1. Details of module and its structure

Module Detail	
Subject Name	Economics
Course Name	Economics (Class XII, Semester - 1)
Module Name/Title	Concept of Cost- Part 4
Module Id	lecc_10304
Pre-requisites	Production, Law of Variable Proportions, Returns to Scale Definitions of Costs
Objectives	After going through this lesson, the learners will be able to understand the following: 1. Average costs in the short run 2. Average cost in the long run 3. Relationship between average and marginal cost in short run and long run
Keywords	Short-run Average Cost, Average Variable Cost, Average Fixed Cost and Long run Average Cost.

2. Development Team

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We have already seen in the last module that cost increases as output increases. In order to analyze the pattern of change in costs as output increases, we look at costs through four different concepts:

- Total Fixed Cost
- Total Variable Cost
- Total Cost
- Marginal Cost

1. Average Cost Concepts

Now, let us learn about some other concepts of costs which help us in understanding the production process and decisions of a firm.

Average Fixed Cost

We know that in the short run costs of all factor inputs are not variable and some remain fixed. The average fixed cost (AFC) refers to the per unit fixed cost of producing a commodity. It is calculated by dividing the total fixed cost by the number of units of commodity produced. For example, if total fixed cost of manufacturing 100 fans is Rs 7,500 then,

$$AFC = \frac{total\ \ cost}{no.\ of\ \ units\ produced}$$

$$= \frac{7500}{100} = Rs.75$$

The fixed cost of producing a single unit of fan will be Rs. 75.

Average Variable Cost

Average variable cost is per unit variable cost of producing a commodity. We calculate it by dividing the total variable cost by the number of units produced. For instance, if the total variable cost of manufacturing 100 fans is Rs 12,500 then

$$AVC = \frac{total\ var iable\ cost}{no.\ of\ units\ produced} = \frac{12500}{100} = Rs.125$$

Then the variable cost of producing a single fan is Rs. 125.

Average Total Cost or Average Cost (Short run)

As the name suggests, average total cost is the per unit cost of production of a commodity**.** We calculate it by dividing the total cost by the number of units produced. Suppose, the fixed cost of producing 100 fans is Rs 7,500 and the variable cost for the same number of units is Rs. 12,500. We know the total cost of producing any commodity is the sum of fixed and variable cost. Therefore, the total cost of producing 100 units of fans is Rs.20000 (12500 + 7500).

Now, the average total cost for the fan is,

$$ATC = \frac{total\ \ cost}{no.\ of\ \ units\ produced}$$
$$= \frac{20000}{100} = Rs.\ 200$$

As we can see from the calculation above, the average cost will be equal to Rs 200.

There is a conceptual and, consequently an algebraic relationship between average fixed cost, average variable cost and average cost. Let us try to solve the following hypothetical schedule before discussing the relationship.

A firm producing ice creams has fixed cost of Rs10. The output and variable cost for the firm is provided in the schedule. Calculate the total cost, marginal cost, average variable cost, average fixed cost and average total cost for the firm.

Quantity	0	1	2	3	4	5	6
Variable Cost	0	10	17	25	40	60	110

Hint: TC = TFC + TVC ; MC = □TC/□Q ; AVC = TVC/Q ; AFC = TFC/Q ; ATC = TC/Q

Solution:

Quantity	Variable Cost	Fixed Cost	Total Cost	Marginal Cost	Average Variable Cost	Average Fixed Cost	Average Total Cost
0	0	10	10	-	-	-	-
1	10	10	20	10	10	10	20
2	17	10	27	7	8.50	5	13.50
3	25	10	35	8	8.33	3.33	11.66
4	40	10	50	15	10	2.50	12.50
5	60	10	70	20	12	2	14
6	110	10	120	50	18.33	1.67	20

There is yet another way of defining the average total cost, observable from the above schedule. We know that,

Average Total Cost = Total Cost /Quantity

ie, ATC = (TFC + TVC) / Q

ATC = TFC/ Q + TVC/Q

ATC = AFC + AVC

Now, let us discuss the relationship between average variable cost, average fixed cost and average total cost through a graphical representation of the curves representing these costs.

As a fun exercise you can also plot the values of various costs from the above schedule on a graph. This will provide an approximate idea of the shapes of the corresponding cost curves. Plot the quantity of output on the X-axis and all other cost values on the Y-axis.

Average Variable Cost

We know that average variable cost is the per unit total variable cost, that is it reflects the per unit changes in total variable cost.

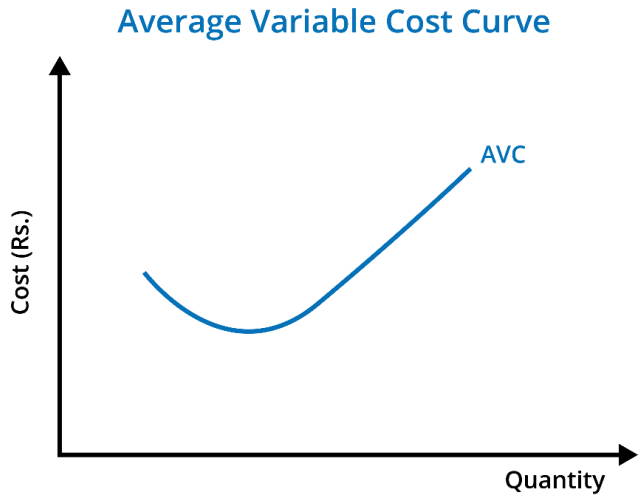

Figure 1: Average variable cost curve

The AVC curve is a U-shaped curve because of the application of the Law of Variable Returns to Factor. As the quantity produced of a commodity increases, the average variable costs diminish, reach a minimum and then start to rise. Initially, the increase in variable input leads to a decrease in variable cost and total cost. However, the inability to increase fixed input in short run means the gains made by additional variable input start to decline. This results in an increase in the total cost and total variable cost at an accelerated rate. Therefore, graphically we observe the AVC curve initially declines and rises after reaching a minimum. The downward moving portion of the AVC curve refers to the initial decline in total variable costs because of the productivity gains made by adding of variable inputs. The upward moving part of the AVC curve, on the other hand, is the result of the increase in TC and TVC because increasing the output and corresponding variable inputs to the production process is only increasing costs beyond this point.

Average Fixed Cost

We know that fixed cost is a constant in the short run. As can be observed from figure 2, AFC is a downward sloping curve. To estimate the AFC we divide this constant cost by a larger and larger quantity of output. Hence the AFC curve will continuously fall with increase in quantity.

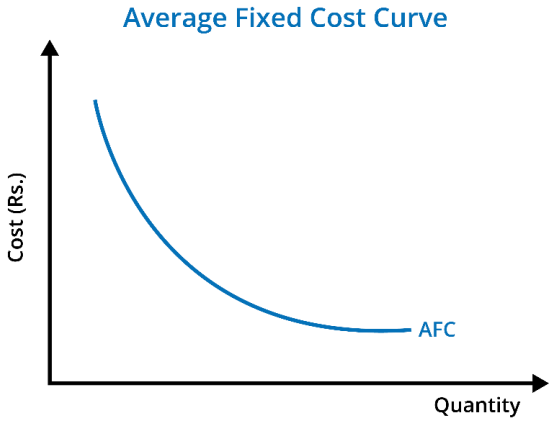

Figure 2: Average fixed cost curve

It is for this reason that the AFC curve is a rectangular hyperbola which means the entire area below AFC is constant. The AFC curve is also asymptotic, implying it never touches either X or Y axis. That AFC curve never reaches X axis implies, there is no output for which the AFC becomes zero. We know, that TFC is a positive constant in short run irrespective of whether the firm produces zero or 100 units of a good. Even if the quantity produced increases to a large number, the AFC which is TFC (constant) divided by the quantity (large number) will produce a positive value tending to zero but never reaching zero. On the other hand, even at zero output the firm will incur the cost of fixed inputs which is a constant. Hence, at zero output AFC is equal to the constant value of TFC divided by zero, which is infinity.

Average Total Cost

In the short run, average cost curve or ATC curve is U-shaped, that is, it falls till a point and then rises. This behavior of AVC is related to the Law of Variable Returns to Factor.

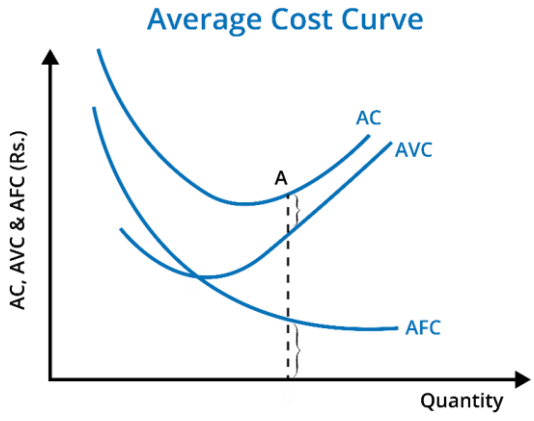

Figure 3 : Average total cost curve

In the above diagram, the minimum point of AVC is at point ‘B’ which is before the minimum point of ATC i.e. point ‘A’. Now let us try to understand the ATC curve with the help of the AFC and AVC curves.

We know that ATC is the sum of AFC and AVC. As the output increases both AVC and AFC start to decline, therefore, ATC which is the sum of the two costs also declines. This is represented graphically by the downward sloping portion of the ATC curve. Since TFC remains constant irrespective of level of output, we know the AFC will continue to diminish with the increase in level of output. Despite this decline, the AFC can never be zero, and graphically never reach the X axis. Given the continuously decreasing value of AFC, the difference between ATC and AVC will always be greater than zero or positive. Therefore, graphically even with increasing output the ATC and AVC curves will never intersect, as difference between the two represents average fixed cost, which can never be zero or negative. In fact, the ATC curve will always lie above AVC curve, as can be seen in Figure 3.

Both ATC and AVC are U-shaped curves but the minimum point of AVC curve, represented in Figure 3 as point ‘B’ is always before the minimum point of ATC curve, represented as the point ‘A’. The decline in ATC is more because of the declining AFC which is also a constituent of the average cost or ATC. Graphically, the downward sloping portion of the ATC curve far exceeds that of the AVC curve.

2. Relationship between Marginal Cost and Average Cost

Before discussing the relationships between marginal cost and average cost we should try to understand how marginal and average are related. Consider an example of a student who scored average marks of 50 in 5 subjects. Now let us say her score in the sixth subject is 80, which is more than her average score of 50. When these marks are added to her previous score, the total score of 6 subjects becomes 330. And the average goes up to 55. On the other hand consider with the same average marks of 50 in 5 subjects she had attained a score of 20 in her sixth subject. This score is much lesser than her average of 5 subjects at 50. Her average score for the 6 subjects will fall to 45. This implies for an additional subject if the marginal score is more than average score it pulls up the average and if the marginal score is less than the average score its pulls down the average.

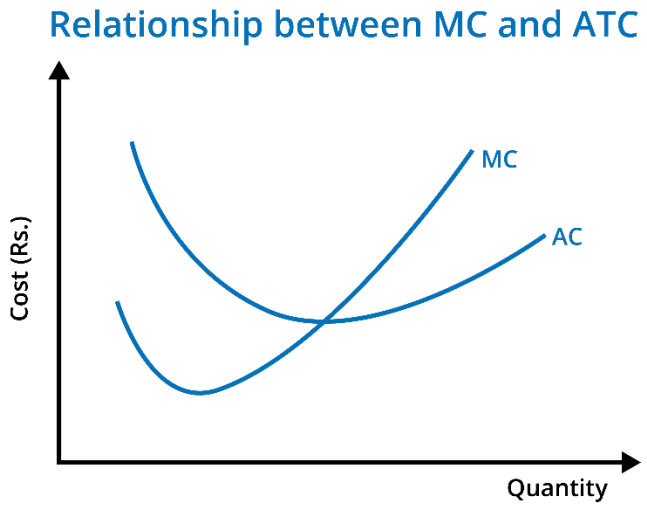

Figure 4: Relationship between average and marginal cost curves

When average total cost (ATC) is falling, marginal cost is less than average cost. As can be observed in the graph, the marginal cost intersects the average cost at its minimum point. The output level at which the value of MC is equal to that of ATC, is the minimum point of ATC. However, as the average cost rises, the marginal cost rises more represented by the portion of MC curve that lies above the ATC curve.

Relationship between Marginal Cost and Average Variable Cost

Both MC and AVC are derived from total variable cost (TVC). Remember, during short run fixed costs do not change: it is only variable cost which changes with change in the level of output. Thus, the changes in marginal costs are in fact due to changes in variable costs.

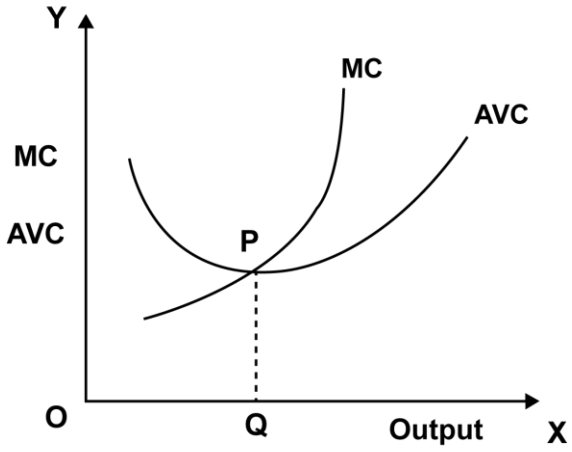

Figure 5: Relationship between marginal and average variable cost

As you can see from figure 5, when average variable cost is falling, the marginal cost is less than average variable cost. This is represented by the downward sloping portion of the AVC curve. The marginal cost curve cuts the AVC at its minimum point. As output increases, the AVC increases leading to a higher rise in the MC. Graphically, this is represented by the portion of the AVC and MC curves beyond output level 'Q'. Here the MC curve lies above the AVC curve.

3. Long-run Average Cost

As we have discussed before, in the long run all inputs are variable, so all costs are variable. This implies, we control the usage of all inputs and can be varied depending on our output level. Now let us look at the long run costs curves (LRAC). The shape of the average cost curve reflects the kind of economies of scale that prevail. The LRAC is a 'U-shaped' or dish-shaped curve if the returns to scale experienced by the firm also varies as output increases.

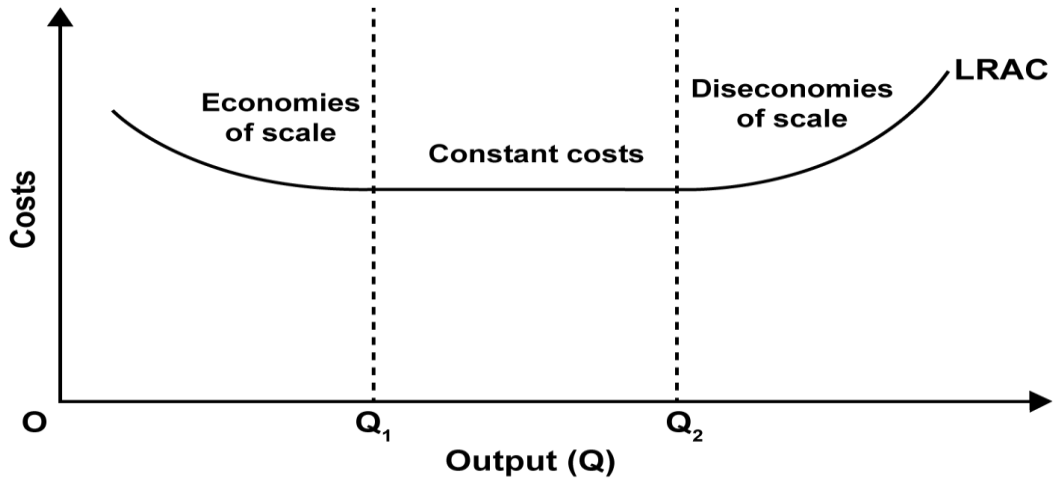

Figure 6: Long-run average cost curve

Initially, in the region OQ_1 this may happen when increasing returns to scale are experienced as output expands for the given technology. Here, technology is an indication of the proportion in which we use the inputs in the production process. For example, the firm may be able to use better machines, more automation etc given its labour force. This leads to gains in output that far outweigh the increase in cost, and firm incurs diminishing costs.

Till Q_1, long-run average costs are witnessing a decline, therefore, LRAC curve slopes downwards. For example, in this phase of production an increase in both the factor inputs by 2 units leads to an

increase in output which is more than 2 units. In other words, the increase in output is more than the proportional increase in inputs, and there are increasing returns to scale This phase of production is referred to as **economies of scale** for the firm.

As output increases beyond Q_1 all the gains from the scale economies are exhausted. Therefore, increasing output further does not lower the average cost. The area between Q_1 and Q_2 is called **minimum efficient scale**. This denotes the range of output for which the average costs are minimum for this firm in the long run. Notice that average costs are constant in this range, corresponding to **constant returns to scale**.

Once, the output goes beyond Q2 the per unit costs start increasing, therefore, LRAC curve starts sloping upwards. It implies that firm's output increases less than in proportion to the increase in inputs. If the firm increases the inputs by 2 units, the increase in the output is lesser than 2 units. These increasing costs are the result of **diseconomies of scale**. These diseconomies may be associated with overcrowding of labour force or, lack of supervision and management, lack of co-ordination and planning to smoothen the supply of inputs etc. In brief, with more production and larger size of the firm, the management/organization of production process becomes inefficient. Therefore, the firm will incur increasing costs and diseconomies of scale.

Cost and Returns to Scale

If the industry faces increasing returns to scale for all ranges of output, the LRAC may never actually begin to slope upwards. In that case the LRAC will be a continuously downward sloping curve. In other words, these are industries for which the more they produce, the lower the long run average cost. These are called **decreasing cost** industries.

Similarly, an industry may never experience increasing returns to scale. If it experiences only constant returns to scale, the LRAC curve will be horizontal. Such an industry is called a **constant cost** industry. Finally, if an industry experiences only decreasing returns to scale, the LRAC will be an upward sloping curve. Such an industry is called an **increasing cost** industry.

Summary

- Average Fixed Cost refers to the per unit fixed cost of production. It is a rectangular hyperbola.

- Average Variable Cost refers to the per unit variable cost of production. It is a U-shaped curve due to law of diminishing returns to factor.
- Average Total Cost refers to the per unit total cost of production and, sum of average fixed cost and average variable cost for a given output. Similar to the AVC curve, it is a U-shaped curve due to law of diminishing returns to factor.
- Relationship between AC and MC
- When MC < AC, AC falls;
- When MC=AC, AC is constant and at its minimum point;
- When MC>AC, AC rises;
- MC increases at a faster rate compared to AC.
- Relationship between AVC and MC
- When MC<AVC, AVC falls;
- When MC=AVC, AVC is at its minimum;
- When MC>AVC, AVC rises;
- MC increases at a faster rate as compared to AVC.
- LRAC can be a downward sloping curve, a horizontal curve and an upward sloping curve depending on whether the firm is reaping economies of scale, constant returns to scale or diseconomies of scale.