Production
&
cost

Production

Production Function

It is an expression of the technological relation between physical inputs and output of a good.

$O_x = f (X_1, X_2, X_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots X_n)$

Here, Ox =Output of the commodity X

F = Functional relationship.

$X_1, X_2, X_3 \ldots\ldots X_n$ = Inputs needed for O_x.

Short Run and Long Run

Short Run

Refers to a period in which output can be changed by changing only variable factors. In the short run, fixed inputs like plant, machinery, building etc. cannotbe changed. It means, production can be raised by increasing variable factors, but till the extent of capacity of fixed factors.

Long Run

Long Run refers to a period in which output can be changed by changing all factors of production. Long period is a period, that is long enough for the firm to adjust all its inputs according to change in the conditions. In the long run, firm can change its factory size, switch to new techniques of production, purchase new machinery etc.

Difference between Short Run and Long Run

Basis	Short Run	Long Run
Meaning	Short Run refers to a period in which output can be changed by changing only variable factors	Long Run refers to a period in which output can be changed by changing all factors of production
Classification	Factors are classified as variable and fixed factor in the short Run	All Factors are Variable in the long run.

Relation with Output	They vary directly with the level of output.	They do not vary directly with the level of output.

Types of Production Function

a. **Short Run Production Function**: This relationship explained by "Law of Variable Proportions.

b. **Long Run Production Function:** This relationship is explained by the Law of Return to Scale".

Concept of Product

1. **Total Physical Product (TPP)**
   Refers to total quantity of goods produced by a firm during a given period of time with given number of inputs.
2. **Average Physical Product (APP)**
   Refers to output per unit of variable input.
   APP = Total Physical Product (TPP) / Units of Variable Factor (n)
3. **Marginal Physical Product (MPP)**
   Refers to addition to total product, when one more of variable factor is employed.

$MPP_n = TPP_n - TPP_{n-1}$

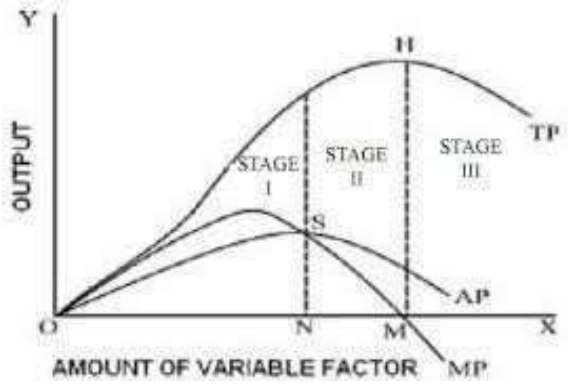
For eg, If 10 labours make 60 kg of rice and 11 labours make 67 kg of rice, then MPP of 11^{th} labour will be :

$MPP_{11} = TPP_{11} - TPP_{10}$

$MPP_{11} = 67 - 60 = 7$ kg.

Relationship between TPP and MPP

1. When MPP rises, TPP increases at increasing rate (Convex)
2. When MPP falls, TPP increases at diminishing rate (Concave)
3. When MPP=0, TPP is Maximum
4. When MPP is negative, TPP declines



Relationship between APP and MPP

1. When MPP > APP, APP increases
2. When MPP = APP, APP is Maximum
3. When MPP < APP, APP decreases.

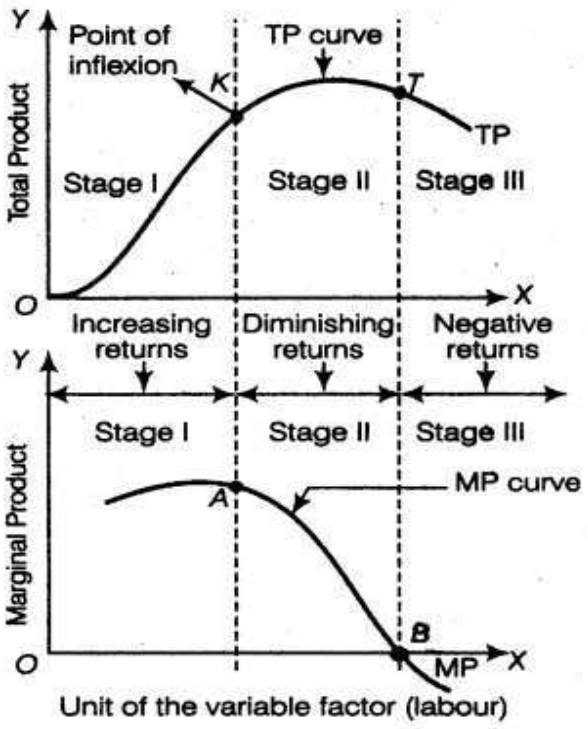
Law of Variable Proportion

The law states that as we increase the quantity of only one input, keeping other inputs fixed, the total product increases at an increasing rate in the beginning, then increases at decreasing rate after a level of output and ultimately falls.

Assumptions

1. It operates in short run, as factors are classified as variable and fixed factor.
2. The law applies to all fixed factors including land
3. This law applies to the field of production only
4. The state of technology is assumed to be constant

Diagrammatic and Tabular Presentation



Explanation of the Law

PHASE I: INCREASING RETURNS TO A FACTOR

In the first phase, every additional variable factor adds more and more to the total output. It means, TPP increases at an increasing rate and MPP of each variable factor rises.

Reasons

As variable input increases specialisation or division of labour takes place, we observe

- Increase in efficiency of the variable input
- Better utilisation of fixed factor.

PHASE II: DIMINISHING RETURNS TO A FACTOR

In the second phase, every additional variable factors adds lesser and lesser amount of output. It means, TPP increases at a diminishing rate and MPP falls with**increase** in variable factor. The second phase ends when MPP= 0, TPP is maximum.

Reasons

With the increase in the quantity of variable input, a pressure on fixed inputs increases, as a result

- Efficiency of the variable input declines
- Imperfect substitutes of fixed and variable factors.

PHASE III: NEGATIVE RETURNS TO A FACTOR

In the third phase, the employment of additional variable factor causes TPP to decline. MPP now becomes negative.

Reasons

Fixed input is too small in relation to variable input. This reduces the efficiency of the variable input so much that MPP becomes negative and TPP starts falling.

Reason for Increasing Returns to a Factor

Better Utilization of the Fixed Factor: In the first phase, the supply of the fixed factor (say, Land) is too large, whereas variable factors are too few. So, the fixed factor is not fully utilised. When variable factors are increased and combined with fixed factor, then fixed factor is better utilised and output increases at an increasing rate.

Increased Efficiency of Variable Factor: When variable factors are increased and combined with the fixed factor, then variable factors are utilised in a more efficient manner. At the same time, there is greater cooperation and high degree of specialisation between different units of the variable factor.

Reasons for Diminishing Returns to a Factor

Optimum Combination of Factors: Among the different combinations between variable and fixed factor, there is one optimum combination, at which total product (TPP) is maximum. After making the optimum use of fixed factor, the marginal return of variable factor begins to diminish.

Reasons for Negative Returns to a Factor

Limitation of Fixed Factor: The negative returns to a factor apply because some factors of production are of fixed nature, which cannot be increased with increase in variable factor in the short run.

Decrease in Efficiency of variable Factor: With continuous increase in variable factor, the advantages of specialization and division of labour start diminishing. It results in inefficiencies of variable factor, which is another reason for the negative returns to eventually set in.

Returns to Scale

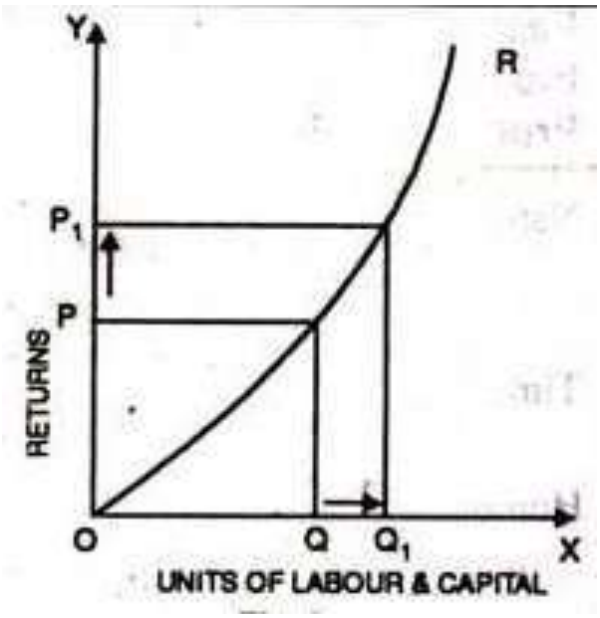
In the long run all factors of production are variable. No factor is fixed. Accordingly, the scale of production can be changed by changing the quantity of all factors of production.

The term "returns to scale" refers to the changes in output as all factors change by the same proportion.

Returns to scale are of three types

Increasing returns to scale

Increasing returns to scale or diminishing cost refers to a situation when all factors of production are increased, output increases at a higher rate. It means if all inputs are doubled, output will also increase at the faster rate than double. Hence, it is said to be increasing returns to scale. This increase is due to many reasons like division of external economies of scale.

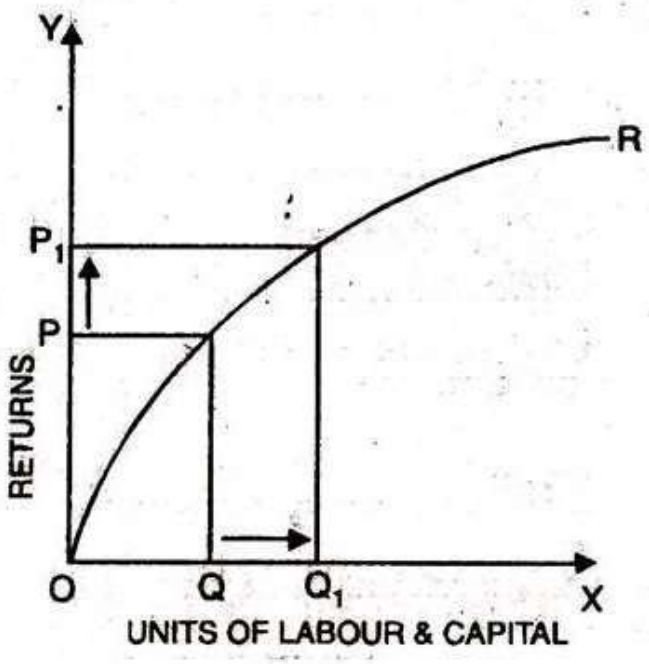


OX axis represents increase in labour and capital while OY axis shows increase in output. When labour and capital increases from Q to Q_1, output also increases from P to P_1 which is higher than the factors of production i.e. labour and capital.

Diminishing Returns to Scale

Diminishing returns or increasing costs refer to that production situation, where if all the factors of production are increased in a given proportion, output increases in a smaller proportion. It means, if inputs are doubled, output will be less than

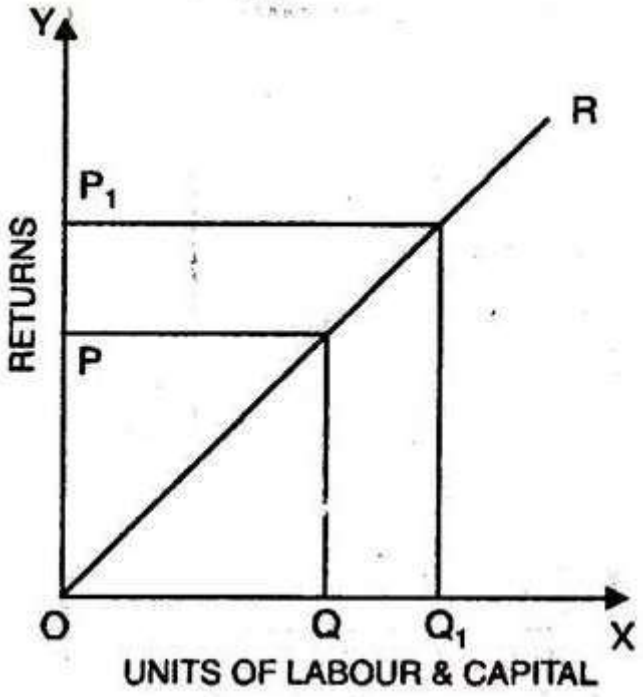
doubled. If 20 percent increase in labour and capital is followed by 10 percent increase in output, then it is an instance of diminishing returns to scale.
The main cause of the operation of diminishing returns to scale is that internal and external economies are less than internal and external diseconomies.



On OX axis, labour and capital are given while on OY axis, output. When factors of production increase from Q to Q_1 (more quantity) but as a result increase in output, i.e. P to P_1 is less. We see that increase in factors of production is more and increase in production is comparatively less, thus diminishing returns to scale apply.

Constant Returns to Scale

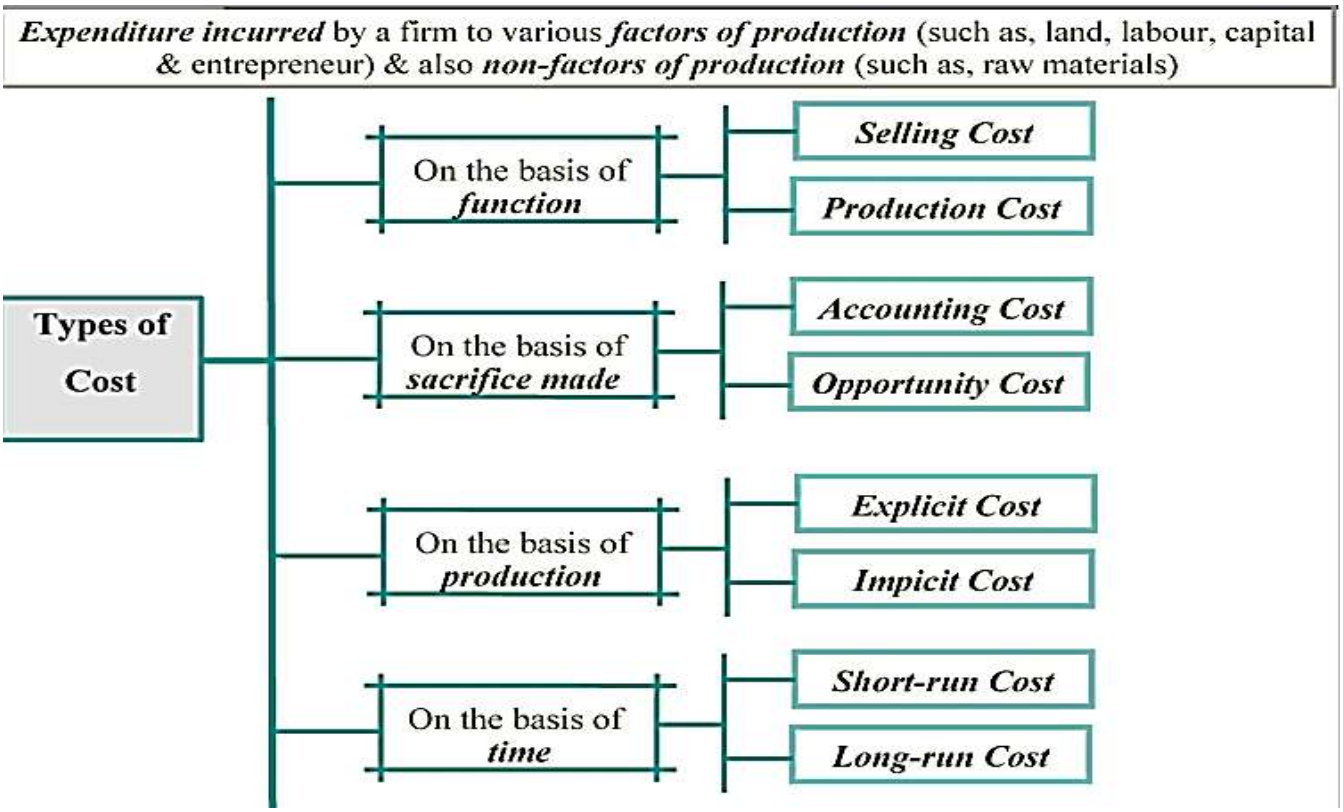
Constant returns to scale or constant cost refers to the production situation in which output increases exactly in the same proportion in which factors of production are increased. In simple terms, if factors of production are doubled output will also be doubled.
In this case internal and external economies are exactly equal to internal and external diseconomies. This situation arises when after reaching a certain level of production, economies of scale are balanced by diseconomies of scale. This is known as homogeneous production function. Cobb-Douglas linear homogenous production function is a good example of this kind.


Y
R
P_1
P
RETURNS
O
Q
Q_1
X
UNITS OF LABOUR & CAPITAL

Cost

MEANING OF COST:

Cost is the total expenditure incurred in producing a commodity. It is the sum total of explicit and implicit cost.



Selling Cost

- *Expenditure incurred* to increase the sale of commodity
- Affects the *demand* for a commodity
- *Example*: Advertisement expenses

Production Cost

- *Expenditure incurred* by a firm on *factors of production* & *non-factors of production*
- Affects the *supply* of a commodity
- *Example*: Expenditure on raw materials, transportation & storage

Accounting Cost

- *Sacrifice of money* or *expenditure incurred* on the purchase of factors of production
- *Recorded* in the books of accounts
- *Example*: Cost incurred in purchasing/hiring raw materials & labour

Opportunity Cost

- *Sacrifice of the next best alternative* in the production of a commodity
- *Not recorded* in the books of accounts
- *Example*: A farmer can produce 80 quintals of rice or 60 quintals of wheat on a piece of land. If *he produces rice*, then *opportunity cost is production of 60 quintals of wheat.*

Explicit Cost: It is the actual money expenditure on inputs or payments made to outsiders for hiring their factor services. For eg, wages paid toemployees, rent for premises etc.

Implicit Cost : It is the estimated value of the inputs supplied by the owners including normal profit. For eg, Interest on own capital , rent forown land / premises, salary for self service of an entrepreneur etc. It is the cost of self supplied factors.

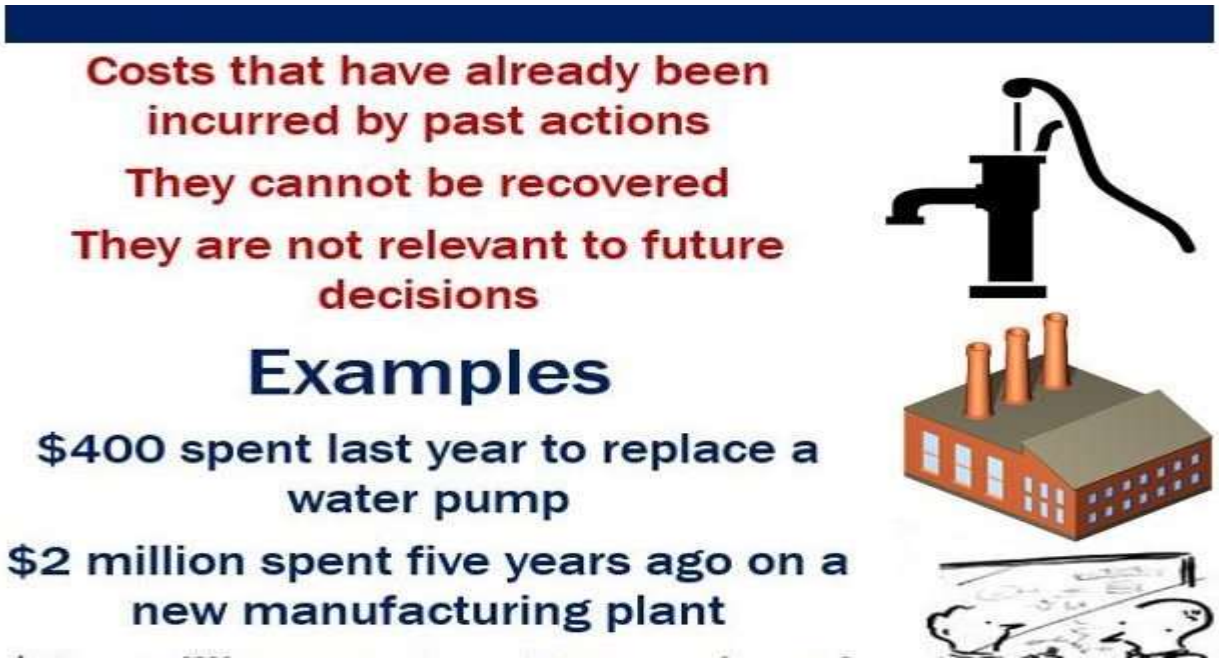
Difference between explicit cost and implicit cost:

Basis	Explicit Cost	Implicit Cost
Meaning	It is the payment madeto outsiders.	It is the cost of self supplied factors.
Payment	It involves actual payment.	It involves imputed value of factors.
Example	Payment of wages, rent, insurance premium etc.	Interest on capital, rent on own premises etc.

Life Cycle Cost:

All types of costs, both recurring and non-recurring that occur from innovation, initiating production for business to disposing of obsolete or old products are known as life cycle costs.

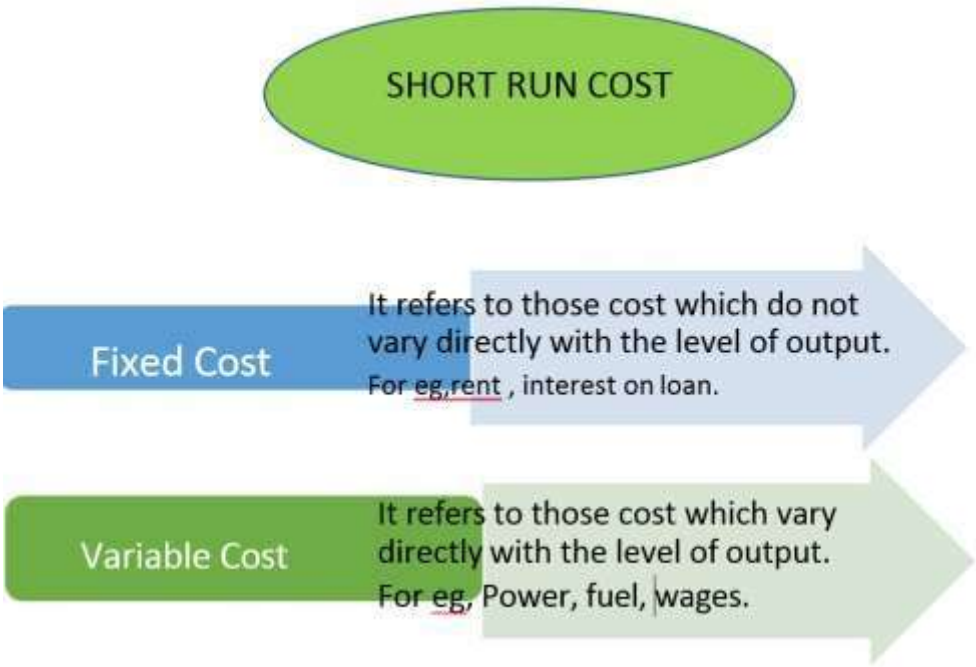
Sunk Cost:



COST FUNCTION :

Cost function refers to the functional relationship between cost and output. It is expressed as : C = f (q)

Where C = Cost of production, f= Functional relationship, and q = quantity of output.



TOTAL COST: It is studied under 3 heads:

(i)Total Fixed Cost(TFC) (ii) Total Variable Cost(TVC) (iii) Total Cost(TC).

TC = TFC + TVC

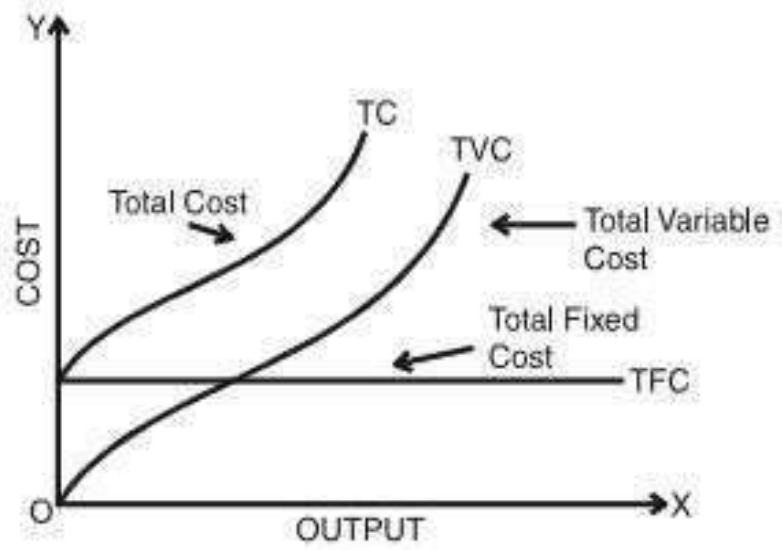
Difference between TFC and TVC

Basis	TVC	TFC
Meaning	It refers to those cost which vary directly with the level of output.	It refers to those cost whichdo not vary directly with thelevel of output.
Time period	It can be changed in the short run.	It cannot be changed in short run.
Zero output	It is zero at no production.	It can never be zero.

Factors of production	It is incurred on variable factors like, labour, raw material etc.	It is incurred on fixed factors like, land, building etc.
Shape of the curve.	TVC is inversely S- shaped	TFC is horizontal straight line parallel to X axis.

Relationship between TC ,TFC and TVC :

1. TFC curve is a horizontal straight line parallel to X-axis.
2. TC and TVC curve are inversely S-shaped. The reason behind it is law of variable proportion.
3. At zero level, TC is equal to TFC because there is no variable cost at zero level of output.
4. The vertical distance between TC and TFC curves is equal to TVC.AS TVC rises with increase in output, the distance between TFC and TC also kept increasing.
5. TC and TVC curves are parallel as the difference between them is TFC which is same at all levels of output.



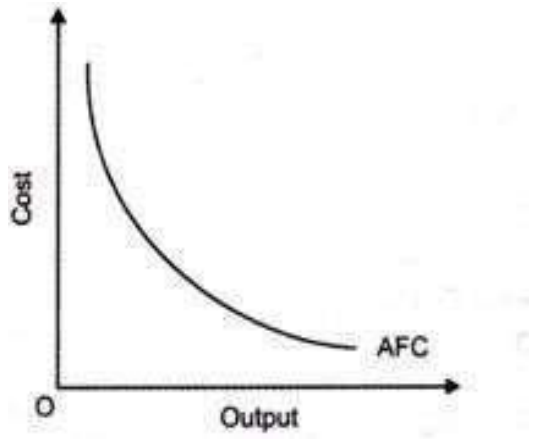
AVERAGE COST :

It is studied under 3 heads:

1. Average Fixed Cost (AFC) 2. Average Variable Cost (AVC) 3. Average Cost (AC)

Average fixed cot refers to the per unit fixed cost of production. It is calculated by dividing TFC by total output.

$$AFC = TFC \div Q$$



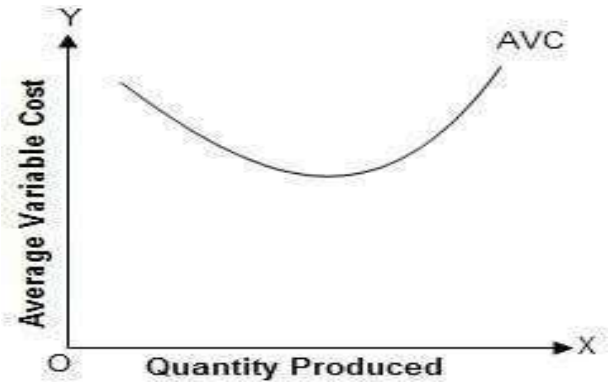
- AFC falls with rise in output as TFC remains same at all the levels ofoutput.
- AFC curve slope downwards as AFC falls with increase in output.
- * AFC is a rectangular hyperbola ie, the area under the curve remains same atall the points.
- * AFC does not touch any of the axis.

  ** It does not touch the X-axis as TFC is never zero.

  ** It does not touch the Y-axis at zero level of output as TFC is apositive value, which divided by 0 will be infinite.

AVC: It refers to the per unit variable cost of production. It is calculated bydividing TVC by total output.

AVC = TVC ÷ Q



AVC initially falls with increase in output and after reaching itsminimum level it starts rising.

The 3 phases of AVC curve ie, decreasing, constant and increasing phases corresponds to the 3 phases of Law of variable proportion.

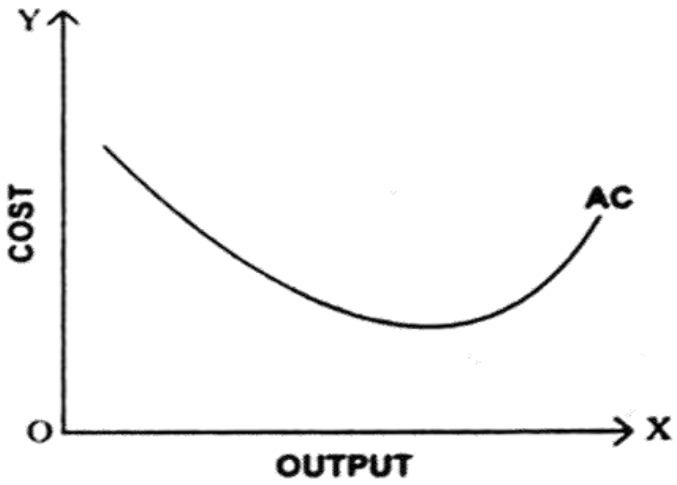
Average Cost / Average Total cost

It refers to the per unit total cost of production. It is calculated by dividing TC by total output.

AC = TC ÷ Q

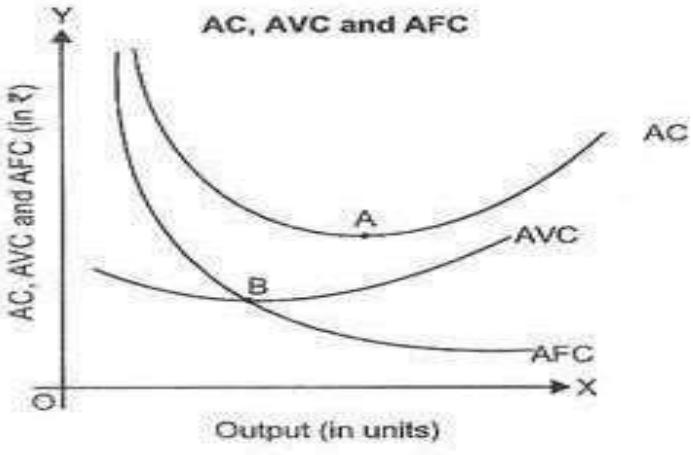
AC is also defined as the sum of AFC and AVC

ie,AC = AFC + AVC.



AC is a U – shaped curve.

- **AC, AVC and AFC**



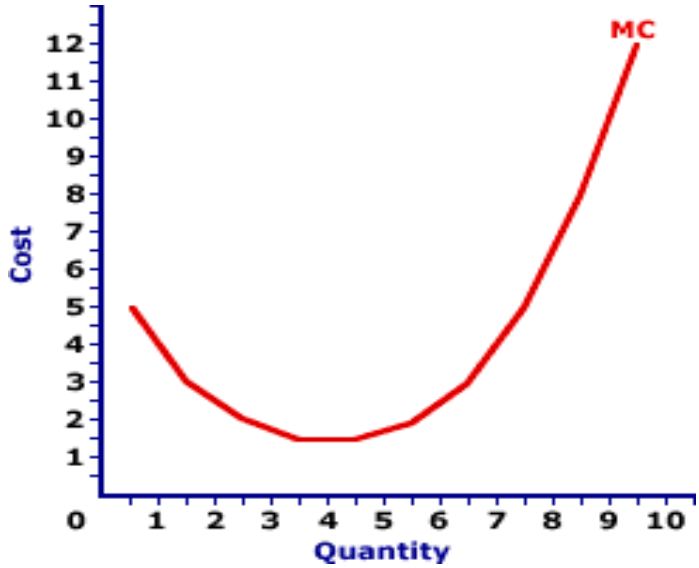
Marginal Cost:

It refers to addition to total cost when one more unit of output is produced.

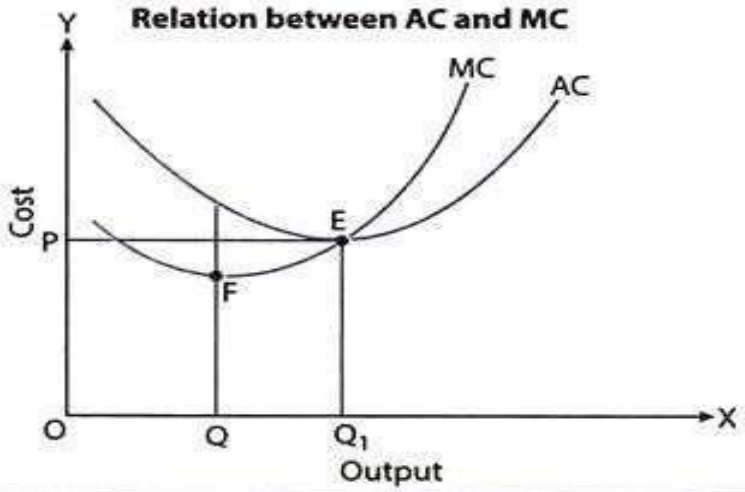
MC n = TCn – TCn-1

Or MC = Change in TC / Change in units of output.

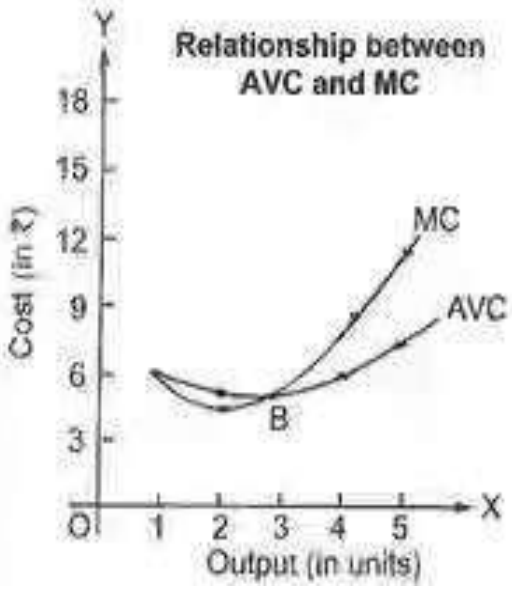
Marginal cost is not affected by Fixed Cost, it is only affected by changes in TVC.



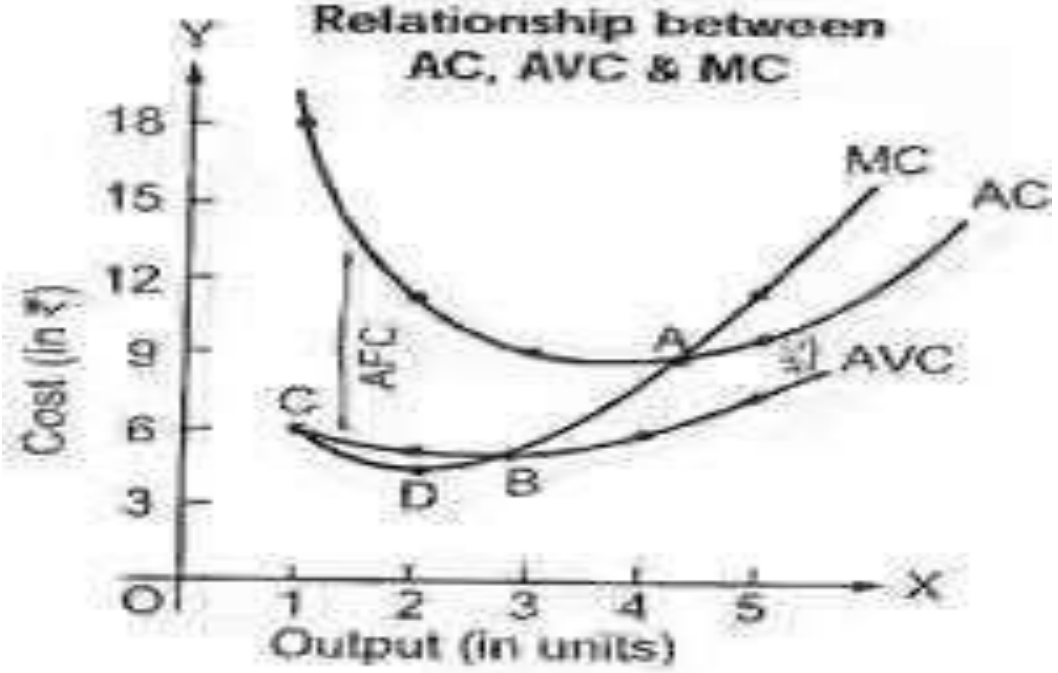
MC is a U-shaped curve, it is due to the law of variable proportion.



- When AC is falling, MC < AC.
- When AC is rising, MC > AC.
- When AC is constant (as at point E), MC = AC.
- MC is always to the left of AC, and cuts AC from its lowest point.



- When MC < AVC, AVC falls
- When MC = AVC, AVC is constant and at its minimum point
- When MC > AVC, AVC rises



Long Run Total Cost

Long Run Average Cost