher than the AC_n , the AC_{n+1} will be higher than AC_n .

Thus, so long as the MC lies below the AC curve, it pulls the latter (AC curve) downwards; when the MC rises above the AC, it pulls the AC upwards, as in Figure 1.8b.

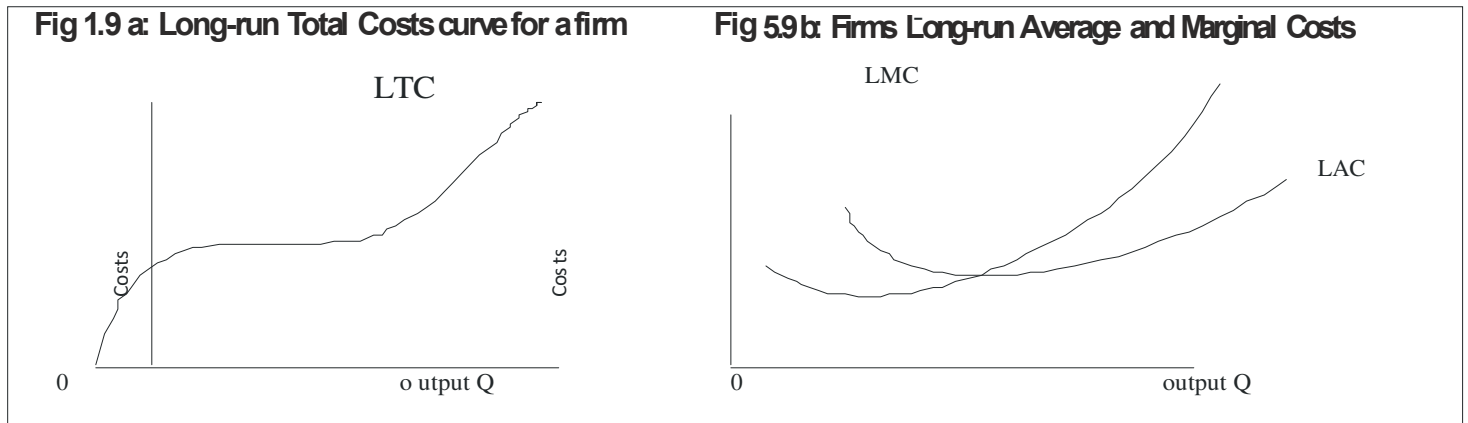
Both the inverse S-shape of the total cost curves and the U-shape of the average and marginal cost curves in the short-run reflect the law of diminishing returns (law of variable proportions). For instance, over the range of output from the origin to Q_1 in Figure 1.8b, productivity per unit of variable factor increases as more of the variable factor is applied to a given quantity of the fixed factor. The AVC falls and reaches its minimum at Q_1 . Beyond Q_1 , as increased quantities of the variable factor are combined with a given quantity of fixed factors, the output per unit of the variable factor declines and the AVC rises. Note that, the TC and the TVC curves in Figure 1.8a have the same shape, since they differ by only a constant amount.

1.3.6 LONG-RUN COSTS OF THE TRADITIONAL THEORY:

THE “ENVELOPE” CURVE

In the Long-run, there are no fixed factors of production, hence all factors are assumed to be variable. Hence, the concepts of fixed and variable factors are not applicable. It follows therefore that: Where LAC is the long-run average cost, LTC is the long-run total cost, and Q is the level of output. Note that the long-run cost curve is a planning curve, as a guide

to the entrepreneur in his decision to plan the future expansion of his output. Similarly, if LMC stands for long-run marginal cost, LTC for long-run total cost, and Q for output, we can define LMC as the relationship between long-run total cost, average cost, and marginal cost are illustrated in Figures 1.9a and 1.9b.



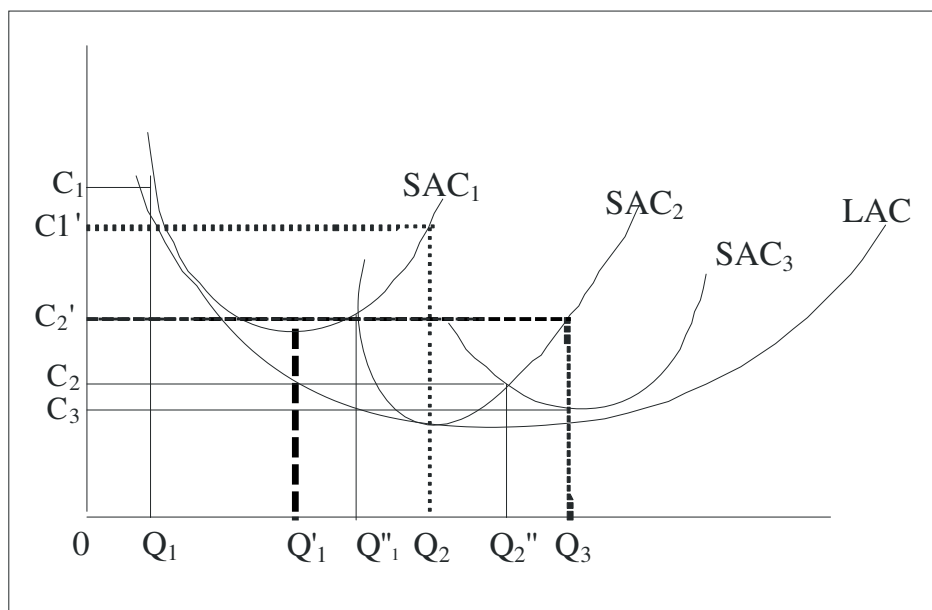
The long-run total cost shows the relationship between the total cost of a firm and its level of output when all inputs are variable, so that it is possible for the firm to produce each level of output with the optimal combination of inputs. The long-run average cost, or cost per unit of output is obtained as total cost divided by quantity of output. The long-run marginal cost is equal to the change in long-run total cost divided by the change in quantity of output.

1.3.7 THE LONG-RUN AVERAGE COST CURVE

In the long-run, it is technically possible for the firm to build a plant of any size according to its desires because all factors of production are variable. The long-run average cost curve (LAC) shows variation in the

firm's unit cost of production as it alters its plant size. But once a firm has installed a particular plant, it goes back to the short-run situation. The long-run average cost (LAC) curve of the firm shows the minimum average cost of producing various levels of output from all possible short-run average cost curves (SAC). Thus, the LAC curve is derived from short-run cost curves. Each point on the LAC corresponds to a point on a short-run cost curve, which is tangent to the LAC at the point. Let's examine in details how the LAC is derived from the SRC curves. Assuming the available technology of the firm at a particular point of time includes three methods of production, each with a different plant size; a small plant, medium plant and large plant. The small plant operates with costs denoted by the curve SAC_1 , the medium size plant operates with the costs on SAC_2 and the large-size plant gives rise to costs shown on SAC_3 .

Figure 1.10: Long-run Average Cost

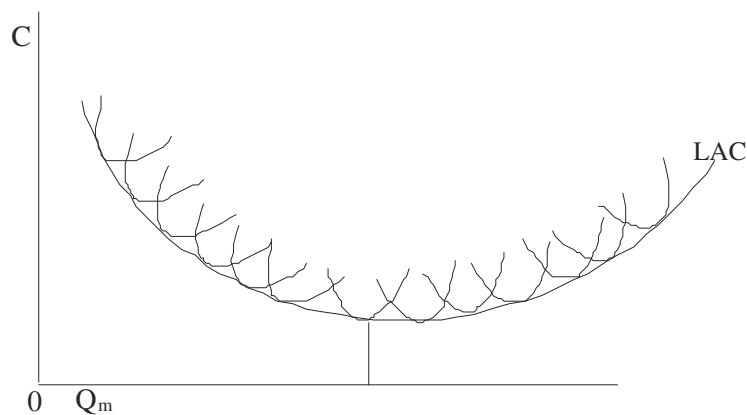


If the firm plans to produce output Q_1 it will choose the small plant. If it plans to produce Q_2 it will choose the medium plant. If it chooses to produce Q_3 it will choose the large size plant. If the firm starts with the small plant and its demand gradually increases, it will produce at lower cost. Beyond that point costs start increasing. If its demand reaches level Q''_1 , the firm can either continue to produce with the small plant or it can install the medium size plant. The decision at this point depends not on costs but on the firm's expectations about its future demand. If the firm expects that the demand will expand further than Q''_1 , it will install the medium plant because with this, plant outputs larger than Q''_1 are produced with a lower cost. Similar considerations hold for the decision of the firm when it reaches the level Q''_2 . If it expects its demand to stay constant at this level, the firm will not install the large plant, given that it involves a larger investment which is profitable only if demand expands beyond Q''_2 . For example, the level of output Q_3 is produced at a cost C_3 with the larger plant, while it costs C'_2 is produced with the medium size plant ($C'_2 < C_3$).

If we relax the assumptions of the existence of only three plants and assume that the available technology includes many plant sizes, each suitable for a certain level of output, the points of intersection of consecutive plants (which are the crucial points for the decision of whether to switch to a larger plant) are more numerous. If we assume that there are a very large number of plants, we obtain a continuous curve, which is the planning LAC curve of the firm. The LAC Curve is a locus of points denoting the least cost of producing the corresponding output. It is a planning curve because on the basis of this curve the firm decides what plant to setup in order to produce optimally (at minimum cost) the expected

level of output. The firm chooses the short-run plant which allows it to produce the anticipated (in the long-run) output at the least possible cost. In the traditional theory of firm, the LAC Curve is U-shaped and it is often called the “envelope curve” because it envelops the SAC Curves as seen on Figure 1.11.

Figure 1.11: The Envelope Curve



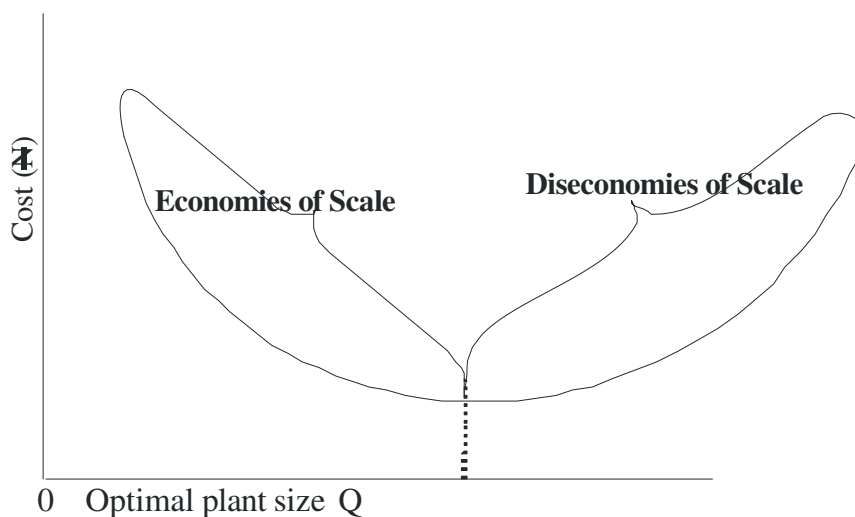
1.4 ECONOMIES AND DISECONOMIES OF SCALE

Economies of scale refer to the cost savings made possible as plant size increases. A firm is said to achieve economies of scale if its long-run average costs decline as it increases the size of its plant. On the other hand, diseconomies of scale refer to the higher unit costs the firm incurs as a result of setting up a larger plant.

Examining the U-shape of the LAC, this shape reflects the law of returns to scale. According to the law, the unit costs of production decreases as plant size increases, due to the economies of scale which the

larger plant sizes make possible. The traditional theory of firm assumes that economies of scale exist only up to a certain size of plant, which is known as the optimal plant size because with this plant size all possible economies of scale are fully exploited. If the plant increases further than this optimal size there are diseconomies of scale, arising from managerial inefficiencies.

Figure 1.12: Economies and Diseconomies of Scale



1.4.1 INTERNAL AND EXTERNAL ECONOMIES OF SCALE

Economies of scale can be internal or external. Internal economies are those cost savings that accrue directly to the firm by increasing its output level (or its plant size). Four main types of internal economies are often discussed:

a.) **Technical economies:** In the mass-producing industries, there is intensive use of machinery giving rise to technical economies because overhead costs are spread over a larger output. Furthermore, a large firm is

able to support its own research and development programme. Since the production process is highly fragmented, it is easy to invent and introduce cost-reducing machines and equipments to perform simple production tasks.

b.) **Managerial economies:** Cost-savings advantages are derived from specialization of labour. In a large firm, specialists are employed, each concentrating on a relatively small fraction of the total work according to their skills and abilities. Each worker becomes more proficient at his or her job thus increasing productivity and lowering unit cost of production.

c.) **Financial economies:** Large firms can easily obtain loans at lower rates of interest than small firms because they can provide collateral security. Hence, they are considered less risky customers than small firms. The rate of interest charged by banks to those firms regarded as best credit risks is called prime lending rate.

d.) **Marketing economies:** A large firm buys its raw materials in bulk and obtain discount. Eventually, the large firm pays lower prices than the small firms. A large firm can also promote its sales through advertising thereby spreading the selling costs over a large output, i.e. the larger the output, the smaller the advertising cost per unit of output.

On the other hand, external economies of scale are cost savings benefits derived when firms in the same or similar industry are concentrated in a particular area. Such costs benefits are called “economies due to localization of industries”.

The serious implicit assumption of the traditional U-shaped cost curve is that each plant size is designed to produce optimally a single level of output. There is no reserve capacity, not even to meet seasonal variations

in demand. As a consequence on this assumption the LAC curves 'envelopes' the SRAC, each point of the LAC is a point of tangency with the corresponding SRAC Curve. At the falling part of the LAC, the plants are not worked to full capacity; to the rising part of the LAC the plants are overworked, only at the minimum point M is the plant optimally employed.

1.4.2 THE OPTIMALITY IMPLIED BY THE LAC PLANNING CURVE

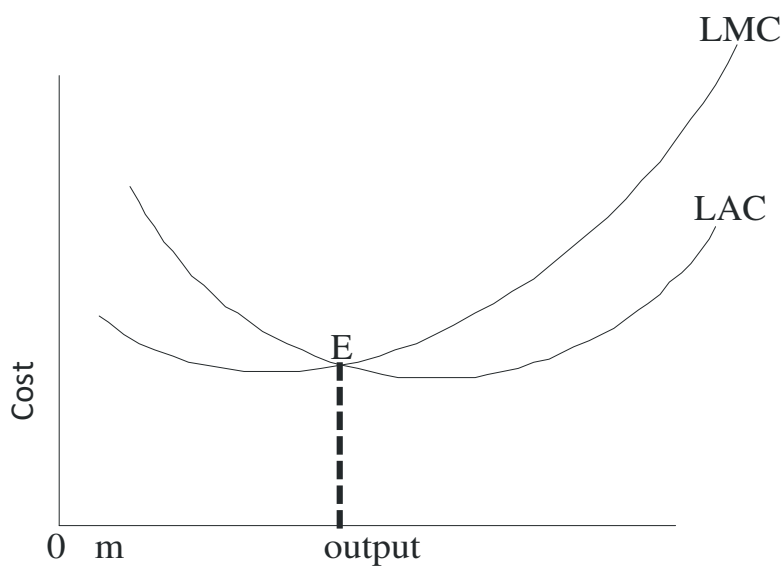
Each point on the LAC Curve represents the least unit cost for producing the corresponding level of output. Any point above the LAC is inefficient in that it shows a higher cost for producing the corresponding level of output. Any point below the LAC is economically desirable because it implies a lower-unit cost, but it is not attainable in the current state of technology and with the prevailing market prices of factors of production.

The long-run marginal cost curve is derived from the SRMC Curve, but does not 'envelop' them. The LRMC is formed from points of interception of the SRMC Curves with vertical lines (to the X-axis).

The LAC curve falls or rises more slowly than the SAC Curve because in the long-run, all costs become variable and few are fixed. The plant and equipment can be worked fully and more efficiently so that both the AFC and AVC are lower in the long-run than in the short-run. As a result of this the LAC curve becomes flatter than the SAC curve. Also, the LMC curve is flatter than the SMC curve because, all costs are variable and there are few fixed costs. In the short-run, the market cost is related to both the fixed and variable costs.

As a result, the SMC curve falls and rises more swiftly than the LAC curve. The LMC curve bears the usual relation to the LAC curve. It first falls and is below the LAC, then, it rises, and cuts the LAC curve at its lowest point E, and is above the latter throughout its length as shown in Figure 1.13.

Figure 1.13: Long-run Optimality



1.5 MODERN THEORY OF COST

The modern theory of cost differs from the traditional theory of costs with regards to the shapes of the cost curves. The U-shaped cost curves of the traditional theory have been questioned by various writers both on theoretical, a priori, and on empirical grounds.

As early as 1939, George Stigler suggested that the short-run average variable cost has a flat stretch over a range of output which reflects the fact that firms build plant with some flexibility in their productive capacity. The reasons for this reserve capacity have been discussed in

detail by various economists. The shape of the long run cost curve has attracted greater attention in economic literature, due to the serious policy implication of the economies of large scale production. Several reasons have been put forward to explain why the long-run cost curve is L-shaped rather than U-shaped. It has been argued that managerial diseconomies can be avoided by the improved methods of modern management science, and when they appear (at a very large scale of output) they are insignificant relative to the technical (production) economies of large plants, so that the total costs per unit of output falls, at least over the scales which have been operated in the real industrial world. Like the traditional theory, modern microeconomics distinguishes between short run and long run costs.

1.5.1 SHORT-RUN COSTS CURVES

As in the traditional theory, short-run costs in the modern theory of costs are distinguished into short-run average fixed cost (AFC), short-run average variable cost (SAVC), short-run average cost (SAC), and short-run marginal cost curves (SMC). As usual, they are derived from the total cost which is divided into fixed cost and total variable cost. But in the modern theory, the SAVC and SMC curves have a saucer-type shape or bowl-shape rather than a U-shape. As the AFC curve is a rectangular hyperbola, the SAC curve has a U-shape even in the modern theory

1.5.2 THE AVERAGE FIXED COST

This is the cost of indirect factors; it is the cost of the physical and personal organizations of the firm. The fixed cost include cost for (a)

salaries and other expenses of administrative staff (b) salaries of staff involved directly in production but paid on a fixed term basis (c.) the wear and tear of machinery (standard depreciation allowance (d.) the expenses for maintenance of buildings (e.) the expenses for the maintenance of land on which the plant is installed and operated.

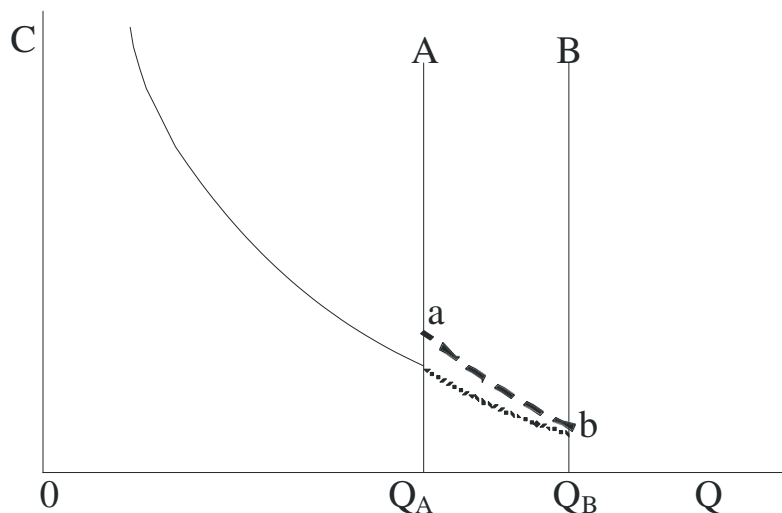
The planning of the plant (or the firm) consists of deciding the size of the fixed and indirect factors which determine the size of the plant, because they set limits to its production capacity. Direct factors such as labour and raw materials are assumed not to set limit on size; the firm can acquire them easily from the market without any time lag. The business man will start his planning with a figure for the level of output which he anticipates selling, and he will choose the size of plant which allows him to produce this level of output more efficiently, and with the maximum flexibility, the business man will want to be able to meet seasonal and cyclical fluctuations in his demand.

Reserve capacity will give the business man greater flexibility for repairs of broken down machinery without disrupting the smooth flow of the production process. The entrepreneur will want to have more freedom to increase his output if demand increases. All businessmen hope for growth. In view of anticipated increase in demand, the entrepreneur builds some reserve capacity because he would not like to let all new demand go to his rivals as this may endanger his future hold in the market. It also gives him some flexibility for minor alterations of his product, in view of changing tastes of customers.

Technology usually makes it necessary to build into the plant some reserve capacity. Some basic types of machinery (e.g. a turbine) may not

be technically fully employed when combined with other small types of machines in certain numbers. More of which may not be required, given the specific size of the chosen plant. Furthermore, some machinery may be so specialized as to be available only on order, which takes time. In this case, such machinery will be bought in excess of the minimum requirement at present numbers, as a reserve. Some reserve capacity will always be allowed in the land and buildings, since expansion of operations may be seriously limited if new land or new buildings have to be acquired. Finally, there will be some reserve capacity on the organizational and administrative level. The administrative staff will be hired at such numbers as to allow some increase in the operations of the firm.

Figure 1.14: Average Fixed Cost Curve



In summary, the businessman will not necessarily choose the plant which will give him the lowest cost, but rather, that equipment which will allow him the greatest possible flexibility for minor alterations of his product or his technique of production.

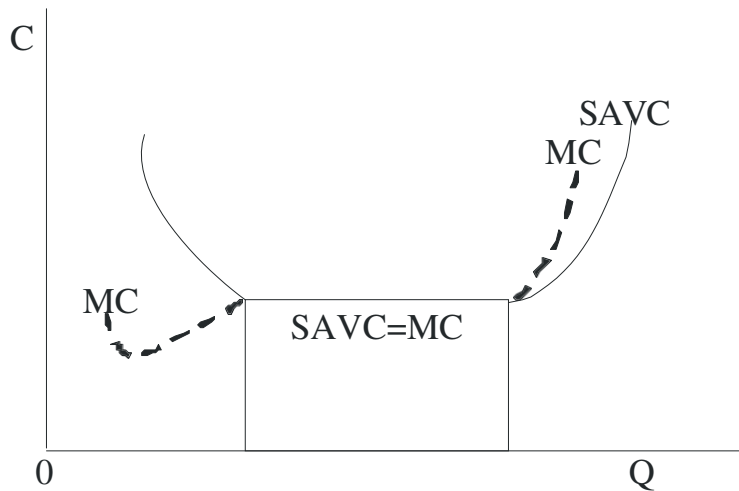
Under these conditions, the AFC curve will be as in Figure 1.14. The firm has some “largest capacity” units of machinery which set an absolute limit to the short-run expansion of output (boundary B). The firm also has small-unit machinery, which sets a limit to expansion (boundary A). This, however, is not an absolute boundary because the firm can increase its output in the short-run (until the absolute limit B is reached), either by paying overtime to direct labour for working longer hours (here the AFC is shown by the dotted line), or by buying some additional small unit type of machinery here the AFC curve shifts upwards, and starts falling again, as shown on line ab).

1.5.3 THE AVERAGE VARIABLE COST

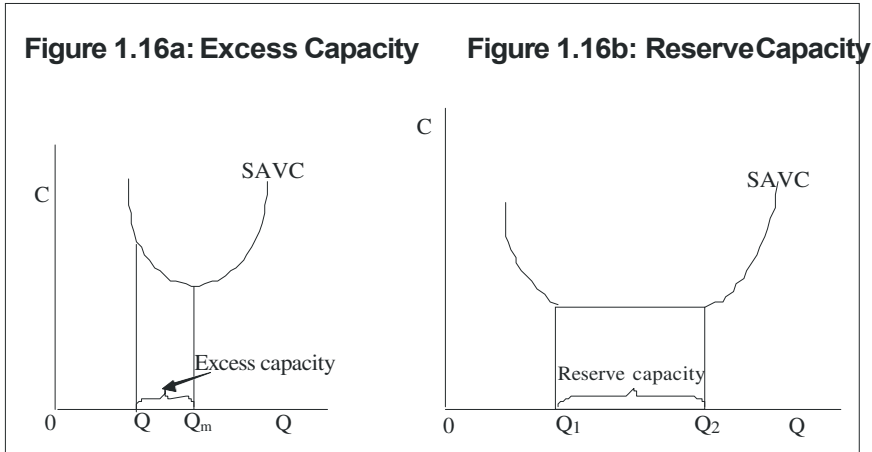
As in the traditional theory, the average variable cost of modern microeconomics includes the cost of: a.) direct labour which varies with output; b.) raw materials; c.) running expenses of machinery.

The short-run average cost curve (SAVC) in modern theory has a saucer-type shape, that is, it is broadly U-shaped but has a flat stretch over a range of output. The flat stretch corresponds to the built-in plant reserve capacity. Over this stretch, the SAVC is equal to the MC both being constant per unit of output. To the left of the flat stretch, MC lies below the SAVC, while to the right of the flat stretch the MC rises above the SAVC. The falling part of the SAVC shows the reduction in cost due to the better utilization of the fixed factor and the consequent increase in skills and productivity of the variable factor (labour). With better skills, the wastes in raw materials are also being reduced and a better utilization of the whole plant is reached.

Figure 1.15: SAVC curve



The increasing part of the SAVC reflects reduction in labour productivity due to the longer hours of work, the increase in cost of labour due to overtime payment (which is higher than the current wage), the wastes in material and the more frequent breakdown of machinery as the firm operates with overtime or with more shifts. The innovation of modern microeconomics in this field is the theoretical establishment of a short-run SAVC curve with a flat stretch over a certain range of output. The reserve capacity makes it possible to have constant SAVC within a certain range of output as shown in Figure 1.15. It should be clear that this reserve capacity is planned in order to give the maximum flexibility in the operation of the firm. It is completely different from the excess capacity which arises with the U-shaped average cost curve of the traditional theory of the firm. The traditional theory assumes that each plant is designed without any flexibility, as such; if the firm produces an output Q , smaller than Q_m , there is excess (unplanned) capacity, equal to the difference $Q_m - Q$. This excess capacity is obviously undesirable because it leads to higher unit costs.

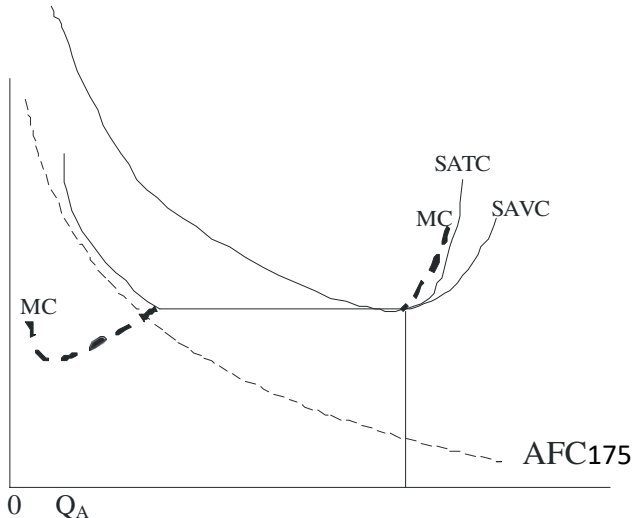


In the modern theory of costs, the range of output Q_1Q_2 in Figure 1.16b reflects the planned capacity which does not lead to increased costs.

1.5.4: THE AVERAGE TOTAL COST

The average total cost is obtained by fixed (inclusive of the normal profit) and the average variable cost at each level of output. The ATC curves fall continuously up to the level of output (Q_2) at which the reserve capacity is exhausted. Beyond that level, ATC will start rising. The MC will intersect the ATC Curve at its minimum point (which occurs to the right of the level of output Q_A , at which the flat stretch of the AVC ends).

Figure 1.17: Short-run Cost Curves



1.5.5 LONG-RUN COSTS IN MODERN MICROECONOMIC THEORY

All costs are variable in the long run and they give rise to a long run cost curve which is roughly L-shaped. Empirical evidence about the long run average cost curve reveals that the LAC curve is L-shaped rather than U-shaped. In the beginning, the LAC curve rapidly falls but after a point, “the curve remains flat, or may slope gently downwards, at its right-hand end”. Production cost fall continuously with increases in output. At very large scales of output, managerial costs may rise. But the fall in production costs more than offsets the increase in the managerial costs, so that the total LAC falls with increases in scale. Economists have assigned the following reasons for the L-shape of the LAC curve.

1. **Production and Managerial costs:** In the long-run, all costs being variable, production costs and managerial costs of a firm are taken into account when considering the effect of expansion of output on average costs. As output increases, production costs fall continuously while managerial cost may rise at very large scales of output. But the fall in production costs outweighs the increase in managerial costs so that the LAC curve falls with increases in output. We analyze the behaviour of production and managerial costs in explaining the L-Shaped of the LAC Curve.

a. **Production Costs:** As a firm increases its scale of production, costs fell steeply in the beginning and then gradually. This is due to the technical economies of large scale production enjoyed by the firm. Initially, these economies are substantial, but after a certain level of output, when all or most of these economies have been achieved, the firm reaches the minimal optimal scale or minimum efficient scale (MES). Given the

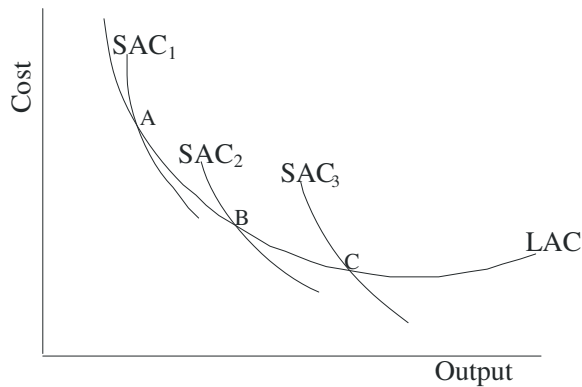
technology of the industry, the firm can continue to enjoy some technical economies at outputs larger than the MES for the following reasons.

- (a) From further decentralization and improvement in skills and productivity of labour.
- (b) From lower repair costs after the firm reaches a certain size; and
- (c) By itself producing some of the materials and equipment cheaply which the firm needs instead of buying them from other firms.

b. **Managerial Costs:** In modern firms, for each plant there is a corresponding managerial set-up for its smooth operation. There are various levels of management, each having a separate management technique applicable to a certain range of output. Thus, given a managerial setup for a plant, its managerial costs first fall with the expansion of output and it is only at a very large scale of output, they rise very slowly.

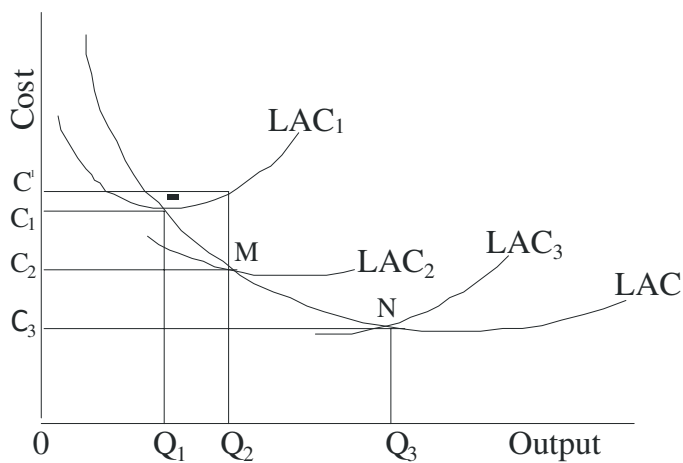
In summary, production costs fall smoothly at very large scales, while managerial costs may rise slowly at very large scales of output. But the fall in production costs more than offsets the rise in managerial costs so that the LAC curve falls smoothly or becomes flat at very large scales of output, thereby giving rise to the L-shape of the LAC curve. In order to draw such an LAC curve, we take three short-run average cost curves SAC1, SAC2, and SAC3 representing three plants with the same technology.

Figure 1.18: The LAC curve



Each SAC curve includes production costs, managerial costs, other fixed costs and a margin for normal profits. Each scale of plant (SAC) is subject to a typical load factor capacity so that points A, B and C represent the minimal optimal scale of output of each plant. By joining all such points as A, B and C of a large number of SACs, we trace out a smooth and continuous LAC curve, as shown in Figure 1.19.

Figure 1.19: LAC Curve



This curve does not turn up at very large scales of output. It does not envelope the SAC curves but intersects them at the optimal level of output of each plant.

2. **Technical progress:** Another reason for the existence of the L-shaped LAC curve in the modern theory of costs is technical progress. The traditional theory of costs assumes no technical progress while explaining the U-shaped LAC curve. The empirical results on long-run costs confirm the widespread existence of economies of scale due to technical progress in firms. The period, between which technical progress has taken place, the long-run average costs show a falling trend. The evidence on diseconomies is much less certain. So an upturn of the LAC at the top end of the size scale has not been observed. The L-shape of the LAC curve due to technical progress is explained in Figure 1.19.

Suppose the firm is producing OQ_1 output on LAC_1 curve at per unit cost of OC_1 output on LAC_1 curve at a per unit cost of OC_1 . If there is an increase in demand for the firm's product to OQ_2 , with no change in technology, the firm will produce OQ_2 output along the LAC_1 curve at per unit cost of OC' . If, however, there is technical progress in the firm, it will install a new plant having LAC_2 as the long-run average cost curve. On this plant, it produces OQ_2 output at a lower cost OC_2 per unit. Similarly, if the firm decides to increase its output to OQ_3 to meet further rise in demand, technical progress may have advanced to such a level that it installs the plant with the LAC_3 curve. Now it produces OQ_3 output at a still lower cost OC_3 per unit. If the minimum points, L, M and N of these U-shaped long-run average cost curves LAC_1 , LAC_2 and LAC_3 are joined by a line, it forms an L-shaped gently sloping downward curve LAC.

3. **Learning:** Yet another reason for the L-shaped long-run average cost curve is the learning process. Learning is the product of experience. If experience in this context can be measured by the amount of a commodity produced, then higher the production is, the lower it is per unit cost. The consequences of learning are similar to increasing returns. First, the knowledge gained from working on a large scale cannot be forgotten. Second, learning increases the rate of productivity. Third, experience is measured by the aggregate output produced since the firm first started to produce the product. *Learning by doing* has been observed when firm starts producing new products. After they have produced the first unit, they are able to reduce the time required for production and thus reduce per unit cost.

Figure 1.20: The Learning Curve

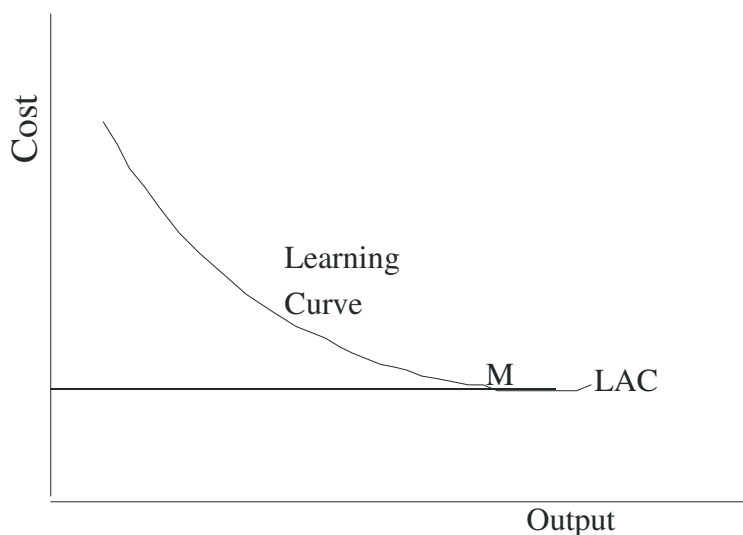


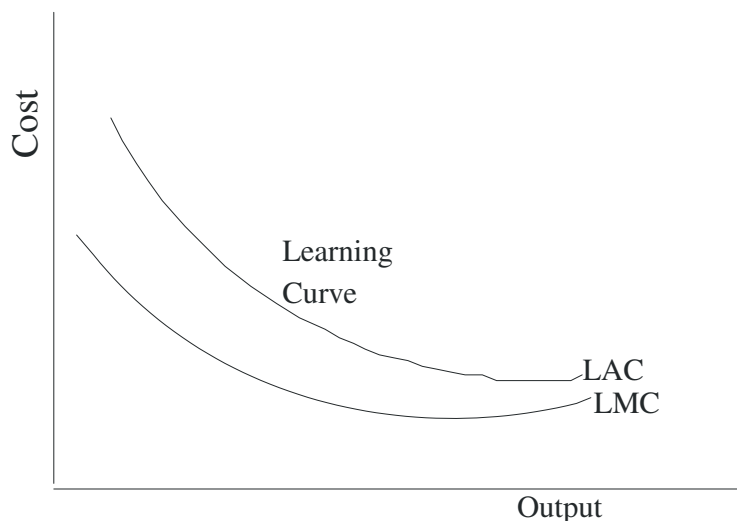
Figure 1.20 shows a learning curve (LAC) which relates the cost of producing a given output to the total output over the entire time period. Growing experience with making the product leads to falling costs as more and more of it is produced. When the firm has exploited all learning

possibilities, costs reach a minimum level, M in the figure. Thus the LAC curve is L-shaped due to learning by doing.

1.5.6 RELATIONSHIP BETWEEN LAC AND LMC CURVES

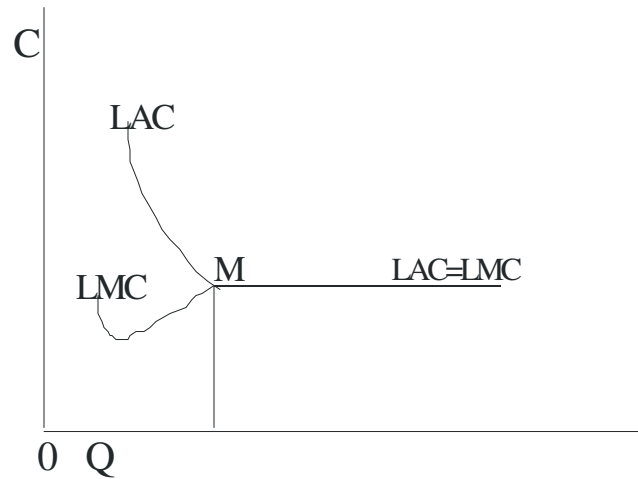
In the modern theory of costs, if the LAC curve falls smoothly and continuously even at very large scales of output, the LMC curve will lie below the LAC curve throughout its length, as shown in the Figure 1.21.

Figure 1.21: LAC and LMC Curves



If the LAC curve is downward sloping up to the point of a minimum optimal scale of plant or a minimum efficient scale (MES) of plant beyond which no further scale economies exist, the LAC curve becomes horizontal. In this case, the LMC curve lies below the LAC curve until the MES point M is reached, and beyond this point the LMC curve coincides with the LAC curve, as shown in Figure 1.22.

Figure 1.22: Relationship between LAC and LMC Curves



1.7 CONCLUSION

The majority of empirical cost studies suggest that the U-shaped cost curves postulated by the traditional theory are not observed in the real world. Two major results emerge predominantly from most studies. First, the SAVC and SMC curves are constant over a wide-range of output. Second, the LAC curve falls sharply over low levels of output, and subsequently remains practically constant as the scale of output increases. This means that the LAC curve is L-shaped rather than U-shaped. Only in very few cases diseconomies of scale were observed, and these at very high levels of output.