# THEORY OF PRODUCTION

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https://sites.google.com/a/nirmauni.ac.in/2hm203-_-eebm_even_2014/

# Production: Meaning

**Any activity which creates value is production.**

**In other words, production is transformation of inputs (such as capital, equipment, labour, and land etc ) into output such as good or service .**

**e.g. – transporting sand, operating a jeweller store, drilling for oil, recruiting new employees, designing a system to measure air pollution, producing biscuits, cultivation, trading and so on.**

# Production Function

**Production function express the technological relationship between physical inputs and physical output of a firm under given technology.**

**A production function may be write as follows**

$$Q = f(N, L, K, E, \ldots..)$$

**where**

**Q = output (total product)**

**N (land), L(labour), K(capital), E(entrepreneurship) , .. are the inputs.**

# Inputs (Factors)of Production/ Factor Inputs/Factors/Inputs

**Factors of production are broadly classified as :**

**Land:**

**Anything which is gift of nature and not the result of human effort, e.g. soil, water, forests, minerals. Owner of land is called landlord. Reward of land is called as *rent*.**

**Labour:**

**Physical or mental effort of human beings that undertakes the production process. Labour is supplied by the workers. Labour can be skilled as well as unskilled, physical or intellectual. Reward/price of labour is called as *wages/ salary*.**

**Capital:**

**Wealth which is used for further production as machine/ equipment/intermediary good. It is outcome of human efforts meaning capital is man-made. Reward of capital is called as *interest***

**Enterprise/Entrepreneurship/organisation:**

**The ability and action to take risk of collecting, coordinating, and utilizing all the factors of production for the purpose of uncertain economic gains. Owner of enterprise is entrepreneur. Reward of entrepreneurship is called as *profit*.**

# Concept of Time

**Alfred Marshal introduced the element of time in production decision. Time can categorize as under:**

## Market Period or Very Short Period:

**Market Period or Very Short Period is a period during which all factors of production and hence cost remains fixed. As such, outputs as well as supply also remain fixed.**

## Short Run:

**Short run a period so brief that the amount of at least one input is variable and rests are fixed. Thus we have both fixed as well as variable factors.**

## Long Run:

**Long Run is a period of time sufficient enough for all inputs (or factors of production), to be variable as far as an individual firm is concerned.**

- **The length of time necessary for all inputs to be variable may differ according to the nature of the industry and the structure of a firm.**

# Factors (Inputs) of Production: Classification

**Factors inputs are classified as fixed and variable.**

**Fixed factors :**

**Fixed factors are not related to volume of output. The cost of these factors remain fixed whether output is more or less or even zero.**

**Variable factors:**

**Variable factors are directly related to volume of output. E.g. Unskilled labour, raw materials, fuel.**

- **Distinction between fixed and variable factors is restricted to short period only. For instance, in the short run plants, machines or equipment are regarded as fixed.**

- **In the long period, all factors are supposed to be variables.**

# Concept of Product

**There are three concepts of product such as:**

- **Total Product**
- **Average Product**
- **Marginal Product**

**Total Product :**

**Total Product refers (TP) to the total volume of goods and services produced by a firm during a given period of time.**

$$TP = AP\,xL = \sum \text{MP}$$

***Where L is quantity of a factor***
***AP is the average productivity of a factor.***

***MP is marginal productivity of a factor .***

## Average Product:

**Average Product (AP) is output (total product) per unit of a factor.**

$$\text{i.e. } AP_L = \frac{Q}{L}$$

**Where**

**Q is total product**
**L is quantity of a factor input.**

## Marginal Product:

**Marginal Product (MP) is rate of change in total product with respect to a factor.**

**In other words, marginal product is the addition to total product by utilizing one more one unit of variable input to the production process, keeping other factor fixed.**

$$\text{i.e. } MP_L = \frac{dQ}{dL}$$

**Where**

**dQ is change in total product**
**dL is change in quantity of a factor input.**

# Laws of Production

**Theory of production is the study of production functions.**

**There are two theories of production. Such as:**

- **Law of Variable Proportions/ Law of Return to a Factor/ Short Run Production Function**
- **Law of Return to scale / Long Run Production Function**

# LAW OF VARIABLE PROPORTIONS/ LAW OF RETURN TO A FACTOR/ SHORT RUN PRODUCTION FUNCTION

**Laws of variable proportion studies reaction of output to changes in a variable factor such as labour while others factor inputs are fixed in short turn.**

**Hence, short-run production function can be written as:**

$$Q = f(L, \overline{K}\ \overline{N}, \overline{E}, \ldots)$$

**where**

**Q = output (total product), L is labour and $\overline{K}$, $\overline{N}$, $\overline{E}$ are fixed capital, fixed land, fixed entrepreneurship respectively.**

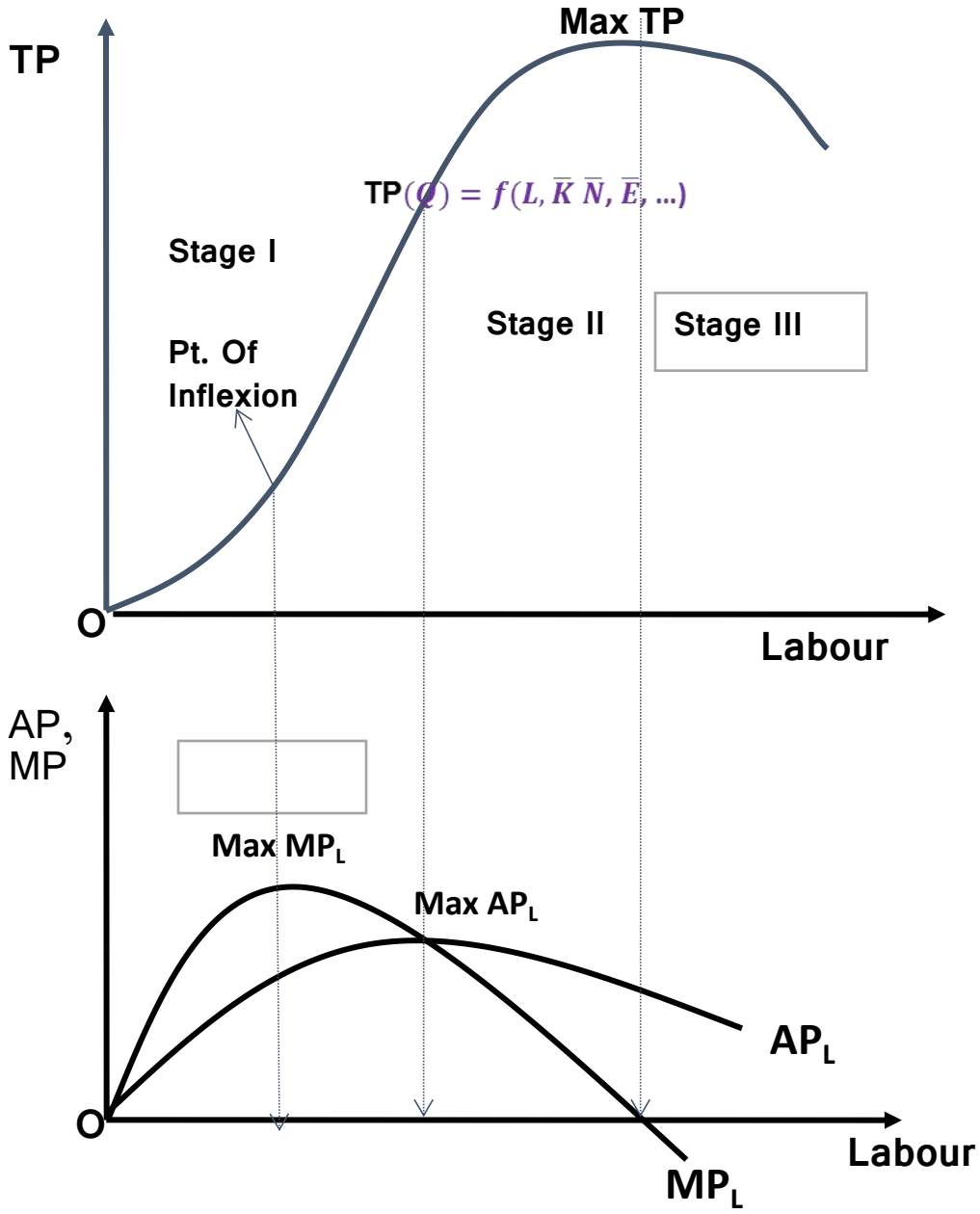
## Statement:

**Law of variable proportion states as more and more quantities of a factor (say labour) is employed with fixed quantities of other factors in short run, total output increases at**

- **an increasing rate (increasing return to a factor),**
- **decreasing rate (decreasing return to a factor),**
- **and finally diminishes after reaching its maximum point (negative returns to a factor) .**

## Assumptions:

1. **There is short run**
2. **State of technology is given and unchanged**
3. **Capital is fixed**
4. **Factor-proportion (ratio of variable input to fixed inputs) is variable . and keeps on chaning.**




**Explanation:** Three stages of law of Variable Portions

As the variable input (Labour) is increased while keeping the other factors, behavior of output exhibits three distinct stages. These stages are illustrated graphically as follows.

**Stage I:** First stage starts from origin and ends at maximum average of the variable factor ($AP_L$). Total Product (TP) is increasing at an increasing rate up to the point of inflexion at which means marginal product of variable factor ($MP_L$) attains its maximum point. After point of inflexion, TP increases at a decreasing rate meaning $MP_L$ is falling. $MP_L$ continues to fall until becomes equal to maximum $AP_L$. At this stage, MP of fixed factor is zero. This stage is called the stage of **increasing returns** as $AP_L$ is increasing.

**Stage II:** Second stage starts from maximum $AP_L$ and ends at maximum TP or zero $MP_L$. TP continues to increase at a decreasing rate meaning $MP_L$ continuing to fall. When TP reaches maxim point, MPL becomes zero. $AP_L$ starts falling from its maximum point. This is stage of **diminishing returns** because both $MP_L$ and $AP_L$ fall from this stage.

**Stage III:** Third stage starts from maximum TP or zero $MP_L$ at this stage TP starts falling for which $MP_L$ negative. $AP_L$ continues to fall but would never become equal to zero. This stage is called the stage of negative **returns** since MP of variable factor is negative.

## Causes of Law of varible proprtion :

**Stage I- increasing returns:**

**i) Indivisibility of Fixed Factor:** In the beginning, the quantity of fixed factor is abundant relative to the quantity of variable factor. Therefore, when more and more units of variable factor are added to the constant quantity of fixed factor (indivisible factors like plant and machinery), then the fixed factor is more intensively and effectively utilized.

**(ii) Division of Labour and Specialization:** The second reason why we get increasing returns at the initial stage is that as more units of the variable factors are employed the efficiency of the variable factor itself increases.This is because when there is a sufficient quantity of the variable factor, it becomes possible to introduce specialization or division of labour which results in higher productivity. Higher productivity leads to decrease in cost per unit.

**Stage II- Diminishing returns:**

**i) Efficinet utilization of the fixed factor:** Once the point is reached at which the amount of variable factor is sufficient to ensure the efficient utilization of fixed factor, the further increase in variable factor will cause marginal and average product to decline because the fixed factor then becomes inadequate in relation to the quantity of variable factor.

## Causes of Law of varible proprtion contd.

**ii) Imperfect Substitutability of the Factors:** Joan Robinson goes deeper into the causes of diminishing returns. She holds that the diminishing returns occur because the factors of production are imperfect substitute for one another. According to her, if factors are perfectly substitute of one another, neither increasing return nor diminishing return occurs.

## Stage III- Negative Returns

**Abundant Variable factors:** In Third stage, the number of variable factors becomes too excessive relative to the fixed factor such that they get in each other's way with the result that the total output falls instead of rising.Due to excessive variable factors, there would be mismanagement, lack of supervision, overcrowding, lack of co-ordination, which ultimately results in decrease in production and as such marginal product of labour will become negative.

## Stage of Operation in law of variable proortion : Decision Making by a Rational Producer

A rational producer will choose none of stage I or stage III (which are completely symmetrical). In stage I, the fixed factor is abundant relative to variable factor and hence, MP of fixed factor is negative. In stage III, variable factor is to much compared to fixed factor, and hence MP of variable factor is negative.

Thus, stage I and stage III are called the stages of economic absurdity or economic non-sense, represent non-economic region in production function.

A rational producer will seek to produce at stage II where both MP and AP of variable factor are diminishing returns. Stage II represents the range of rational production decision.

# LAW OF RETURNS TO SCALE / LONG RUN PRODUCTION FUNCTION

Long-run proudction function or “Returns to scale” studies the behavior of output or returns when all factor inputs are increased or decreased simultaneously, and in the same proportion in the long-run.

While the choices of inputs will obviously vary with the type of firm, a simplifying assumption is often made that the firm uses two inputs such as: labor(L) and capital (K). Long run production function can be wrtiine as :

$Q = f(L, K)$

Returns to scale is the rate at which output increases in response to given proportional increase in all inputs.

The concept of Returns to Scale helps a producer to work out the most desirable combination of factor inputs so as to maximize his output and minimize his production cost.

## Assumptions _Laws of Retunns to scale

- All factors (inputs) are variable but enterprise is fixed
- A worker works with given tools and implements
- Technological changes are absent
- There is perfect competition
- The product is measured in quantities
- Factor proportion (ratio of labour  to capital) is given and fixed.

**Law of Retuns to scale _ Statement :**

**When scale (set of all inputs) is expanded in the same proportion, effect on output may take tree forms such as:**

- **increasing returns to scale**
- **constant returns to scale**
- **diminishing returns to scale**

**If output increases by the same proportion as the factors or inputs, we say that there are constant returns to scale.**

**If outputincreases more than proportionally with the increase in the inputs , we have increasing returns to scale.**

**If output increases less than proportionally with the increase in theinputs , we have decreasing returns to scale.**

## Three Phases: Numerical Illustation

**Let us assume that scale of production compose of quantities of labor and capital. It is increased by 100 percent. Doubling the scale will give us 100 percent increase in scale. The reaction of output to 100 percent increase in scale is given as follows in the following table:**

**Table: Showing Three Phases of Returns to Scale**

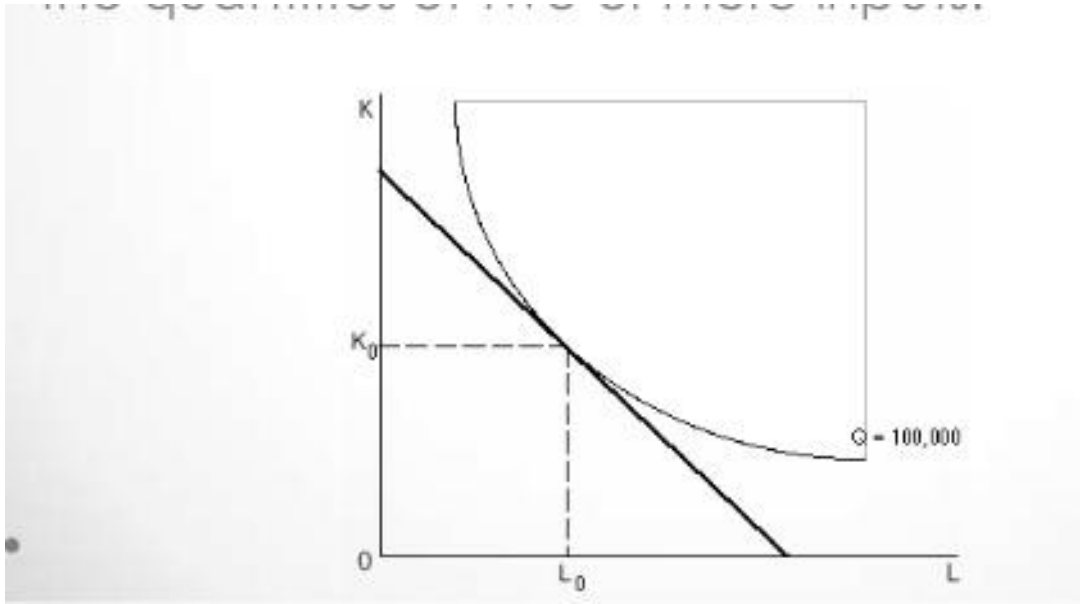
| Scale of Production (Units of Labour & Capital ) | Total Product (Units) | Return to Scale |
|---|---|---|
| 1 labour + 2 capital | 10 | Increasing |
| 2 labour + 4 capital | 25 | |
| 4 labour + 8 capital | 60 | Constant |
| 8 labour + 16 capital | 120 | |
| 16 labour + 32 capital | 240 | Decreasing |
| 32 labour + 64 capital | 450 | |
| 64 labour + 128 capital | 800 | |

## Iso-quants and Law of returns to scale:

An iso-quant meaning equal product curve is a locus of points of combination of two factor inputs to produce a given level of output.

Iso-quant is two-Input production function such as: labor(L) and capital (K)

| Factor Combination | Labour (L)a | Capital (K) | Output | $MRTS_{LK}$ = - dk/dL |
|---|---|---|---|---|
| A | 1 | 15 | 10000 | ----- |
| B | 2 | 11 | 10000 | 4 |
| C | 3 | 8 | 10000 | 3 |
| D | 4 | 6 | 10000 | 2 |
| E | 5 | 5 | 10000 | 1 |




Iso-quants

**Properties of Iso-quant:**

- **Isoquant have a negative slope**
- **Isoquant is convex to the origin meaning that marginal rate of tchnical substituion (MRTS) between two factor inputs goes on falling.**
- **Two Isoquant cannot intersect or be tangent to each other**
- **Upper isoquant represent higher level of output.**

**Iso-quant can be used to study law of returns to scale.**

## Constant returns to scale:

Along any isocline, the distance between successive multiple-isoquants is constant. Doubling the factor inputs achieves double the level of the initial output; trebling inputs achieves treble output, and so on

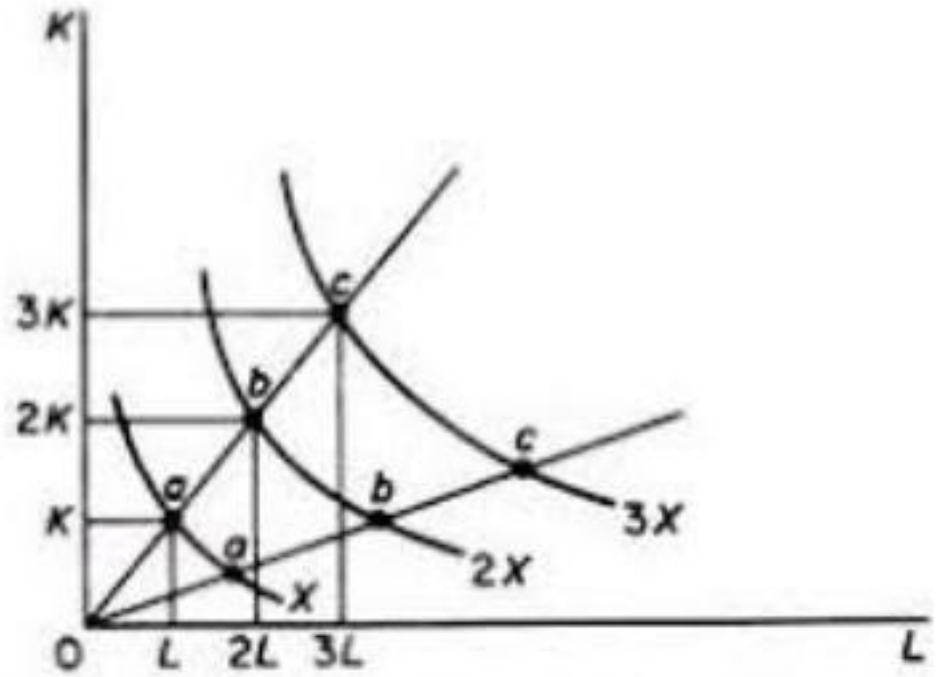



Figure 3.18 Constant returns to scale: $0a = ab = bc$

## Increasing returns to scale:

**The distance between consecutive multiple-isoquants decreases. By doubling the inputs, output is more than doubled. In the given figure, doubling K and L leads to point b' which lies on an isoquant above the one denoting 2X.**

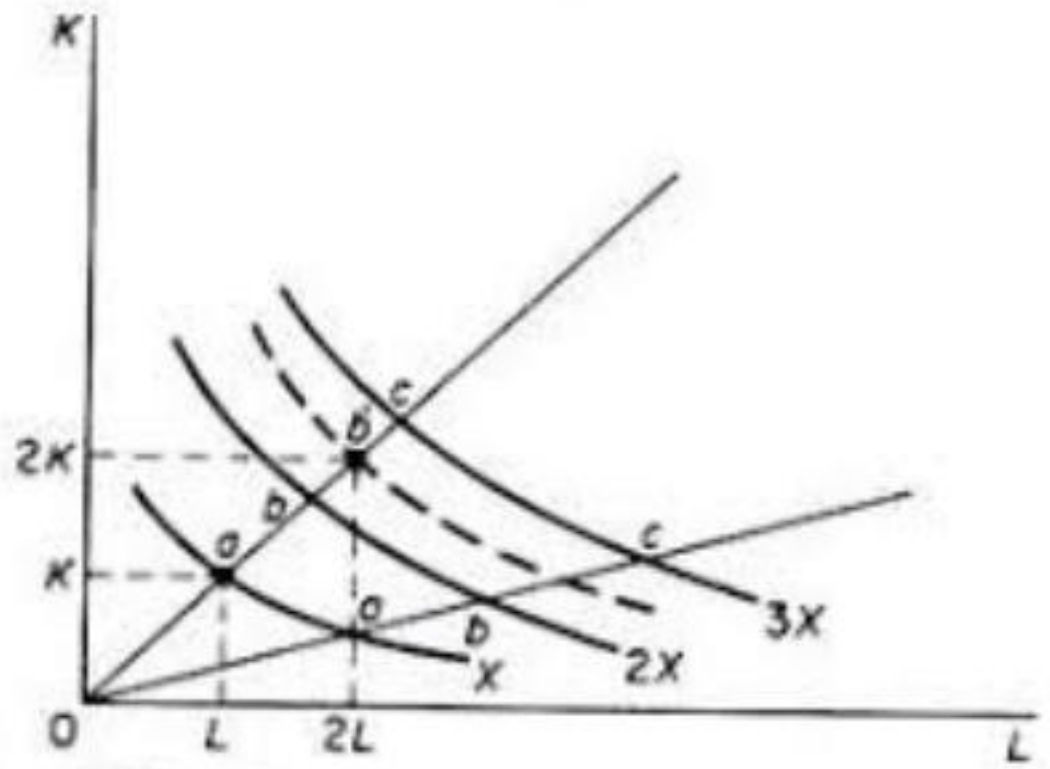



Figure 3.20 Increasing returns to scale: $Oa > ab > bc$

## Decreasing returns to scale:

The distance between consecutive multiple-isoquants increases. By doubling the inputs, output increases by less than twice its original level. In figure the given, point a', defined by 2K and 2L, lies on an isoquant below the one showing 2X.

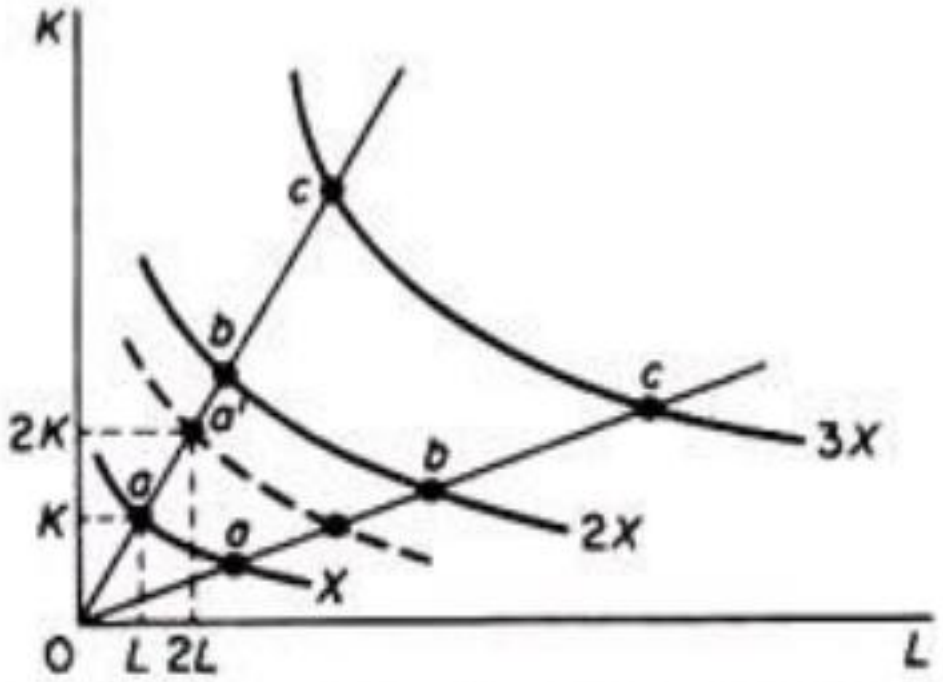



Figure 3.19 Decreasing returns to scale: $0a < ab < bc$

## Causes of Law of Retiurns to scale

Causes of different phases of returns to scale can be attributed economies of scale, and dis-economies of scale.

**Economies of Scale:** Economies of scale (internal and external) are the cost advantages (i.e. decreasing marginal cost and decreasing cost per unit of output) that an organization obtains due to large scale operation.

**Internal Economies of scale** occur within the firm when it grows. When a firm operate at large scale production, it can use its fixed factors like machines and plants more effectively, introduce division of labour and specialization, avail cheaper raw materials(as it purchases in bulk), cheaper loan facilities, generates by-products, utilities inputs in a better ways, manages inventories and stock through development of store and logistics, develop better supply chain through distributorship, sell in bulk, introduces promotional activities through advertisement, take risk. Tall these advantages will help in reducing average cost and marginal cost.

**External economies** of scale occur outside of an individual firm but within the same industry. When an industry grows, it leads to development of infrastructure facilitate like transport service network, telecommunications , facilitates research and development in universities, growth of banking and financial facilities, localization of industries, and clustering of business in certain geographical areas, development of ancillary (supporting) industries, easy availability of raw-materials and skilled labour. These facilities will help in reducing cost of production.

## Causes of Law of Retiurns to Scale

**Dis-economies of scale:** Economies of scale are the cost dis-advantages (i.e. increasing marginal cost and increasing cost per unit of output) that an organization obtains due to large scale operation.

**Internal dis-economies of scale** are the cost disadvantages which a firm faces by expanding the scale of production ( increase in size of firm and output). When a firm expand scale of production, it may result in managerial dis-economies (such as : inefficiency in management, lack of co-coronation and control; technical economies(i.e. operating beyond the maximum production limit), financial dis-economies (such as curbs on large borrowers , various concessions to small firms), limited availability of natural human resources.

**External dis-economies of scale occur** outside of an individual firm but within the same industry. When an industry grows, this will result in intense competition among the firms for raw material and making them expensive, scarcity of electricity, water, finance, and other factors of production which raises their prices, scarcity of local labour and pyaing higher wages to attract new workers, scarcity of land and factories causing hike in rents, increasing traffic congestion, rising pollution and health hazards. These disadvantage will increase cost of production.

## Causes of Law of Retiurns to scale contd.

**Increasing Returns :**

**Increasing returns to scale is due to internal and external economies of scale. in increaing rturns to scale, internal and external economies are more than internal and external dis-economies.**

**Decreasing 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 dis-economies.**

**Constant Returns : In this case internal and external economies are exactly equal to internal and external dis-economies. This situation arises when after reaching a certain level of production, economies of scale are balanced by dis-economies of scale**

# Difference Between Law Variable Proportion & Law of Returns to Scale

| Point of Difference | Law Variable of Proportion | Law of Return to Scale |
|---|---|---|
| Period of Time | Short Run | Long Run |
| Variability of Inputs | Only one factor input say labour, is variable others are fixed | All factor Inputs are variables |
| Factor Proportion | Variable | Fixed |
| Relationship | Studies how output reacts to changes variable input, while other inputs are kept fixed. | Studies how output reacts to a give proportionate change in all inputs (scale of production) |