UNIT 5 THEORY OF COST

Structure

5.0 OBJECTIVES

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

- identify the types of cost incurred in the process of production;
- consider the nature of cost in short-and long-run;
- assess the theoretical insights on the shape of the cost curves; and
- examine the traditional and modern theories of cost.

5.1 INTRODUCTION

In a production process, cost is involved due to employment factors of production. In this regard, it is essential to know various types of costs a producer faces while deciding upon the employment of factors. We can think of two types of costs – explicit and implicit. The "explicit" cost is incurred for using a particular factor. For example, if a producer employs 20 units of labour at Rs.5 per unit, the explicit cost is Rs.100. This is also called the accounting cost. The "implicit" or "opportunity cost" is defined as the value of a resource in its next best use; suppose a Miss Sen quits her job of Rs.5, 00,000 per year and opens her own small business. Although, the accounting cost to her from her own business is zero, the opportunity cost is Rs.5, 00,000 per year.

In following, we would deal with "explicit" costs of production. These costs could be of two types – fixed and variable. Fixed cost is incurred on account of a fixed factor. For example, office building, a piece of land etc.

Variable cost, on the other hand, is incurred from a variable factor. For example, payment according to labour hours, purchasing certain raw materials, whose volume of employment can be easily changed.

However, no factor can be strictly fixed or variable. The definition of a fixed or variable factor depends, therefore, on the time frame in which the production process is being considered. If the time frame is very short, a particular input cannot be varied whereas it becomes variable if the time period is sufficiently long.

5.2 CONCEPT OF SHORT-RUN AND LONG-RUN

The short-run is defined as a period of time in which amount of certain types of inputs cannot be changed, regardless of the level of output. The short-run is a nebulous concept. It can be a day, a month, a year or even a nanosecond! In one nanosecond, virtually nothing can be changed in the production process. In a day, it may be possible to intensify the usage of certain machines. In a month the entrepreneur may be able to rent some additional equipment, in a year she may build a new plant. There are, therefore, many "short-runs", and the longer the time the greater are the possibilities for factor substitution and adjustment and greater is the scope of treating fixed costs as variable costs. Accordingly, the long-run is defined as a period of time when all inputs, used in the production process, are variable.

Cost of producing a given output clearly depends on the time available to make adjustments in the amount used of the productive factors. Let us now look at how the costs change in long and short periods.

5.2.1 Long-Run Costs

Suppose we have a production function,

Q = F(L,K), where Q = quantity of output produced

L = units of labour employed

K = units of capital employed

If we take w = wage rate per unit of labour and

r = rent per unit of capital,

total cost (TC) is:

$$C = w L + rK$$

Assuming total cost C remains constant i.e., $C=\overline{C}$, we get,

$$\overline{C} = wL + rK \ldots\ldots\ldots\ldots\ldots(1)$$

$$\text{or, } K = \frac{\overline{C} - wL}{r}$$

Equation (1) gives the idea of iso-cost and can be used to obtain what is known as an iso-cost line. In the iso-cost line because, we can have different combinations of L and K employed at the same cost outlay. Graphically, this is represented as a downward sloping straight line with slope $\frac{w}{r}$ in the K-L space (Figure 5.1).

Different levels of cost outlays give rise to different iso-cost lines, with the highest cost being represented as the one lying farthest from the origin.

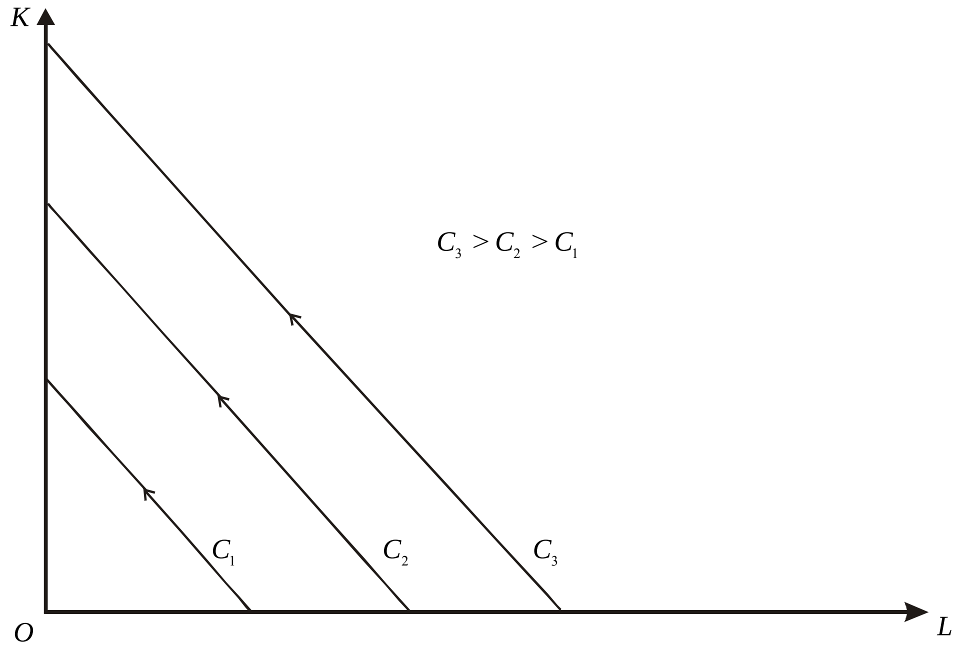

Fig. 5.1: Iso-cost lines

Given an output level say $\overline{Q}$, the optimal L and K, is obtained from the point of tangency between the lowest iso-cost and the iso-quant, as shown in Figure 5.2

From the figure, with cost-outlay C_0, $\overline{Q}$ cannot be produced. In addition, C_2 becomes too costly for producing $\overline{Q}$. Thus, C_1 is the optimum cost-outlay for production of output level $\overline{Q}$.

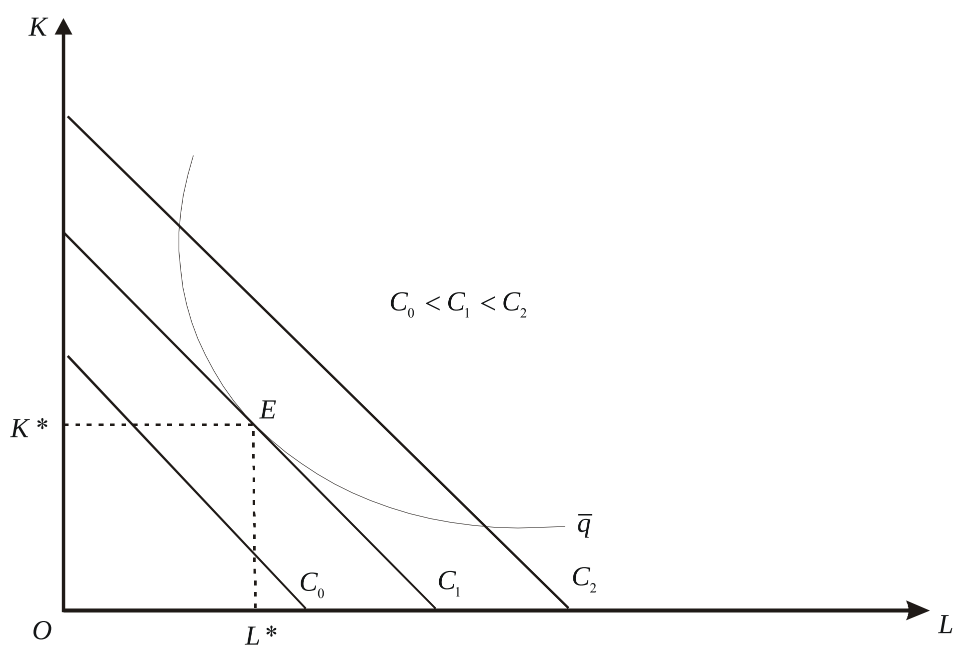

Fig. 5.2: Optimal Cost-output Condition

With C_1 level of cost outlay, $\overline{Q}$ is just producible.

Therefore, C_1 is the associated cost for output level $\overline{Q}$

In the long-run, L and K are both variable and hence higher levels of output are producible. And as above, the optimum cost would be given by the tangency between the iso-cost and the iso-quants, as shown in Figure 5.3.

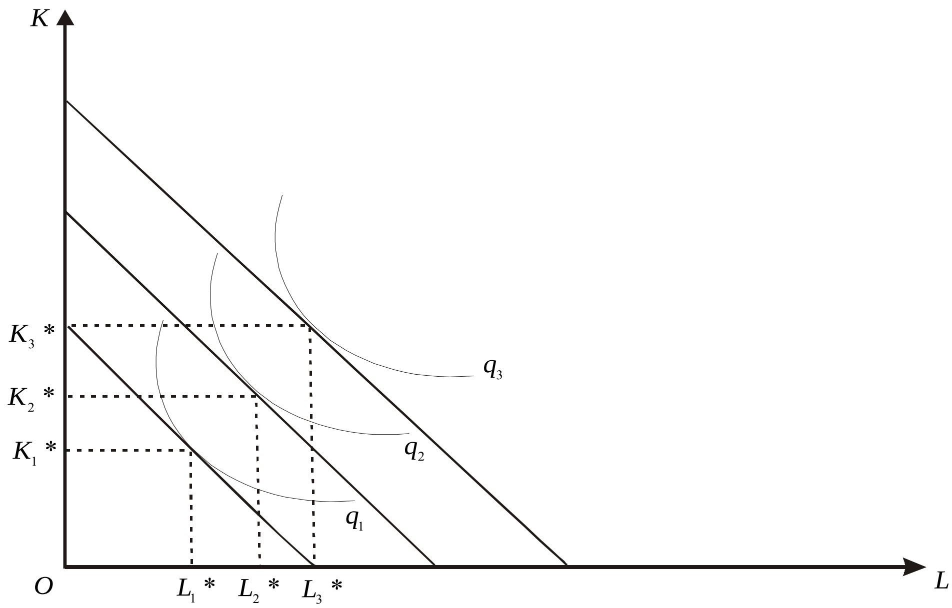

Fig. 5.3: Map of Optimal Cost-output Combination

Thus, for output Q_1, cost is C_1, for Q_2 it is C_2 and for Q_3 it is C_3. Accordingly, in the C-Q plane we get a long-run total cost curve (LRTC) as the one shown in Figure 5.4, which is upward rising.

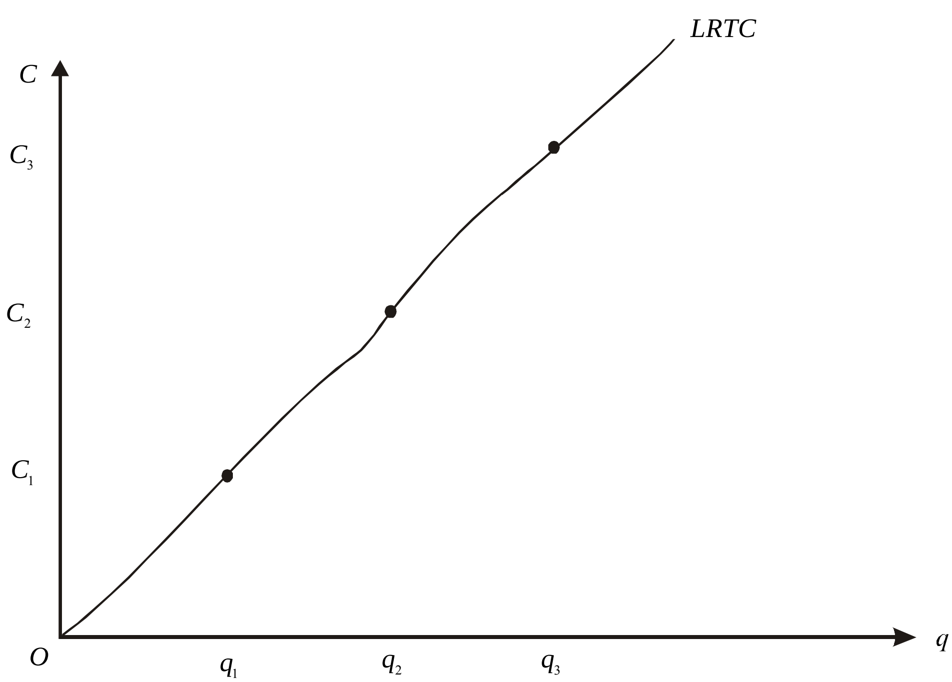

Fig. 5.4: Long-run Total Cost Curve

5.2.2 Short-Run Costs

There are a large number of "short-runs" depending on the time period involved. Each such short-run is characterised by the fact that not all factors of production can be fully adjusted in the given time period. We would illustrate this with the help of an example.

Suppose a firm wishes to raise output and must acquire 150 more machines to do so at the lowest cost. Let us assume there are 4 short-runs each of which is 3 months longer than the previous one. Because of delivery lag, no new machine can be added in the first 3 months. Therefore, the firm can have 50 machines in 6 months, 100 in 9 months and 150 in 12 months.

To produce the new output level, different amounts of labour are required in each of the 3-month periods. Let us assume that man-hours can be freely adjusted at all times and that the wage rate remains the same. These features are represented in the following diagram.

In Figure 5.5 Let Q_0 denote the initial output level, and the new higher output is shown by the iso-quant Q_1. During the first three months, Q_1 is produced with K_0=30 and L_1 man-hours, and total cost is given by C_1.

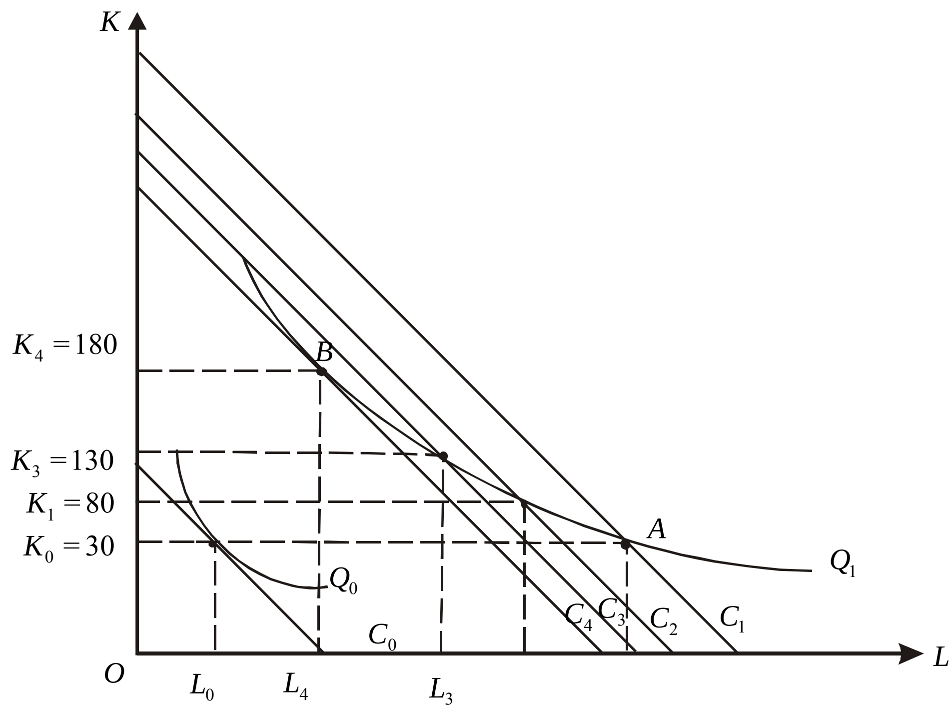

Fig. 5.5: Short-run Cost

Note: Q_1 is not tangent to C_1.

During the next 3 months, 50 new machines are available, so that total $K=K_2=K_1+50$ = 30+50=80. This allows the entrepreneur to reduce the labour cost to OL_2. As a result, total cost falls to C_2. Gradually, as new machines are added and the K stock is increased, the entrepreneur is able to produce Q_1 optimally at a total cost C_4, because C_4 is the lowest possible cost at which Q_1 can be produced.

The relation between short-run cost and output is shown in the adjacent diagram (Figure 5.6). Point Á in this figure corresponds to A in Figure 5.5, so does B′ corresponding to B. LRTC gives the long-run total cost (when all factors vary), and SRTC the short-run total cost, when only labour is the variable input.

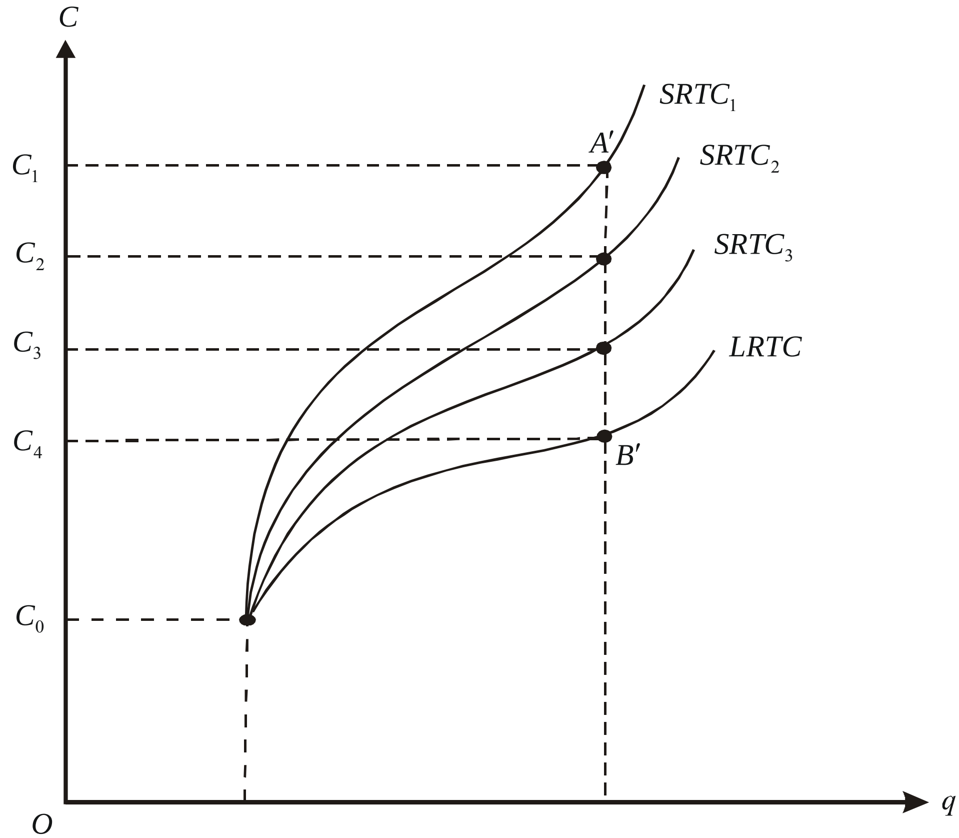

Fig. 5.6: LRTC and SRTC.

It is seen that SRTC is greater than LRTC.

Check Your Progress 1

1) What is the difference between a short-run and a long-run?

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2) Given that there are 2 factors of production – L and K, can the SRTC curve lie above the LRTC curve, if K is fixed in the short-run?

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5.3 TRADITIONAL THEORY OF COST

As seen above, theory of cost distinguishes between two time periods, the short-run and long-run. We know that the short-run is the period during which some factor(s) is fixed, while the long-run is the period over which all factors become variable.

5.3.1 Theory of Cost in the Short-Run

In the short-run, an entrepreneur has to face both variable and fixed costs. Therefore, we have,

TC = TVC + TFC where TC = Total Cost

TVC = Total Variable Cost

TFC = Total Fixed Cost.

Average and Marginal Costs

1) Average fixed cost – It is TFC dived by output.

   i.e., $AFC = \frac{TFC}{Q}$ where Q = Quantity of output produced.

2) Average variable cost – It is TVC divided by output.

   i.e., $AVC = \frac{TVC}{Q}$

3) Average total cost – It is TC divided by output

   i.e., $ATC = \frac{TC}{Q}$

4) Marginal cost – It is the addition to TC attributable to the addition of one unit of output, i.e.,

   $$MC = \frac{\partial TC}{\partial Q} = \frac{\partial}{\partial Q} TVC$$

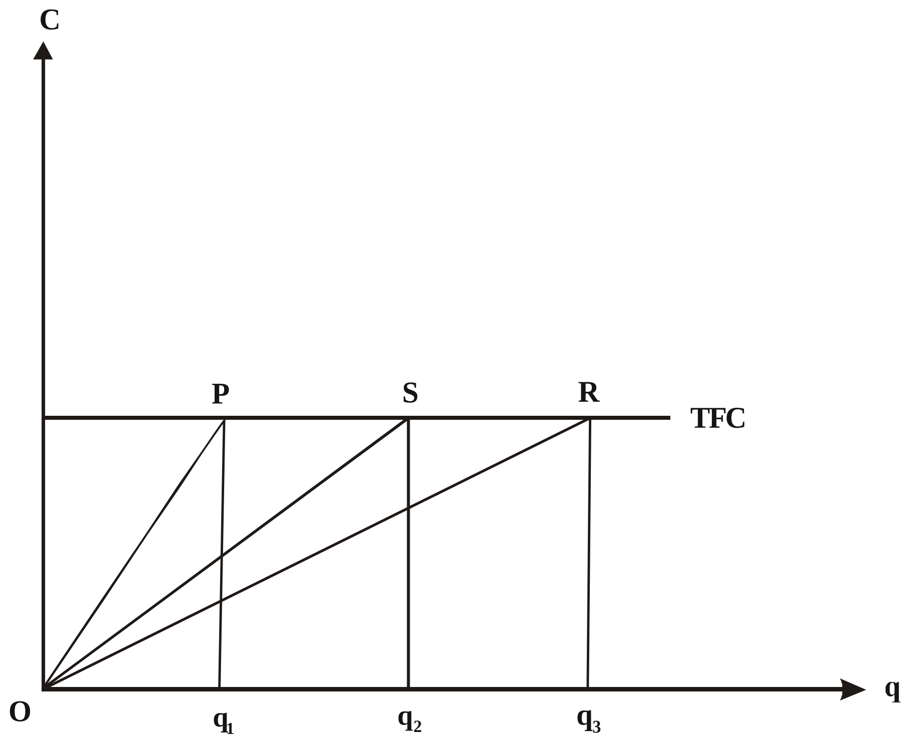
   Thus, in the short-run MC gives the slope of both TC and TVC.

Geometry of Average and Marginal Cost Curves

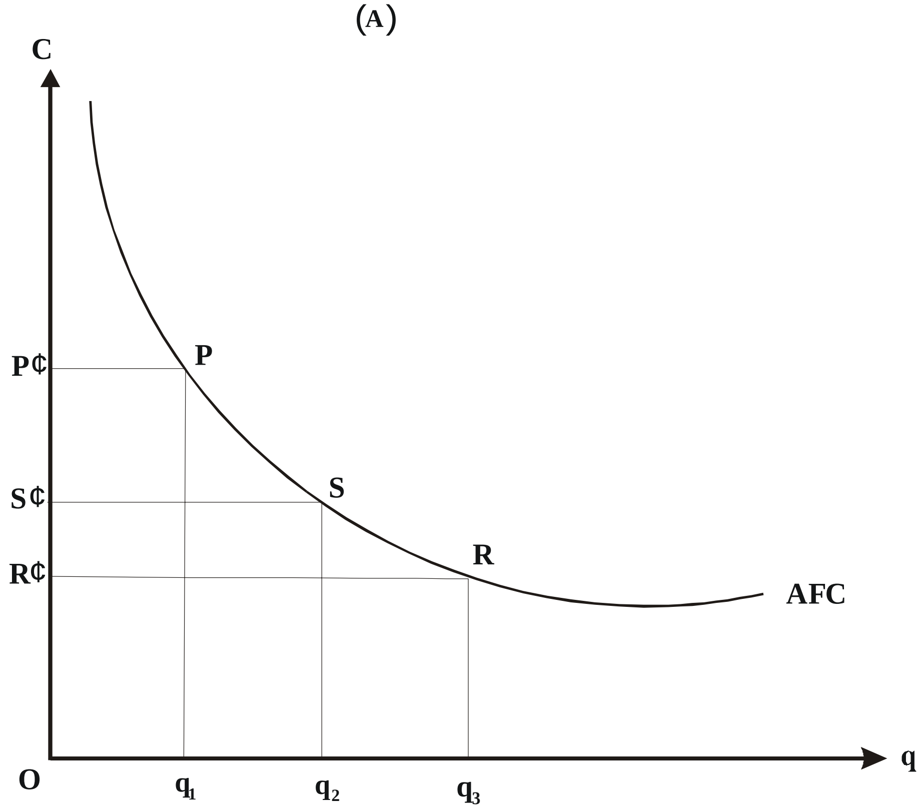
We will derive the average and marginal cost curves from the TC curve, using the above definitions.

i) AFC – This curve is derived from the TFC curve, which is a horizontal straight line in the C-Q plane, as shown below.

   As AFC*Q= TFC, which is a constant, AFC is a rectangular hyperbola. It is downward sloping because as Q increases AFC must decrease in order to maintain a constant TFC. This is shown in panel B of the following Figure 5.7.



(A)



(B)

Fig. 5.7: Derivation of AFC from TFC

In the C-Q plane, TFC is a horizontal straight line and AFC is given by the slope of a ray from the origin to any point on the TFC. The points P_1S_1R on TFC correspond to P_1S_1R on AFC.

ii) AVC – This is derived form the TVC. AVC is given by the slope of a ray drawn from the origin to a point on the TVC, for any level of output.

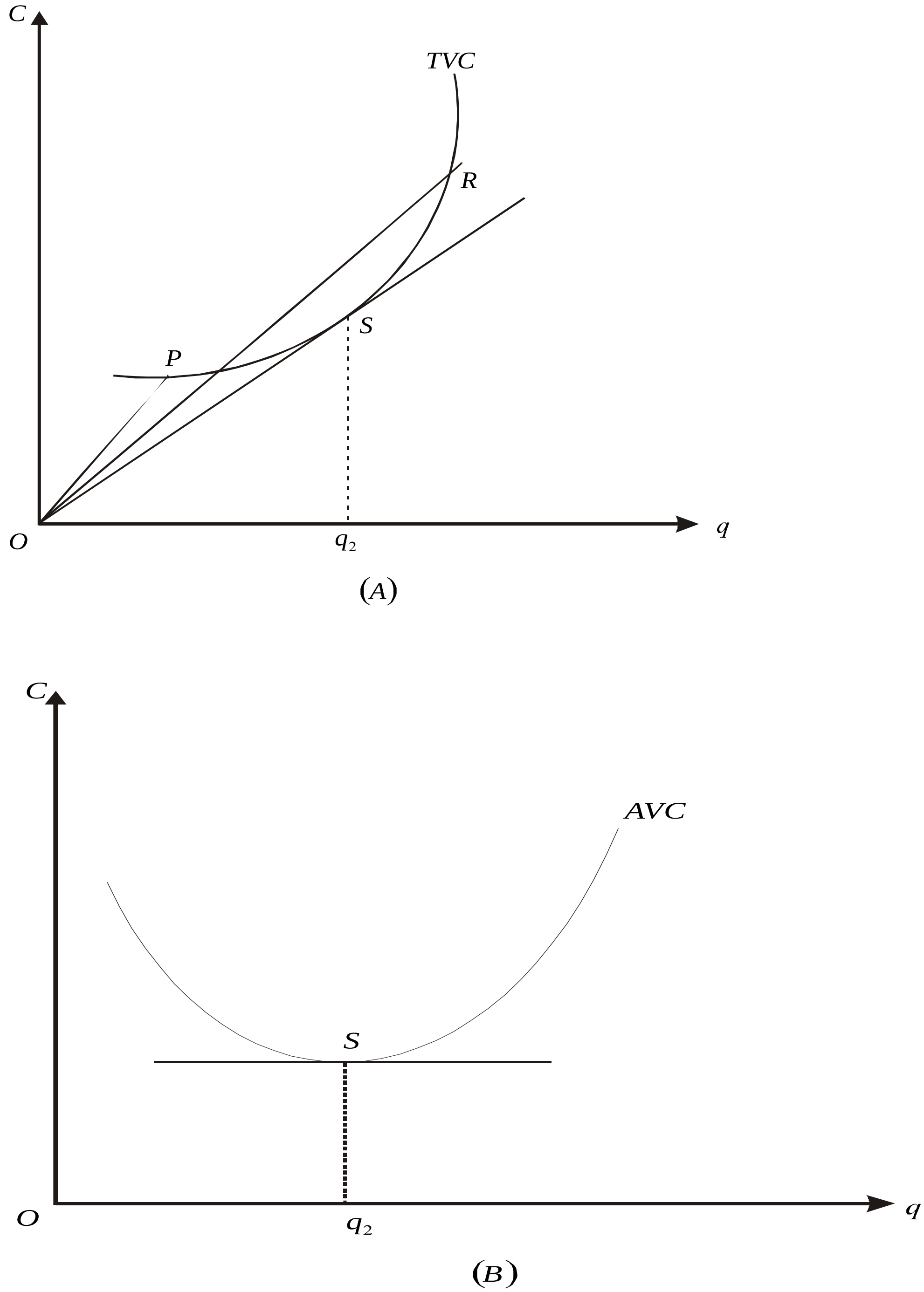


Fig. 5.8: Derivation of AFC from TVC

As is seen in panel A of Figure 5.8, the slope of a ray from the origin to the TVC curve steadily decreases as one passes through point such as P until it becomes tangent to the TVC curve at point S (associated with output OQ_2). Thereafter the slope increases, as one moves from S towards point, such as R. All this is shown in panel B and by constructing a U-shaped AVC, which is downward sloping till output OQ_2 and upward sloping beyond that.

iii) ATC – This curve is derived from the TC. As is the case of AVC, ATC is given by the slope of a ray from the origin to any point on the TC curve.

Figure 5.9 shows the derivation of ATC from TC. We find that in panel A, the slope of the ray to TC diminishes as we move along TC until we reach points and beyond which the slope rises. Accordingly, we get a U-shaped ATC, which initially falls until output level OQ_2' and thereafter rises. OQ_2' in panel A is the same as OQ_2' in panel (B).

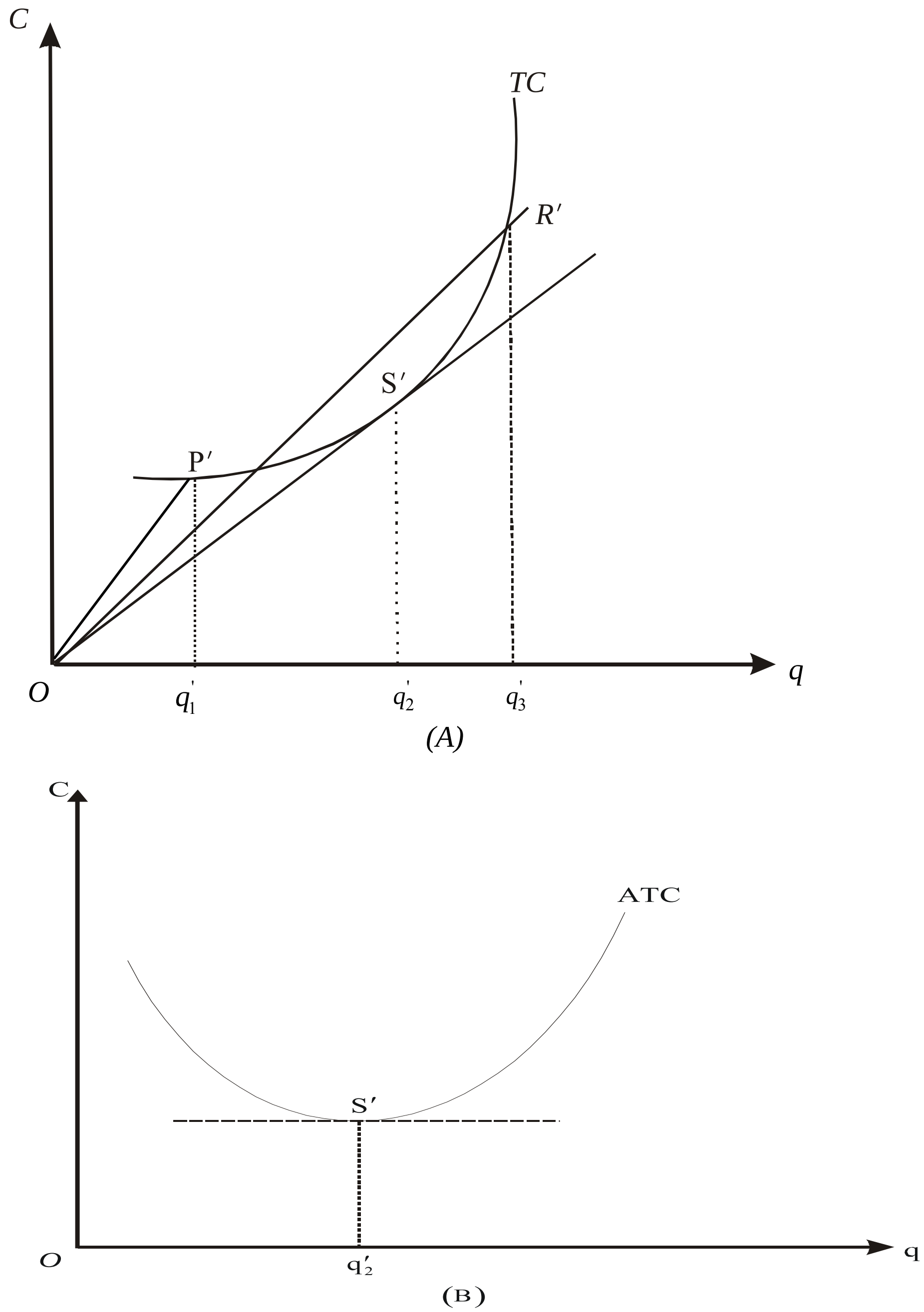


Fig. 5.9: Derivation of ATC from TC

iv) MC – It is derived from the TC curve.

Panel A of Figure 5.10 shows the TC curve. As output increases from OQ_1 to OQ_2, one moves from point P to point V, the total cost rises from TC_1 to TC_2. So, MC is given by,

$$MC = \frac{TC_2 - TC_1}{QQ_2 - QQ_1} = \frac{VR}{PR}$$

Now, let point P move towards V, along TC. As the distance between P and V becomes smaller and smaller, the slope of the tangent T at point V becomes a progressively better estimate of VR/PR. In the limit, for movements in a small neighbourhood around point V, the slope of the tangent gives the MC.

As one moves along TC through points such as P and V, the slope of TC diminishes. It continues to diminish until point S is reached at output level OQ_3 and thereafter increases. Accordingly, we have the MC curve to fall until output level OQ_3 is attained and increases after that.

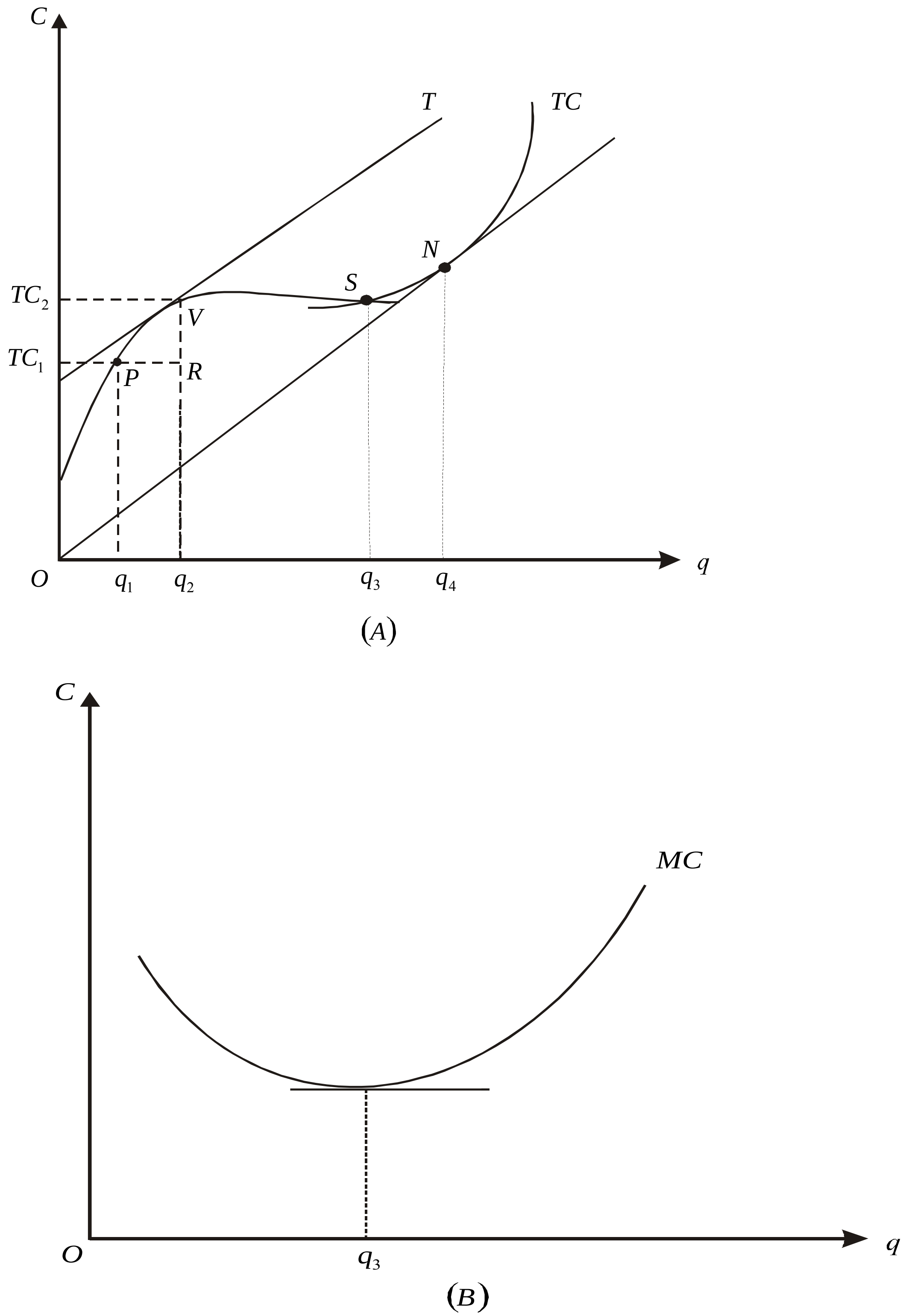


Fig.5.10: Derivation of MC from TC

It will be useful to see that, TC and TVC (in the short-run) have the same slope at each level of output. TC is simply TVC displaced upward by the constant amount of TFC. This is shown in Figure 5.11. Since the slopes are the same, MC is given by the slope of either curve.

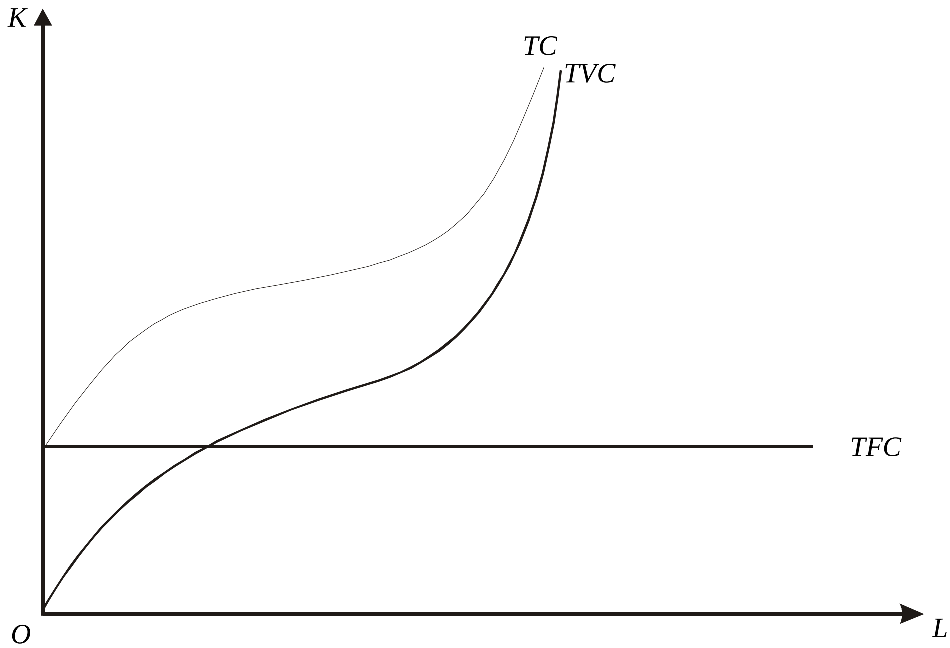


Fig. 5.11: TC, TVC, TFC.

In panel A of Figure 5.8, the slope of the ray OS gives the minimum point on AVC, which is also tangent to TVC. Hence, it gives MC at this point. Thus, MC=AVC, when the latter attains its minimum value.

Similarly, in panel A of Figure 5.10, the slope of the ray ON gives the minimum ATC. The ray being tangent to TC, its slope gives MC. Consequently, MC=ATC, when the latter attains its minimum value.

The properties of the average and marginal cost curves as derived in the previous section can be illustrated the short-run cost curves (Figure 5.12). These are summarised in the following.

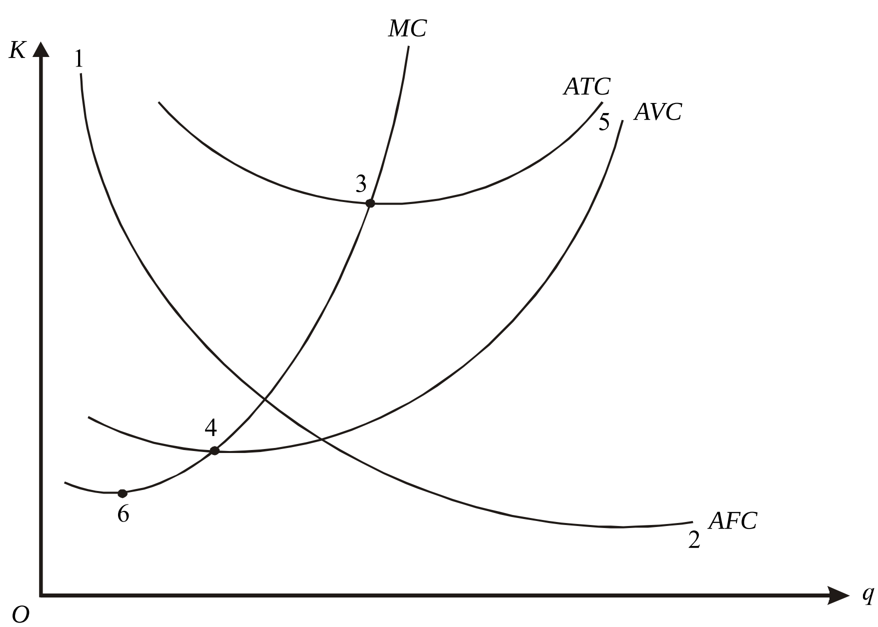


Fig. 5.12: Short-run Average Cost Curves

AFC curve declines continuously approaching both axes asymptotically, as shown by points 1 and 2 in Figure 5.12. AFC is a rectangular hyperbola.

i) AVC first declines, reaches a minimum at point 4 and rises thereafter. When AVC attains its minimum at point 4, MC equals AVC. As AFC approaches the horizontal axis, asymptotically, AVC also approaches ATC asymptotically, as shown by point 5.

ii) ATC first declines, reaches a minimum at point 3 and rises thereafter. When ATC attains its minimum at point 3, MC equals ATC.

iii) MC first declines, reaches a minimum at point 6 and rises thereafter. MC equals both AVC and ATC when these curves attain their minimum values. Furthermore, MC lies below both AVC and ATC over the range in which the curves decline; it lies above them when they are rising.

Check Your Progress 2

1) How are the average curves derived from the TC curves?

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2) Can the MC be derived from the ATC and AVC?

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3) What is the difference between ATC and AVC, if there derivatives are equal?

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4) What kind of a curve is AFC?

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5.3.2 Theory of Cost in the Long-Run

Long-run is a period of time where all inputs are variable. To explain what long period means, suppose technology is such that plants in a certain industry can have only three different sizes – small, medium and large.

Let the plant sizes give rise to the short-run average cost curve SAC_1, SAC_2 and SAC_3.

This is shown in Figure 5.13.

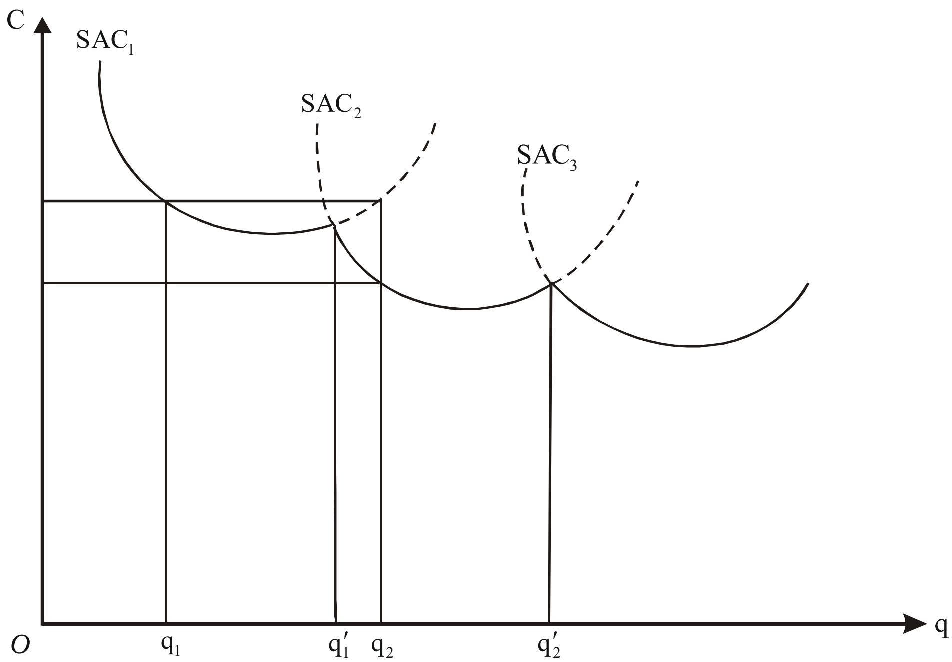

Fig. 5.13: Choice of Plant

In the long-run, a manager has to choose from the three alternative plants. The manager's choice of plant will depend on planned or expected output. To produce output OQ_1, the firm would choose to do it from plant 1, because it is cheapest to produce there. If output is OQ_2, then plant 2 is selected. For output levels OQ_1 and OQ_2, the decision involves some ambiguity. This is because, in these cases, both plants have the same average cost. The manager would choose the bigger plant if she expects demand to rise in future.

Long-Run Average Cost Curve (LRAC)

To derive the LRAC, let us consider six plants at the manager's disposal. These are represented by SCA_1, SAC_2, SAC_3, SAC_4, SAC_5 and SAC_6 as shown in Figure 5.14.

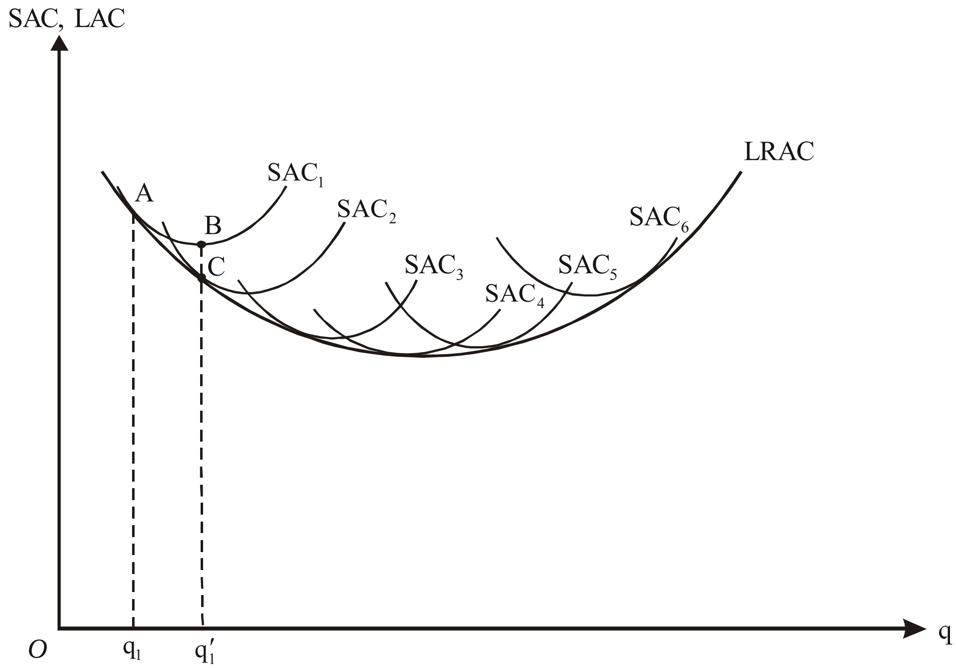

Fig. 5.14: "Envelope" Curve-LAC

Suppose the manager of the firm thinks producing output OQ_1 would be the most profitable. In such a case, plant 1 with average cost curve SAC_1 would be constructed to produce OQ_1. With this plant if output is expanded to OQ_1' then unit cost would fall; because then plant 1 would have been operated at the minimum point (which is shown by point B). Let this level of output be produced at a lower cost (represented by point C) from plant 2. By similar logic, we can see that as output rises, it would be most efficiently (i.e., at lower cost) produced from newly set up plants. The long-run planning curve, LAC, is a locus of points representing the least unit cost of producing the corresponding output. LAC is, therefore, an "envelope" curve of the SCAs.

An interesting point to note here it that at point B, Plant 1 is being most efficiently operated. Yet it pays the manager to shift to plant 2. This is because unit cost is lower at point C than at point B, even though C is not the most efficient point for plant 2. In fact, all plants smaller than type 4 are only used when they are operating at less than the efficient level. Therefore, it is not efficiency for a given plant that matters, but efficiency overall. The LAC is the locus of points with minimum unit cost associated with a particular level of output with respect to all available plants.

Long-Run Marginal Cost Curve (LRMC)

The LRMC is derived from the short-run marginal cost (SRMC) curves. LRMC is formed from the points of intersection of the SRMC curves with the vertical lines (to the X-axis) drawn from the points of tangency of the corresponding SAC curves and LRAC curve. This is shown in Figure 5.16. The LMC must be equal to the SMC for the output at which the corresponding SAC is tangent to the LAC.

For levels of output (Q) to the left of tangency 'a', as shown in Figure 5.15, the SAC > LAC. At the point of tangency, SAC = LAC. As we move from a' to a, i.e., from a position of where SRAC ≠ LRAC, to one of SRAC = LRAC the change in long-run cost becomes greater than that for the short-run i.e., $\frac{\partial}{\partial Q}$ LAC > $\frac{\partial}{\partial Q}$ SAC this means LMC > SMC.

For levels of output, to the right of 'a', SAC > LAC, which by similar reasoning leads to the result that LMC < SMC.

Thus, if we draw a vertical line form 'a' to x-axis, its point of intersection with SMC would be a point on LMC.

Repeating the above procedure for all points of tangency of the SRAC and LAC curves to the left of the minimum point of the LAC, we obtain points of the section of the LMC, which lies below the LAC. At the minimum point M, LMC intersects the LAC. To the right of M, the LMC would lie above the LAC curve and at M, we have,

$SAC_M = SMC_M = LAC = LMC$

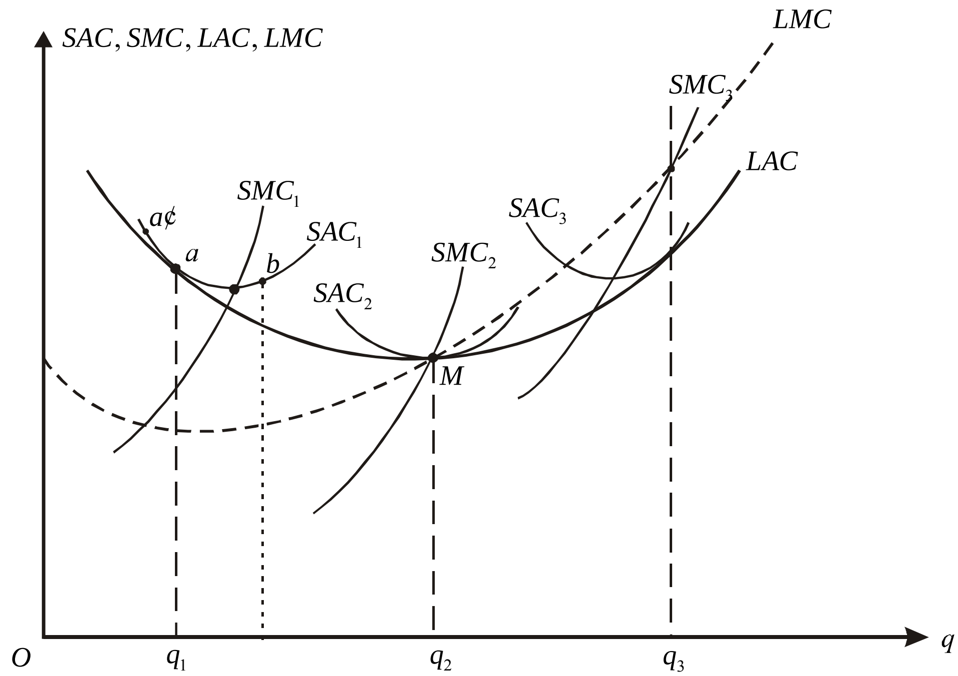

Fig. 5.15: Derivation of the LMC

5.3.3 Economies of Scale

The economies of scale determine the shape of the long-run average cost curve.

As the size of the plant and the scale of operation become larger, certain economies of scale are usually realised. Factors like specialisation and division of labour and other technological improvements enable producers to reduce the unit cost. These factors give rise to a negatively sloped position of the LRAC.

The rising portion of the LAC is usually attributed to the "diseconomies of scale". Such a feature could take place due to limitations in efficient management. It is difficult to determine just when diseconomies of scale set in and when they become strong enough to outweigh the economies of scale. In businesses where economies scale are negligible, diseconomies may soon become of paramount importance and cause the LAC to turn up at a relatively small volume of output. Panel A of Figure 5.16 shows the LRAC for such a firm. Sometimes the LAC may not turn upward until a very large volume of output is attained. This is shown in panel B of Figure 5.16. It is the case of 'natural monopolies'. In many situations, a very modest scale of operation may enable firm to capture all the economies of scale. Diseconomies may not be incurred until the volume of output is very high. In such a case, LAC would have a horizontal stretch, as shown in panel (C).

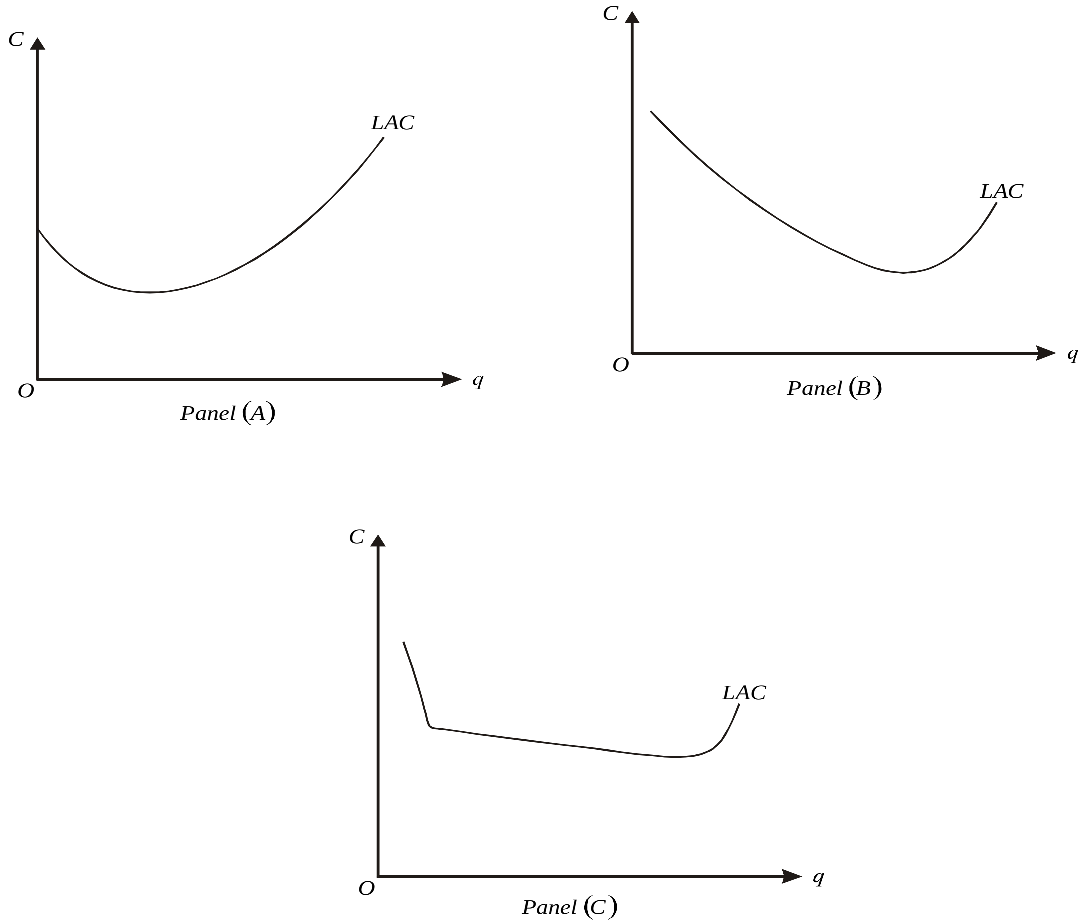

Fig. 5.16: Different Types of LAC

Check Your Progress 3

1) Analyse the relation between LMC and SMC to the right of its minimum point.

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2) Is the LMC also an envelope of the SMCs?

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3) Why is the LRAC called the "envelope" of the SACs?

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4) Does the LRAC contain the minimum points of each SAC curve?

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5.4 MODERN THEORY OF COST

The U-shaped cost curves of the traditional theory have been questioned both on theoretical as well as empirical grounds. George Stigles suggests that the short-run average variable cost has a flat stretch over a range of output, which reflects the fact that firms build plants with some flexibility in their productive capacity. The reasons for this reserve have been discussed in detail by various economists. The U-shape of LAC has been questioned and is often pointed out that it is L-shaped.

In the following sections, we would look at the short-run and the long-run costs under modern cost theory.

Short-Run

Short-run total cost (SRTC) consists of short-run total variable cost (SRTVC) and the short-run total fixed cost (SRTFC) i.e., SRTC = SRTVC + SRTFC.

The corresponding average costs are obtained by dividing each of the above by total output 'Q'.

$$STC = STVC + STFC$$

$$\text{or, } \frac{STC}{Q} = \frac{STVC}{Q} + \frac{STFC}{Q}$$

$$\text{or, } ATC = AVC + AFC$$

Average Fixed Cost

This cost consists of the physical and personal organisation of the firm. These include expenses of maintenance of buildings, land machinery, salaries of the administrative staff etc.

The 'planning' of the firm consists in deciding the 'size' of these fixed factors, which sets a limit to the firm's production (In contrast, variable factors, like labour hours, do not limit the firm's production because these can be hired very easily from the market).

The entrepreneur will plan to produce that level of output, which she anticipates to sell and accordingly she would choose that size of plant, which will allow her to produce that level of output efficiently and with maximum flexibility. The chosen plant would, therefore, have a capacity larger than the 'expected average' level of sales, because the entrepreneur would want to have some **reserve capacity** for various reasons.

The reserve capacity helps to meet the seasonal and cyclical fluctuations in demand. It gives the entrepreneur greater flexibility in repairing broken-down of the production process. Besides, some machinery may be so specialised that they are available only to order, which takes time. In such a cases, the machinery will be bought in excess of the minimum requirement, as a reserve. Generally, some reserve capacities are always allowed in the land and building since expansion of operations may be seriously limited if these have to be acquired. Therefore, an entrepreneur will not necessarily choose the plant, which will give her today the lowest cost, but rather that equipment which will allow the greatest flexibility.

Under these conditions the AFC curve would look like as shown in Figure 5.17. The firm has some 'larges-capacity' units of machinery, which set an absolute limit to the short-run expansion of output (boundary II). The firm also has small unit machinery, which can set a limit to expansion (boundary I). Boundary I is not an absolute boundary, because the firm can increase its output in the short-run, until it is encountered. This can be done in two ways: either by raising the variable factors employed in production or, by buying some additional small-unit types of machinery. If the first method is chosen, then we have the AFC getting extended beyond I, (this then looks like the AFC in traditional theory of cost), if the second is chosen there occurs a break in AFC, whereby we have the portion 'ab'.

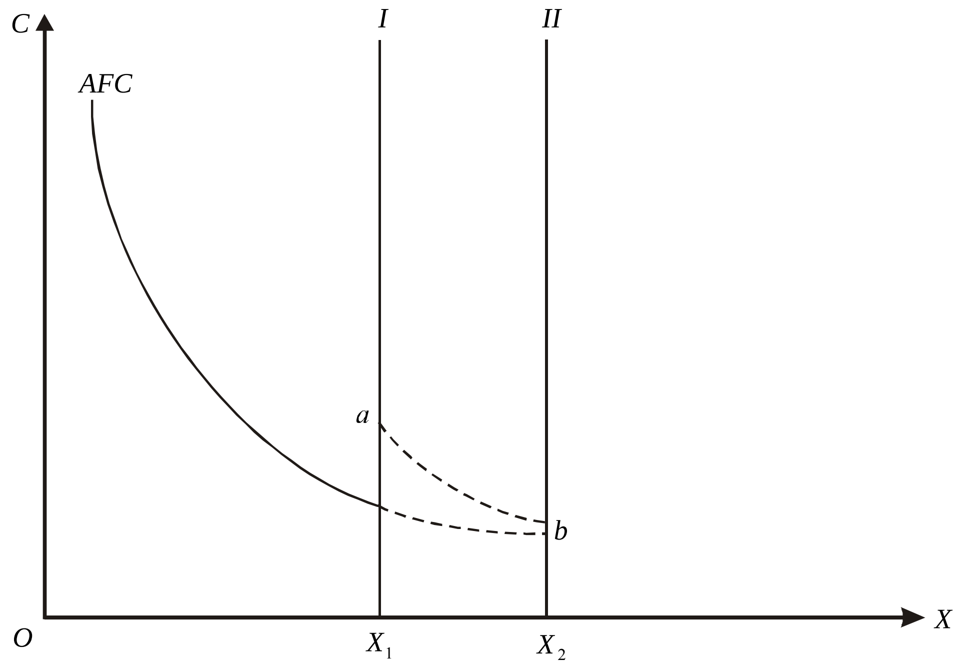


Fig. 5.17: Average Fixed cost in the Modern Theory

Average Variable Cost

As in the traditional theory, the average variable cost of modern theory consists of the cost of variable inputs like labour and raw materials. The SAVC, in modern cost theory is U-shaped but it also has a flat stretch over a range of output, as shown in Figure 5.18. Over this stretch the SAVC = MC, i.e., both being constant per unit of output. As usual, to the left of the flat stretch, MC lies below SAVC and to the right, it lies above SAVC.

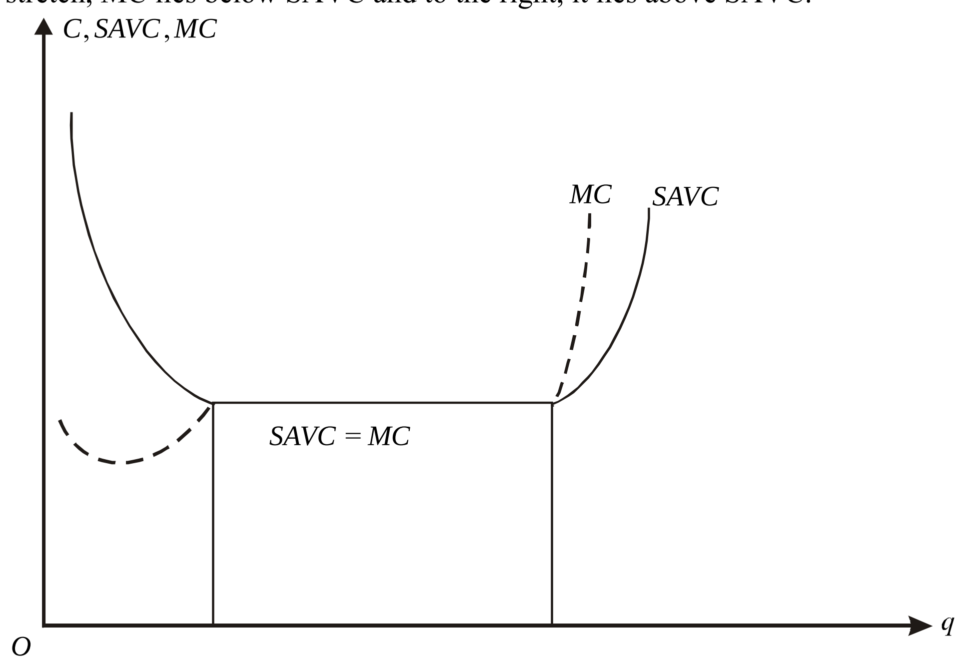


Fig. 5.18: Short-run Average Variable Cost in Modern Theory

The flat stretch in the SAVC is due to the presence of "reserve capacity". It may be important to take note of features that the reserve capacity is planned in order to give the maximum flexibility in the operation of the firm. It is different from "excess capacity", which arises with the U-shaped costs of the traditional theory of the firm. By definition, excess capacity is given by the difference in output corresponding to the minimum level of average cost curve and any other point on the average cost curve to the left of the minimum point. This is shown in panel A of following figure.

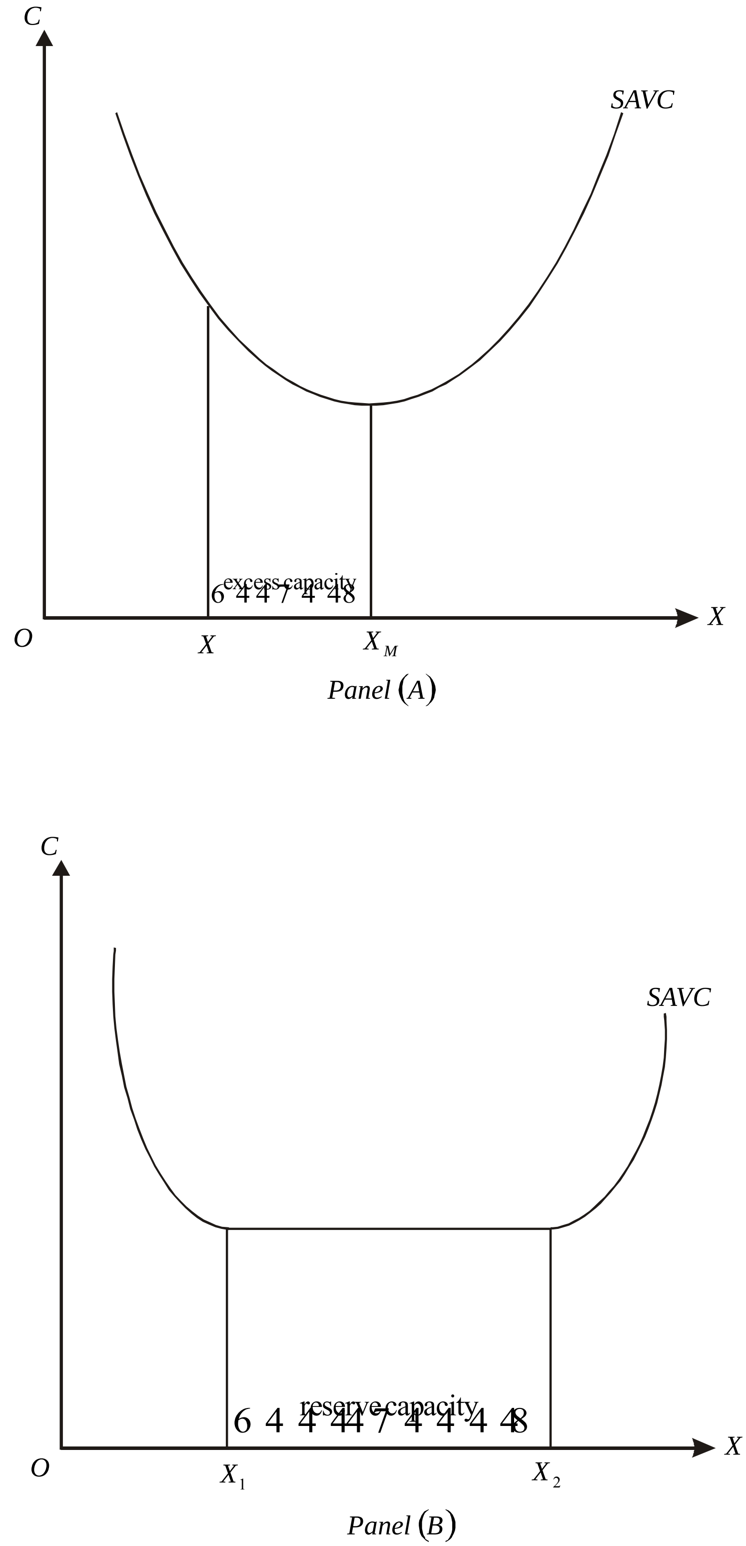
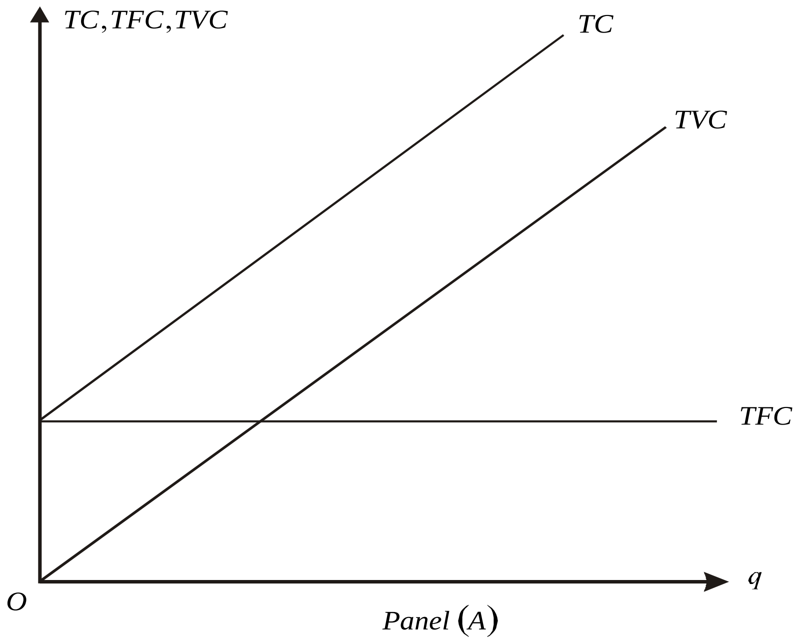


Fig. 5.19: SAVC under Traditional & Modern Theory

The traditional theory assumes that each plant is designed without any flexibility i.e., it is designed to produce optimally only a single level of output (X_M, as shown in panel (A) of Figure 5.19). If the firm produces an output $X < X_M$ there is excess (unplanned) capacity, equal to the difference $X_M - X$. This excess capacity is undesirable because it leads to higher unit costs.

In the modern theory of costs, the range of output X_1X_2 in panel (B) of Figure 5.19, reflects the planned reserve capacity, which does not lead to increases in costs. The firm sometimes chooses to operate the plant closer to X_1 and at others closer to X_2. Generally, the entrepreneur expects to operate her plant within the X_1X_2 range.



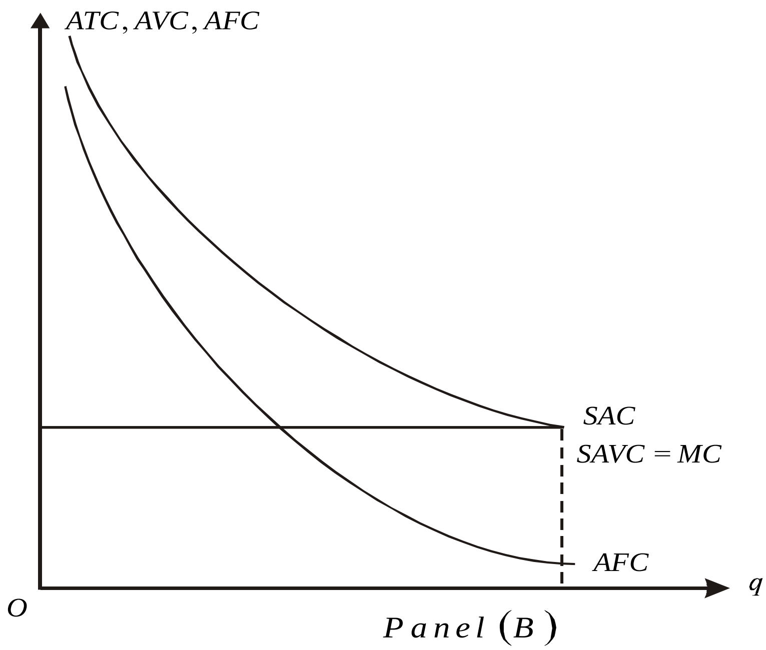


Fig.5.20: Derivation of Short-run Average Cost Curves from Total Cost Curves

Average Total Cost

The ATC is obtained by adding the AFC and AVC at each level of output. The ATC is shown in Figure 5.20. The ATC curve falls continuously up to the level of output (X_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 X_A, at which the flat stretch of the AVC ends).

Long-Run

In the modern theory of cost, the long-run cost curve is taken to be L-shaped. The production costs fall steeply to begin with and then gradually as the scale of production increases. The L-shape of the production cost curve is explained by the technical economies of large-scale production. Initially, these economies are substantial, but after a certain level of output is reached, all or most of these are attained and the firm is said to have reached the **minimum optimal scale**, given the technology of the industry. If new techniques are invented for larger scales of output, they must be cheaper to operate. But even with the existing known technologies some economies can always be achieved at larger outputs like the economies from further decentralization and improvement in skills. Also, being a large firm it may undertake production of some raw materials or equipments needed in production, and thereby may reduce costs.

Derivation of LAC

The LAC as in the traditional theory is derived from the SATC. Let us assume that the firm faces plant sizes represented by short-run costs – $SATC_1$, $SATC_2$, $SATC_3$ and $SATC_4$.

Let us further assume that for all SATCs, costs fall as size increases. In business practice, it is customary to consider that a plant is used 'normally' when it operated at a level between $\frac{2}{3}$rd or, $\frac{3}{4}$th of capacity. Therefore, assuming that the typical load factor of each plant is $\frac{2}{3}$rd of its full capacity, we draw the LAC curve by joining the points on full capacity of each plant size. This is shown in Figure 5.21. Assuming that there are a very large number of available plant sizes, the LAC will be continuous (Figure 5.22). If there is a minimum optimal scale of plant (X in Figure 5.23.), at which all possible scale economies are reaped, then beyond that point the LAC remains constant. As usual if LAC falls continuously, then LMC lies below LAC as in Figure 5.22 and beyond the optimal output level X, LAC = LMC (see Figure 5.23).

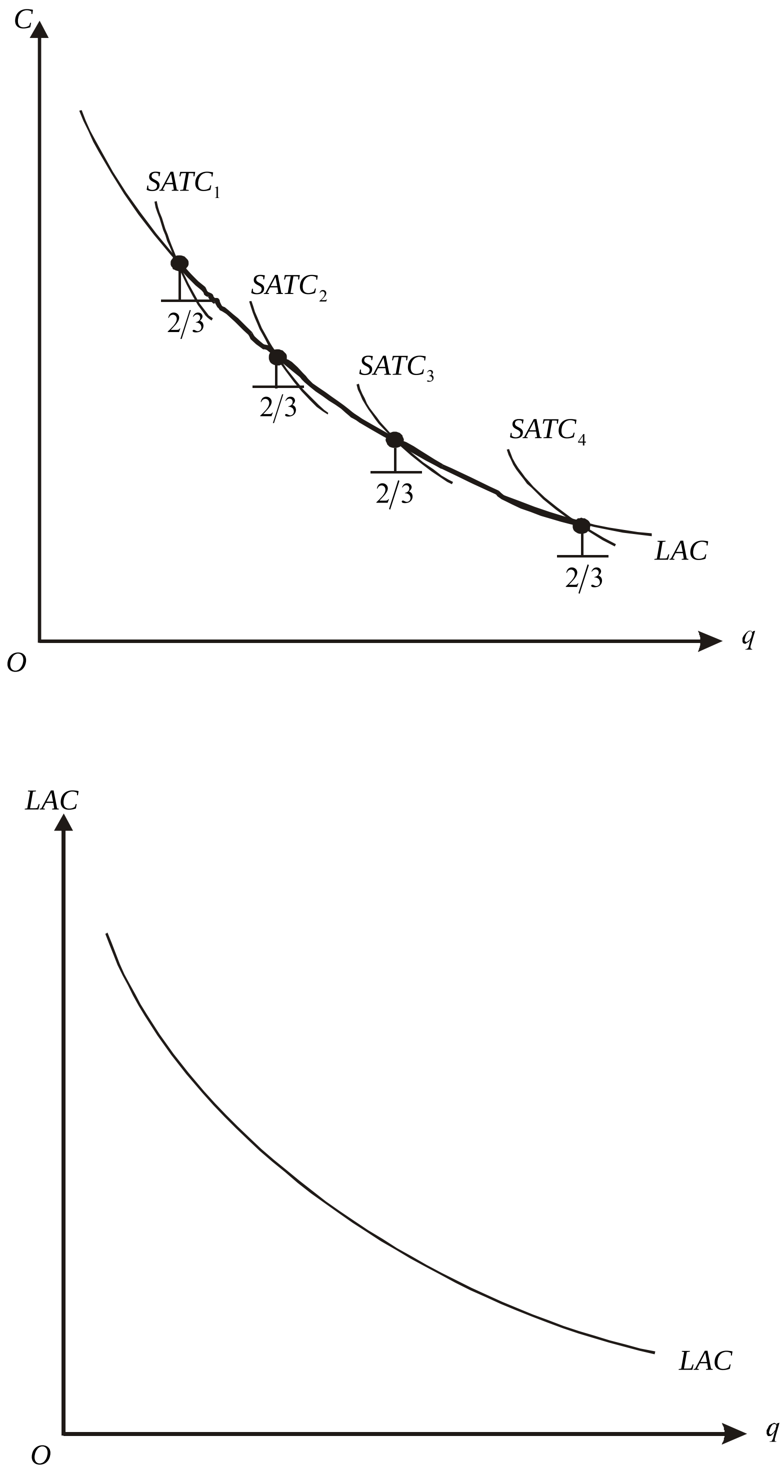


Fig. 5.21: LAC under Modern Theory

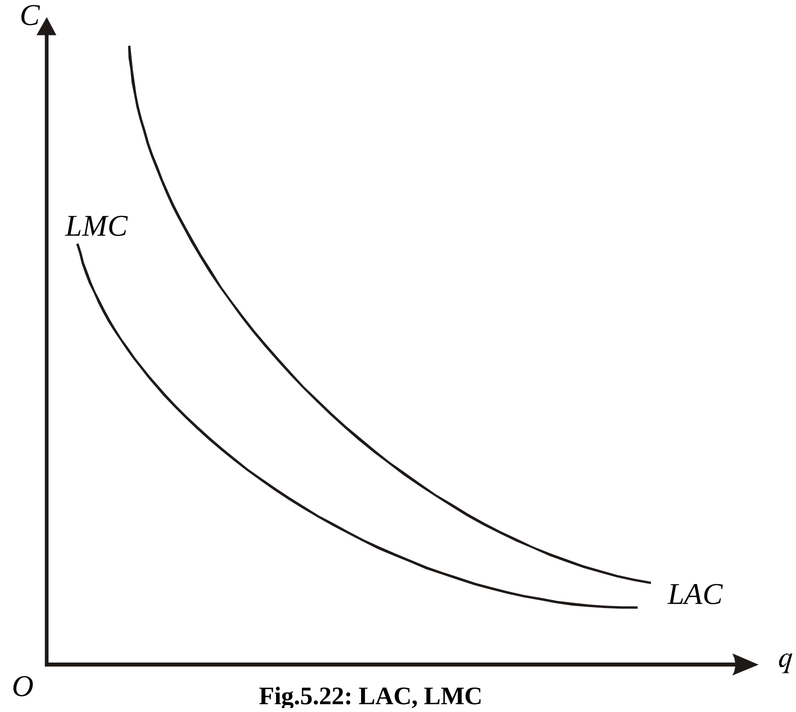


Fig.5.22: LAC, LMC

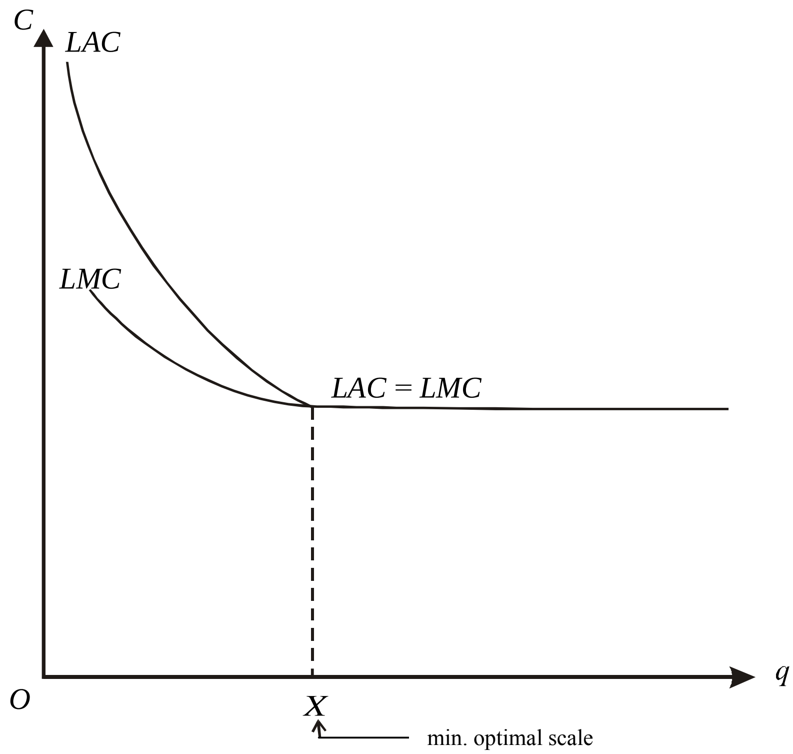


Fig. 5.23: LAC, LMC, Beyond Output X

Most of the empirical studies on cost have provided evidence, which substantiates the hypotheses of a flat-bottomed SAVC and of an L-shaped LAC.

Check Your Progress 4

1) How does the AFC curve in modern cost theory differ (graphically) from that of in traditional cost theory?

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2) What is the shape of the SAVC curve in the modern theory?

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3) What leads to the flat portion of the SAVC curve?

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4) What are the characteristics of the modern LAC?

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5.5 LET US SUM UP

In a production process, costs play an important role. Much of the output to be produced depends on cost conditions. Costs differ with time. Generally, costs are higher if the production occurs in a short period of time due to lack of flexibility in inputs. Therefore, we need to analysis issues for the short-run. This gives rise to concept of short-run cost functions.

In the long-run with greater flexibility, costs conditions are different from that of the short-run. This gives rise to long-run cost functions – LAC, LMC, etc. Another important issue associated with the long-run in the concept of "Economies of Scale", which affects the shape of the LRAC.

Finally, we consider the modern theory of costs, which is more closer to reality. Unlike the traditional theory, which rules out the existence of "reserve capacity", generally maintained by the firms, the modern theory incorporates it and accordingly, we get somewhat different short-run and long-run cost functions.

5.6 KEY WORDS

Average Cost: Cost per unit of output.

Economies of Scale: Factors, which cause to LRAC to decrease as the firms output increases. The firms LRAC is negatively sloped in the presence of scale economies.

Explicit/Accounting Cost: Cost incurred due to the usage of resource in a production process.

Excess Capacity: Difference between the optimum output and the output corresponding to any other point on the AC curve.

Fixed Costs: Costs that the producer has to incur whether she undertakes production with variable inputs or not.

Implicit Cost: It is the opportunity for using the variable inputs in a production process.

Long-Run: A period of time when all inputs are variable.

Marginal Cost: Change in total cost for a unit change in output.

Reserve Capacity: This implies that range of output for which average cost remain same.

Short-Run: A period of time when some inputs remain fixed.

Variable Cost: Cost incurred for using the variable inputs in a production process.

5.7 SOME USEFUL BOOKS

Ferguson and Gould (1989), *Microeconomic Theory*, Irwin Publications in Economics; Homewood, IL: Irwin.

Koutsoyiannis, A. (1979), *Modern Microeconomics*, Second edition, London: Macmillian.

5.8 ANSWER OR HINTS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Short-run is a period when some factors remain fixed; whereas long-run is a period when none remain fixed and all the factors vary.

2) In the long-run, the producer can substitute K for L, and thereby choose the optimum K and L that can produce (see Figure 5.24 below).

Check Your Progress 2

1) The average cost, AC = $\frac{TC}{Q}$ for any level of output, q, AC is given by the slope of the ray from the origin to any point on the AC curve.

2) Yes. This is because of the following:

TC=TVC+TFC.

$$MC = \frac{\partial(TC)}{\partial Q} = \frac{\partial(TVC + TFC)}{\partial Q}$$

$$= \frac{\partial(TVC)}{\partial Q} + 0 \ [\therefore TFC = \text{Constant}]$$

$$\therefore \ MC = \frac{\partial}{\partial Q} TC = \frac{\partial}{\partial Q} TVC$$

3) TC = TVC + TFC

or, $$\frac{TC}{Q} = \frac{TVC}{Q} + \frac{TFC}{Q}$$

or, AC = AVC + AFC

$\therefore$ AC – AVC = AFC

4) It is a rectangular hyperbola. Therefore all along the curve AFC.Q=TFC = some constant.

Check Your Progress 3

1) Let us consider SAC_3, SMC_3 and LAC in Figure 5.15. To the left of the tangency between SAC_3 and LAC, SAC_3 > LAC. From that point we arrive at a point where SAC = LAC. It implies SMC < LMC. Similarly, to the right of the tangency between SAC_3 and LAC, we have SAC > LAC. So from a point where SAC = LAC, we arrive where SAC > LAC, implying SMC > LMC.

2) No. LMC intersects the SMCs.

3) By joining the efficient point of operation of all plants we arrive at the LRAC. Precisely, LRAC is seen to be tangential to the SACs, at some point. On observation it seems as if the SACs are contained in the LRAC curve and also seems as if LRAC envelopes the SACs. Therefore, LRAC is also name as the "envelope curve".

4) No. Except at the minimum point of the U-shaped LRAC, nowhere does the LRAC contain the minimum points of the SACs. The efficient point of the SACs does not necessarily give the lowest cost of producing an output given all the plants at the firm's disposal.

Check Your Progress 4

1) Graphically, the AFC in traditional theory is a rectangular hyperbola, which is falling throughout and is asymptotic to the two axes. Traditional theory does not allow for usage of reserve capacity.

The modern theory, allows for the usage of reserve capacity, so that even in the short-run capacity can be increased till a certain extent. Accordingly, we get a broken AFC curve as shown in Figure 5.17.

2) The SAVC curve falls up to a certain output level, then flattens out for a particular range of output and then rises beyond.

3) Generally firms maintain a 'reserve capacity'. Whereby at the same average variable cost they can produce more output from the given plant (such a plant is planned by the firms from beforehand).

4) a) It does not turn up at very large scales of output.

b) It becomes flat beyond a certain output level.

c) It is not the envelope of the SATCs, but rather intersects them at the level of output defined by the 'typical load factor' of each plant.

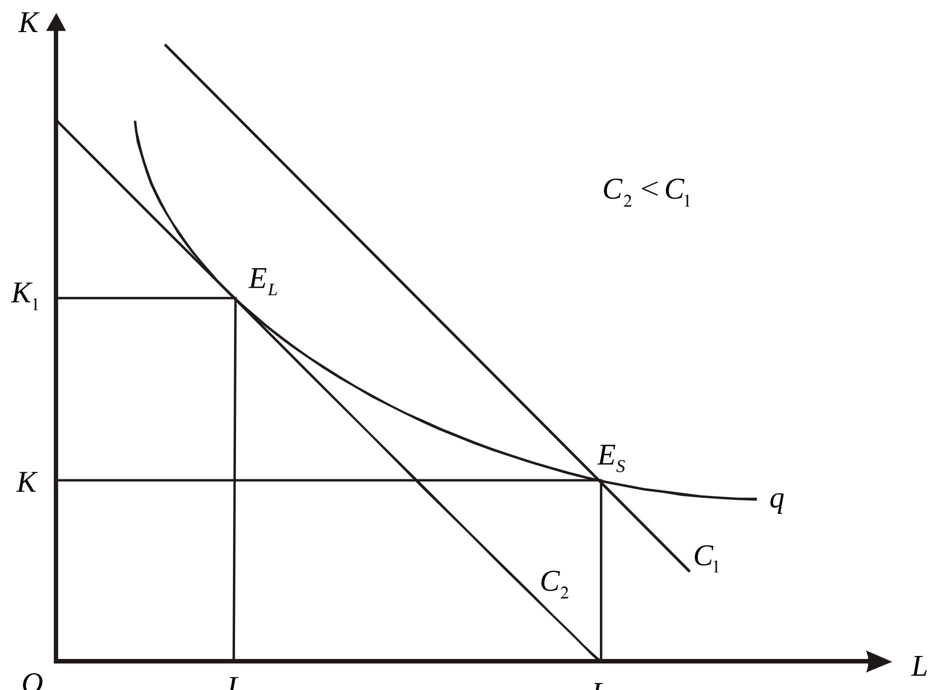

Fig. 5.24

(In the short-run K=$\overline{K}$, so that to produce $\overline{Q}$, more of L has to be employed from the figure we see that equilibrium in the short-run (E_S) occurs at a higher total cost line than E_L **(the long-run equilibrium)**. Therefore, total cost is higher in the short-run. As this will hold for all q and SRTC will always the above LRTC.)

5.9 EXERCISES

1) What are the difference between the LAC under traditional theory and that under modern theory?

2) Derive the short-run cost function for Cobb-Douglas production function given by:

$q = AK^{\alpha}L^{\beta}$, A, α, $\beta > 0$,

where q => quantity of output, K => capital, L => Labour,

[Hint: In the short-run, suppose $K = \overline{K}$]

Show also how the cost curves depend on the parameter β. [Hint: Assume β to be $\frac{\geq}{<}$ 1].

3) Let $c = aq^3 + bq^2 + fq + e$ is a short-run cost function. What should be the restrictions on the parameters (a, b, f, e) for a valid cost function?

4) Suppose a producer's total cost function is as follows:

   $TC = 300 + 3Q + 0.02Q^2$

   where TC = total cost, Q = units of output produced.

   What are the corresponding TFC function, AFC function, TVC function, and AVC function? Plot these curves as well as the MC curve for the first six units of Q.

5) If the long-run total cost curve is linear, what do the corresponding average and marginal cost curves look like?

6) Examine whether the following statements are true or false. Explain your answer.

   a) SRATC is never less then LRATC.

   b) STMC is never less than LRMC.

   c) If the production function exhibits increasing returns to scale everywhere, a firm's LRAC curve must be declining.

   d) Is the MC equal to the slope of both TC and TVC curves, in the short-run?