Production Theory

Production

- The process of transformation of resources (like land, labour, capital and entrepreneurship) into goods and services of utility to consumers and/or producers.
- The process of creation of value or wealth through the production of goods and services that have economic value.

- Goods includes all tangible items such as furniture, house, machine, food, car, television etc
- Services include all intangible items, like banking, education, management, consultancy, transportation.

Types of Inputs

Technology

- determines the type, quantity and proportion of inputs.
- **Fixed and Variable Inputs**
- Production analysis of a firm uses two distinct time frames:
  - short run
  - long run
- *Variable input* : that can be made to vary in the short run, e.g. raw material, unskilled/semi skilled labour, etc.
- *Fixed input:* that cannot be varied in the short run, e.g. land, machine, technology, skill set, etc.

Factors of Production

5 factors of production

- **Land(l)**
  - gift of nature
  - Reward is called as *rent*
- **Labour(L)**
  - Skilled as well as unskilled.
  - Reward is called as *wages*
- **Capital(K)**
  - Wealth which is used for further production as machine/ equipment/intermediary good
  - Reward is called as *interest*
- **Enterprise(E)**
  - The ability and action to take risk of collecting, coordinating, and utilizing all the factors of production for the purpose of uncertain economic gains
  - Reward is called as *profit*
- **Organization(O)**
  - Combination of highly skilled labour and specialized human capital/managerial aspect of business.
  - Reward is called as *salary*

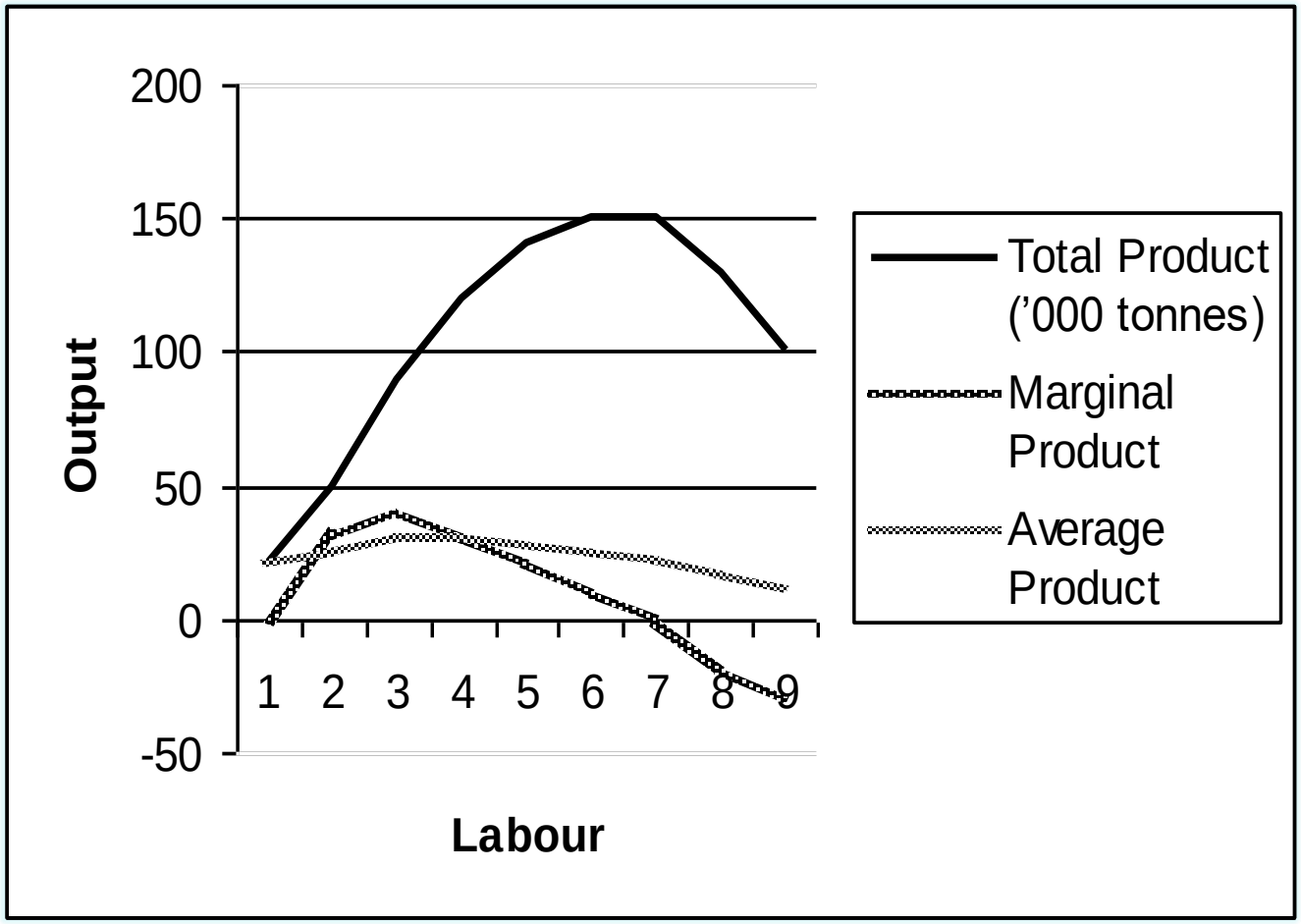
Production Function

- A technological relationship between physical inputs and physical outputs over a given period of time.
- production function is:
- Always related to a given time period
- Always related to a certain level of technology
- Depends upon relation between inputs.
- Normally a production function is written as:
- $$Q = f(L,K,I,R,E)$$
- where Q is the maximum quantity of output of a good being produced, and L=labour; K=capital; l=land; R=raw material; E= efficiency parameter.
- *Technical efficiency is defined as a situation when using more of one input with either the same amount or more of the other input must increase output.*

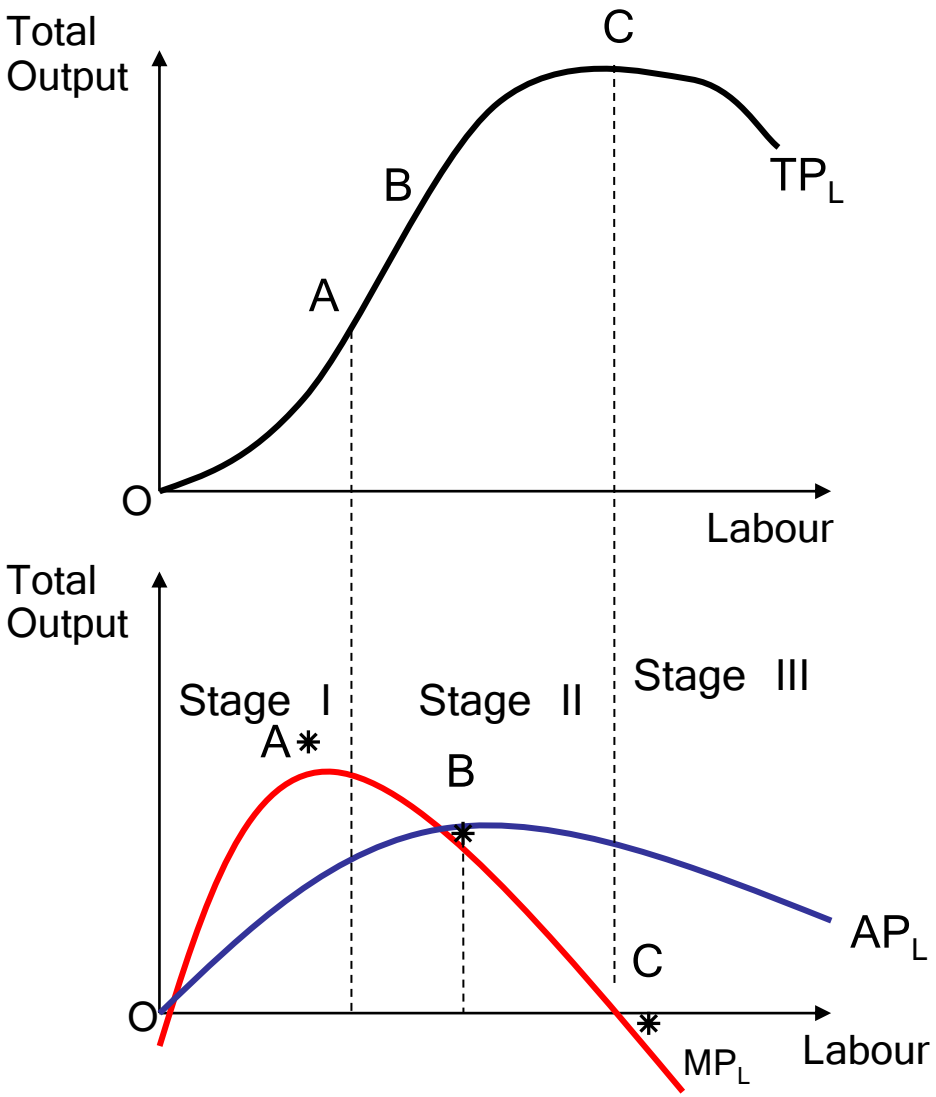
Production Function with One Variable Input

- short term production function
- Shows the maximum output a firm can produce when only one of its inputs can be varied, other inputs remaining fixed:
- $$Q = f(L, \overline{K})$$
- where Q = output, L = labour and K = fixed amount of capital
- Total product is a function of labour: $TP_L = f(\overline{K}, L)$
  - Average Product (AP)= $AP_L = \frac{TP}{L}$
  - Marginal product of labour (MP_L) = $MP_L = \frac{\Delta TP}{\Delta L}$

Labour (’00 units)	Total Product (’000 tonnes)	MP	AP	Stages
1	20	-	20	Increasing returns
2	50	30	25	
3	90	40	30	
4	120	30	30	Diminishing returns
5	140	20	28	
6	150	10	25	
7	150	0	21.5	
8	130	-20	16.3	Negative returns
9	100	-30	11.1	


200
150
100
50
0
-50
Output
1
2
3
4
5
6
7
8
9
Labour
Total Product ('000 tonnes)
Marginal Product
Average Product

Law of Variable Proportions

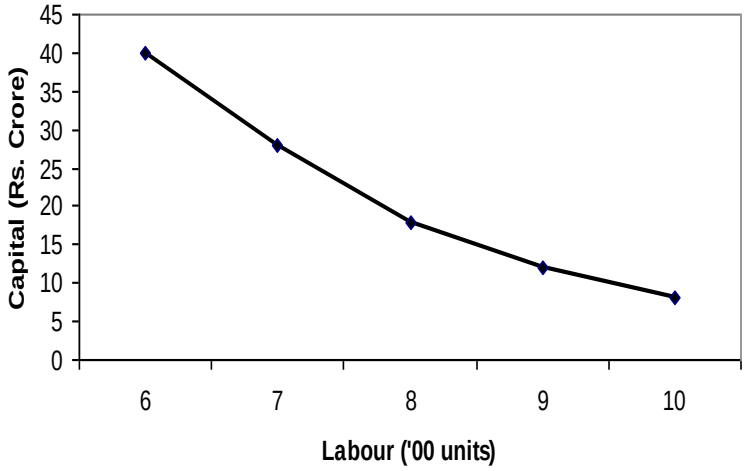


- **First stage**
  - Increasing Returns to the Variable Factor
  - MP>0 and MP>AP
- **Second stage**
  - Diminishing Returns to a Variable Factor
  - MP>0 and MP<AP
- **Third Stage**
  - Negative Returns
  - MP<0 while AP is falling but positive
  - Technically inefficient stage of production
  - A rational firm will never operate in this stage

Production Function with Two Variable Inputs

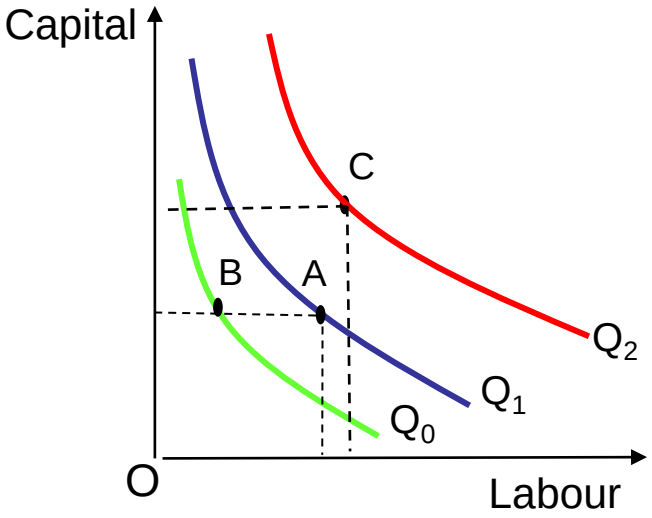
- All inputs are variable in long run and only two inputs are used
- Firm has the opportunity to select that combination of inputs which maximizes returns
- Curves showing such production function are called *isoquants* or *iso-product curves*.
- **An *isoquant* is the locus of all technically efficient combinations of two inputs for producing a given level of output**
- Represented as: $\overline{Q} = f(L, K)$

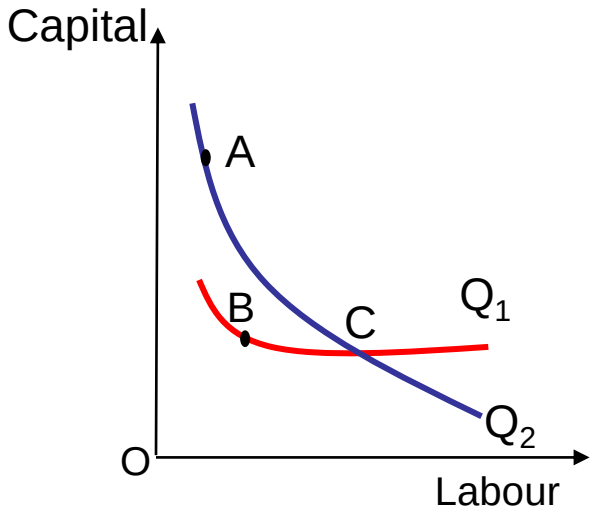
Capital (Rs. crore)	Labour ('00 units)
40	6
28	7
18	8
12	9
8	10



Characteristics of Isoquants

- Downward sloping
- Convex to the origin
- A higher isoquant represents a higher output
- Two isoquants can not intersect each other





Marginal Rate of Technical Substitution

- Measures the reduction in one input, due to unit increase in the other input that is just sufficient to maintain the same level of output.

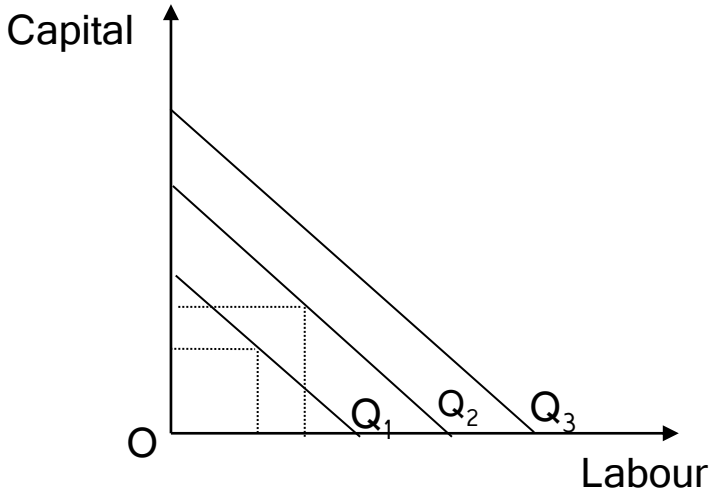
$$MRTS_{LK} = -\frac{\Delta K}{\Delta L}$$

- MRTS of labour for capital is equal to the slope of the isoquant.
- It is also equal to the ratio of the marginal product of one input to the marginal product of other input

$$\Delta Q = MP_L \times \Delta L + MP_K \times \Delta K$$

$$0 = MP_L \times \Delta L + MP_K \times \Delta K$$

$$MRTS_{LK} = \frac{MP_L}{MP_K} = -\frac{\Delta K}{\Delta L}$$



Linear isoquants

$\bar{Q} = f(L,K) = \alpha K + \beta L$

- Perfect substitutability between two factors
- Isoquants are downward sloping straight lines
- Constant MRTS

Elasticity of Substitution

- Measures the percentage change in factor proportions due to a change in marginal rate of technical substitution

$$\sigma = \frac{d(K/L)/K/L}{d(MRTS)/MRTS}$$

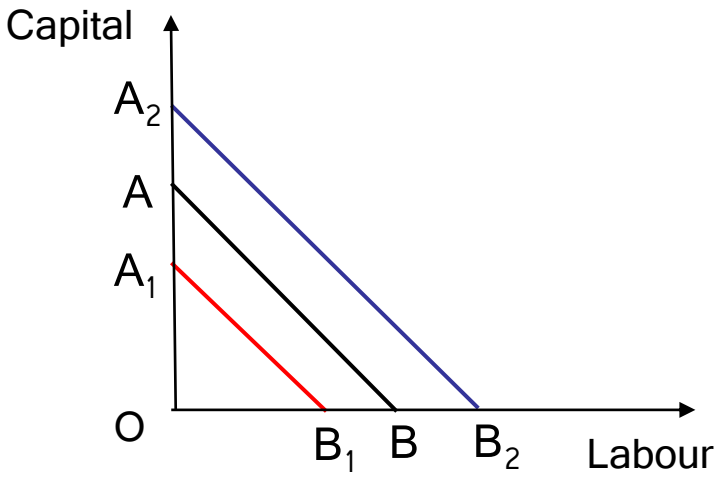
- σ is effectively a measure of the curvature of an isoquant
- More curved or convex is the isoquant, the lower is σ
- In Leontief (zero substitution) technology, with L shaped isoquants, there is no substitutability between the inputs
  - σ = 0
- In perfect substitution or linear production technology, the MRTS does not change at all along the isoquant.

  σ is infinite

Isocost Lines

Total Cost is sum of Labour cost (wL) and Capital cost (rK) where wage (w) and interest (r)

$$C = wL + rK$$

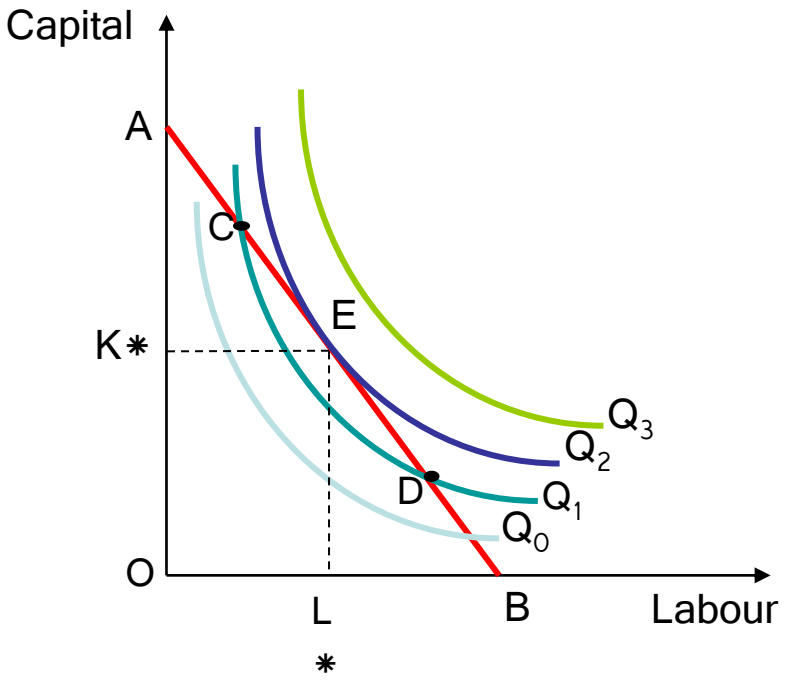


•The isocost line represents the locus of points of all the different combinations of two inputs that a firm can procure, given the total cost and prices of the inputs.

The (absolute) slope of this line is equal to the ratio of the input prices.

$$Slope = -\frac{\Delta K}{\Delta L} = \frac{C/r}{C/w} = \frac{w}{r}$$

Producer's Equilibrium

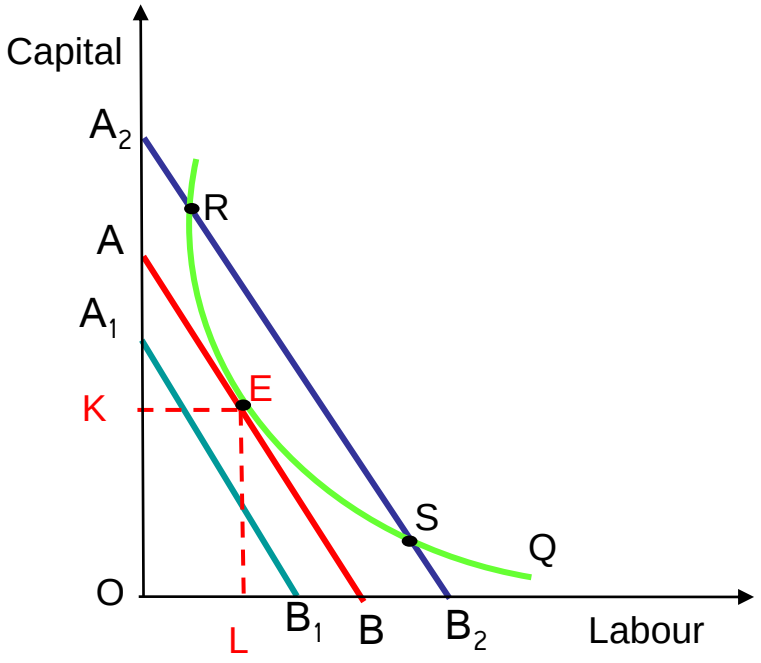


Maximization of output subject to cost constraint

Necessary condition for equilibrium
Slope of isoquant = Slope of isocost line

- AB is the isocost line
- Any point below AB is feasible but not desirable
- E is the point of tangency of Q_2 with isocost line AB
  - Corresponds to the highest level of output with given cost function.
- Firm would employ L* and K* units of labour and capital
- Q_3 is beyond reach of the firm
- Points C and D are also on the same isocost line, but they are on isoquant Q_1, which is lower to Q_2. Hence show lower output.
- E is preferred to C and D, which is on the highest *feasible* isoquant.

Producer's Equilibrium

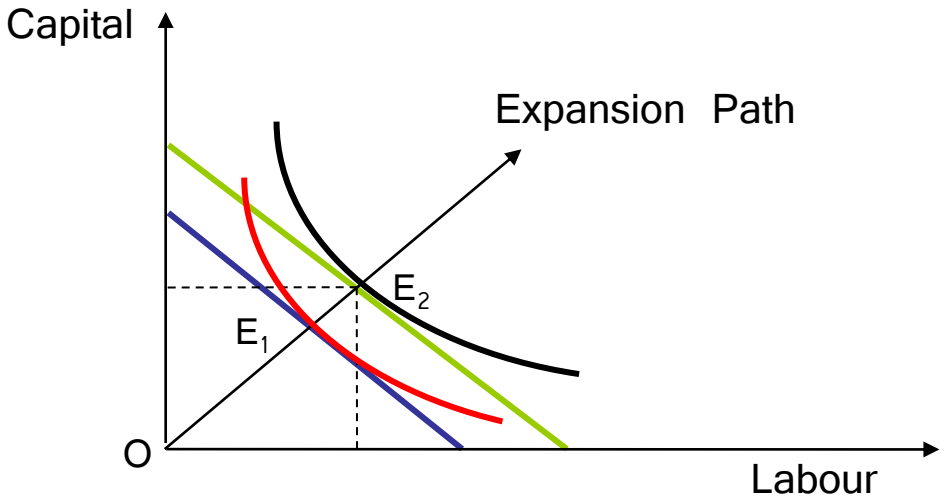


Minimization of cost for a given level of output

Necessary condition for equilibrium
Slope of isoquant = Slope of isocost line

- Firm has decided the level output to be produced shown by the isoquant Q
  - Will be indifferent between output combinations shown by R, S, E on isquant Q.
- Has to ascertain that combination of inputs Labour and Capital which minimizes the cost of production
- Hence a map of isocost lines will be prepared
- The isocost lines are parallel to each other because price of the inputs is given.
- A_1B_1 line is not feasible
- It will use OK and OL of capital and labour respectively, at point E which is also on AB, the lowest possible isocost line.
- R, S are not desirable because they are on higher cost line $A_2 B_2$.

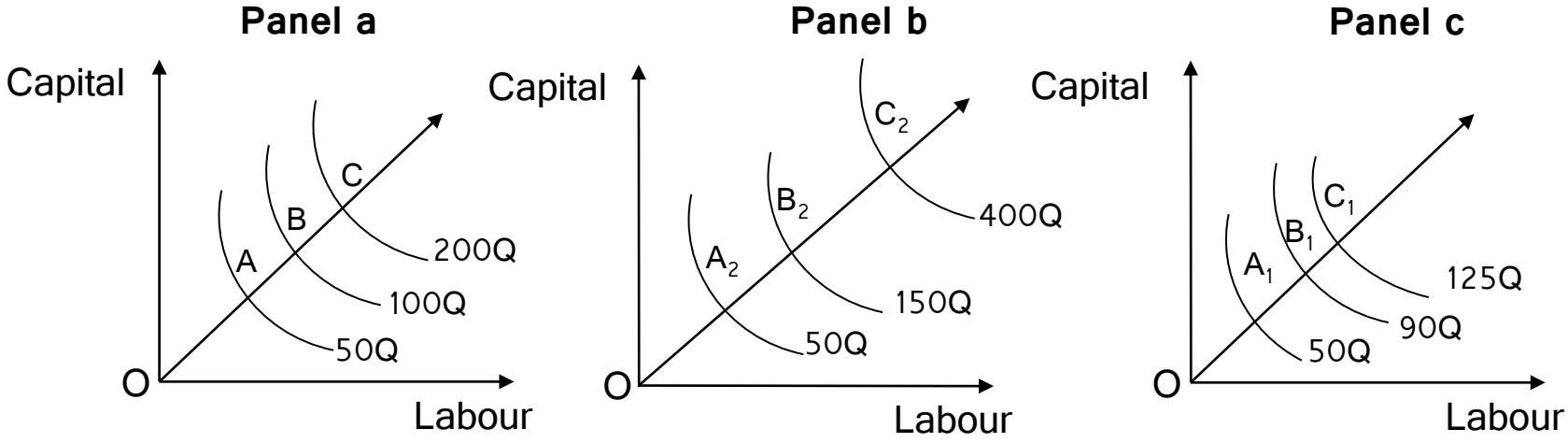
Expansion Path



- Line formed by joining the tangency points between various isocost lines and the corresponding highest attainable isoquants is known as Expansion Path.
- For homogeneous production function and given factor prices (and hence factor ratio):
  - expansion path is a straight line through the origin.
- For non- homogeneous production function:
  - optimal expansion path is non linear.

Returns to Scale

- Returns to Scale show the degree by which the level of output changes in response to a given change in *all* the inputs in a production system.



- **Constant Returns to Scale :** When a proportional increase in all inputs yields an equal proportional increase in output *(Panel a)*
- **Increasing Returns to Scale :** When a proportional increase in all inputs yields a more than proportional increase in output *(Panel b).*
- **Decreasing Returns to Scale :** When a proportional increase in all inputs yields a less than proportional increase in output *(Panel c).*

Cobb-Douglas Production Function

- Proposed by Wicksell and tested against statistical evidence by Charles W. Cobb and Paul H. Douglas in 1928
- $Q = AK^{\alpha} L^{\beta}$ where α, β are constants. A is the technological parameter, α is the elasticity of output with respect to capital, and β is the elasticity of output with respect to labour.
- **Properties**
- Homogeneous of degree $(\alpha+\beta)$
- The returns to scale is immediately revealed by the sum of the two parameters α and β
  - **Constant Returns to Scale:** $(\alpha + \beta) = 1$
  - **Increasing Returns to Scale:** $(\alpha + \beta) > 1$
  - **Decreasing Returns to Scale:** $(\alpha + \beta) < 1$
- Isoquants are negatively sloped and convex to the origin
- $MRTS_{LK}$ is a function of input ratio
- Elasticity of substitution is equal to 1