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Production & Cost Analysis

Programme Educational Objectives

- ***Our program will create graduates who:***

- ***1. Will be recognized as a creative and an enterprising team leader.***
- ***2. Will be a flexible, adaptable and an ethical individual.***
- ***3. Will have a holistic approach to problem solving in the dynamic business environment.***

Managerial Economics Course Outcomes

- **CO1-Given the changes in the price of a commodity, substitute or complementary goods and services, consumers' income in addition to the changes in quantity demanded, the student manager will be able to establish the interrelationship between the independent variable and demand that would aid in decision making.**
- **CO2-Given a set of historical & current demand data the student manager will be able to estimate future demand for goods and services using survey and statistical techniques (such as Consumer survey, Sales force opinion, Expert opinion and Delphi technique; times series analysis and regression technique).**
- **CO3-Given the scale of inputs in a production scenario, the student manager will be able to comment on the output and categorize the reasons for economies and diseconomies of scale.**

- **CO4-Given the structural details of a market (Monopoly, Oligopoly, Monopolistic competition and Perfect competition) the student manager will be able to determine the price and output for a given market structure.**

- **CO5-Given the components of national income, the student managers will be able to ascertain the GDP, GNP, NDP & NNP at factor cost and market prices using the product, income and expenditure method and vice-versa.**

- **CO6-Given the components of monetary and fiscal policy, the student manager will be able to explain the impact of the same on the business activities.**

Production

- An entrepreneur must put together resources -- land, labour, capital -- and produce a product people will be willing and able to purchase

Economic Agent

PRODUCTION FUNCTION

- THE RELATIONSHIP BETWEEN THE AMOUNT OF INPUT REQUIRED AND THE AMOUNT OF OUTPUT THAT CAN BE OBTAINED IS CALLED THE PRODUCTION FUNCTION

- SHORT RUN PRODUCTION FUNCTION
- Qc = f(K, L), K is constant and L is variable
- LONG RUN PRODUCTION FUNCTION
- Qc = f(K,L) all variable (K is Capital, L is Labour)

What can you say about Marginal Product ?

- As the quantity of a variable input (labour, in the example) increases while all other inputs are fixed, output rises. Initially, output will rise more and more rapidly, but eventually it will slow down and perhaps even decline.
- This is called the **LAW OF DIMINISHING MARGINAL RETURNS**
- This is happening as other factors are limited or fixed

LAW OF DIMINISHING RETURNS

IT HOLDS THAT WE WILL GET LESS & LESS EXTRA OUTPUT WHEN WE ADD ADDITIONAL DOSES OF AN INPUT WHILE HOLDING OTHER INPUTS FIXED. IT IS ALSO KNOWN AS LAW OF VARIABLE PROPORTIONS.

Assumptions

- Labour is the only variable i/p and Capital Constant
- Labour is homogeneous
- State of Technology is given
- Input prices are given

COMBINING RESOURCES

- THERE ARE MANY COMBINATIONS OF RESOURCES THAT COULD BE USED
- CONSIDER THE FOLLOWING TABLE SHOWING DIFFERENT NUMBER OF MECHANICS AND AMOUNT OF CAPITAL THAT THE HYPOTHETICAL FIRM, INDIA INC., MIGHT USE

ALTERNATIVE QUANTITIES OF OUTPUT THAT CAN BE PRODUCED BY DIFFERENT COMBINATIONS OF RESOURCES

Number of Mechanics	CAPITAL							
	5	10	15	20	25	30	35	40
0	0	0	0	0	0	0	0	0
1	**30**	**100**	**250**	**340**	**410**	**400**	**400**	**390**
2	**60**	**250**	**360**	**450**	**520**	**530**	**520**	**500**
3	**100**	**360**	**480**	**570**	**610**	**620**	**620**	**610**
4	**130**	**440**	**580**	**640**	**690**	**700**	**700**	**690**
5	**130**	**500**	**650**	**710**	**760**	**770**	**780**	**770**
6	**110**	**540**	**700**	**760**	**800**	**820**	**830**	**840**
7	**100**	**550**	**720**	**790**	**820**	**850**	**870**	**890**

PRODUCTION IN THE SHORT RUN

- THE **SHORT RUN** IS A PERIOD JUST SHORT ENOUGH THAT AT LEAST ONE RESOURCE (INPUT-INDUSTRIAL PLANT,MACHINES) CANNOT BE CHANGED -- IS **FIXED OR INELASTIC.** THUS IN THE SHORT RUN PROUDCTION OF A COMMODITY CAN BE INCREASED BY INCREASING THE USE OF ONLY VARIABLE INPUTS LIKE LABOUR AND RAW MATERIALS.

Quantities of Output that Can Be Produced When One Resource is Fixed

Number of Mechanics	CAPITAL							
	5	10	15	20	25	30	35	40
0	0	0	0	0	0	0	0	0
1	30	100	250	340	410	400	400	390
2	60	250	360	450	520	530	520	500
3	100	360	480	570	610	620	620	610
4	130	440	580	640	690	700	700	690
5	130	500	650	710	760	770	780	770
6	110	540	700	760	800	820	830	840
7	100	550	720	790	820	850	870	890

LONG RUN

- THE LONG RUN IS A PERIOD SUFFIECIENTLY LONG THAT ALL FACTORS INCLUDING CAPITAL CAN BE ADJUSTED OR ARE VARIABLE.

- THIS MEANS THAT THE FIRM CAN CHOOSE ANY COMBINATION ON THE MANUFACTURING TABLE -- NOT JUST THOSE ALONG COLUMN LABELLED “10”

The Long Run or Planning Period: As we double both resources, what happens to output?

Number of Mechanics	5	CAPITAL 10	15
0	0	0	0
1	30	100	250
2	60	250	360
3	100	360	480
4	130	440	580
5	130	500	650
6	110	540	700
7	100	550	720

SHORT RUN
LAWS OF PRODUCTION

LAW OF

VARIABLE PROPORTIONS

Functions

Total Product : $Qc = -L^3+15L^2+10L$

Marginal Product : $MP_L = TP_L - TP_{L-1}$

Average Product : $APL = -L3+15L2+10L / L = -L^2+15L+10$

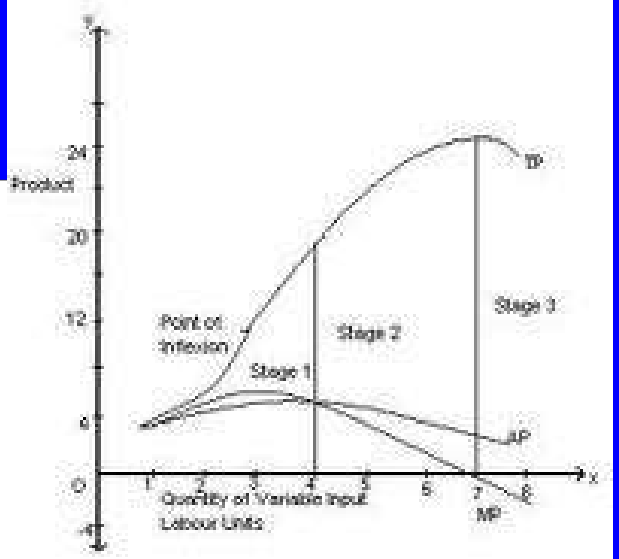
Statement of Law

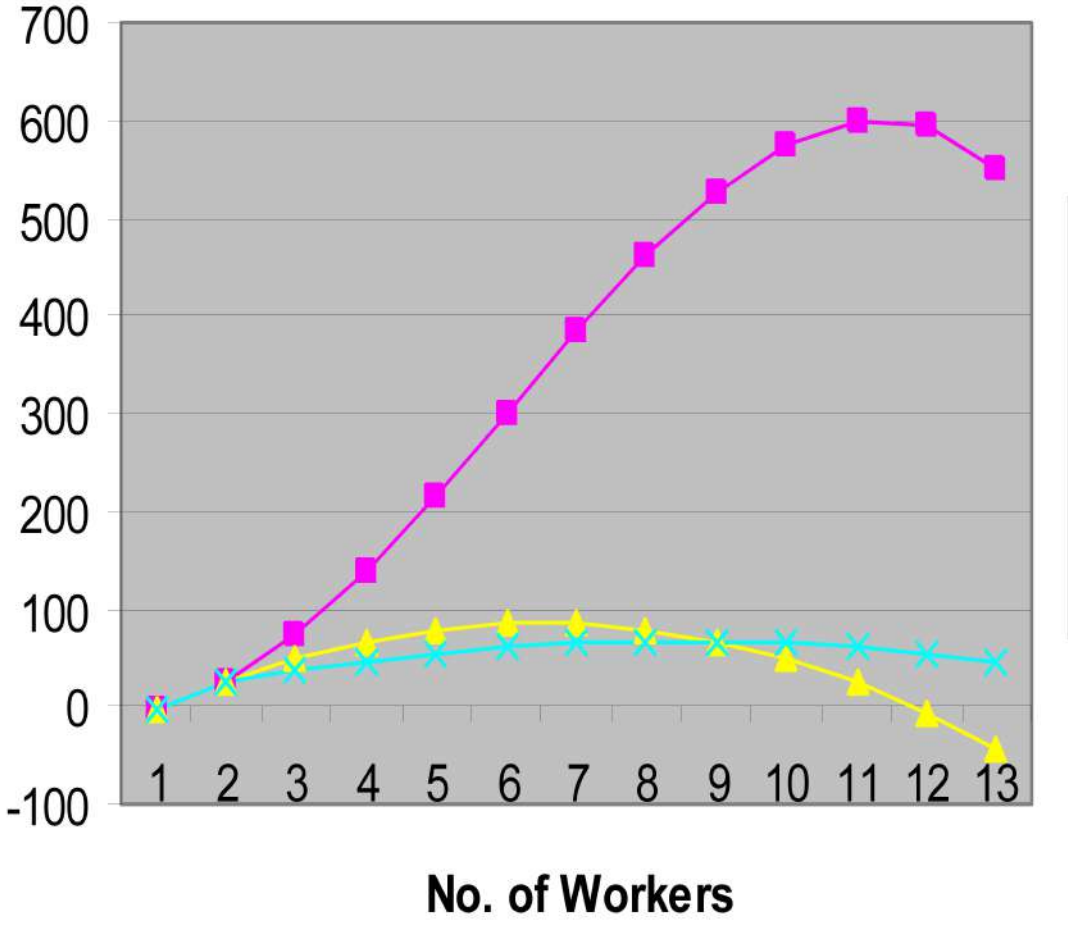
- **The law states that all other things remaining constant, an increase in the input of a factor of production results in an increase in the output but at a diminishing rate.**

THREE STAGES OF PRODUCTION

No. of workers (N)	Total product – TP_L (tonnes)	Marginal Product (MP_L)	Average Product (AP_L)	Stage of production
(1)	(2)	(3)	(4)	(5)
1	24	24	24	I INCREASING AND CONSTANT RETURNS
2	72	48	36	
3	138	66	46	
4	216	78	54	
5	300	84	60	
6	384	84	64	
7	462	78	66	II DIMINISHING RETURNS
8	528	66	66	
9	576	48	64	
10	600	24	60	
11	594	-6	54	III -VE RETURNS
12	552	-42	46	

Law of Variable Proportions





- Total product – TPL (tonnes)
- Marginal Product (MPL)
- Average Product (APL)

BEHAVIOUR OF TPP,MPP AND APP DURING THE THREE STAGES OF PRODUCTION

TOTAL PHYSICAL PRODUCT	MARGINAL PHYSICAL PRODUCT	AVERAGE PHYSICAL PRODUCT
STAGE I INCREASES AT AN INCREASING RATE	INCREASES, REACHES ITS MAXIMUM & THEN DECLINES TILL MR = AP	INCREASES & REACHES ITS MAXIMUM
STAGE II INCREASES AT A DIMINISHING RATE TILL IT REACHES MAXIMUM	IS DIMINISHING AND BECOMES EQUAL TO ZERO	STARTS DIMINISHING
STAGE III STARTS	BECOMES NEGATIVE	CONTINUES

FROM THE ABOVE TABLE ONLY STAGE II IS RATIONAL WHICH MEANS RELEVANT RANGE FOR A RATIONAL FIRM TO OPERATE.

IN STAGE I IT IS PROFITABLE FOR THE FIRM TO KEEP ON INCREASING THE USE OF LABOUR.

IN STAGE III, MP IS NEGATIVE AND HENCE IT IS INADVISABLE TO USE ADDITIONAL LABOUR.

i.e ONLY STAGE I AND III ARE IRRATIONAL

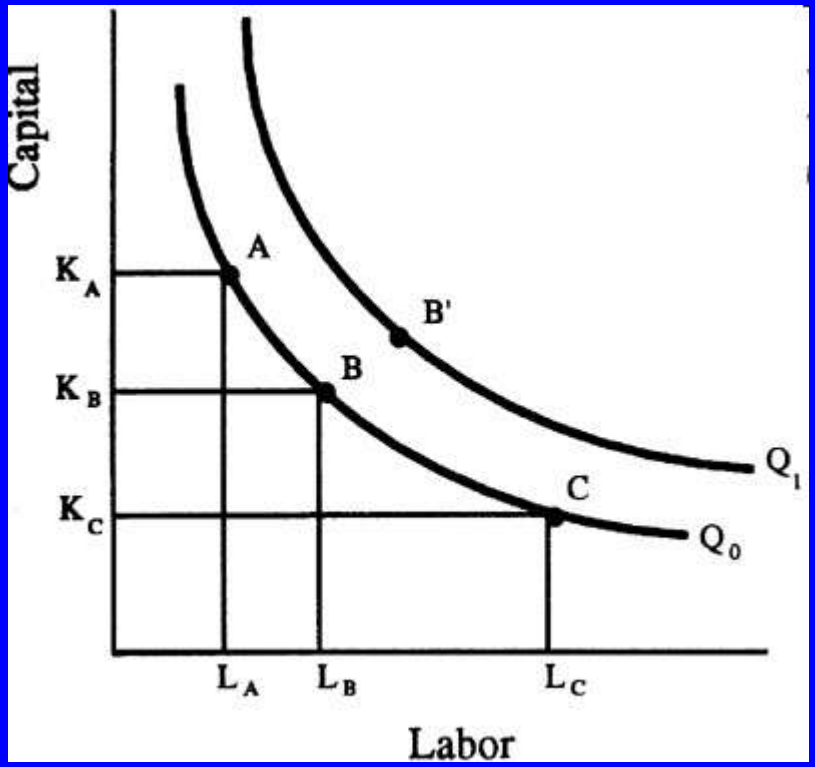
LONG TERM
LAWS OF PRODUCTION

- ISOQUANT
- LAWS OF RETURN TO SCALE

ISOQUANT

AN ISOQUANT OR ISO PRODUCT CURVE OR EQUAL PRODUCT CURVE OR A PRODUCTION INDIFFERENCE CURVE SHOW THE VARIOUS COMBINATIONS OF TWO VARIABLE INPUTS RESULTING IN THE SAME LEVEL OF OUTPUT.

IT IS DEFINED AS A CURVE PASSING THROUGH THE PLOTTED POINTS REPRESENTING ALL THE COMBINATIONS OF THE TWO FACTORS OF PRODUCTION WHICH WILL PRODUCE A GIVEN OUTPUT.



- **For example from the following table we can see that different pairs of labour and capital result in the same output.**

Labour (Units)	Capital (Units)	Output (Units)
1	5	10
2	3	10
3	2	10
4	1	10
5	0	10

FOR EACH LEVEL OF OUTPUT THERE WILL BE A DIFFERENT ISOQUANT. WHEN THE WHOLE ARRAY OF ISOQUANTS ARE REPRESENTED ON A GRAPH, IT IS CALLED AN ISOQUANT MAP.

IMPORTANT ASSUMPTIONS

THE TWO INPUTS CAN BE SUBSTITUTED FOR EACH OTHER. FOR EXAMPLE IF LABOUR IS REDUCED IN A COMPANY IT WOULD HAVE TO BE COMPENSATED BY ADDITIONAL MACHINERY TO GET THE SAME OUTPUT.

SLOPE OF ISOQUANT

THE SLOPE OF AN ISOQUANT HAS A TECHNICAL NAME CALLED THE MARGINAL RATE OF TECHNICAL SUBSTITUTION (MRTS) OR THE MARGINAL RATE OF SUBSTITUTION IN PRODUCTION. THUS IN TERMS OF CAPITAL SERVICES K AND LABOUR L

MRTS = Dk/DL

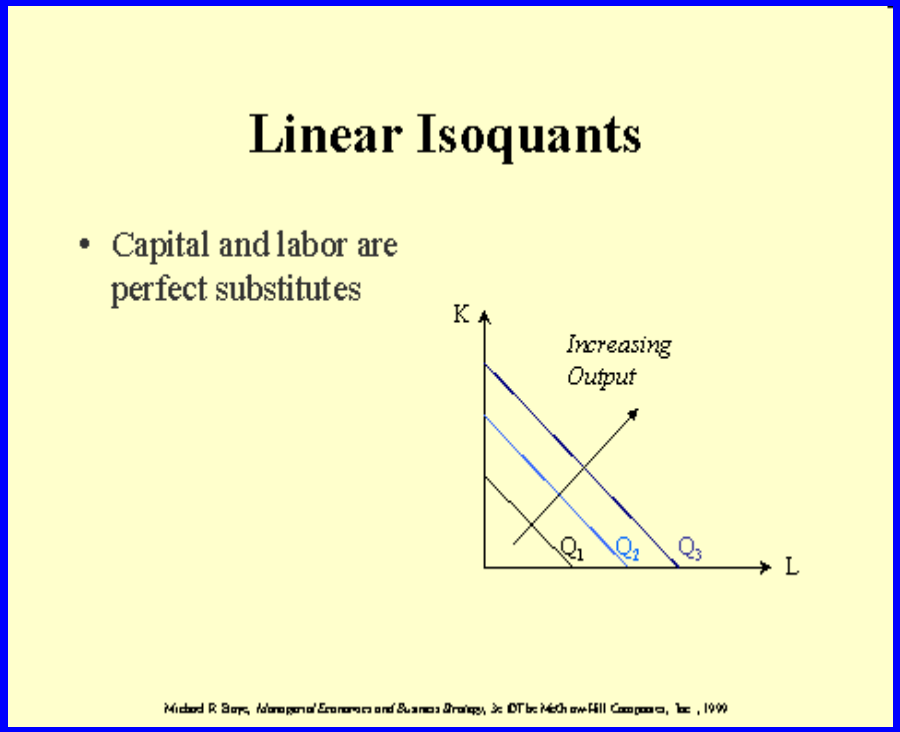
TYPES OF ISOQUANTS

1. LINEAR ISOQUANT
2. RIGHT-ANGLE ISOQUANT
3. CONVEX ISOQUANT

LINEAR ISOQUANT

IN LINEAR ISOQUANTS THERE IS PERFECT SUBSTIUTABILTY OF INPUTS.

FOR EXAMPLE IN A POWER PLANT EQUIPED TO BURN OIL OR GAS. VARIOUS AMOUNTS OF ELECTRICITY COULD BE PRODUCED BY BURNING GAS, OIL OR A COMBINATION. i.e OIL AND GAS ARE PERFECT SUBSITUTES. HENCE THE ISOQUANT WOULD BE A STRAIGHT LINE.



RIGHT-ANGLE / L Shaped / Fixed Factor Proportion ISOQUANT

IN RIGHT-ANGLE ISOQUANTS THERE IS COMPLETE NON-SUBSTIUTABILTY BETWEEN INPUTS.

FOR EXAMPLE TWO WHEELS AND A FRAME ARE REQUIRED TO PRODUCE A BYCYCLE THESE CANNOT BE INTERCHANGED.

THIS IS ALSO KNOWN AS LEONTIEF ISOQUANT OR INPUT-OUTPUT ISOQUANT.

For runing one taxi one driver and for n, n requires

CONVEX ISOQUANT

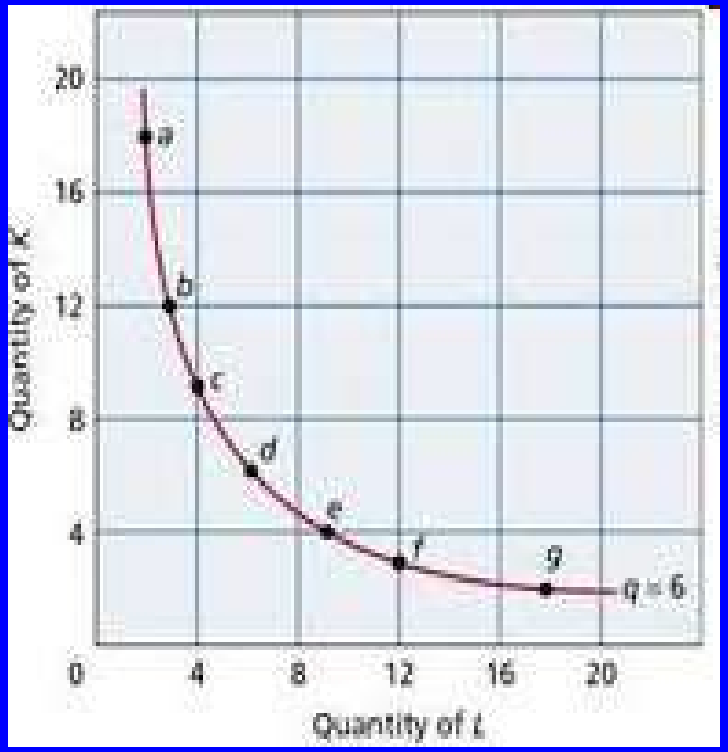
IN CONVEX ISOQUANTS THERE IS SUBSTIUTABILTY BETWEEN INPUTS BUT IT IS NOT PERFECT.

FOR EXAMPLE

(1) A SHIRT CAN BE MADE WITH LARGE AMOUNT OF LABOUR AND A SMALL AMOUNT MACHINERY.

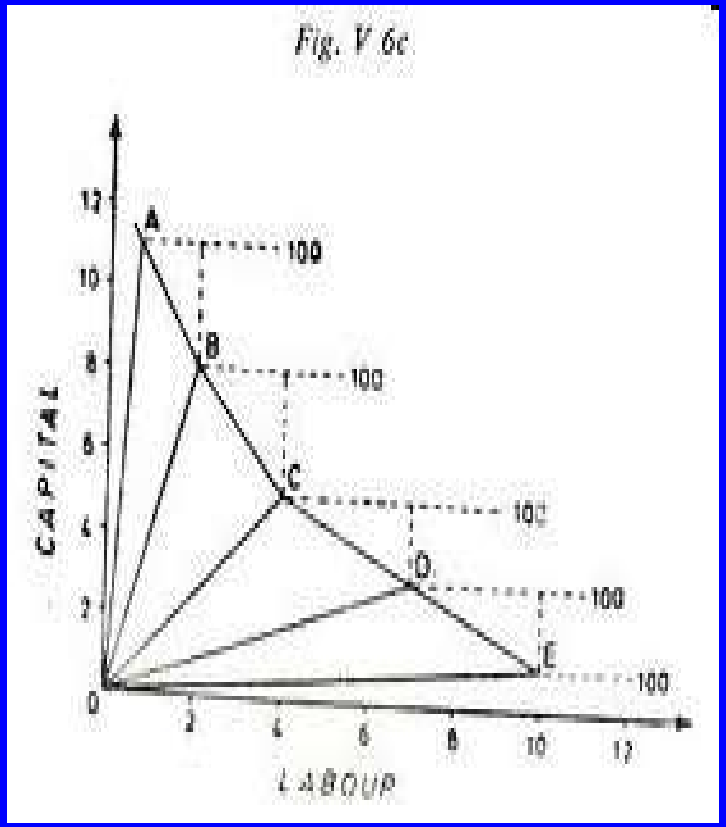
(2) THE SAME SHIRT CAN BE WITH LESS LABOURERS, BY INCREASING MACHINERY.

(3) THE SAME SHIRT CAN BE MADE WITH STILL LESS LABOURERS BUT WITH A LARGER INCREASE IN MACHINERY.



Kinked Isoquant/ Linear Programming Isoquant

- **ABCDE is kinked Isoquant, only each kink is feasible point than the typical isoquant, where each point on it is feasible**

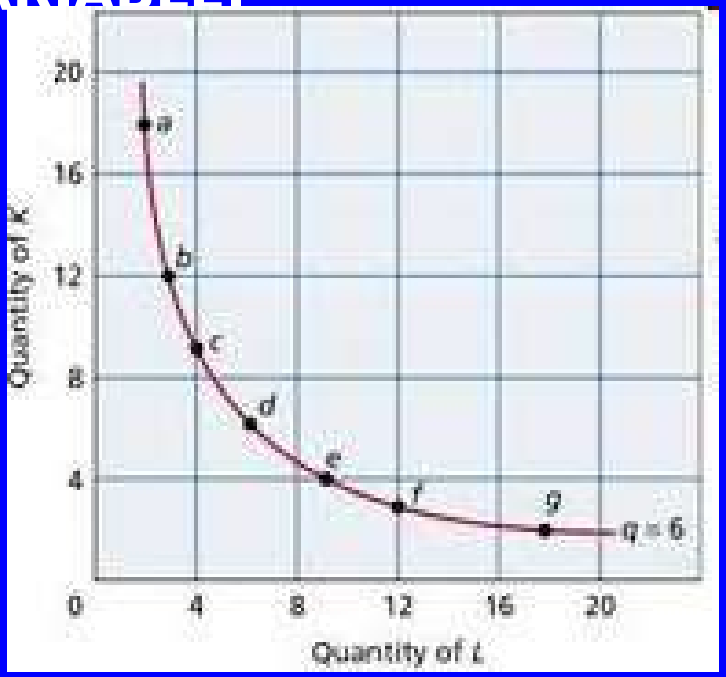


WHILE A RELATIVELY SMALL ADDITION OF MACHINERY FROM M1(MANUAL EMBROIDERY) TO M2(TAILORING MACHINE EMBROIDERY) ALLOWS THE INPUT OF LABOURERS TO BE REDUCED FROM L1 TO L2. A VERY LARGE INCREASE IN MACHINERY TO M3 (COMPUTERISED EMBROIDERY) IS REQUIRED TO FURTHER DECREASE LABOUR FROM L2 TO L3.

THUS SUBSTIUTABILITY OF LABOURERS FOR MACHINERY DIMINISHES FROM M1 TO M2 TO M3.

PROPERTIES OF ISOQUANTS

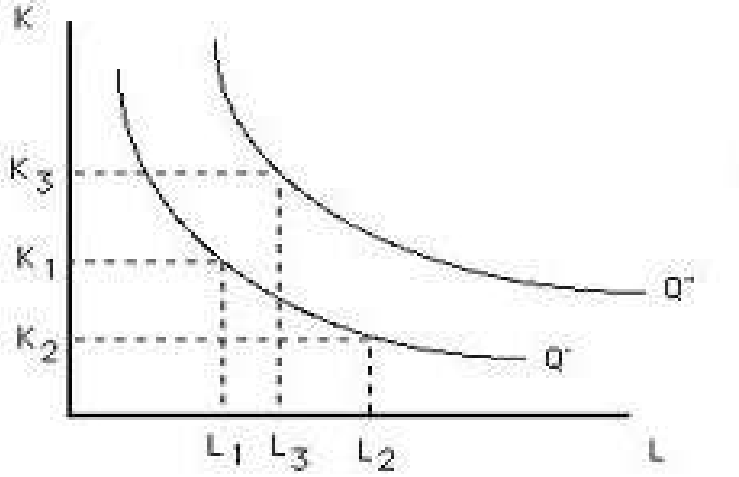
1. AN ISOQUANT IS DOWNWARD SLOPING TO THE RIGHT. i.e NEGATIVELY INCLINED. THIS IMPLIES THAT FOR THE SAME LEVEL OF OUTPUT, THE QUANTITY OF ONE VARIABLE WILL HAVE TO BE REDUCED IN ORDER TO INCREASE THE QUANTITY OF OTHER VARIABLE.



PROPERTIES OF ISOQUANTS

2. A HIGHER ISOQUANT REPRESENTS LARGER OUTPUT. THAT IS WITH THE SAME QUANTITY OF 0NE INPUT AND LARGER QUANTITY OF THE OTHER INPUT, LARGER OUTPUT WILL BE PRODUCED.

Figure 7.3
Two Isoquants



PROPERTIES OF ISOQUANTS

3. NO TWO ISOQUANTS INTERSECT OR TOUCH EACH OTHER. IF THE TWO ISOQUANTS DO TOUCH OR INTERSECT THAT MEANS THAT A SAME AMOUNT OF TWO INPUTS CAN PRODUCE TWO DIFFERENT LEVELS OF OUTPUT WHICH IS ABSURD.

PROPERTIES OF ISOQUANTS

4. ISOQUANT IS CONVEX TO THE ORIGIN. THIS MEANS THAT THE SLOPE DECLINES FROM LEFT TO RIGHT ALONG THE CURVE. THAT IS WHEN WE GO ON INCREASING THE QUANTITY OF ONE INPUT SAY LABOUR BY REDUCING THE QUANTITY OF OTHER INPUT SAY CAPITAL, WE SEE LESS UNITS OF CAPITAL ARE SACRIFICED FOR THE ADDITIONAL UNITS OF LABOUR.

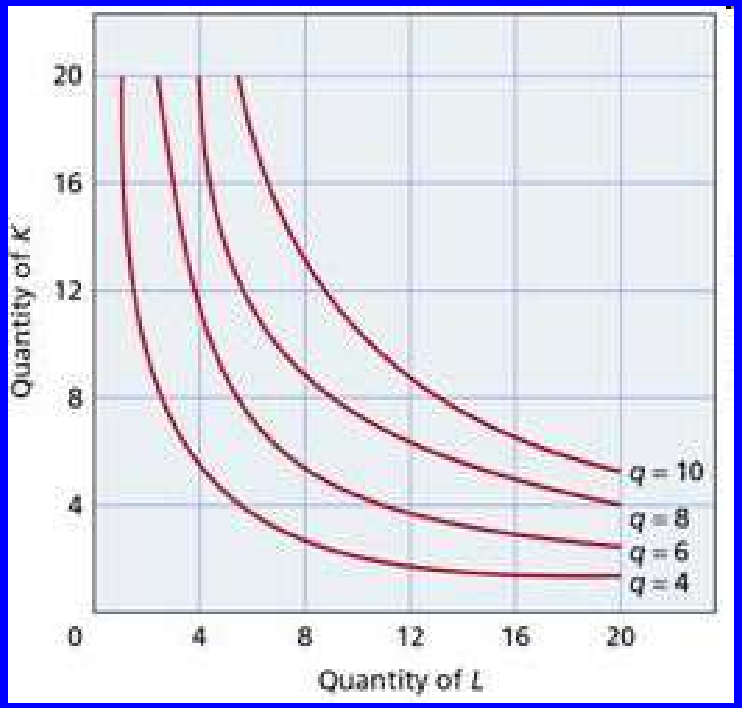
MRTS (Marginal Rate of Technical Substitution)

is the rate at which a marginal unit of labour can substitute a marginal unit of capital (moving downward on the isoquant) without affecting the total output.

MRTS = change in K / change in L

ISOQUANT MAP

- Each isoquant refers to a specific output, connecting alternative combinations of inputs that are technologically efficient methods of achieving that output. If we plot a representative set of these isoquants on a single graph, we obtain an isoquant map.



An isoquant map shows a set of isoquants, one for each level of output. The figure shows four isoquants drawn from the production function and corresponding to 4, 6, 8, and 10 units of production. The higher the level of output, the further is the isoquant from the origin.

Long Run Law of Production

For Curves, please refer class notes

Laws of Returns to Scale

- Having introduced the isoquant-the basic tool of analysis-we now move towards the laws of returns to scale.
- The laws of returns to scale explain the behavior of output in response to a proportional and simultaneous change in inputs.
- Increasing inputs proportionately and simultaneously is in fact, an expansion of the scale of production.

Three technical possibilities

- When a firm expands its scale, i.e. it increases both the inputs proportionately, then there are three technical possibilities:
- Total output may increase more than proportionately
- Total output may increase proportionately
- Total output may increase less than proportionately

Kinds of Returns to Scale

- Accordingly, there are three kinds of returns to scale;
- Increasing returns to scale
- Constant returns to scale
- Decreasing returns to scale

Laws of Returns to Scale

- **Let us now explain the laws of returns to scale with the help of isoquant for a two input and single output production system.**

Increasing returns to scale

- When inputs K & L are increased at a certain proportion and output increases more than proportionately, it exhibits increasing returns to scale.
- For example, if the quantities of both the inputs K and L are doubled and the resultant output is more than doubled, the return to scale is said to be increasing.

Factors behind increasing returns to scale

- Technical and managerial indivisibilities
- Higher degree of specialization
- Dimensional relations

Constant Returns to Scale

- When increase in output is proportionate to the increase in inputs, it exhibits constant returns to scale.
- For example if quantities of both the inputs, K and L are doubled and output is doubled, then the returns to scale are said to be constant.

Decreasing returns to scale

- Firms are faced with decreasing returns to scale when a certain proportionate increase in inputs, K and L leads to a less than proportionate increase in output.
- For example, when inputs are doubled and output is less than doubled, then decreasing returns to scale is in operation.

Costs of Production

For Long Run cost analysis and curve refer class notes

Inputs multiplied by their respective prices and added together give the money value of the inputs, i.e. the cost of production

The cost of production is an important factor in almost all business analysis and business decision-making, specially those pertaining to

- Locating the weak points in production management
- Minimizing the cost
- Finding the optimum level of output
- Determining the price and dealer's margin
- Estimating or projecting the cost of business operation

Cost Concepts

- Money Costs
- Real Costs
- Opportunity Costs
- Private and Social Costs
- Sunk Cost

Cost Classification for Cost Analysis

- Fixed Cost
- Variable Cost
- Total Cost
- Average Cost
  - Average Fixed Cost
  - Average Variable Cost
  - Average Total Cost

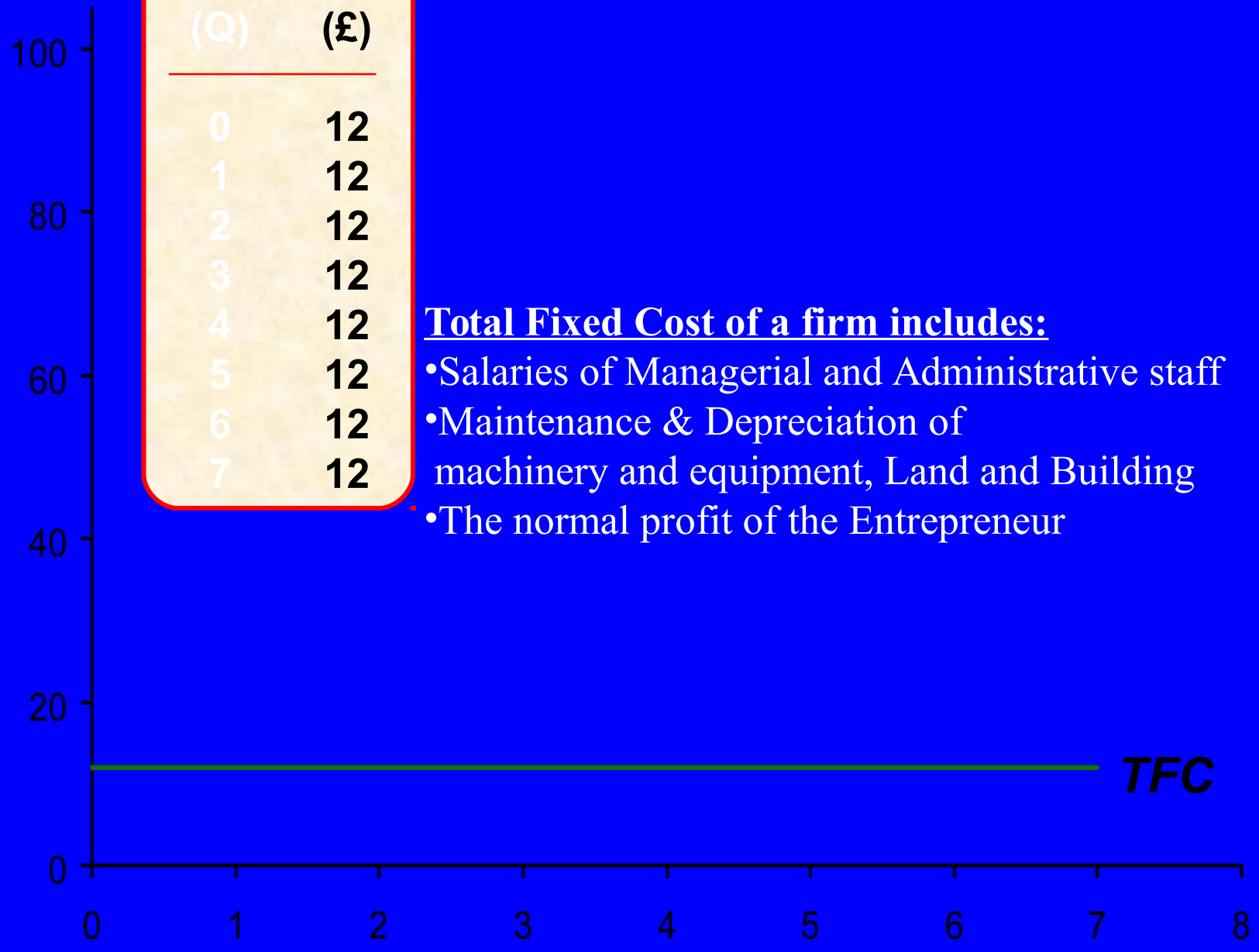
- Marginal Cost

Total Fixed costs for firm X

Output (Q)	*TFC* (£)
0	12
1	12
2	12
3	12
4	12
5	12
6	12
7	12

Total Fixed Cost of a firm includes:

- Salaries of Managerial and Administrative staff
- Maintenance & Depreciation of machinery and equipment, Land and Building
- The normal profit of the Entrepreneur

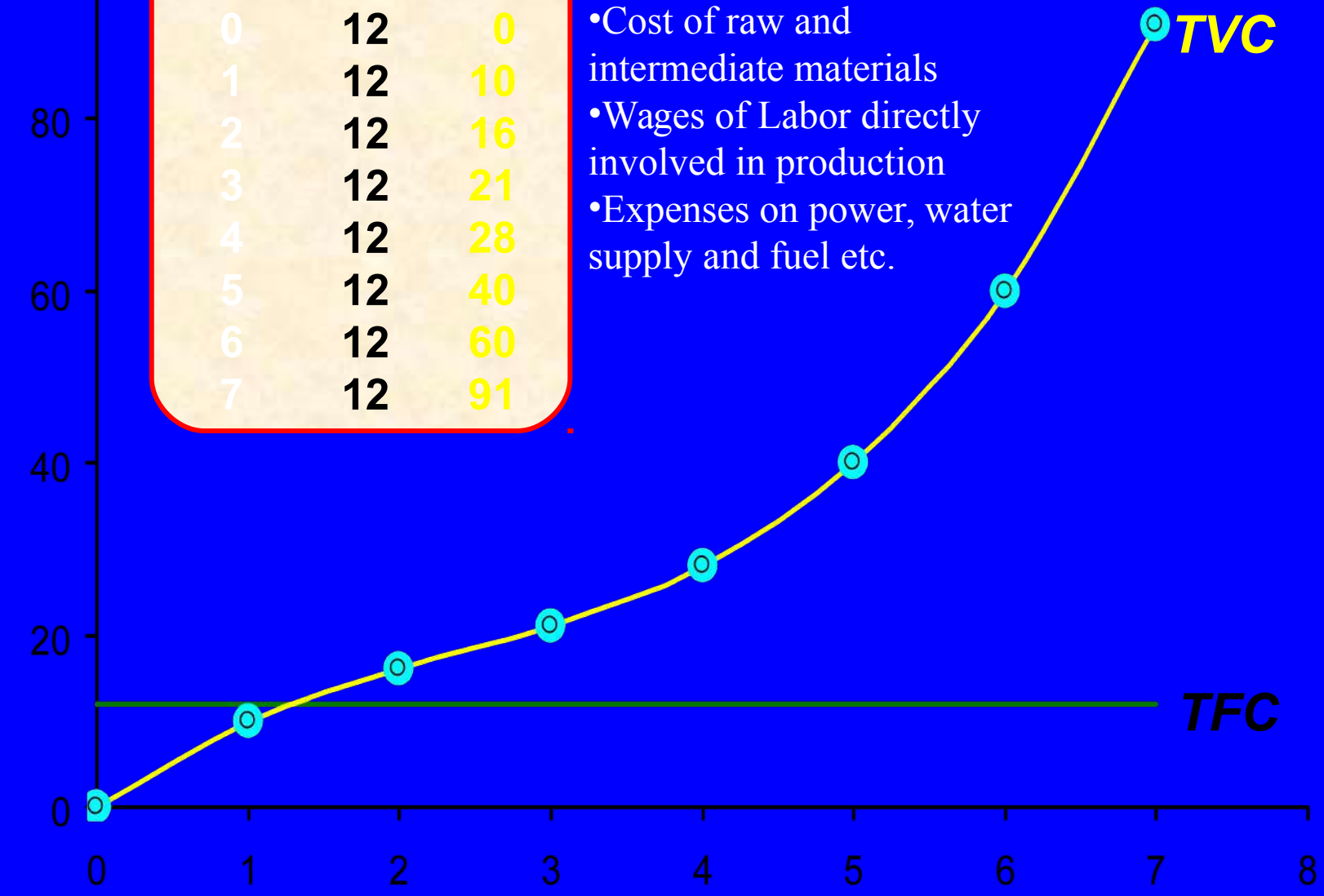


Total Variable costs for firm X

Output (Q)	TFC (£)	TVC (£)
0	12	0
1	12	10
2	12	16
3	12	21
4	12	28
5	12	40
6	12	60
7	12	91

Total Variable Cost of a firm includes:

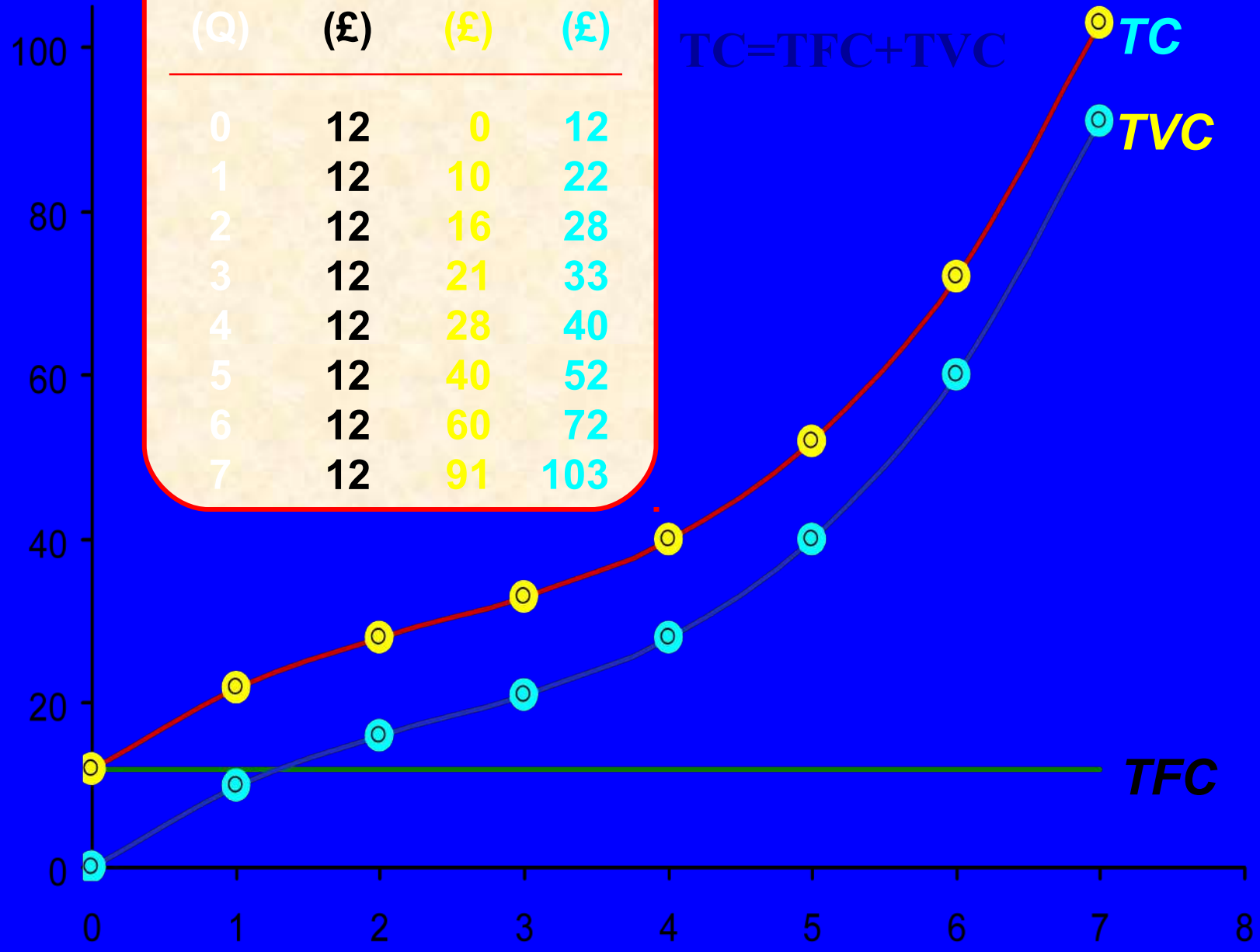
- Cost of raw and intermediate materials
- Wages of Labor directly involved in production
- Expenses on power, water supply and fuel etc.



Total costs for firm X

Output (Q)	TFC (£)	TVC (£)	TC (£)
0	12	0	12
1	12	10	22
2	12	16	28
3	12	21	33
4	12	28	40
5	12	40	52
6	12	60	72
7	12	91	103

TC=TFC+TVC



Costs in the Short run

- **Average cost**
  - **average fixed cost (*AFC*)**
  - **average variable cost (*AVC*)**
  - **average (total) cost (*AC*)**
- **Relationship between average and marginal cost**

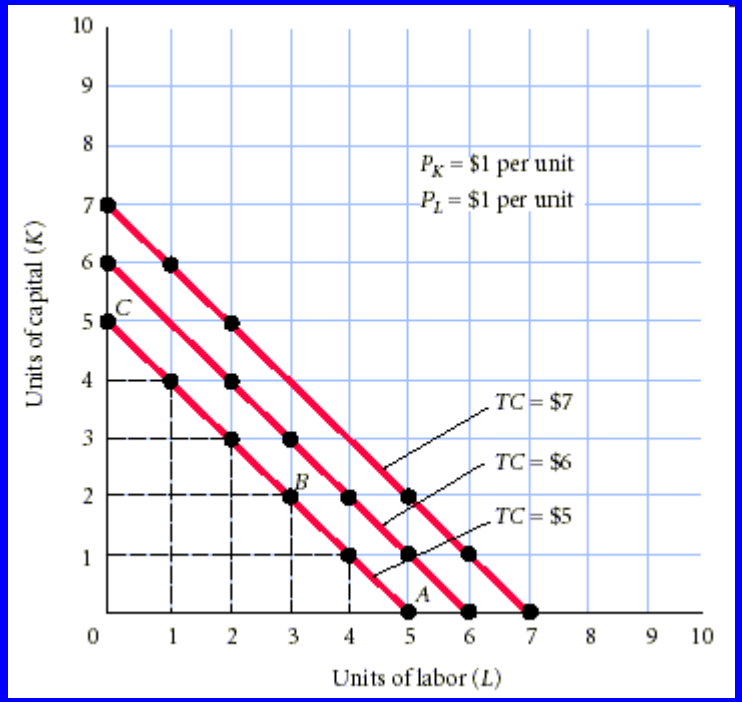
OPTIMAL COMBINATION OF INPUT

TO FIND INPUT COMBINATION THAT MINIMIZES TOTAL COST

- **BUDGET LINE**
- **LEAST COST CRITERIA**

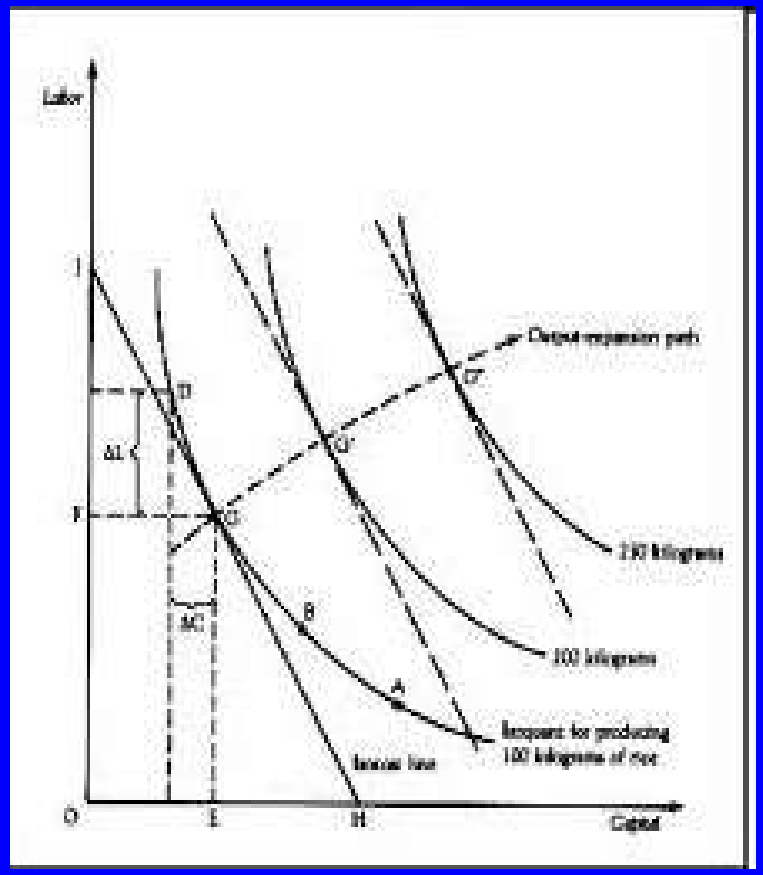
BUDGET LINE/ BUDGET CONSTRAINT LINE/ ISOCLINE/ ISOCOST

- ANY COMBINATION MAY BE POSSIBLE FOR A REQUIRED OUTPUT TECHNICALLY.
- WHAT ECONOMICALLY
- COMBINIG THE PRODCUTION AND COST FUNCTION OF THE FIRM, YIELDS A LINE, SHOWN IN FIG. WHICH REPRESENT ALATERNATIVE COMBINATION OF K & L THAT CAN BE PURCHASED OUT OF THE TOTAL COST



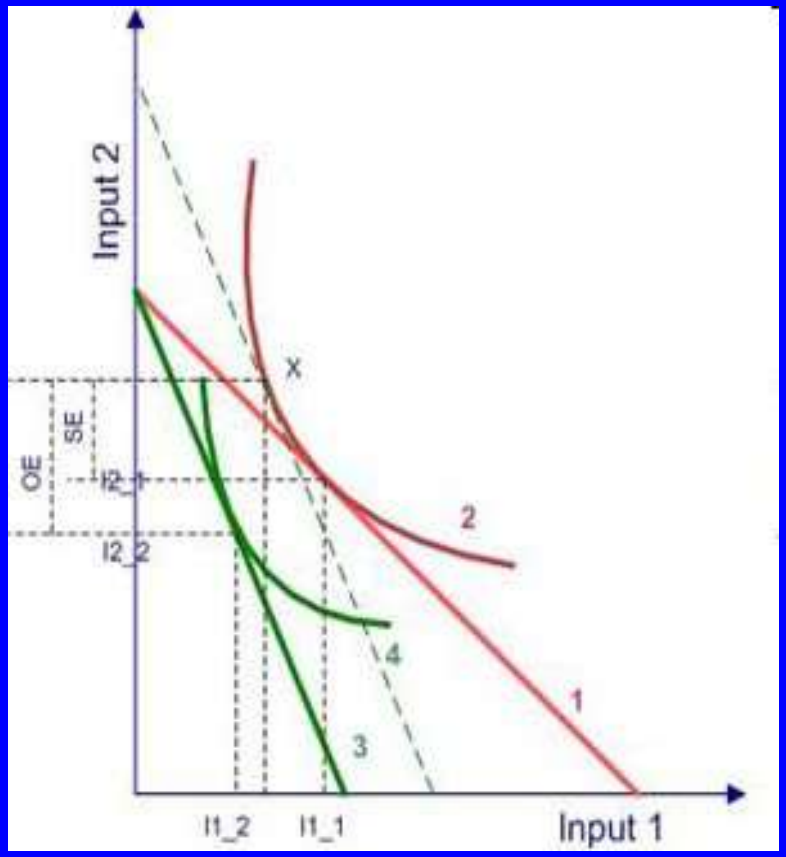
LEAST COST CRITERIA

- COMBINING ISOQUANT AND ISOCOST TO DETERMINE THE OPTIMAL INPUT COMBINATION
- IT IS AT THE POINT WHERE, THE ISOQUANT IS TANGET TO ISOCOST



SUBSTITUTION EFFECT & INPUT COMBINATION

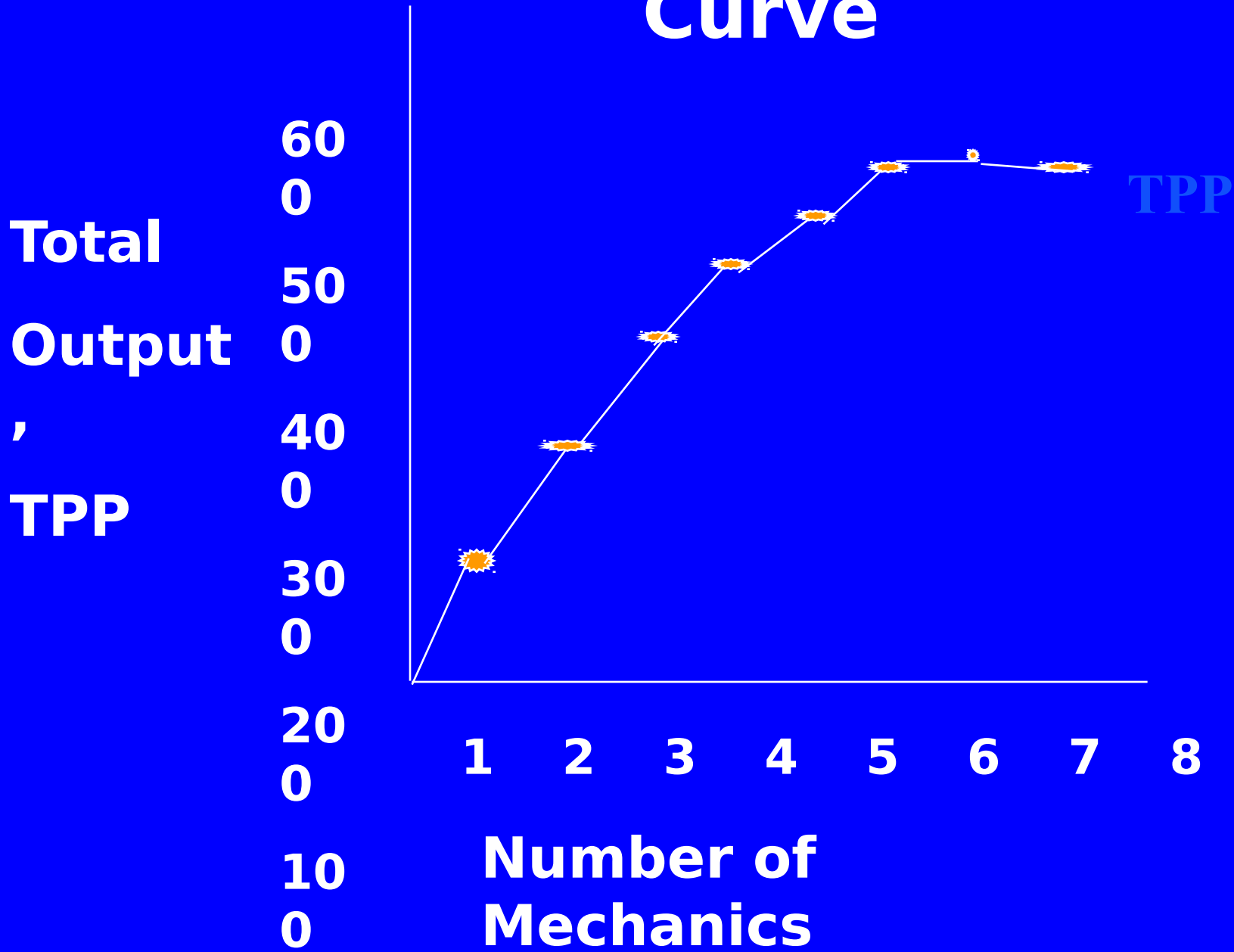
- CHANGE IN RELATIVE PRICES OF INPUTS
- CHANGES BOTH INPUT COMBINATION AND LEVEL OF INPUT
- THEREFORE, SUBSTITUE THE CHEAPER INPUT FOR THE COSTLIER ONE.



Now, let's just consider the column under "10 capital"

Number Mechanics	Total Output
0	0
1	100
2	250
3	360
4	440
5	500
6	540
7	550
8	540

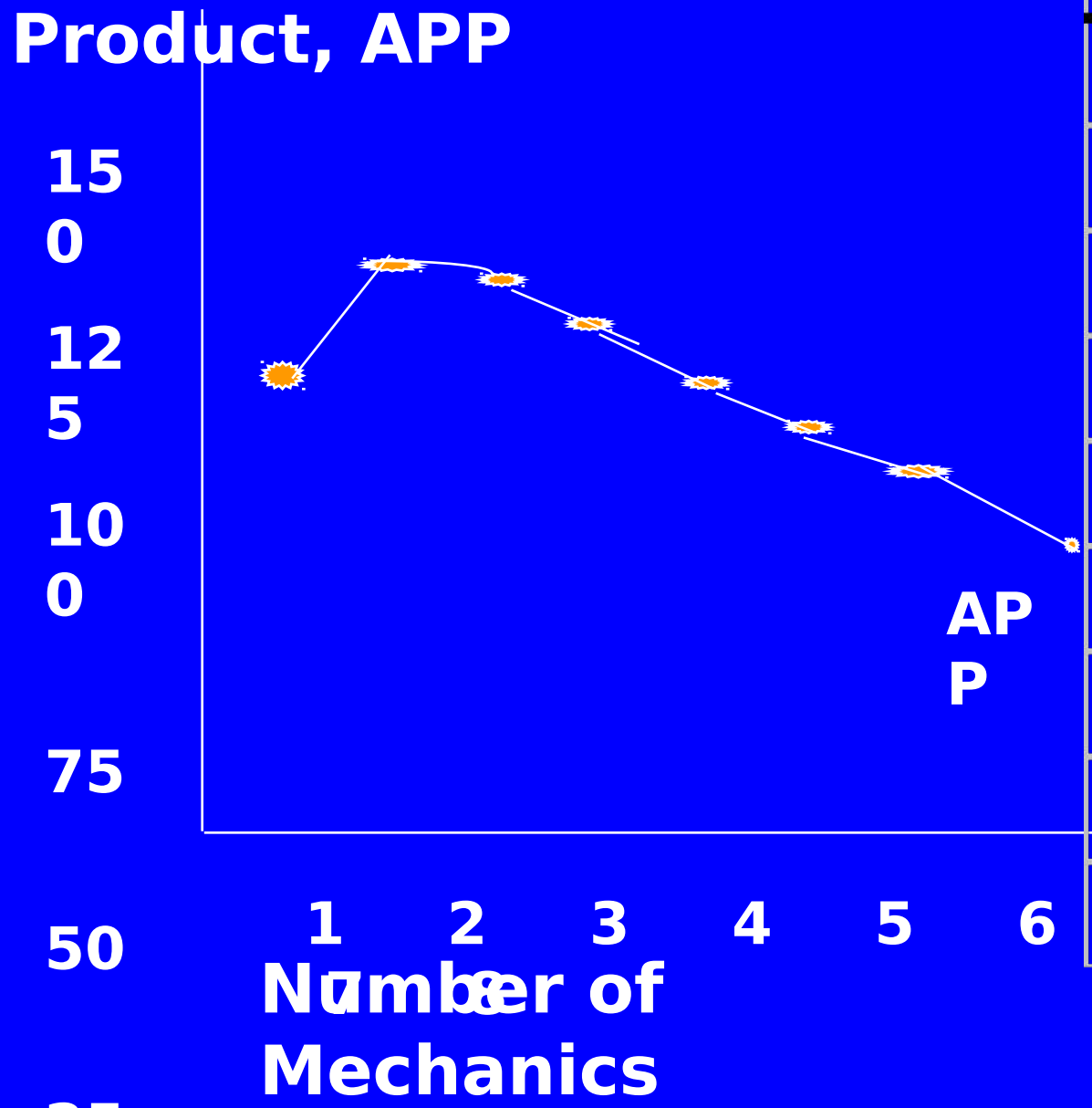
The Total Product Curve



$$\text{Average Product} = \frac{\text{Total Output}}{\text{\# of mechanics}}$$

0	0	0
1	100	100
2	250	125
3	360	120
4	440	110
5	500	100
6	540	90
7	550	78.6
8	540	67.5

Average Product, APP



Number Mechanics	Total Output	Average Product
0	0	0
1	100	100
2	250	125
3	360	120
4	440	110
5	500	100
6	540	90
7	550	78.6
8	540	67.5

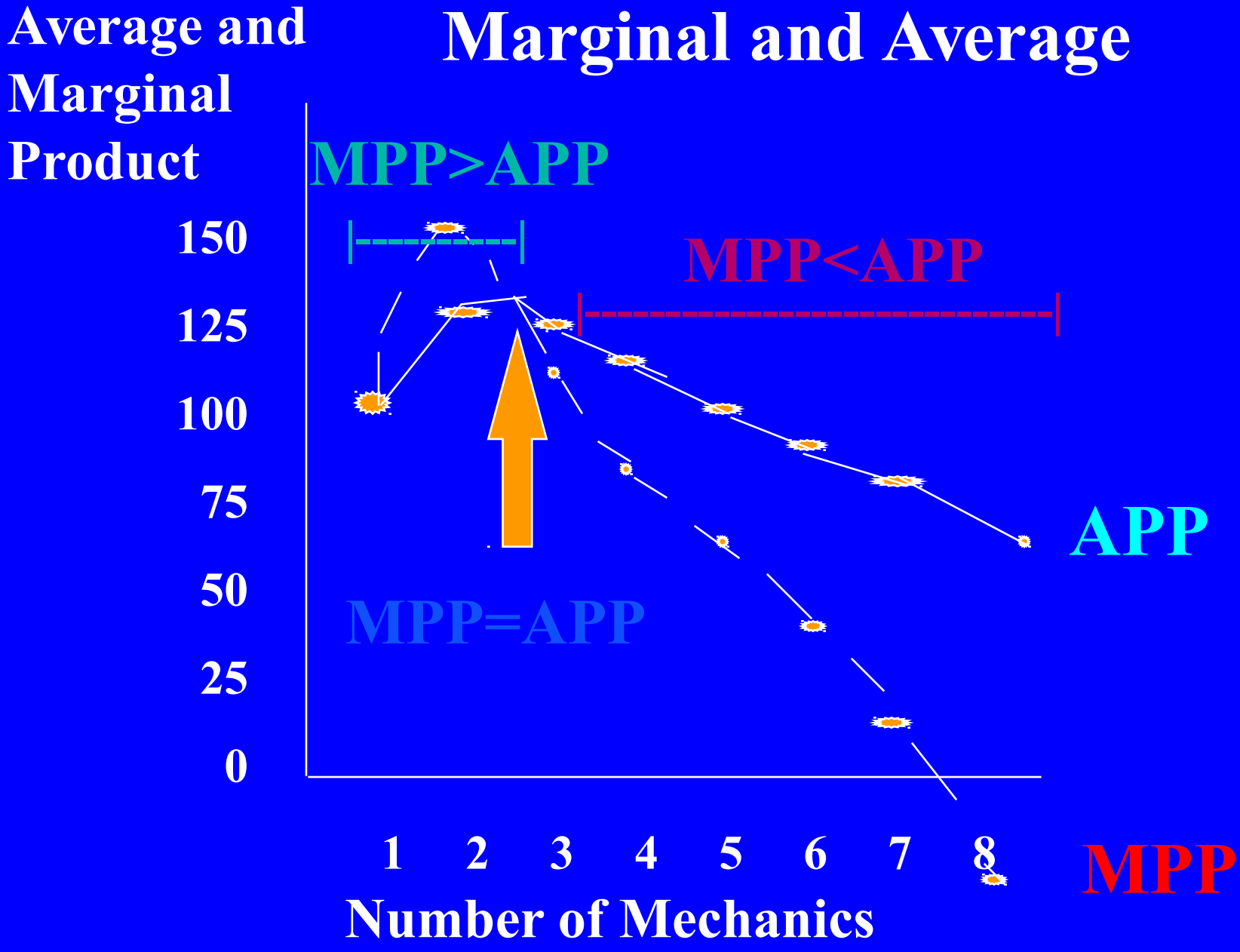
Marginal Product of Mechanics = **Change in Total Output / Change in Number of**

Mechanics	TOTAL Output	AVERAGE Product	MARGINAL Product
0	0	0	0
1	100	100	100
2	250	125	150
3	360	120	110
4	440	110	80
5	500	100	60
6	540	90	40
7	550	78.6	10
8	540	67.5	-10

Let's Plot the MPP Schedule

We'll place it on top of the APP schedule so we can compare the two

Marginal and Average



Economies of Scale

Economies of scale

- Economies of scale arise when the cost per unit falls as output increases.
- Economies of scale are the main advantage of increasing the scale of production and becoming ‘big’.

Why are economies of scale important?

- - Firstly, because a large business can pass on lower costs to customers through lower prices and increase its share of a market.
- - Secondly, a business could choose to maintain its current price for its product and accept higher profit margins. For example, a furniture-maker which could produce 1,000 cabinets at Rs. 250 each might expand and be able to produce 2,000 cabinets at Rs. 200 each. The total production cost will have risen to Rs. 400,000 from Rs. 250,000, but the cost per unit has fallen from Rs. 250 to Rs. 200. Assuming the business sells the cabinets for Rs. 350 each, the profit margin per cabinet rises from Rs. 100 to Rs. 150.

Economies of Scale

- There are two main types of economies of scale:
- Internal and external.
- Internal economies of scale have a greater potential impact on the costs and profitability of a business.
- External economies of scale occur when a firm benefits from lower unit costs as a result of the whole industry growing in size. External economies are those economies which accrue to each member firm as a result of the expansion of the industry as a whole.

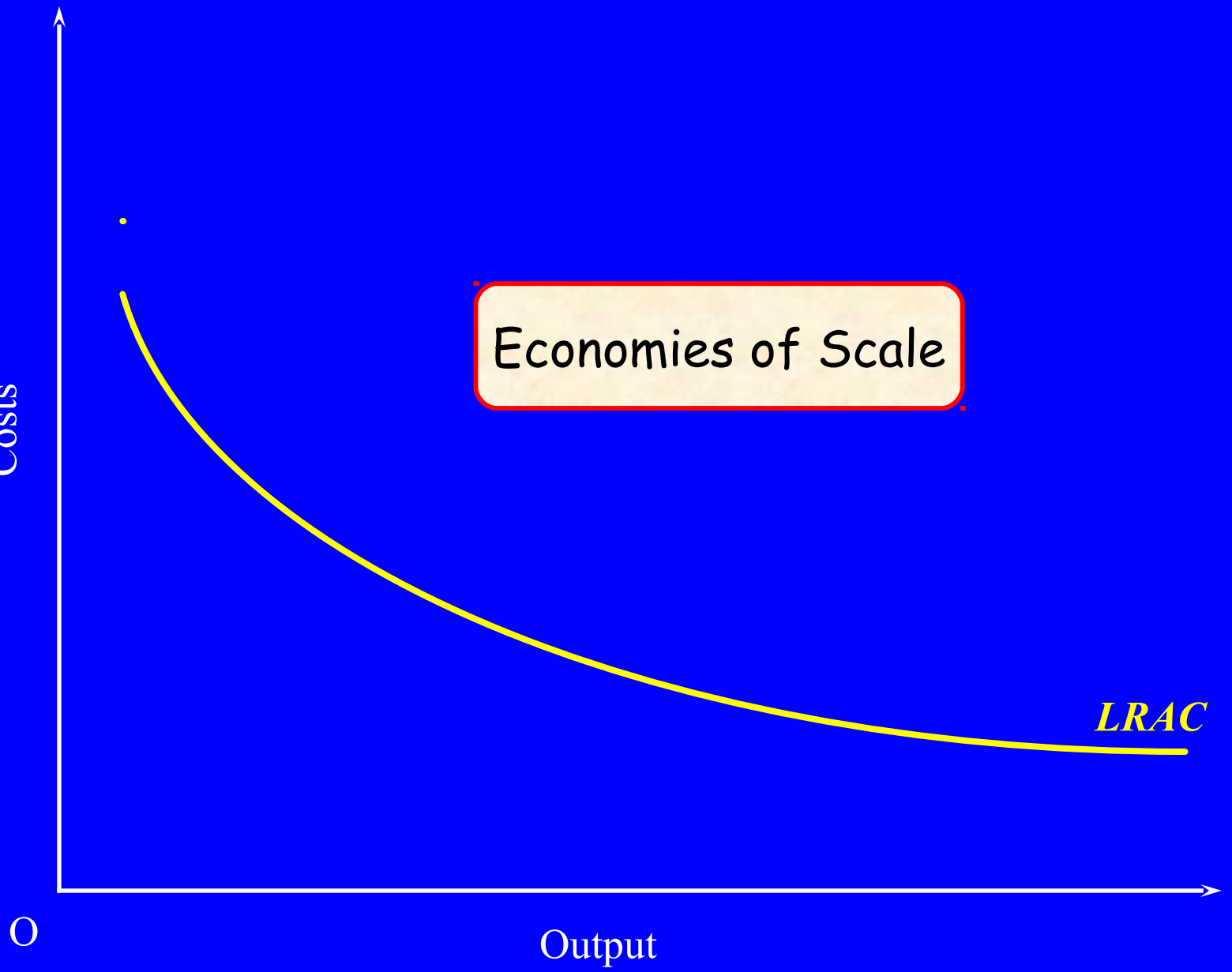
Internal economies of scale

- Bulk-buying economies
- Technical Economies
- Financial Economies
- Marketing Economies
- Managerial Economies
- Labor Economies
- Risk bearing Economies

External Economies of Scale

- Transportation and Communication
- Industry focused training and education
- Growth of ancillary industries
- Technical economies
- Cheap raw material
- Economies of by product

Alternative long-run average cost curves



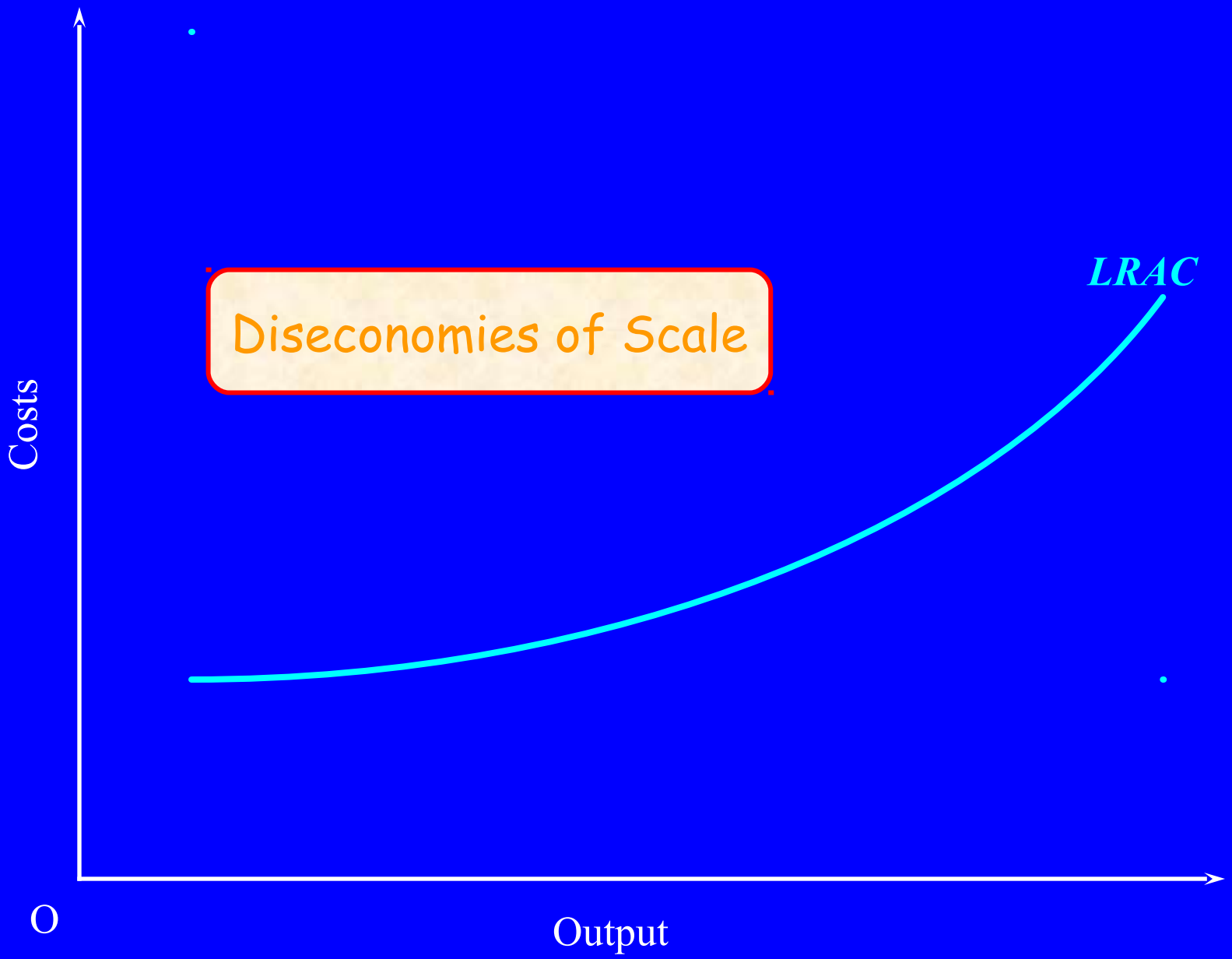
Diseconomies of scale

- Increasing the size of a business does not always result in lower costs per unit. Sometimes a business can get too big!
- Diseconomies of scale occur when a business grows so large that the costs per unit increase.
- Diseconomies of scale occur for several reasons, but all as a result of the difficulties of managing a larger workforce.

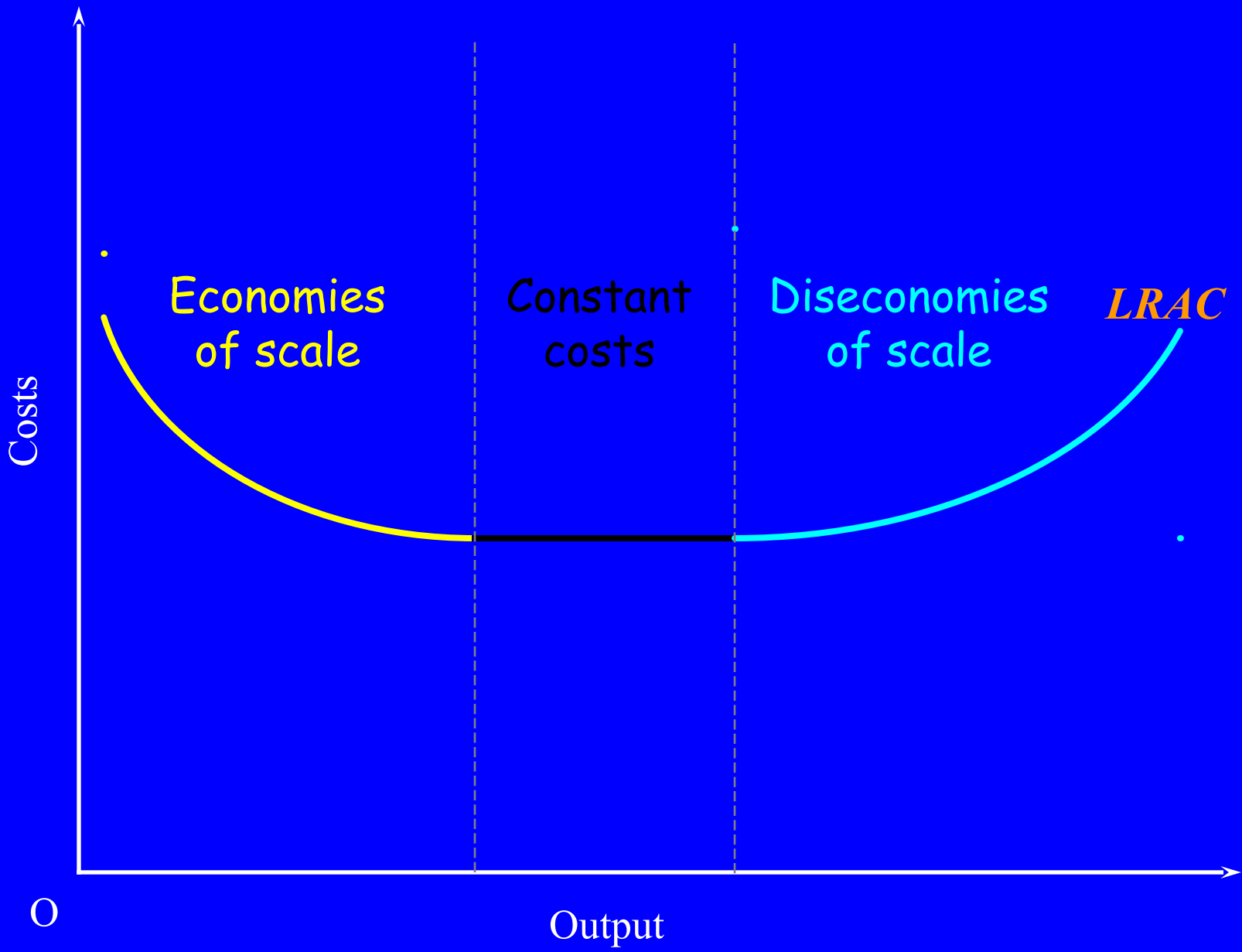
Diseconomies of scale

- **Internal diseconomies**
  - **Managerial inefficiency**
    - **Poor Communication**
    - **Lack of Motivation**
    - **Loss of Direction and coordination**
    - **Slow Decision making and implementation**
  - **Labor inefficiency**
- **External diseconomies of scale**
  - **Natural constraints; discounts enjoyed**

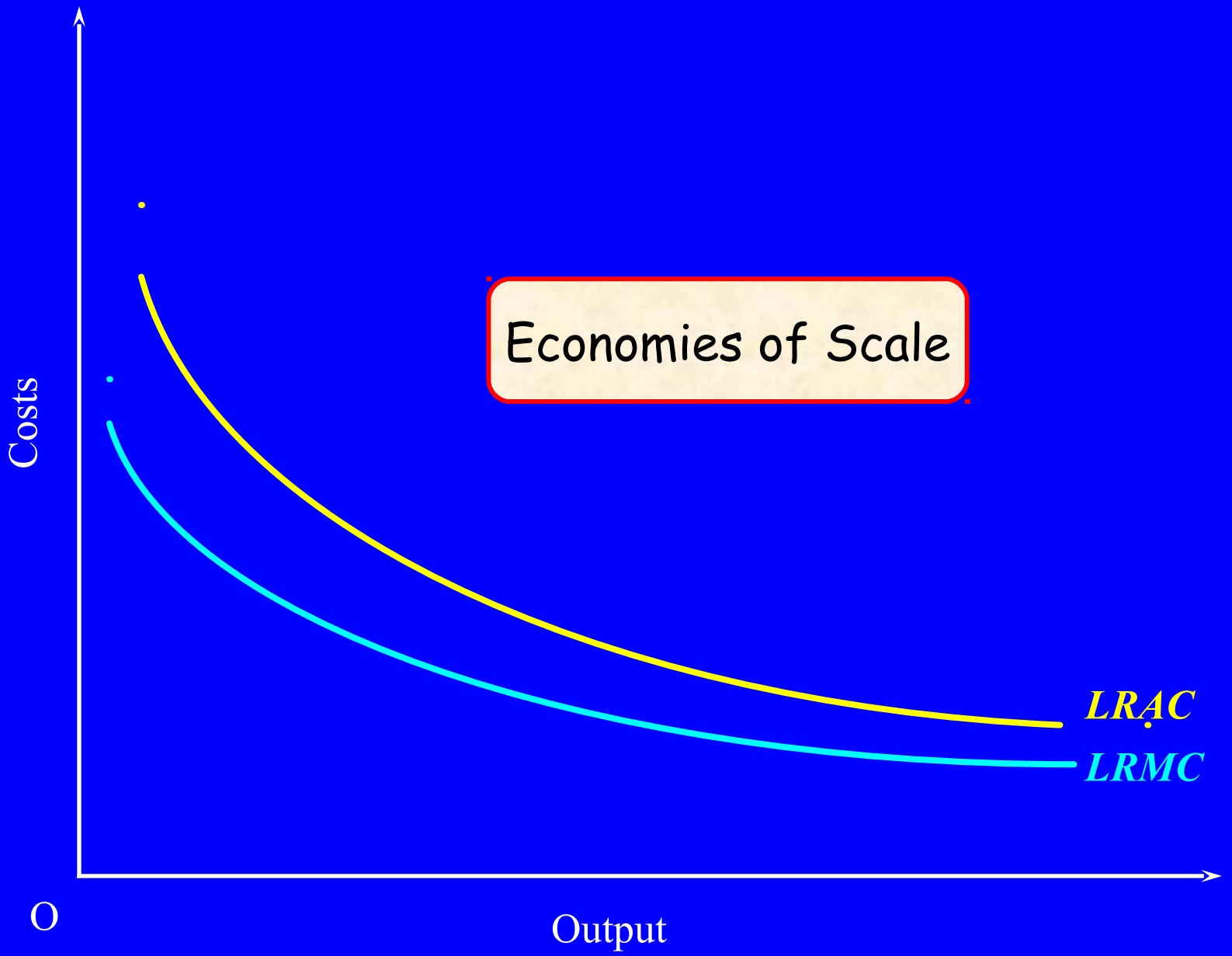
Alternative long-run average cost curves



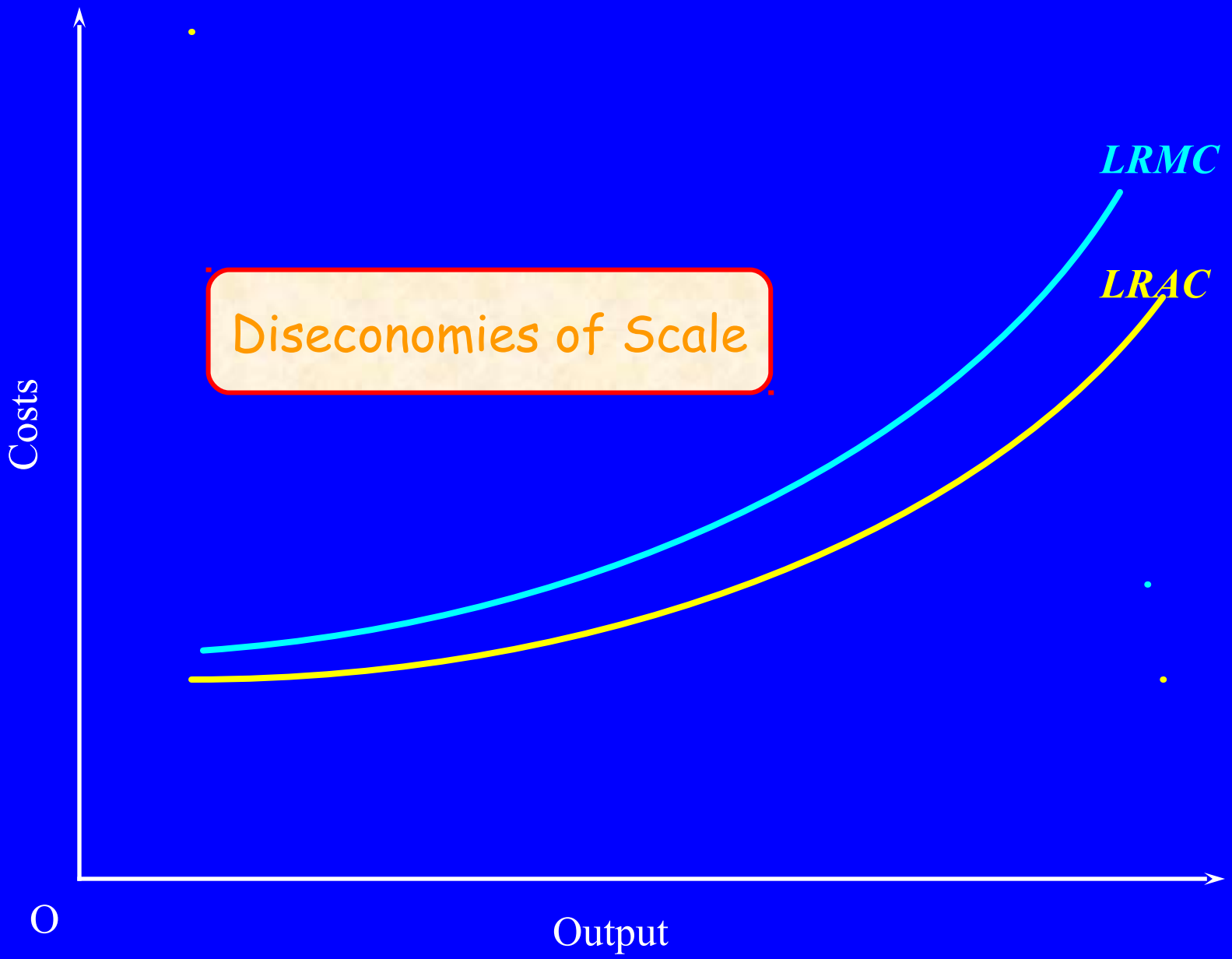
A typical long-run average cost curve



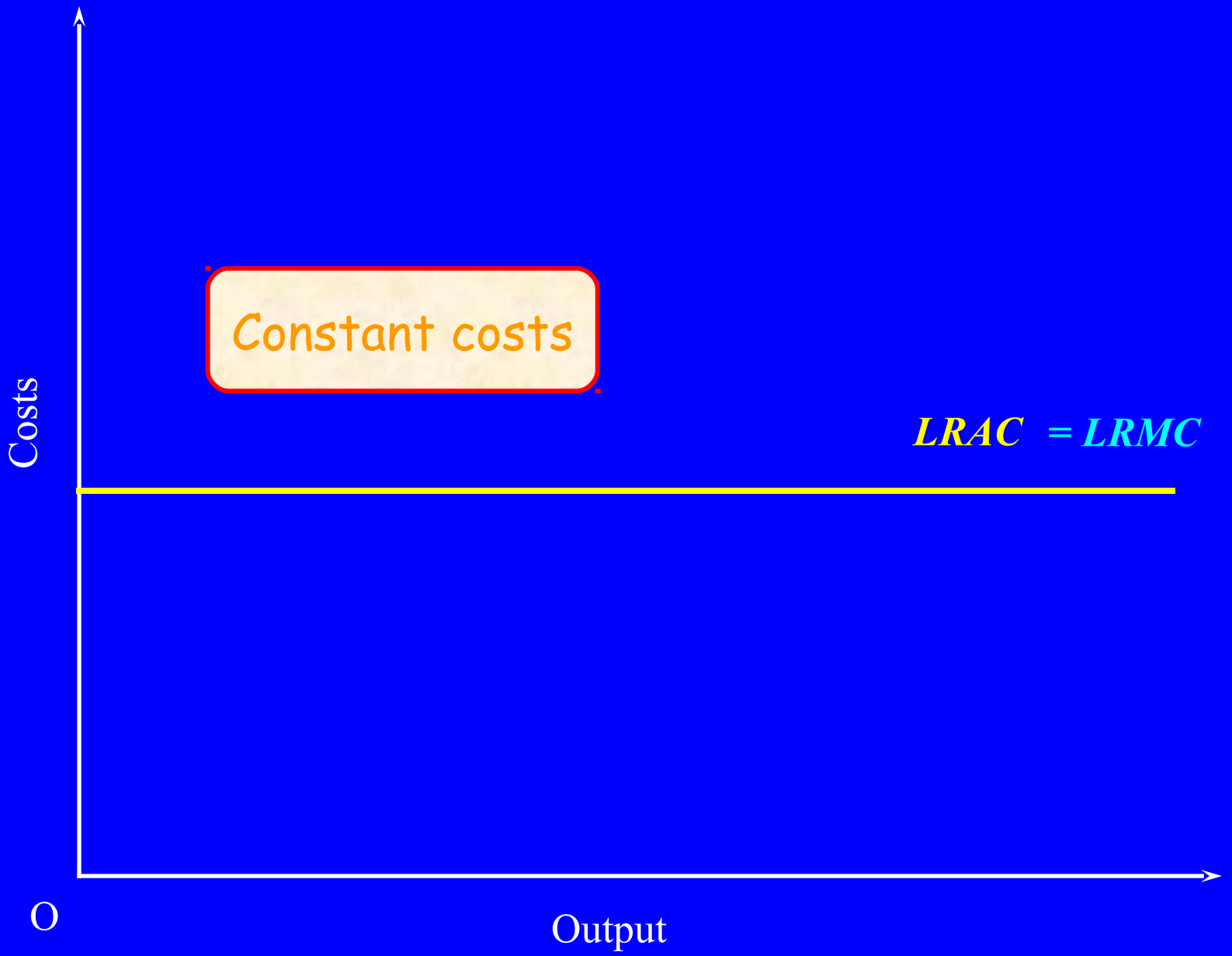
Long-run average and marginal costs



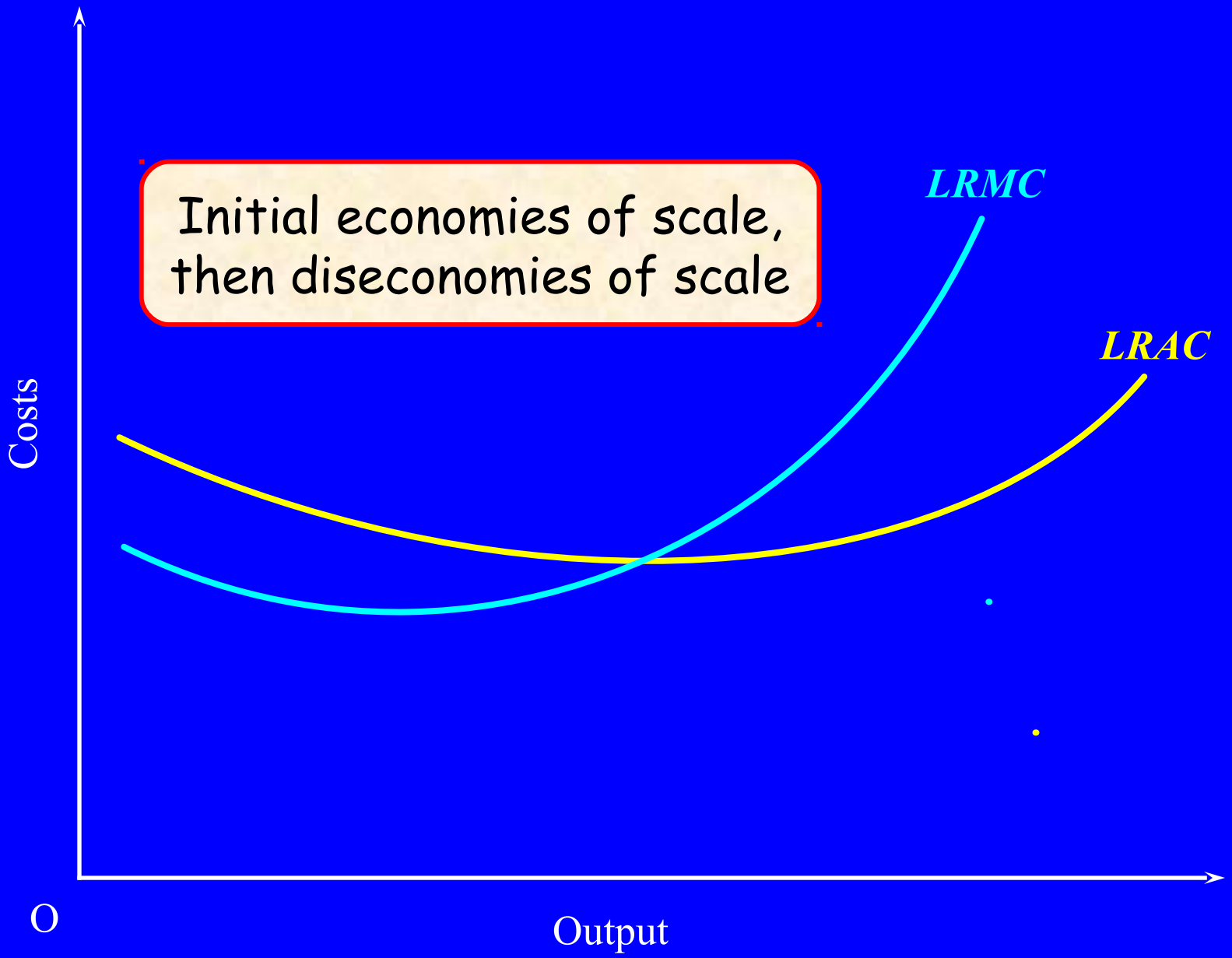
Long-run average and marginal costs



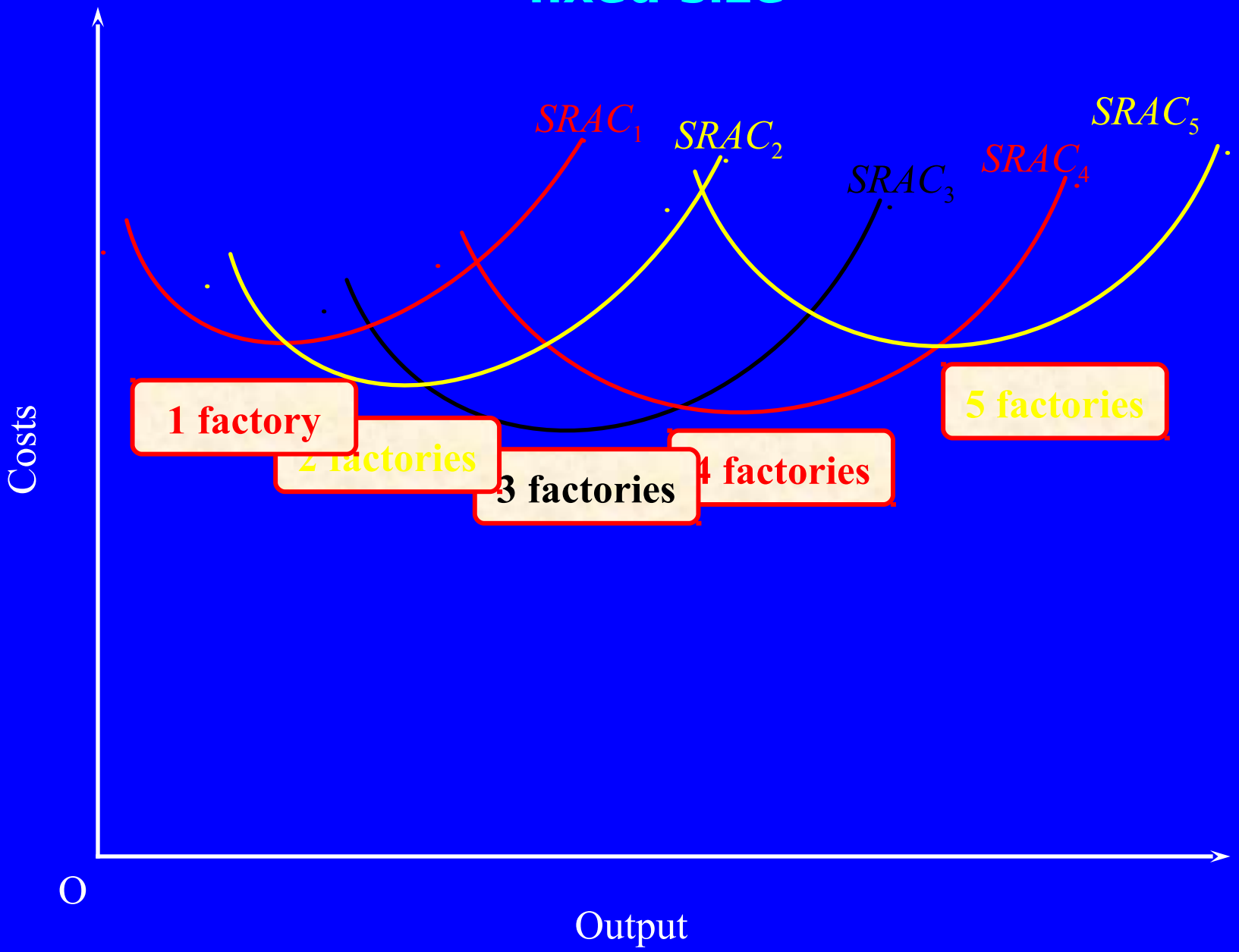
Long-run average and marginal costs



Long-run average and marginal costs



Deriving long-run average cost curves: factories of fixed size



Deriving a long-run average cost curve (Envelope Curve)