Production and Costs in the Short run

EE311

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SR
(at least one fixed FoP)

→ Law of Diminishing Returns

↓

SR Production

↓

SR Cost

LR
(all FoP's are variable)

→ Returns to Scale

↓

LR Production

↓

LR Cost (Economies of Scale)

What tasks should be done in-house and what should be done by out-sourcing?

- In-house production generates internal managerial costs that increase with the production scale
  - Monitoring costs: costs associated with quality assurance and shirking minimization
  - Coordination costs: the cost related to team-work coordination efforts

What tasks should be done in-house and what should be done by out-sourcing?

- Out-sourcing generates transaction costs that decrease with the production scale
  - Information costs
  - Negotiation costs
  - Enforcement costs
- The optimal firm size is where the combined costs are minimized.

Transaction costs: determinants

- The faster we need the information, the higher the information costs.
  - Inventory can decrease the transaction costs.
- The more the market is changed, the higher the transaction cost.
  - Need to update information.
- Advertisement and middlemen can reduce the transaction costs.
- Standardization decreases transaction costs.

Transaction costs: applications

- Similar products are sold at different prices
  - Each product has different quality, terms.
  - Each consumer has different information.
  - Each consumer has different opportunity cost of time

    --> willing to search for information differently.
- Hotels often have extra rooms. Restaurants, theaters, barber shops often have excess seats.

Production Decisions of a Firm

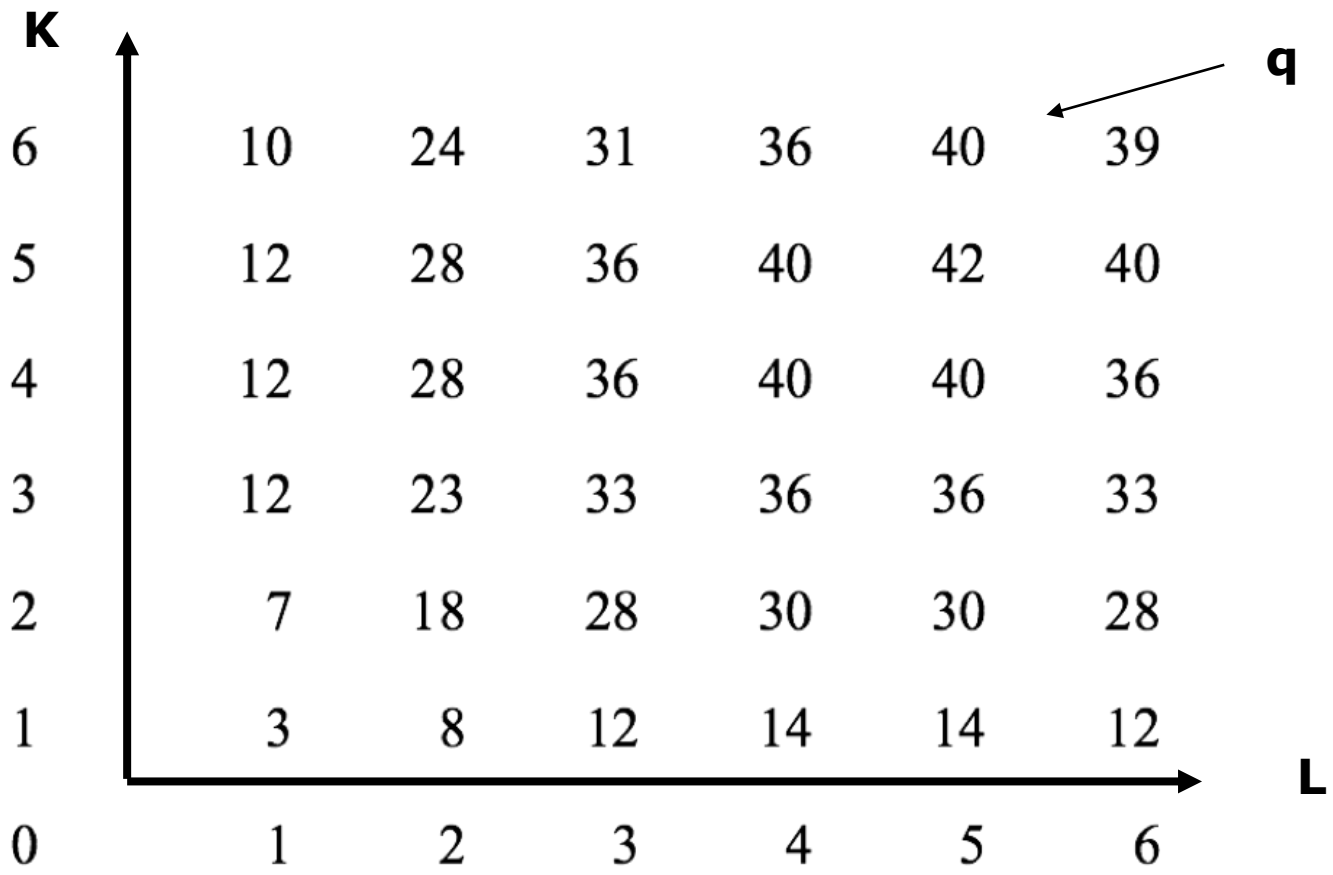
- Production Technology
  - Describe how *inputs* can be transformed into *outputs*
    - Inputs: land, labor, capital & raw materials
    - Outputs: cars, desks, books, etc.
  - Firms can produce different amounts of outputs using different combinations of inputs
  - We can represent the firm's production technology in for form of a production function

The Technology of Production

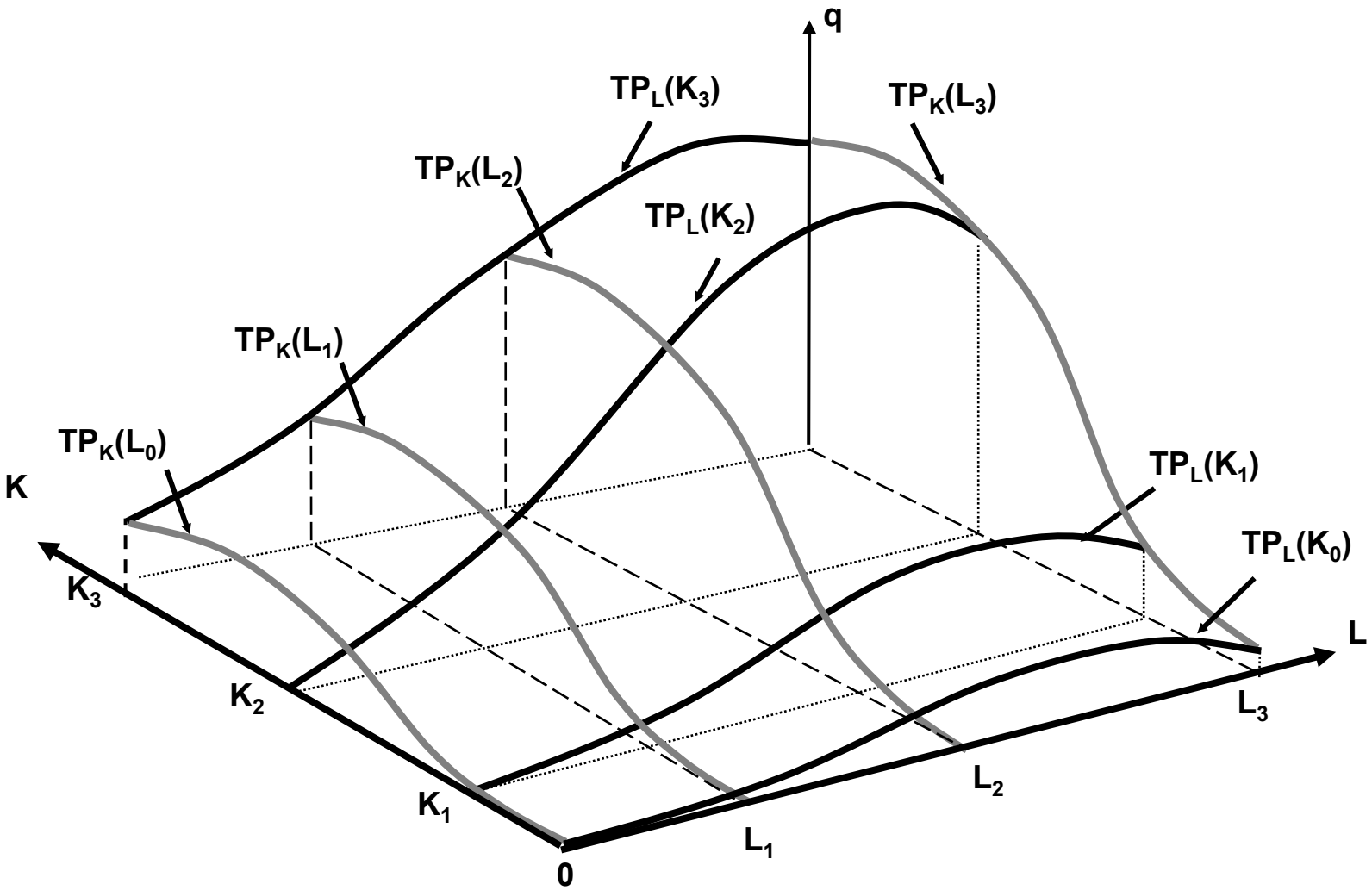
- Production Function:
  - Indicates the highest output (q) that a firm can produce for every specified combination of inputs.
  - For simplicity, we will consider only labor (L) and capital (K)
  - Shows what is technically feasible when the firm operates efficiently
- The production function for two inputs:

$$q = F(K,L)$$

Representation of a production function



Representation of a production function



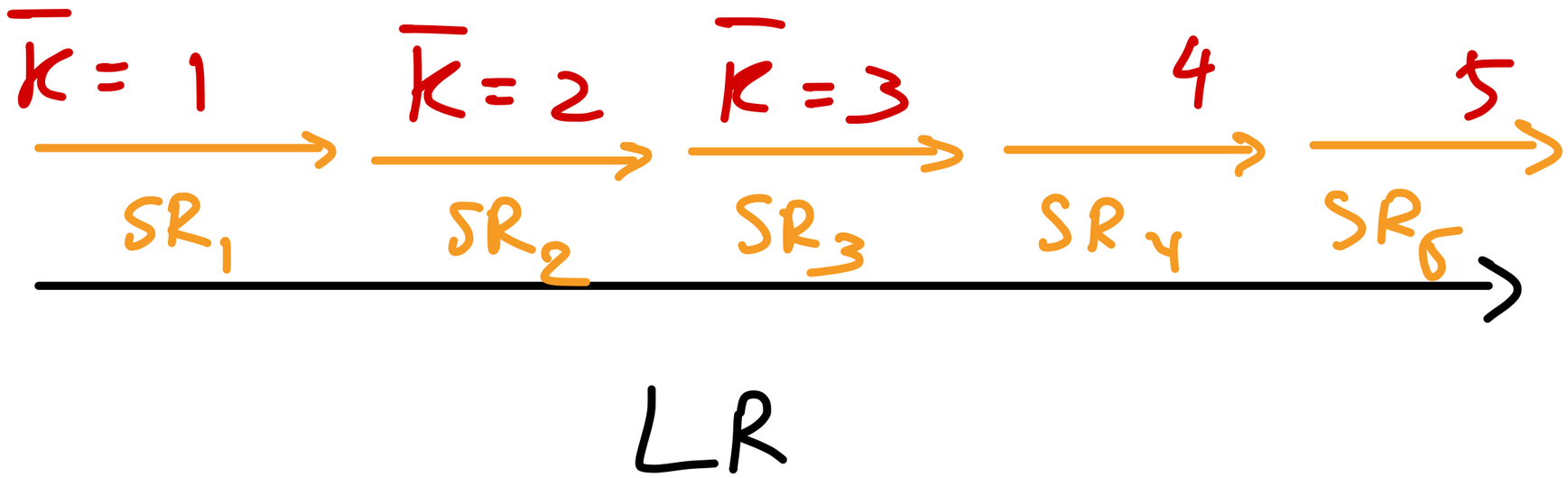
The Technology of Production

- Short Run
  - Period of time in which quantities of one or more production factors cannot be changed.
  - These inputs are called fixed inputs.
  - Those that can change are called variable input.

- Long-run
  - Amount of time needed to make all production inputs variable.
- Short run and long run are not time specific

in SR → fixed $\bar{K}$

in LR → K can change



S-R Production: One Variable Input

- We will begin looking at the short run when only one input can be varied
- We assume capital is fixed and labor is variable
  - Output can only be increased by increasing labor
  - Must know how output changes as the amount of labor is changed

S-R Production: One Variable Input

Amount of Labor (L)	Amount of Capital (K)	Total Output (q)	Average Product (q/L)	Marginal Product (Δq/ΔL)
0	10	0	—	—
1	10	10	10	10
2	10	30	15	20
3	10	60	20	30
4	10	80	20	20
5	10	95	19	15
6	10	108	18	13
7	10	112	16	4
8	10	112	14	0
9	10	108	12	−4
10	10	100	10	−8

SR Production is characterized by the Law of Diminishing Returns.

LoDR: in SR where at least one FoP is fixed, as variable input (e.g. labor) is added to to fixed input (e.g. land), the MP of variable input eventually diminishes.

$$MP_L = \frac{\Delta TP}{\Delta L}$$

e.g. $MP_L = 3$: $L \uparrow$ 1 unit $\rightarrow$ $TP \uparrow$ 3 units

TP

MP > 0

MP increasing
(TP steeper)

MP > 0

MP < 0

MP = 0
TP max.

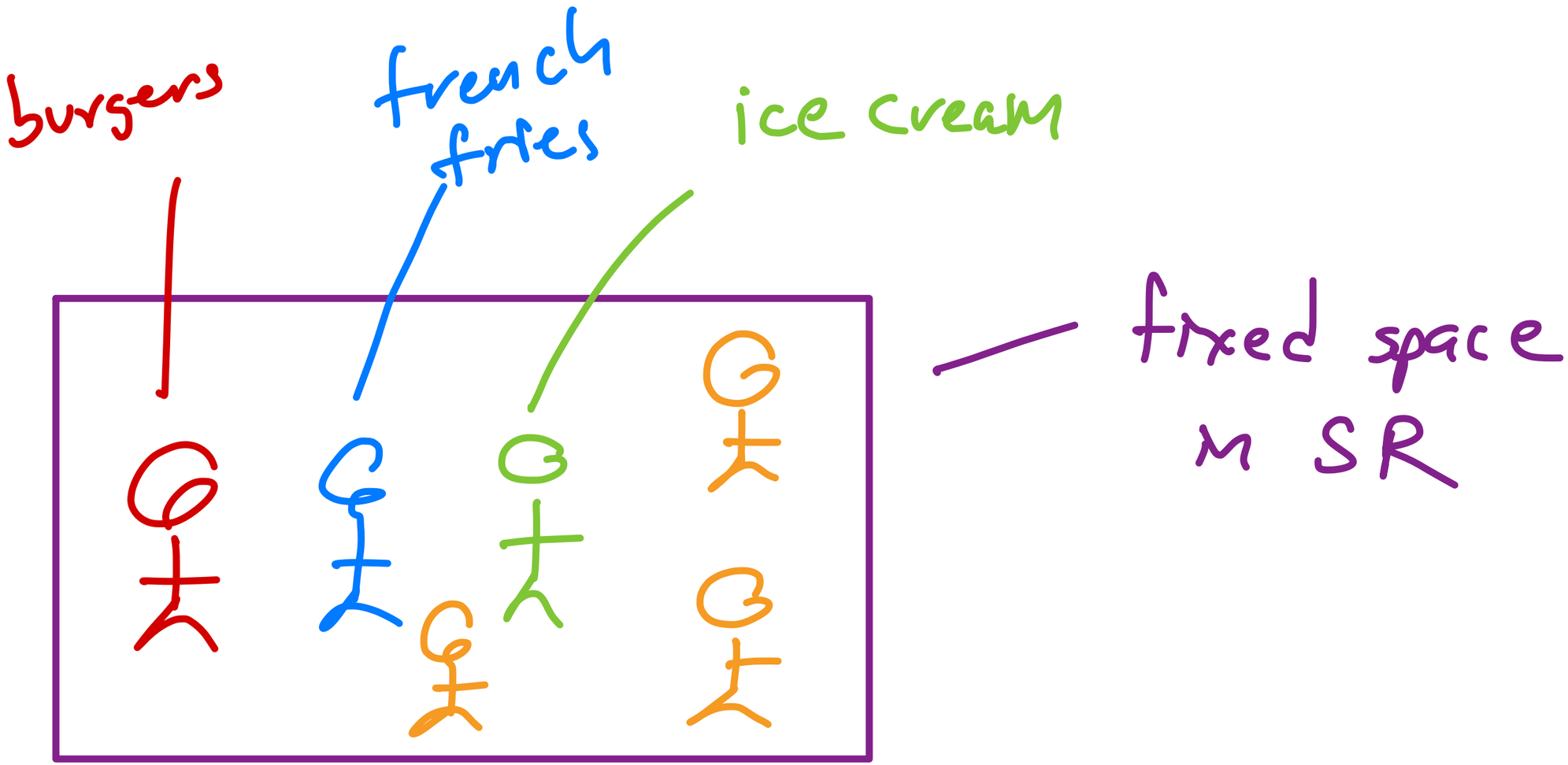
MP decreasing
(TP flatter)

TP = $F(\bar{K}, L)$

MP is slope of TP

Labor

L^* ← LoDR sets M


burgers
french fries
ice cream
fixed space
M SR

★ MP represents productivity of workers ★

MP > 0 : L ↑ → TP ↑

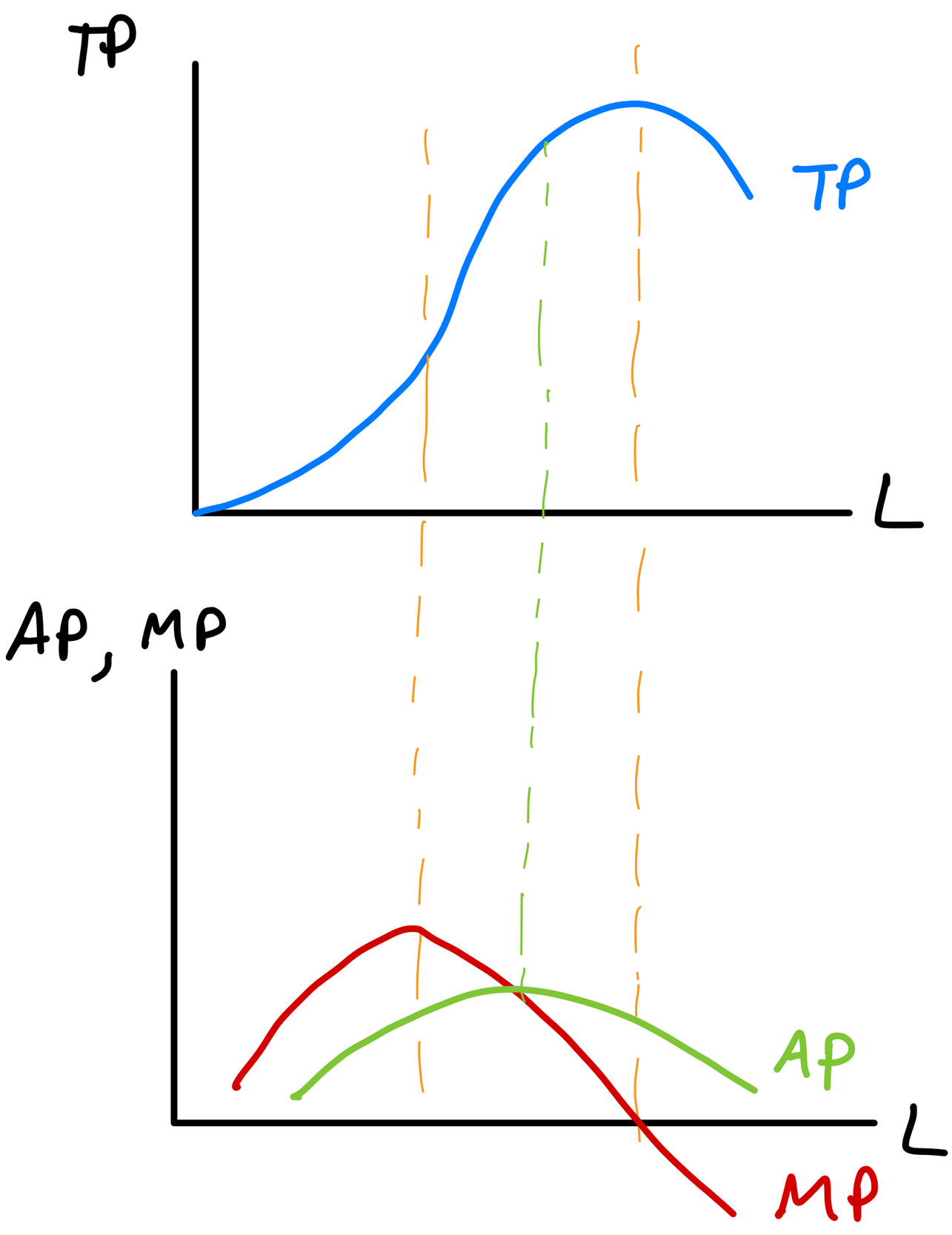
MP < 0 : L ↑ → TP ↓

MP increasing due to Division of Labor Effect

→ productivity of each extra worker increases

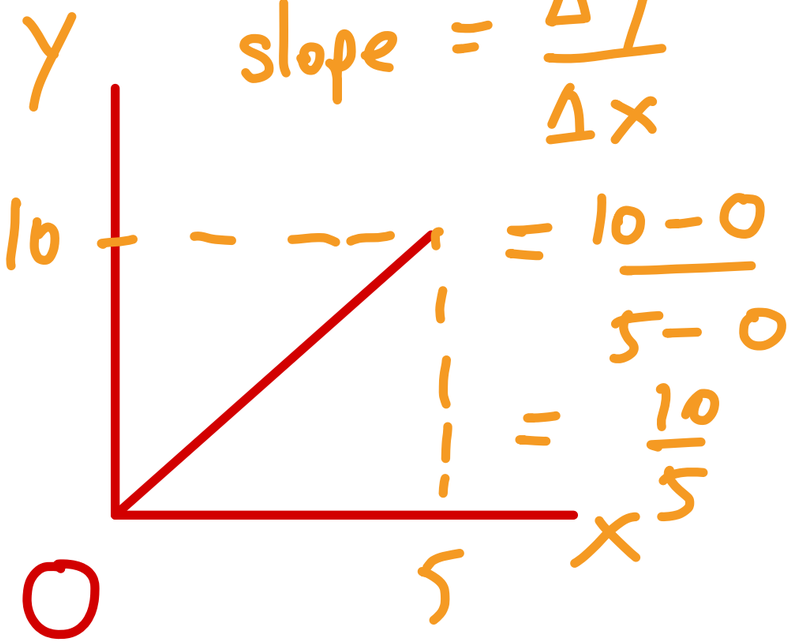
MP decreasing due to LoDR (fixed input)

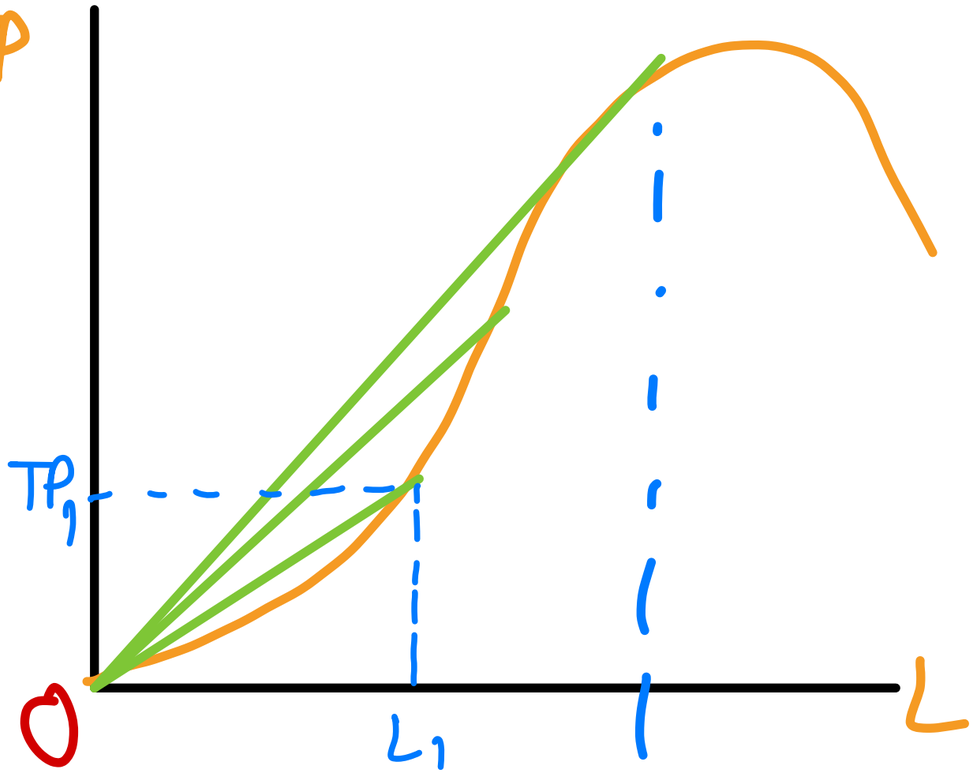
→ productivity of each extra workers decreases



$$AP_L = \frac{TP}{L}$$

$$MP_L = \frac{\Delta TP}{\Delta L}$$



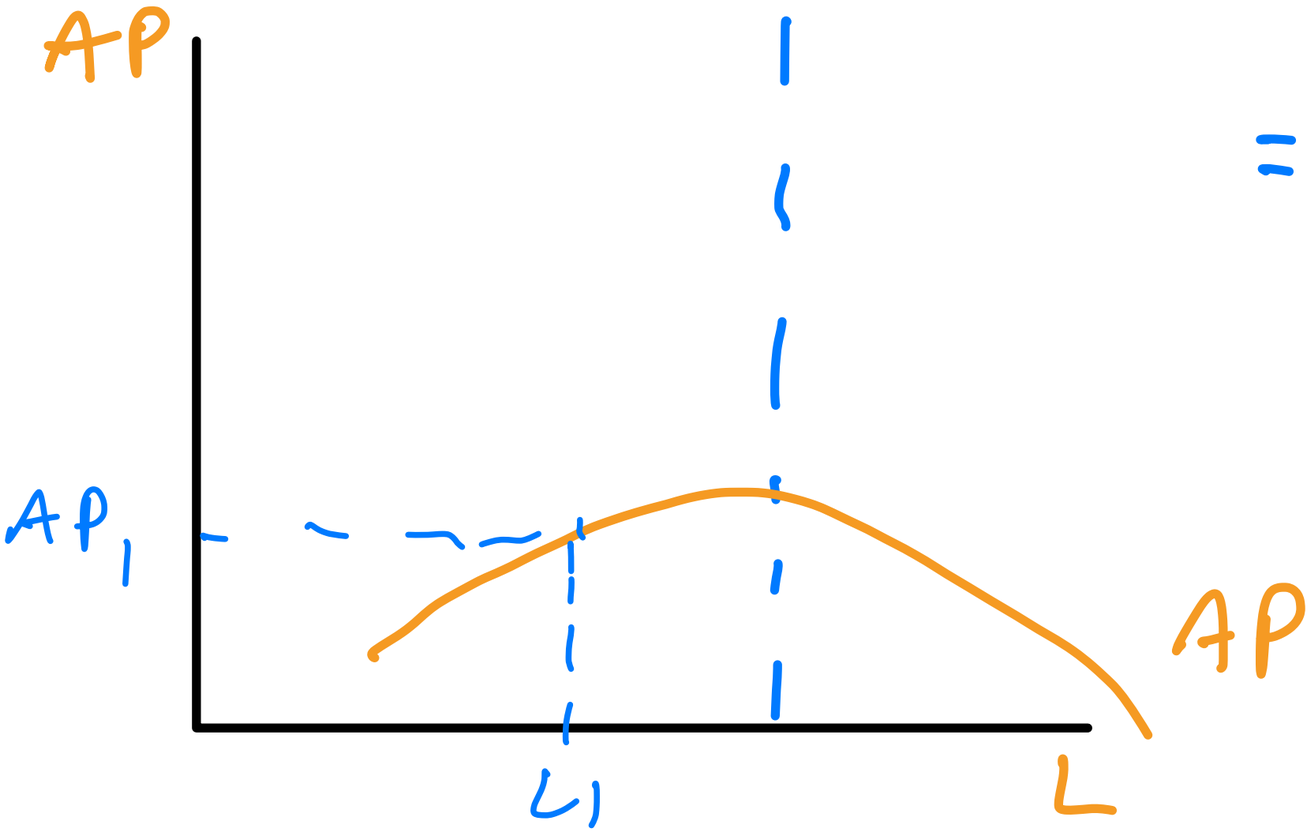


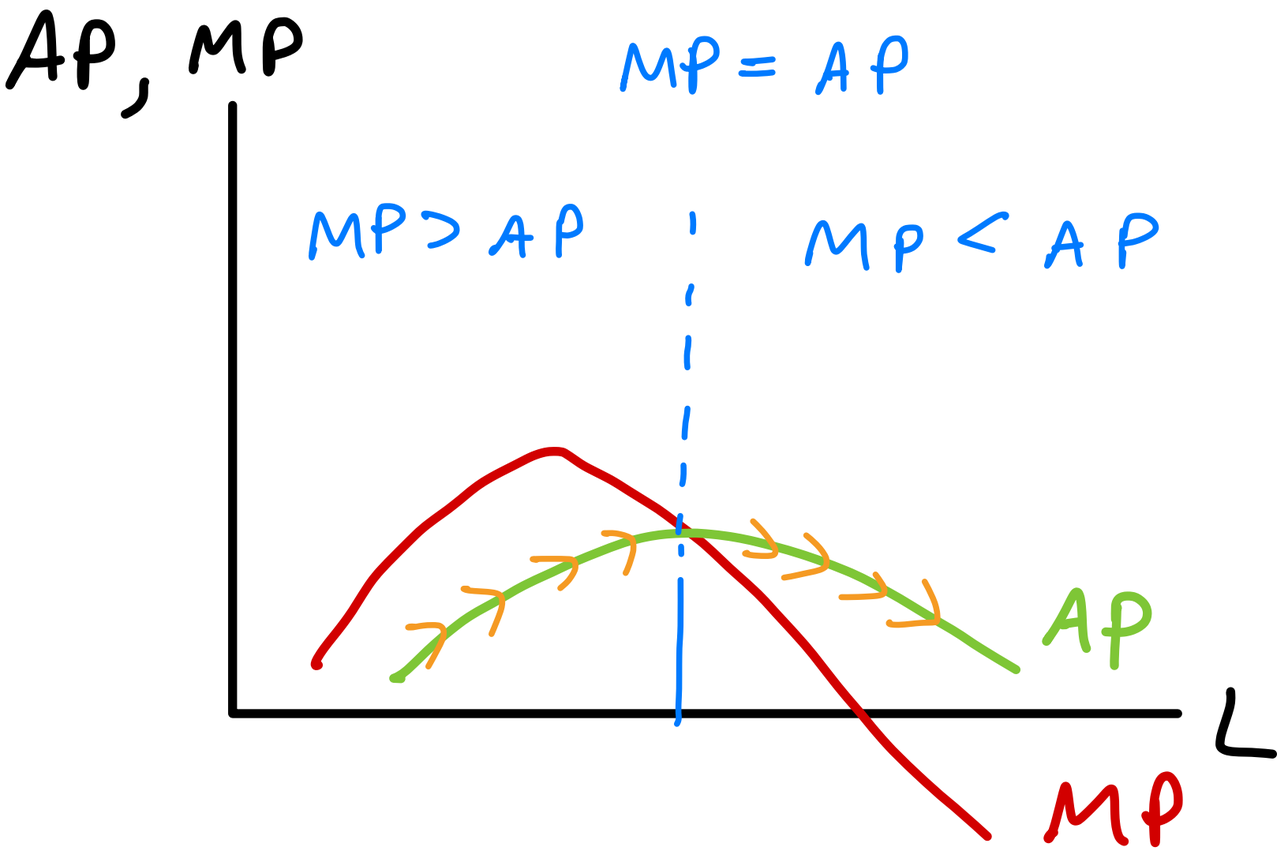
slope of green lines

$= \frac{\Delta TP}{\Delta L}$

$= \frac{TP - O}{L - O}$

$= AP$





MP > AP

→ AP rising

MP < AP

→ AP falling

MP = AP

→ AP max.

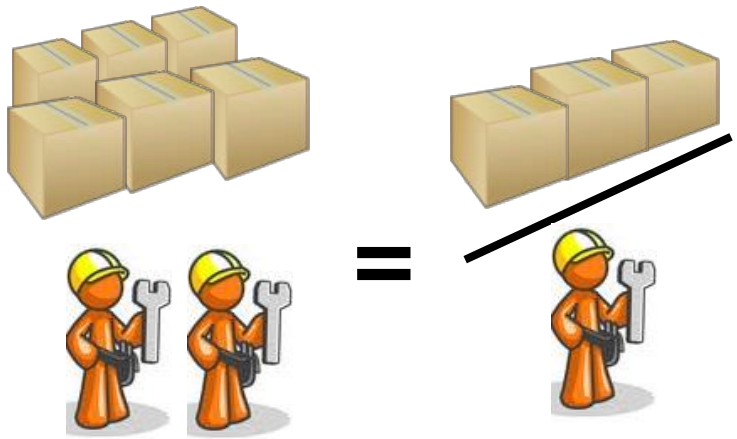
S-R Production: One Variable Input

- Observations:
  - When labor is zero, output is zero as well
  - With additional workers, output (q) increases up to 8 units of labor.
  - Beyond this point, output declines
    - Increasing labor can make better use of existing capital initially
    - After a point, more labor is not useful and can be counterproductive

S-R Production: One Variable Input

- Average product of Labor - Output per unit of a particular product
- Measures the productivity of a firm's labor in terms of how much, on average, each worker can produce

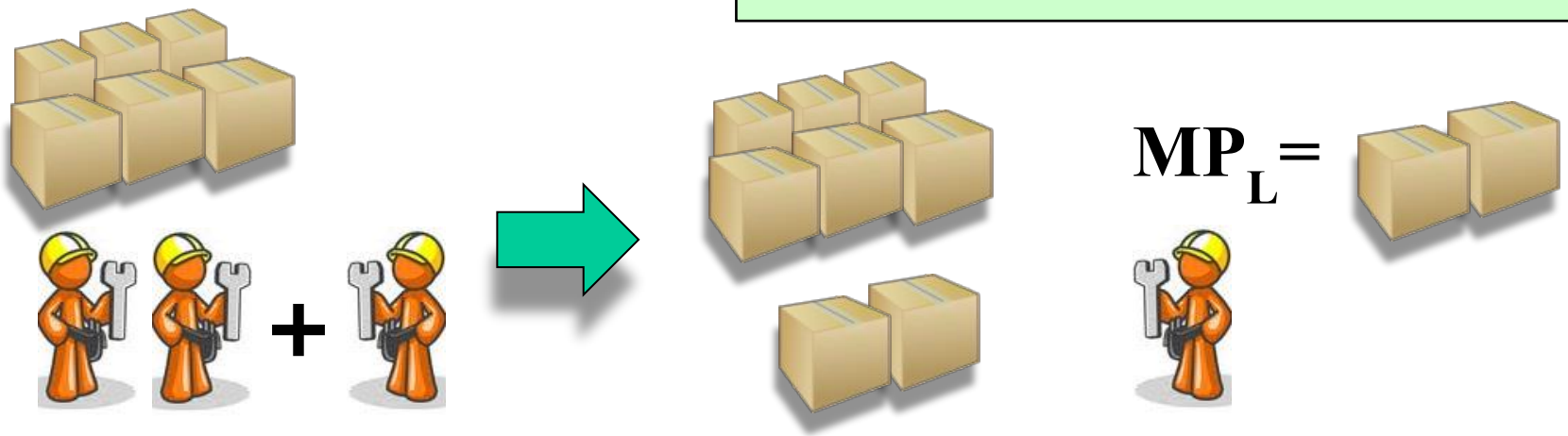
$$AP_L = \frac{\text{Output}}{\text{Labor Input}} = \frac{q}{L}$$



S-R Production: One Variable Input

- Marginal Product of Labor – additional output produced when labor increases by one unit
- Change in output divided by the change in labor
- MP_L is the slope of TP_L

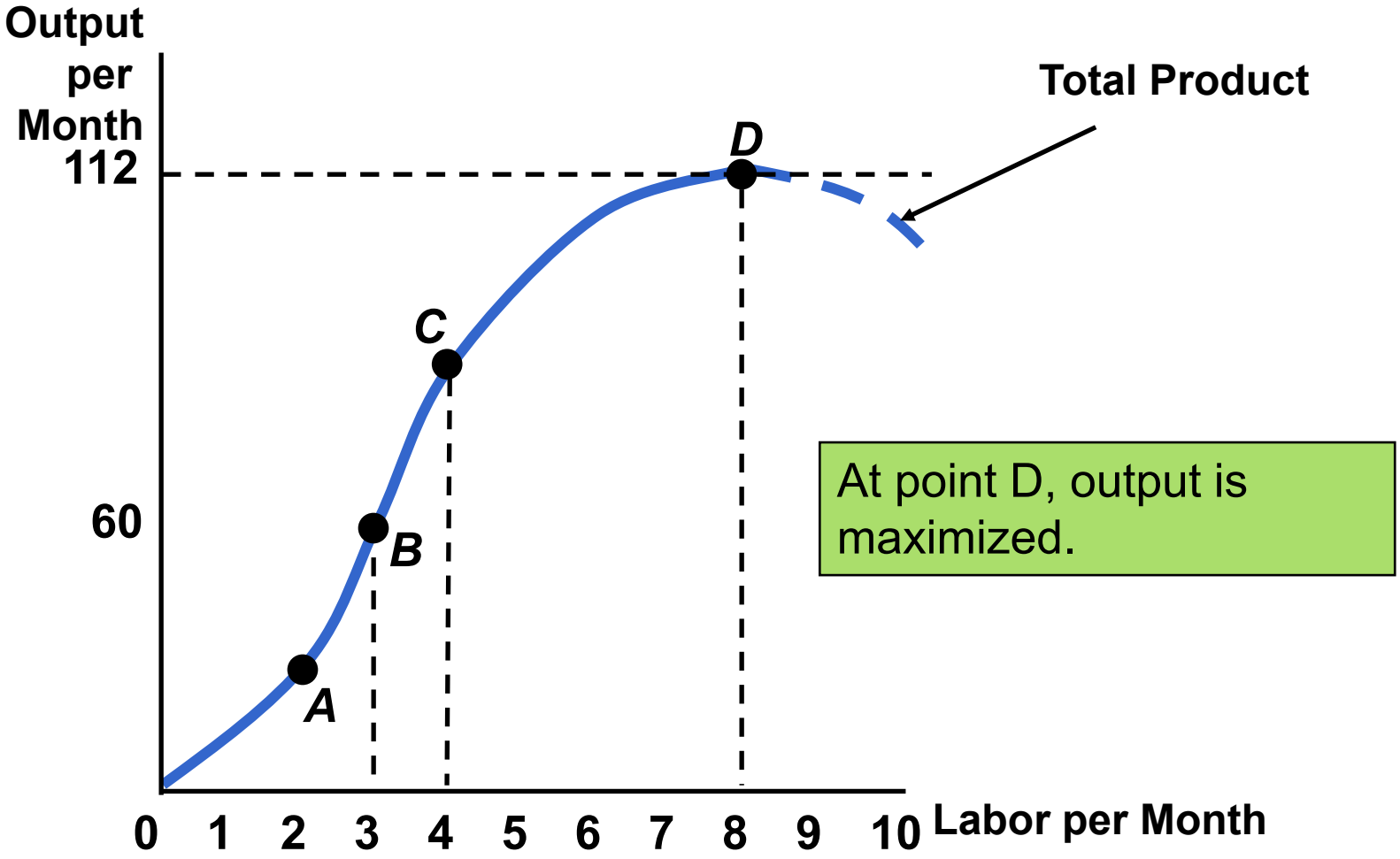
$$MP_L = \frac{\Delta \text{Output}}{\Delta \text{Labor Input}} = \frac{\Delta q}{\Delta L}$$



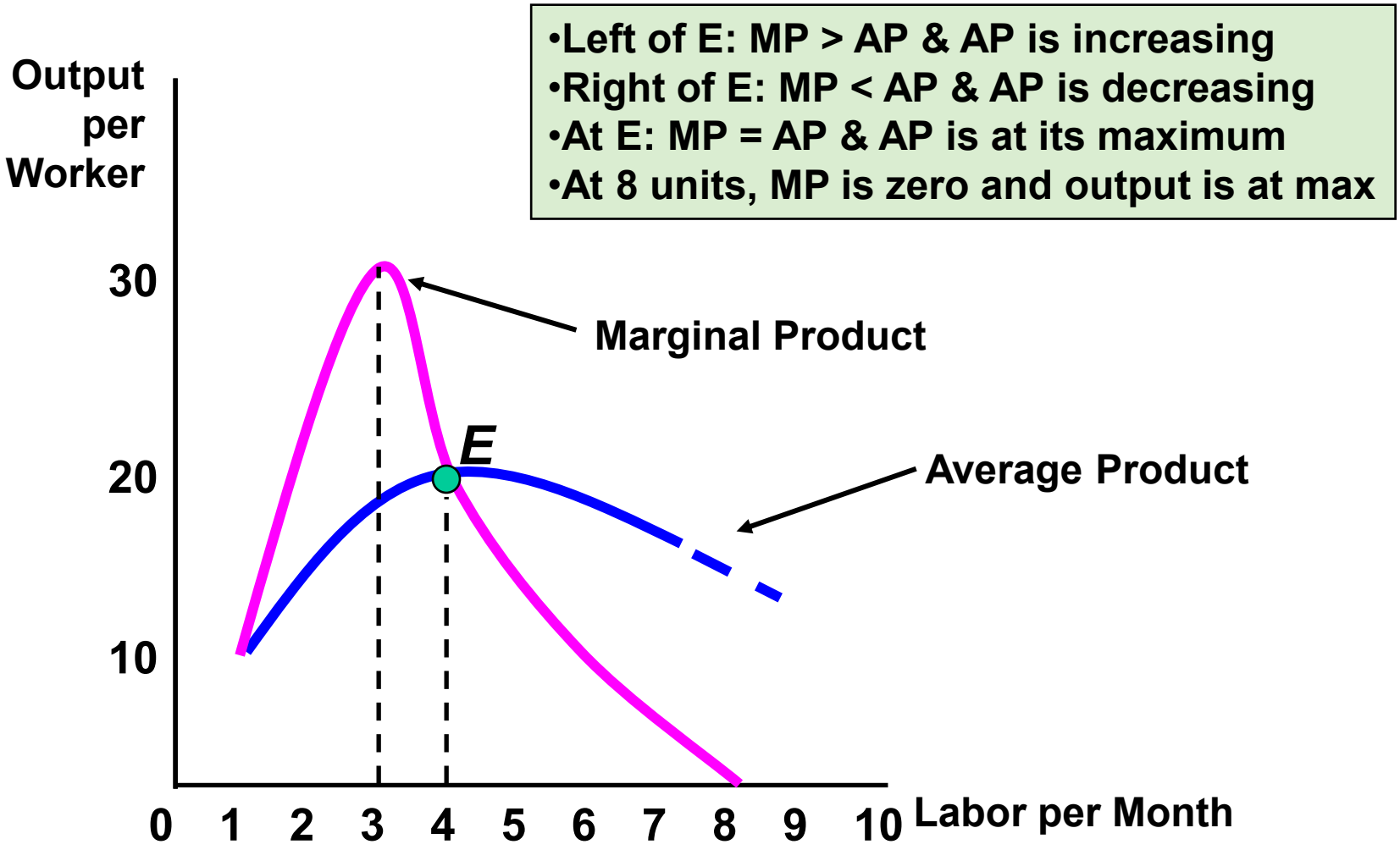
S-R Production: One Variable Input

- We can graph the information in the Table to show
  - How output varies with changes in labor
    - Output is maximized at 112 units
  - Average and Marginal Products
    - Marginal product is positive as long as total output is increasing
    - Marginal Product crosses Average Product at its maximum

S-R Production: One Variable Input



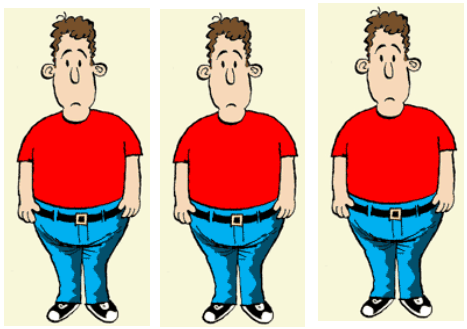
S-R Production: One Variable Input



Marginal & Average Product

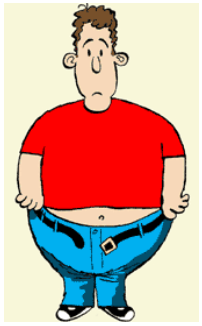
- When MP > AP, AP is increasing
- When MP > AP, AP is decreasing
- MP crosses AP at its maximum
- When MP = 0, TP is at its maximum

Example



= 70kg/person

\+  50 kg → < 70kg/Person

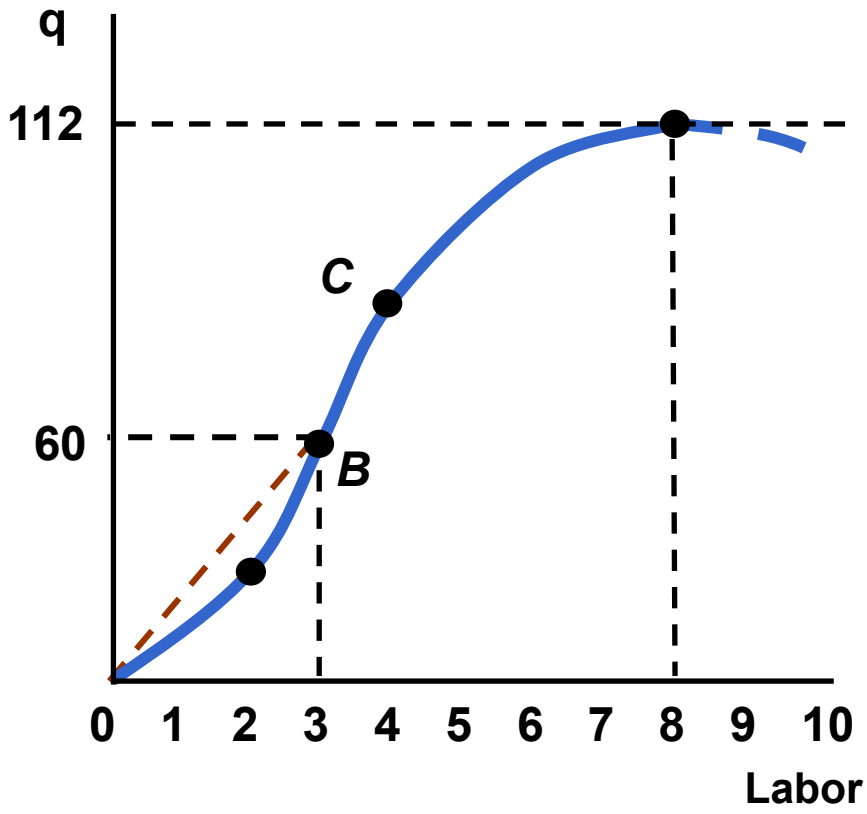
\+  90 kg → > 70kg/Person

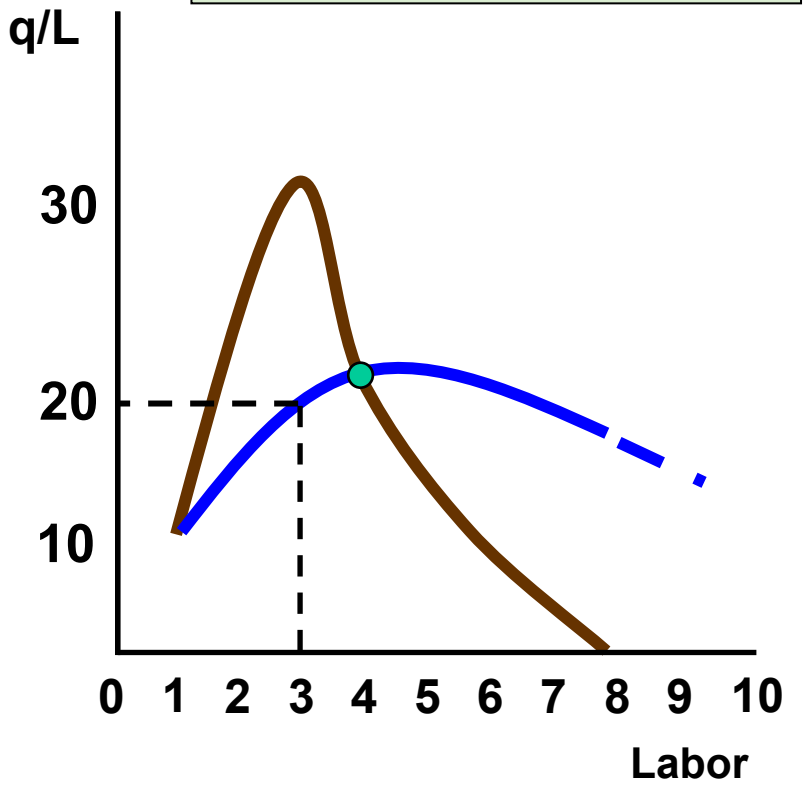
Product Curves

- We can show a geometric relationship between the total product and the average and marginal product curves
  - Slope of line from origin to any point on the total product curve is the average product
  - At point B, AP = 60/3 = 20 which is the same as the slope of the line from the origin to point B on the total product curve

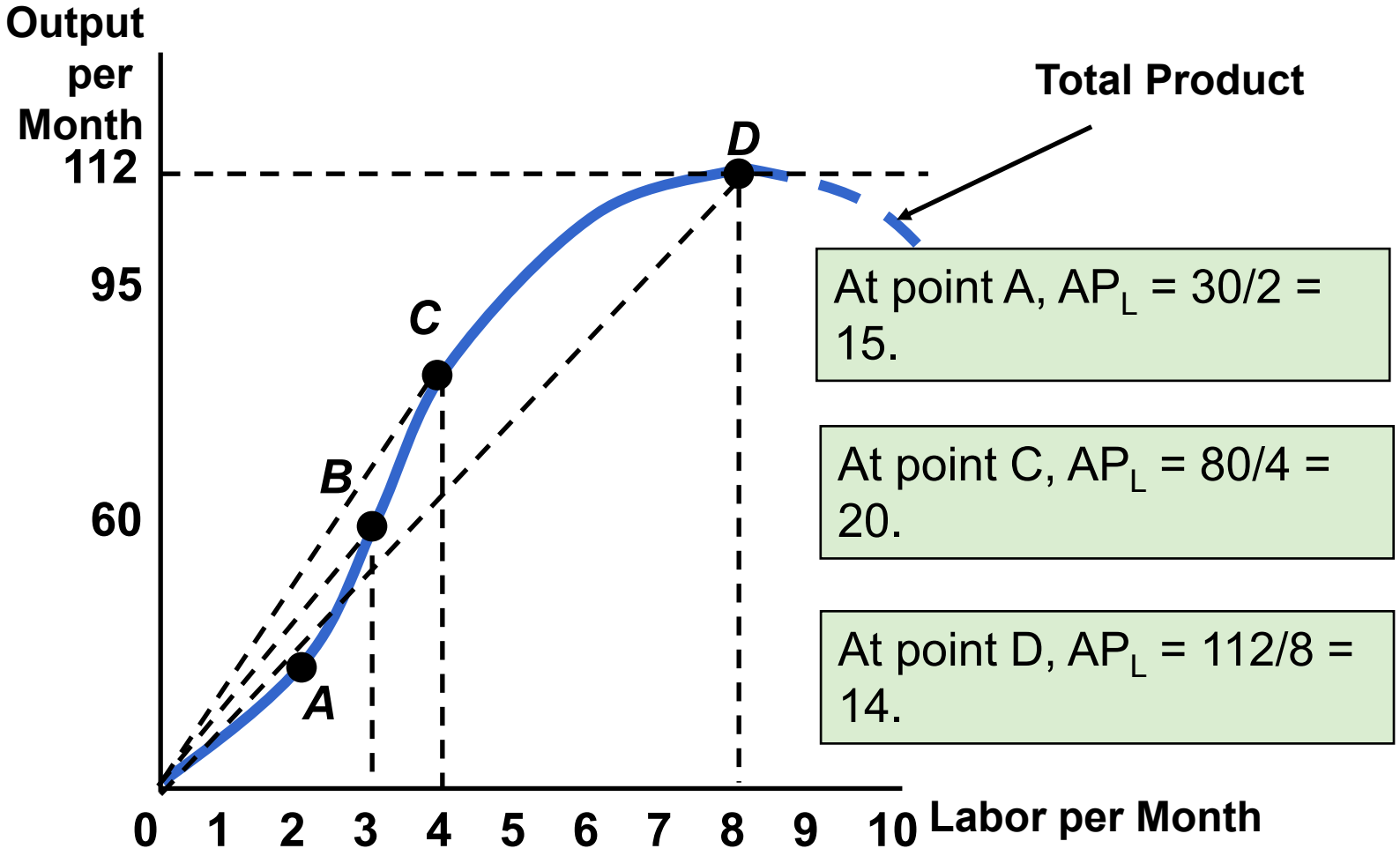
Product Curves

AP is slope of line from origin to point on TP curve





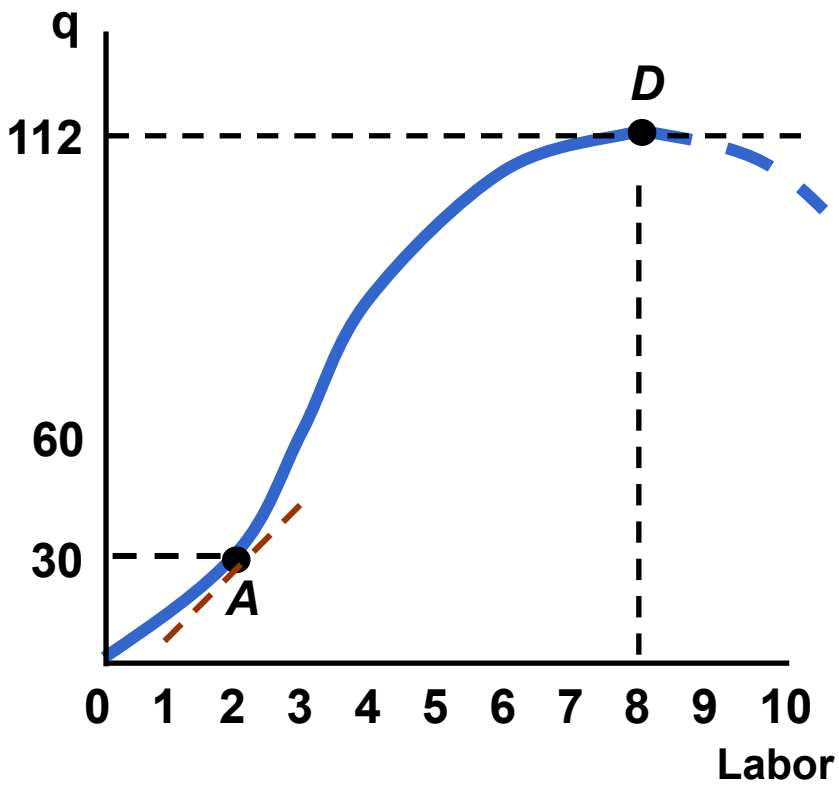
AP_L = the slope of the line from the origin to the point on TP_L curve.



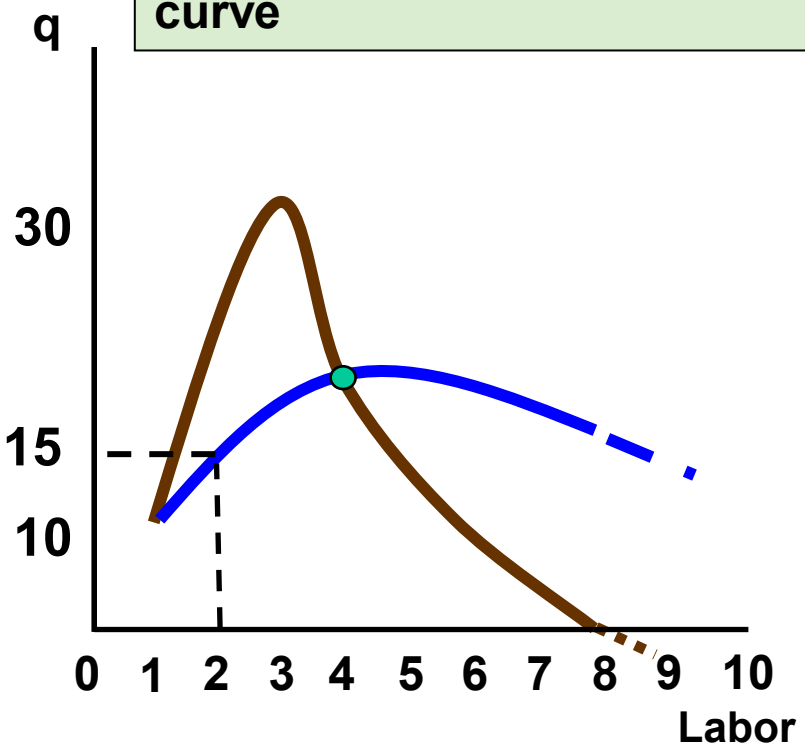
Product Curves

- Geometric relationship between total product and marginal product
  - The marginal product is the slope of the line tangent to any corresponding point on the total product curve
  - For 2 units of labor, MP = 30/2 = 15 which is slope of total product curve at point A

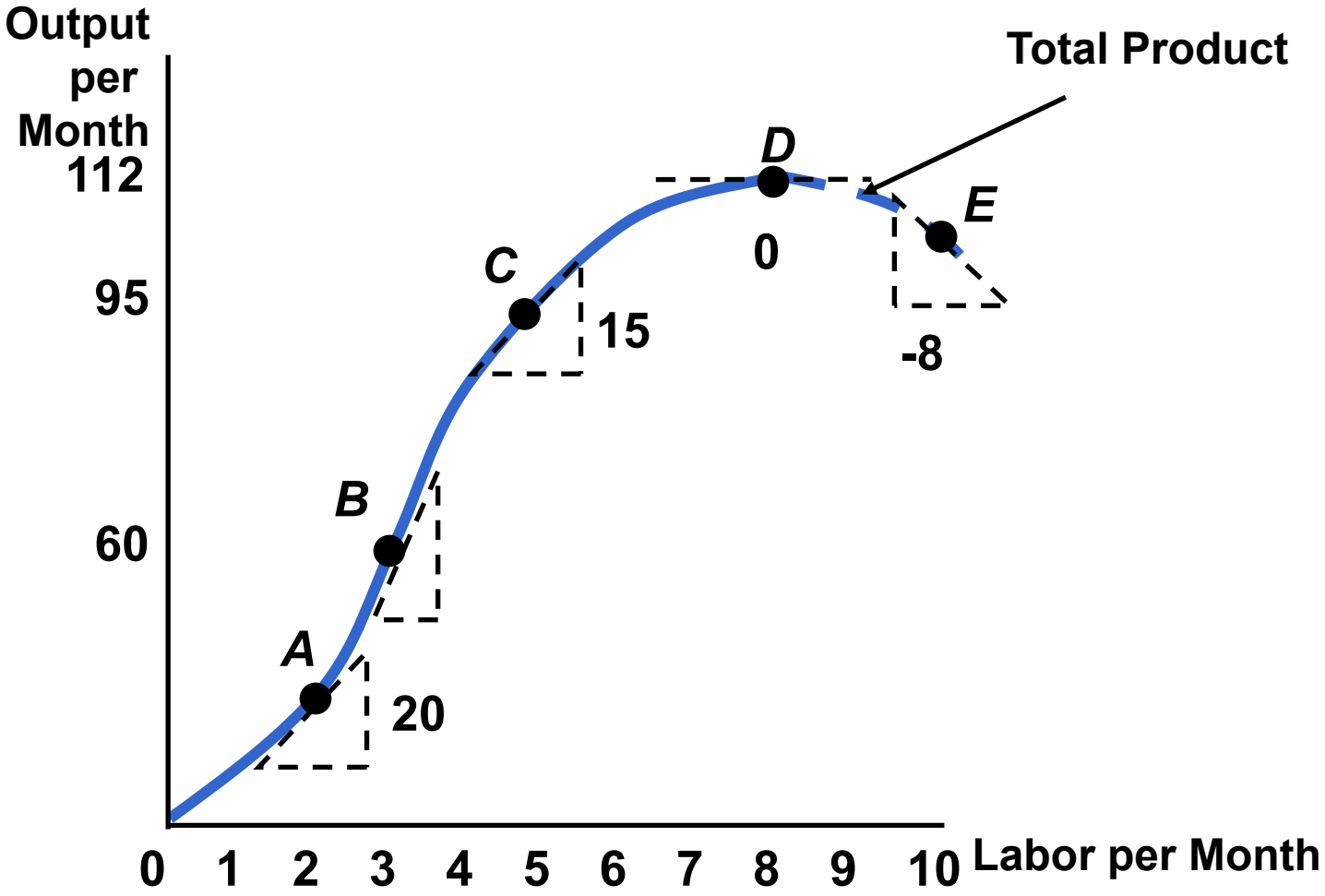
Product Curves



MP is slope of line tangent to corresponding point on TP curve



MP_L = the slope of the line tangent to the TP_L curve.



Production: One Variable Input

- From the previous example, we can see that as we increase labor the additional output produced declines
- Law of Diminishing Marginal Returns: As the use of an input increases with other inputs fixed, the resulting additions to output will eventually decrease.

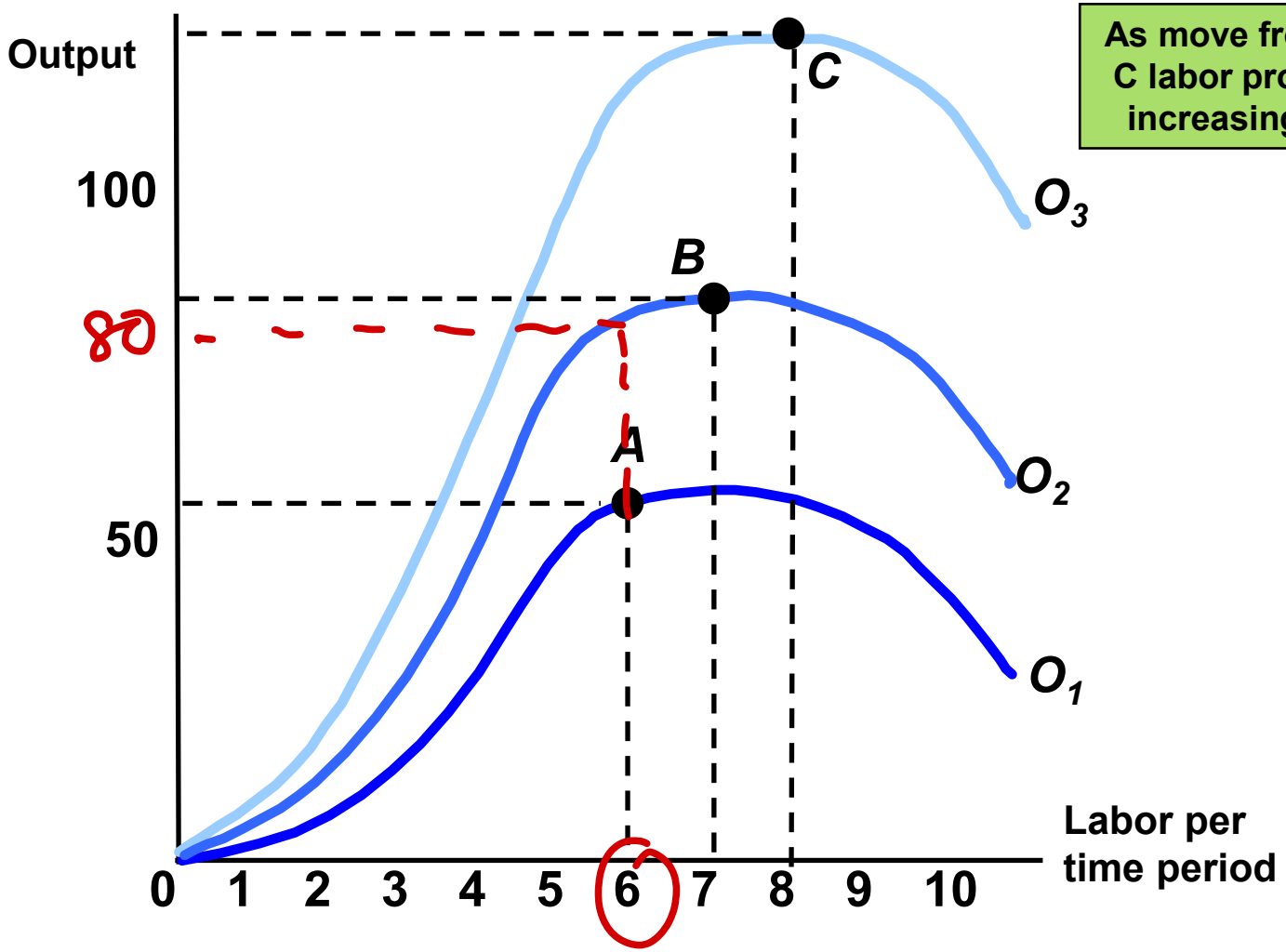
Law of Diminishing Marginal Returns

- When the labor input is small and capital is fixed, output increases considerably since workers can begin to specialize and MP of labor increases
- When the labor input is large, some workers become less efficient and MP of labor decreases

Law of Diminishing Marginal Returns

- Easily confused with negative returns – decreases in output.
- Explains a *declining* marginal product, **not** necessarily a negative one
  - *Additional* output can be declining while *total* output is increasing

The Effect of Technological Improvement



As move from A to B to C labor productivity is increasing over time

SR Production → SR Cost

SRTC = fixed cost (FC) + variable cost (VC)

FC : cost of fixed inputs

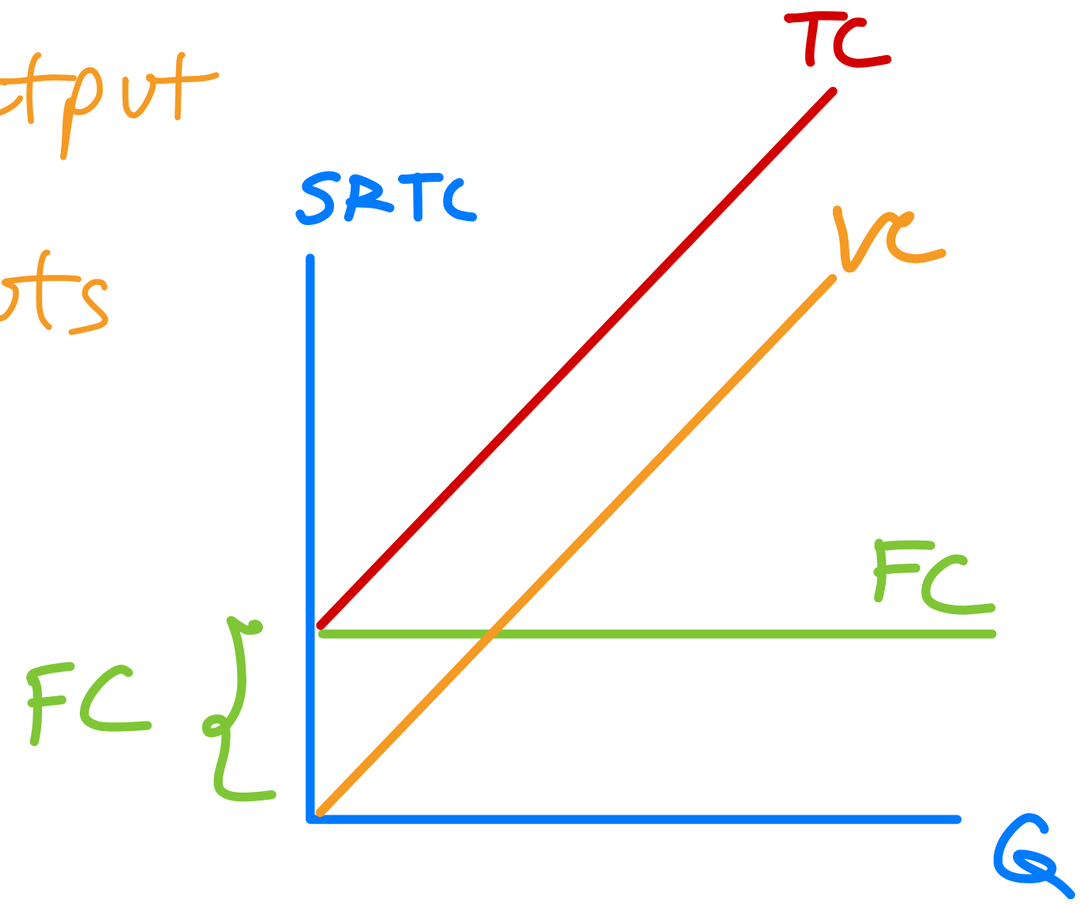
constant regardless of output

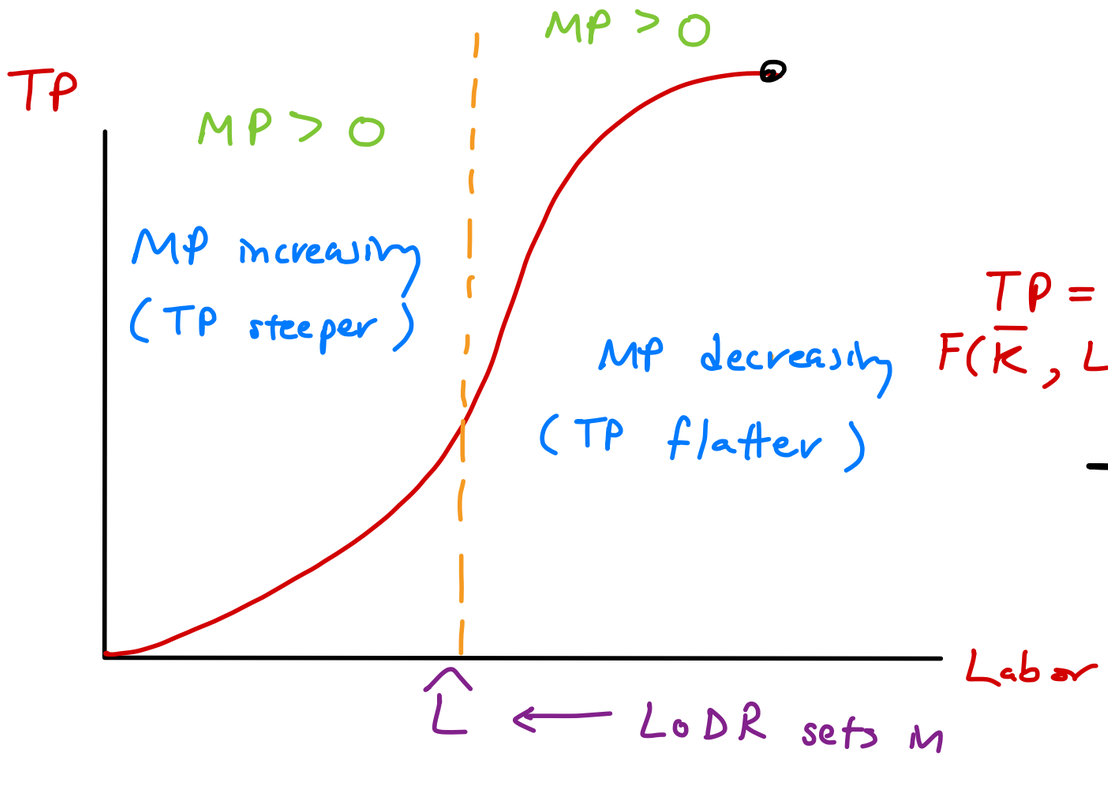
VC : cost of variable inputs

increasing with output

when Q = 0, VC = 0

but FC > 0



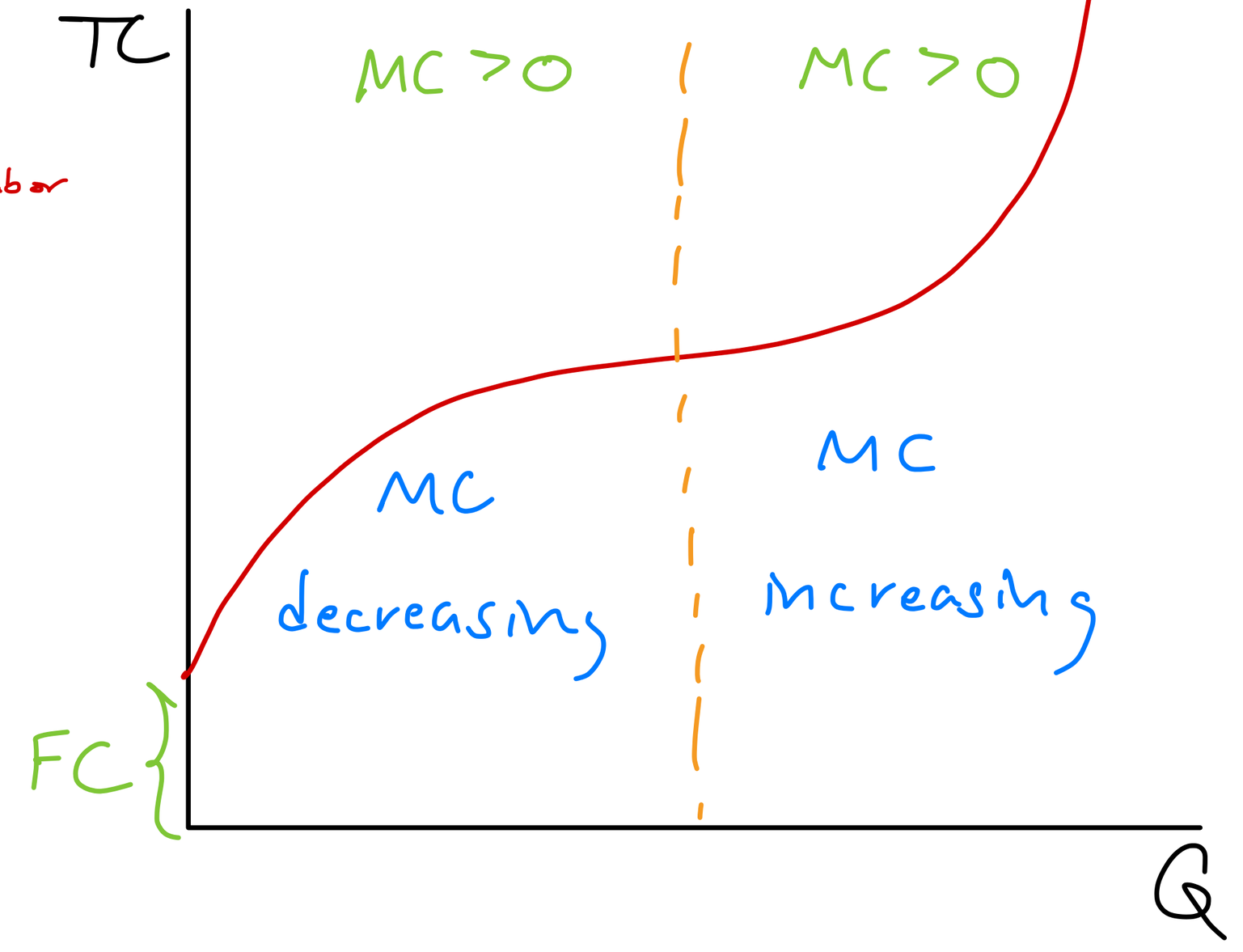


$$MC = \frac{\Delta TC}{\Delta Q} = \text{slope of } TC$$

e.g. MC = 3:

Q ↑ 1 ⟶ TC ↑ 3

$$AC = \frac{TC}{Q}$$

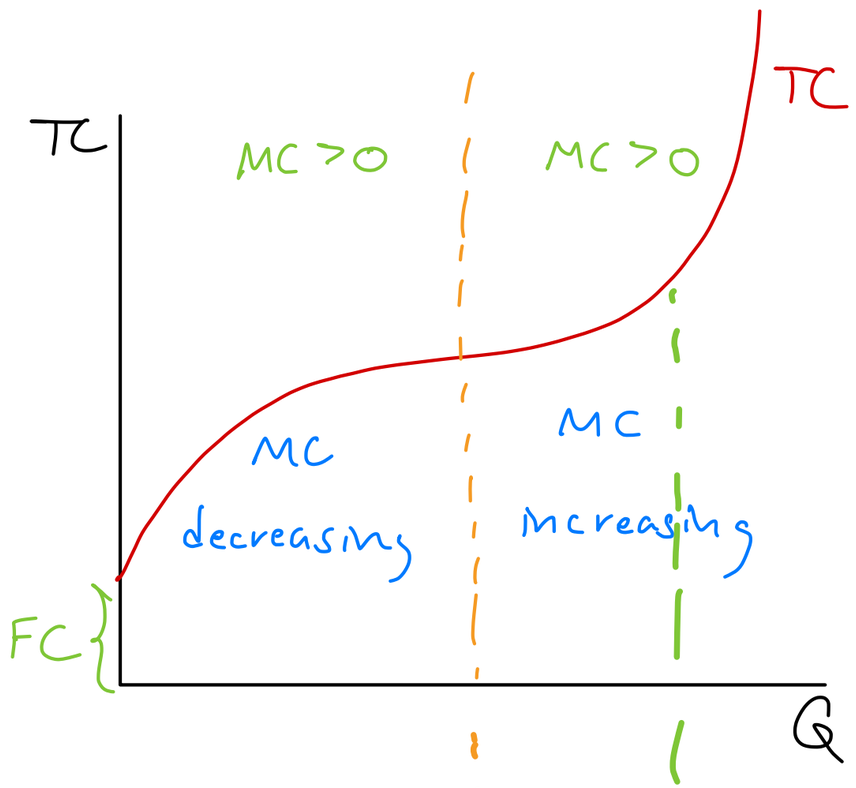


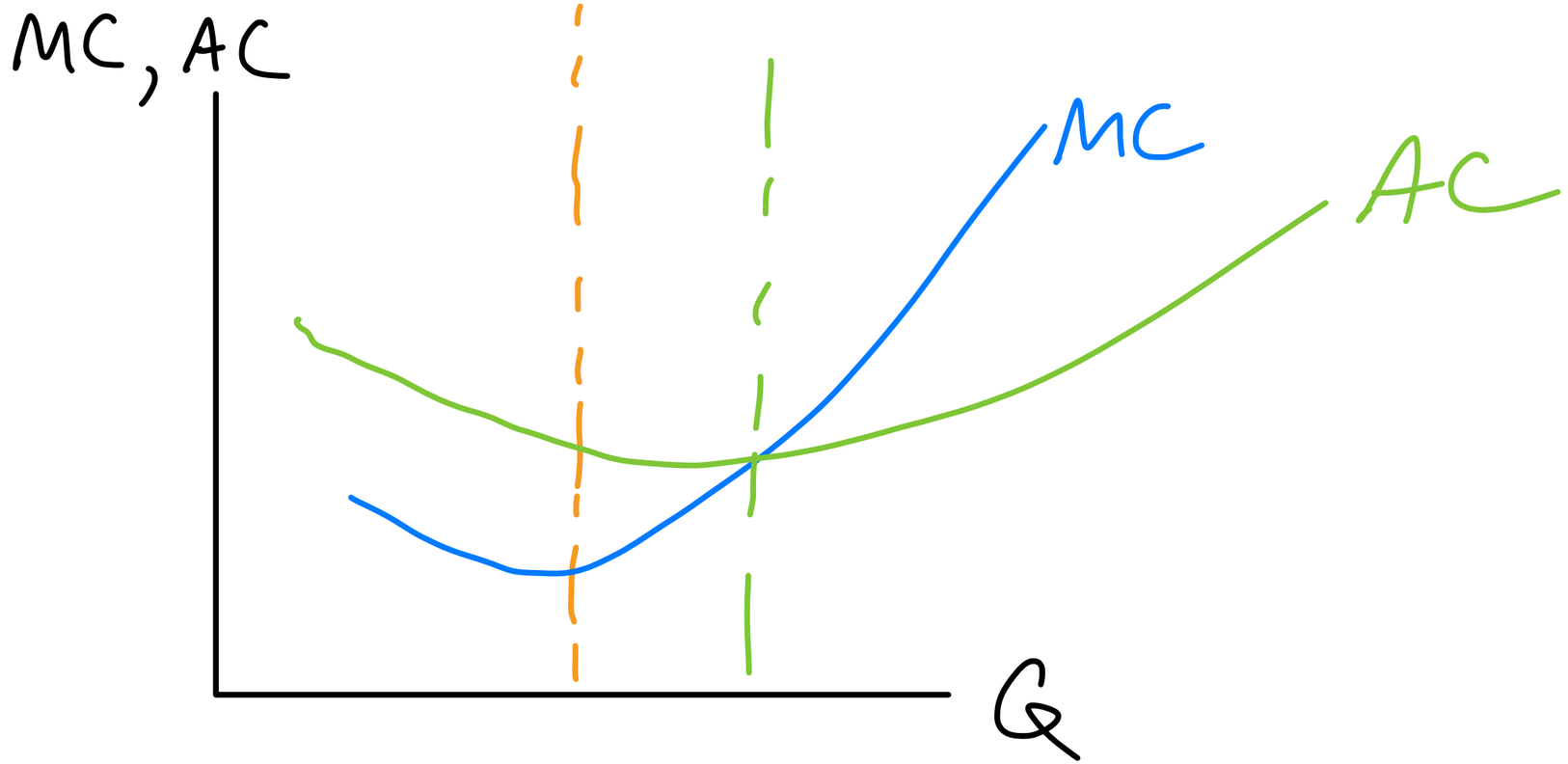
$MC > 0$: $Q \uparrow \rightarrow TC \uparrow$

When MP is increasing, MC is decreasing

→ extra worker is more productive, so hiring him gives a lot of output, which mean extra cost to produce extra output falls

= MC


TC
MC >0
MC >0
TC
MC
decreasing
MC
increasing
FC
Q


MC, AC
MC
AC
Q

Profit = TR − TC

normal profit : $\pi = 0$

level of profit that is just sufficient to keep the firm running

abnormal profit : $\pi > 0$

> economic profit

economic profit = TR − explicit cost − implicit cost

account profit = TR − explicit cost

explicit cost : cost that involves payment and arises from the use of FoP

e.g. material cost

implicit cost : cost that does not involve payment but arises from the foregone use of FoP

e.g. opportunity cost of running a firm (foregone salary from working as salaryman)

You

run business

TR = 50k

explicit cost = 20k

accounting profit = 30k

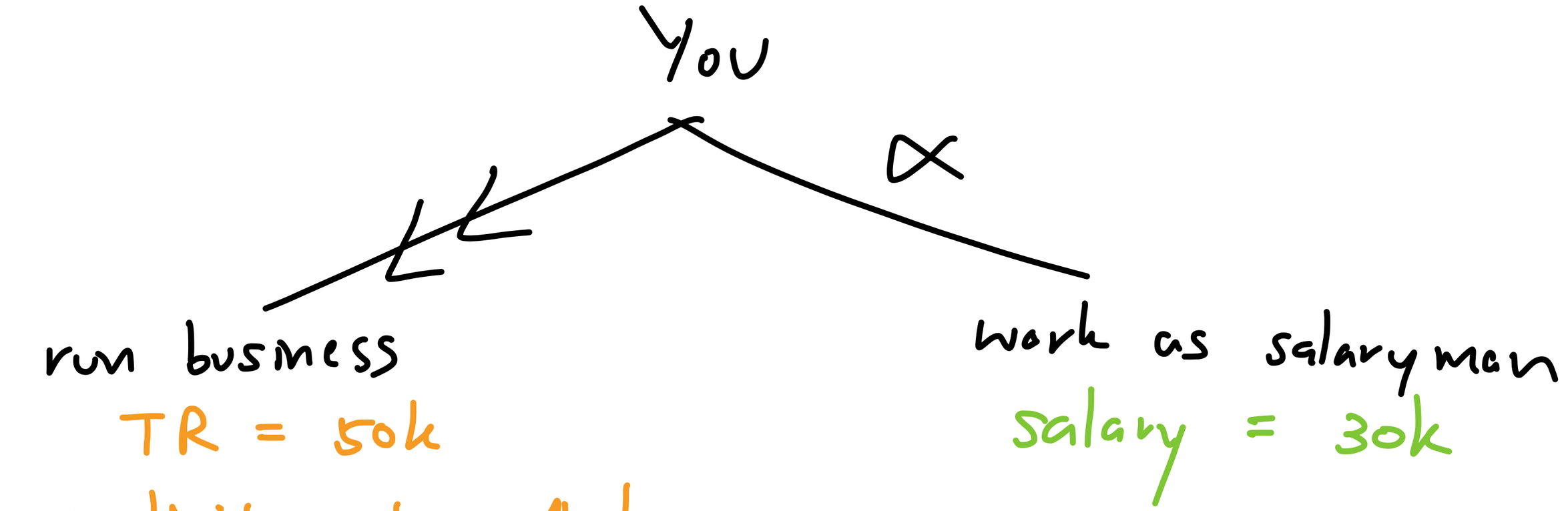
work as salaryman

salary = 30k

(implicit cost = 30k)

economic profit = 0

(normal profit)



economic profit = −20k

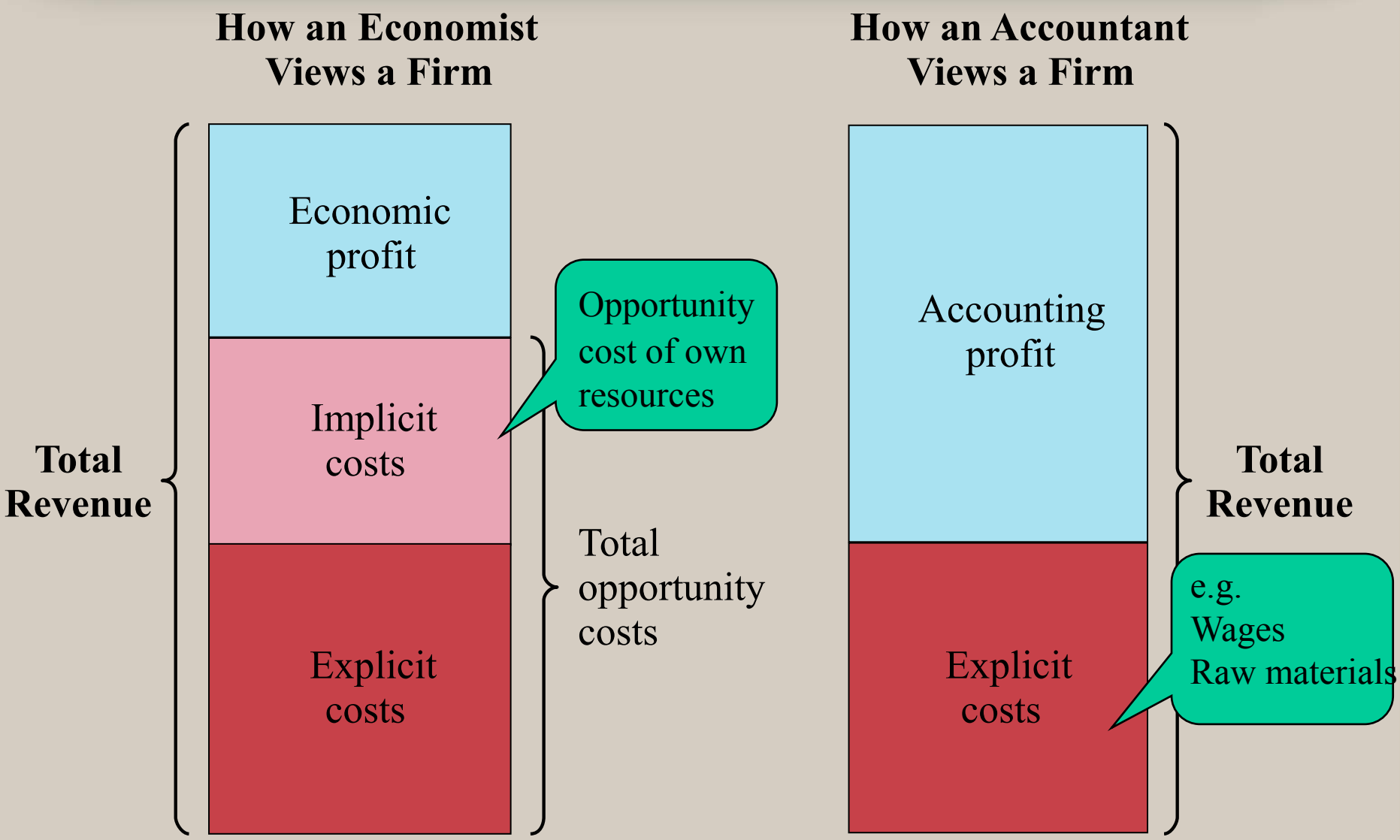
(loss → shutdown)

& work as salaryman

Measuring Cost: Which Costs Matter?

- Accountants tend to take a retrospective view of firms costs, where as economists tend to take a forward-looking view
- Accounting Cost
  - Actual expenses plus depreciation charges for capital equipment --> only explicit costs
- Economic Cost
  - Cost to a firm of utilizing economic resources in production, including opportunity cost
    -->both explicit and implicit costs

Economics versus Accountancy



Measuring Cost: Which Costs Matter?

- Economic costs distinguish between costs the firm can control and those it cannot
- Opportunity cost
  - Cost associated with the highest opportunities that are foregone when a firm's resources are used.
  - The minimum payment needed to pay the resource owners so it continues be used in that operation.

Opportunity Cost

- An Example
  - A firm owns its own building and pays no rent for office space
  - Does this mean the cost of office space is zero?
  - The building could have been rented instead
  - Foregone rent is the opportunity cost of using the building for production and should be included in economic costs of doing business

Opportunity Cost

- A person starting their own business must take into account the opportunity cost of their time
  - Could have worked elsewhere making a competitive salary
- Accountants and economists often treat depreciation differently as well
  - depreciation in economic means the user cost of that capital
  - the different between the value of capital selling today and selling one year from now.

Accounting Versus Economic Profit

Item	Accounting Profit	Economic Profit
Total Revenue	$500,000	$500,000
Less Explicit costs:		
Wages & salaries	$400,000	$400,000
Materials	$50,000	$50,000
Interest paid	$10,000	$10,000
Other payments	$10,000	$10,000
Less implicit costs:		
Foregone salary	0	50,000
Foregone rent	0	10,000
Foregone interest	0	5,000
Equals profit	$30,000	-$35,000

Accounting Versus Economic Profit

Item	Accounting Profit	Economic Profit
Total Revenue	$535,000	$535,000
Less Explicit costs:		
Wages & salaries	$400,000	$400,000
Materials	$50,000	$50,000
Interest paid	$10,000	$10,000
Other payments	$10,000	$10,000
Less implicit costs:		
Foregone salary	0	50,000
Foregone rent	0	10,000
Foregone interest	0	5,000
Equals profit	$65,000	$0

Normal profit

- Normal profit is a minimum accounting profit that is just sufficient to compensate for the opportunity costs of the firm owner
- When a firm earns a normal profit, the economic profit must be zero
- The firm owner is compensated exactly equals to his best alternative

Measuring Cost: Which Costs Matter?

- Although opportunity costs are hidden and should be taken into account, sunk costs should not
- Sunk Cost
  - Expenditure that has been made and cannot be recovered
  - Should not influence a firm's future economic decisions.

Sunk Cost

- Firm buys a piece of equipment that cannot be converted to another use
- Expenditure on the equipment is a sunk cost
  - Has no alternative use so cost cannot be recovered – opportunity cost is zero
  - Decision to buy the equipment might have been good or bad, but now does not matter

Measuring Cost: Which Costs Matter?

- Some costs vary with output, while some remain the same no matter amount of output
- Total cost can be divided into:
- Fixed Cost
  - Does not vary with the level of output
- Variable Cost
  - Cost that varies as output varies

Fixed and Variable Costs

- Total output is a function of variable inputs and fixed inputs.
- Therefore, the total cost of production equals the fixed cost plus the variable cost

$$TC = TFC + TVC$$

$$TC = rK \quad wL$$

- Example: If q = 5 units needs K = 2, L = 10, r = 10, w = 0.5. TC = (10)(2) + (0.5)(10) = 20 + 5

Example

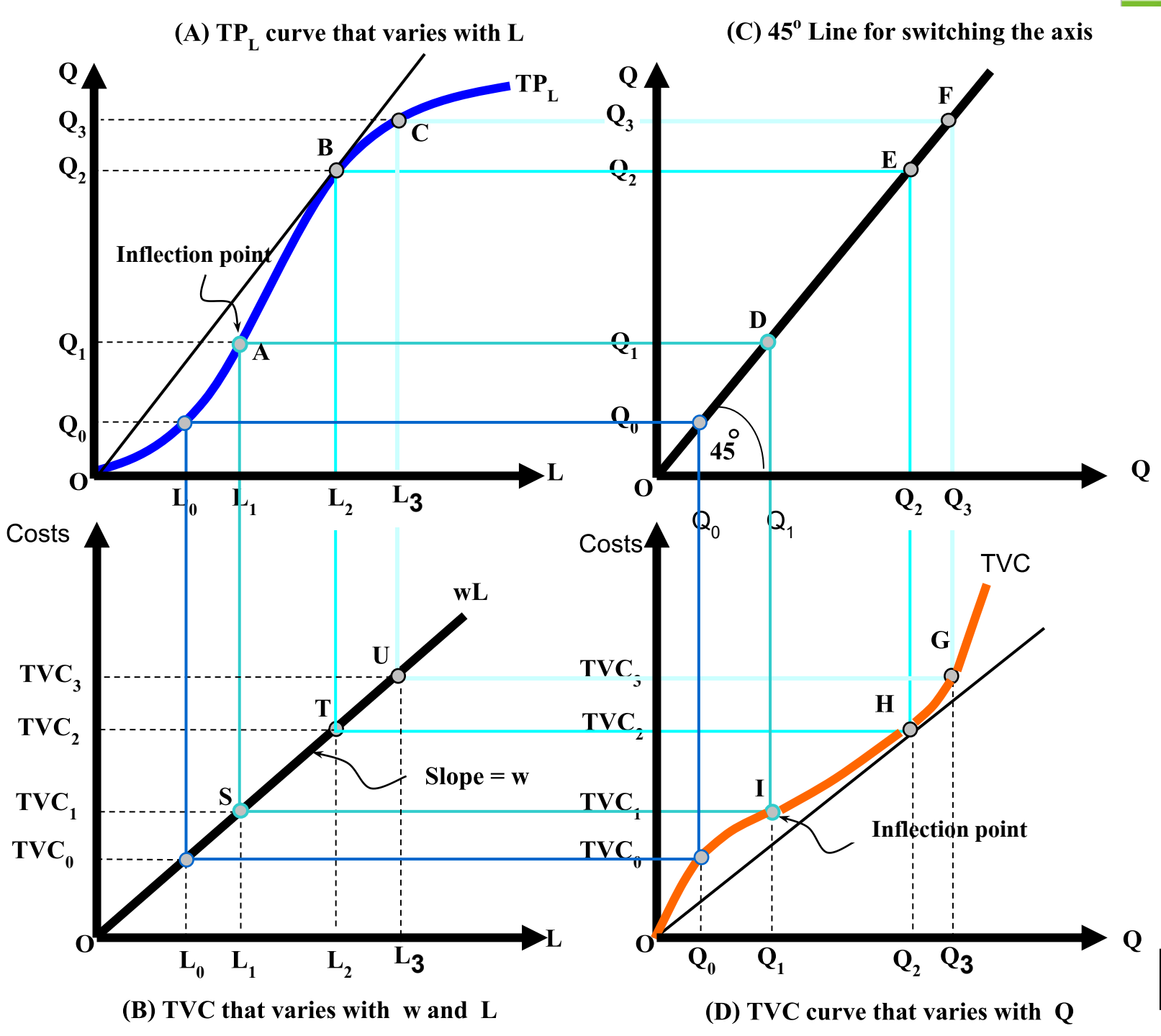
- From $Q = K^{0.5}L^{0.5}$. Capital is fixed, K = 4; hence

$$L = \left(Q/K^{0.5}\right)^2 = \left(Q/4^{0.5}\right)^2 = Q^2/4$$

- If r = 10, w = 4, then

$$TC = rK + wL$$

$$= (10)(4) + 4Q^2/4 = 40 + Q^2$$


(A) TP$_L$ curve that varies with L
Q
Q$_3$
Q$_2$
Q$_1$
Q$_0$
O
TP$_L$
B
C
A
Inflection point
L
L$_0$
L$_1$
L$_2$
L$_3$
(C) 45^0 Line for switching the axis
F
E
D
45°
Q$_0$
Q$_1$
Q$_2$
Q$_3$
Costs
wL
TVC$_3$
TVC$_2$
TVC$_1$
TVC$_0$
U
T
S
Slope = w
(B) TVC that varies with w and L
TVC
G
H
I
Inflection point
(D) TVC curve that varies with Q

Fixed Cost Versus Sunk Cost

- Fixed cost and sunk cost are often confused
- Fixed Cost
  - Cost paid by a firm that is in business regardless of the level of output
  - It is avoidable when the firm exit the market
- Sunk Cost
  - Cost that have been incurred and cannot be recovered
  - It is not avoidable when the firm exit the market

Fixed Cost Versus Sunk Cost

- Example: You are about to invest to make a casting mold worth ฿50 Th. The mold is specifically designed and cannot be used for other things.
- Before the payment is done, the investment is avoidable, so it is not a sunk cost.
  - It is a fixed cost and can be used for making decision whether you should continue your business or not.
- After the payment is done, the cost is sunk.
  - The cost should not be used for making decision whether you should continue your business or not.

Measuring Costs

- Average Total Cost (ATC)
  - Cost per unit of output
  - Also equals average fixed cost (AFC) plus average variable cost (AVC).

$$ATC = \frac{TC}{q} = AFC + AVC$$

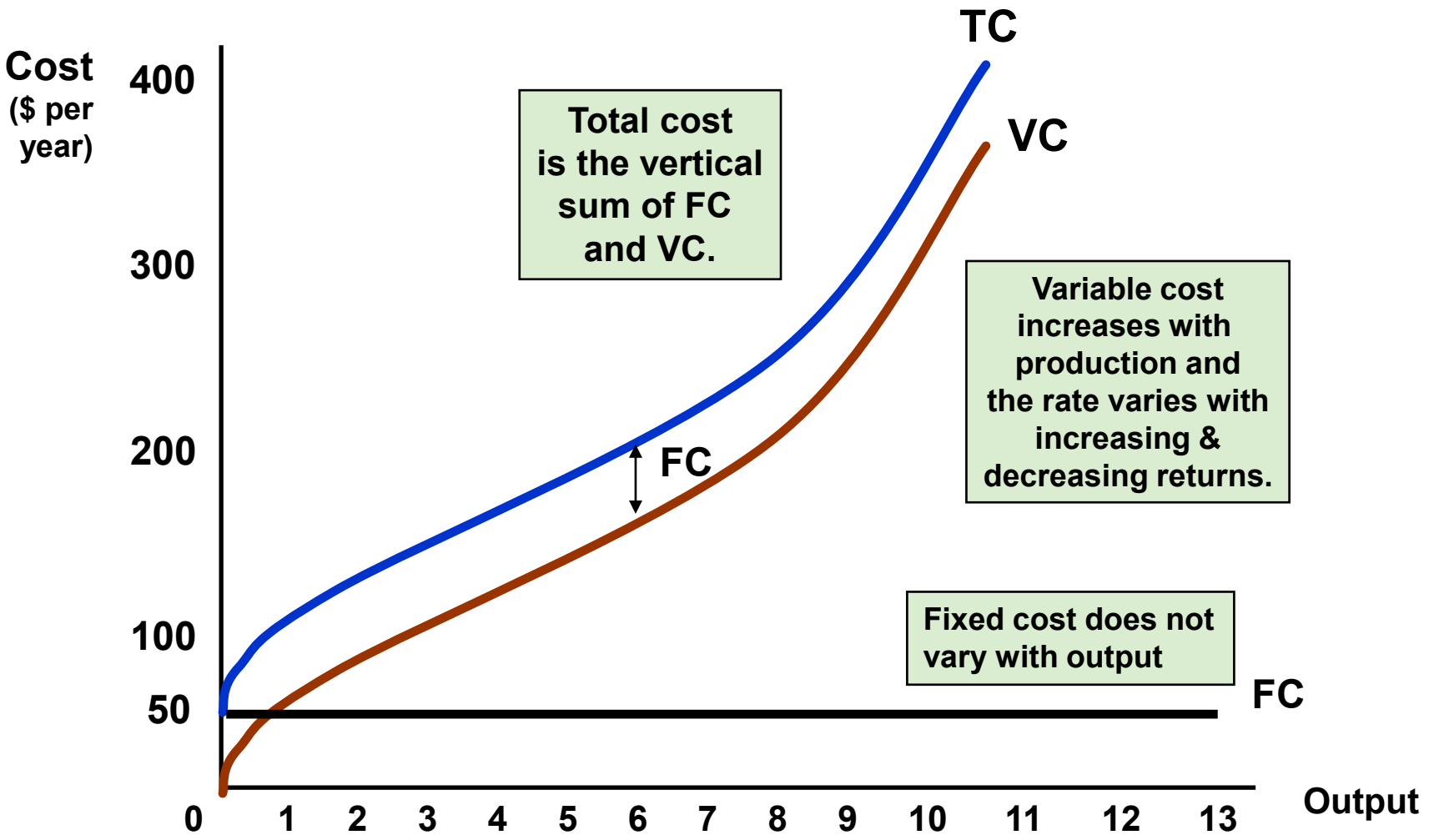
$$ATC = \frac{TFC}{q} + \frac{TVC}{q}$$

Measuring Costs

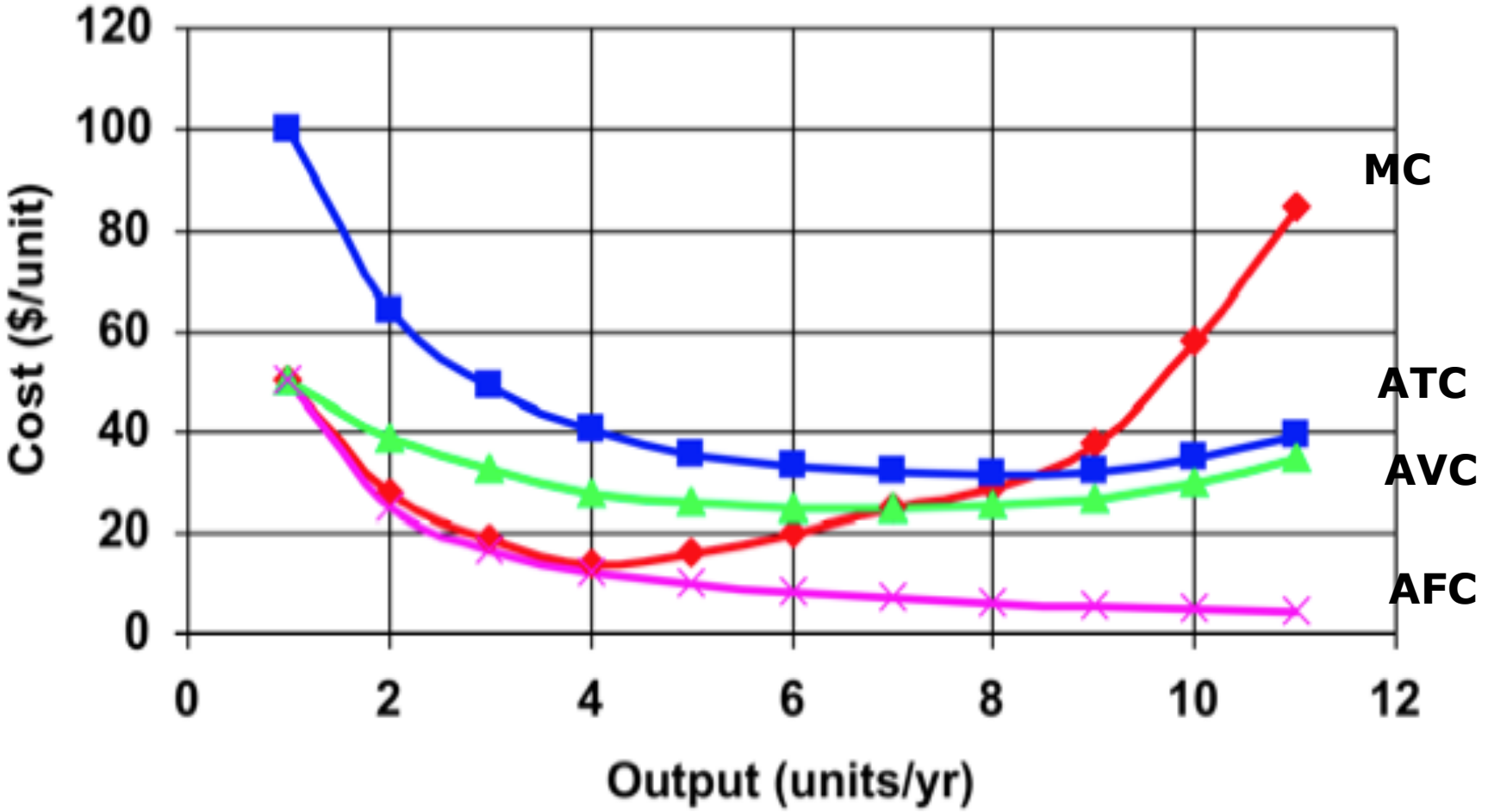
- Marginal Cost (MC):
  - The cost of expanding output by one unit.
  - Fixed cost have no impact on marginal cost, so it can be written as:

$$MC = \frac{\Delta TVC}{\Delta q} = \frac{\Delta TC}{\Delta q}$$

Cost Curves for a Firm

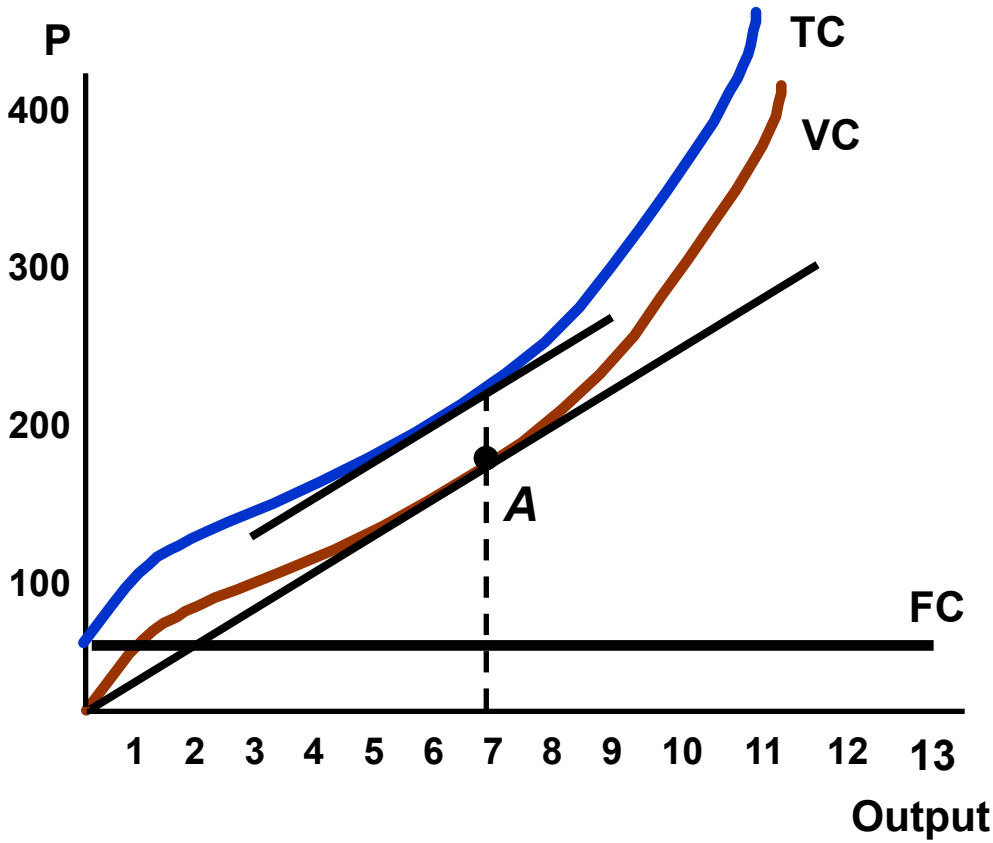


Cost Curves


120
100
80
60
40
20
0
Cost ($/unit)
0
2
4
6
8
10
12
Output (units/yr)
MC
ATC
AVC
AFC

Cost Curves for a Firm

- The line drawn from the origin to the variable cost curve:
  - Its slope equals AVC
  - The slope of a point on TVC or TC equals MC
  - Therefore, MC = AVC at 7 units of output (point A)



Determinants of Short-run Costs

- If marginal product of labor decreases only slightly as labor increase
  - Costs will not rise very fast when output is increased
- If marginal product of labor decreases significantly as more labor is hired
  - Costs of production increase rapidly
  - Greater and greater expenditures must be made to produce more output

Determinants of Short-run Costs

- Assume the wage rate (w) is fixed, TVC = wL.

$$MC = \frac{\Delta TVC}{\Delta q} = \frac{\Delta[wL]}{\Delta q} = \frac{w\Delta L}{\Delta q} = \frac{w}{MP_L}$$

- …and a low marginal product (MP) leads to a high marginal cost (MC) and vise versa.

The Average – Marginal relationship

- When MC is below AVC, AVC is falling
- When MC is above AVC, AVC is rising
- When MC is below ATC, ATC is falling
- When MC is above ATC, ATC is rising
- Therefore, MC crosses AVC and ATC at the minimums