Production and Costs in the Short run

EE311

Chayun Tantivasadakarn

Faculty of Economics, Thammasat University

Topics to be Discussed

- Firms and why do firms exist
- Transaction costs
- The Technology of Production
- Production with One Variable Input (Labor)
- Measuring Cost: Which Costs Matter?
- Cost in the Short Run

Firms

- Firms: Organization that produces goods and services to maximize profit.
- Why do firms exist?
  - because firms can produce goods and services at cheaper costs or with higher quality than consumers produce them by themselves.
  - but firms also need other firms to produce intermediate inputs
  - some other firms, on the other hand, merge together and some takeover other firms.

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
  - Coordination costs
- Out-sourcing generates transaction costs that decrease with the production scale
  - Information costs
  - Negotiation costs
  - Enforcement costs
- The optimum firm size locates at the size where the combining costs are minimized.

Optimal search time

- Search until the marginal benefit = marginal cost.
- Longer search time when
  - Larger price differences
  - Expensive products
  - Infrequent purchase
  - Low opportunity cost of time
  - Large market

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.
- Why do we need uniform?

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.

Transaction costs: applications

- Tourists are willing to pay higher prices for well known chained hotels and McDonald.
- ISO standard and exports.
- Japanese sub-contracting system.
- Franchise.
- Information centers: classified ads, Google, Wikipedia.

Production Decisions of a Firm

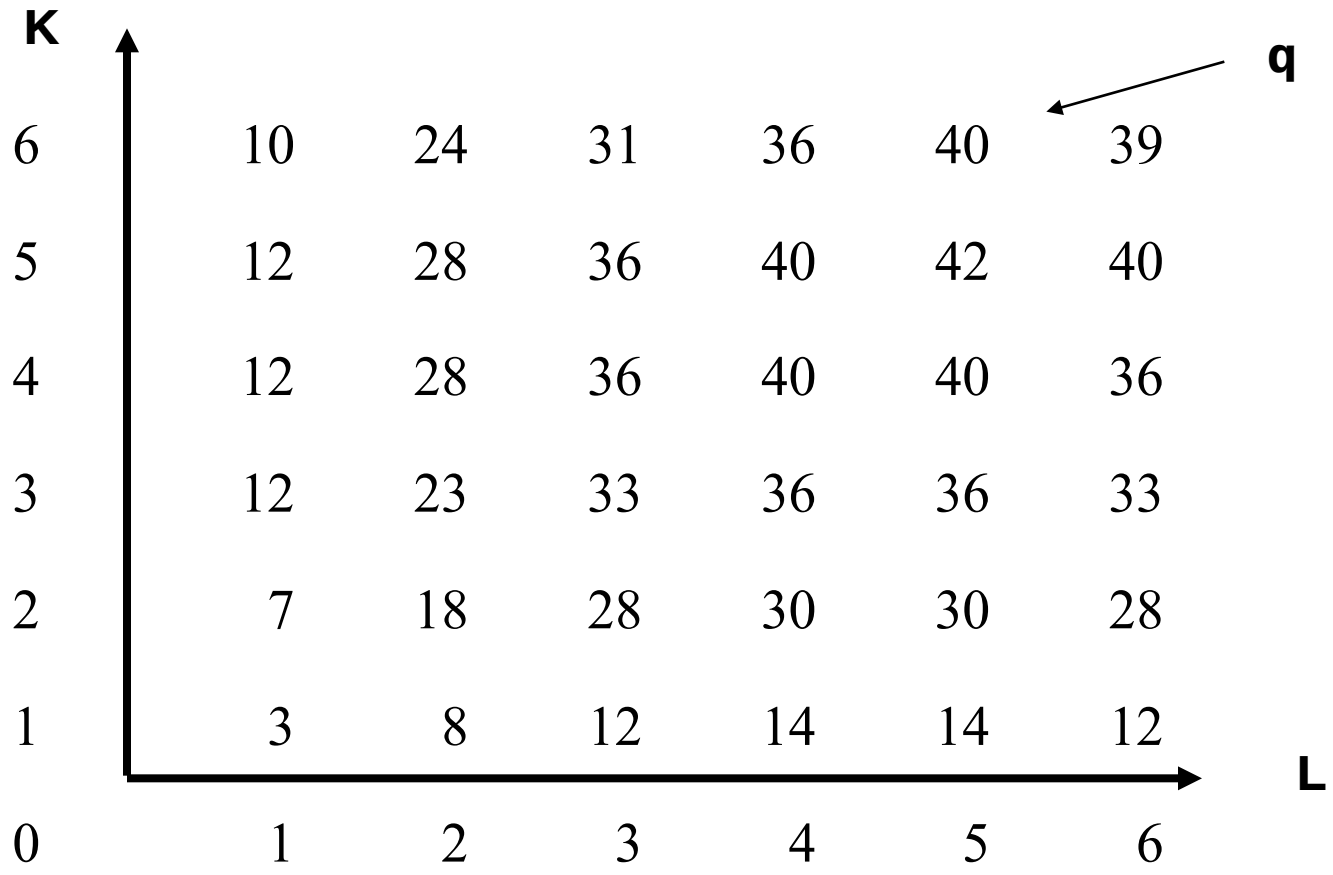
- Production Technology
  - Describe how *inputs* can be transformed into *outputs*
    - Inputs: land, labor, capital & raw materials
    - Outputs: cars, desks, books, etc.
  - Firms can produce different amounts of outputs using different combinations of inputs
  - We can represent the firm's production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

The Technology of Production

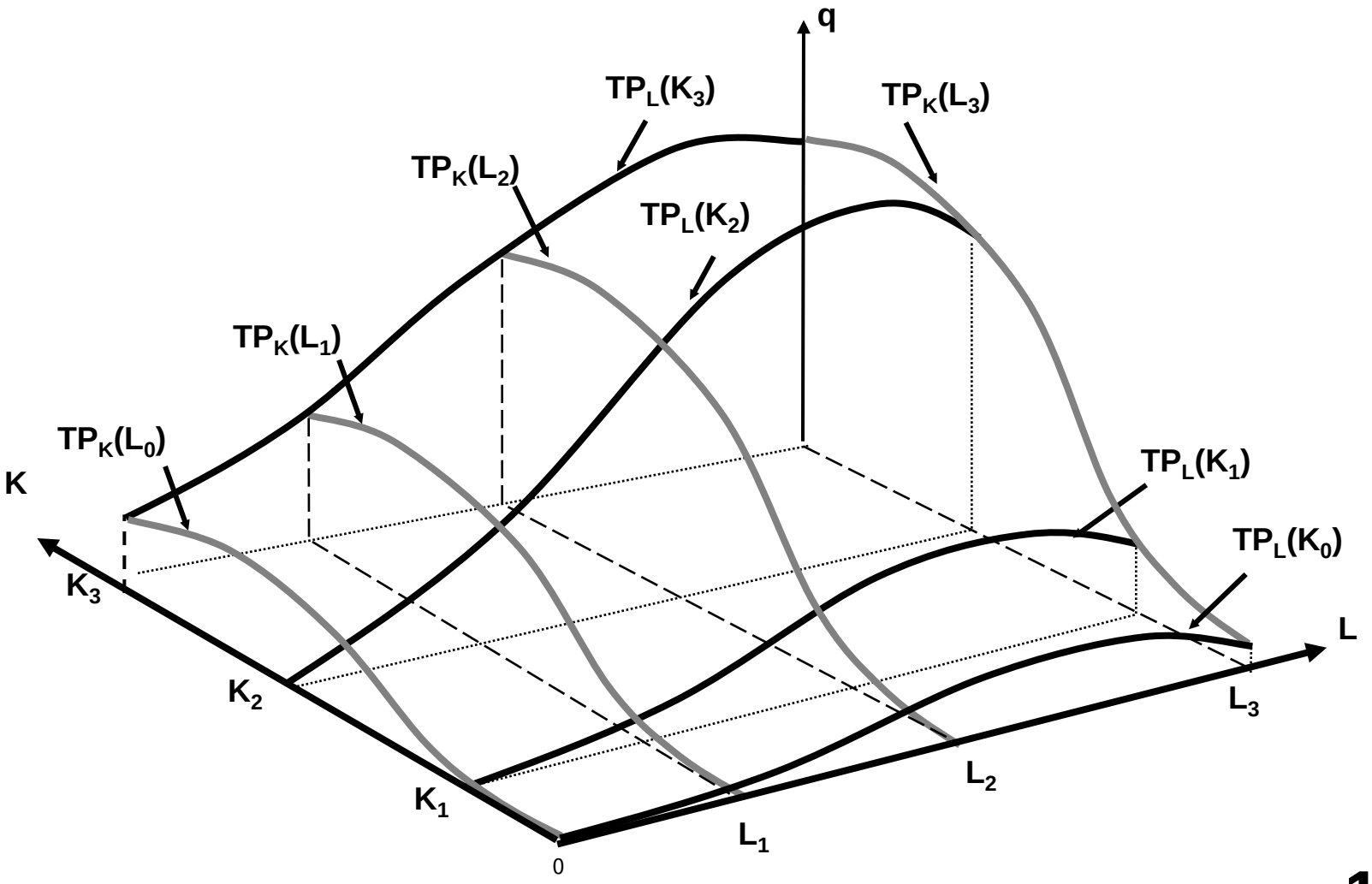
- Production Function:
  - Indicates the highest output (q) that a firm can produce for every specified combination of inputs.
  - For simplicity, we will consider only labor (L) and capital (K)
  - Shows what is technically feasible when the firm operates efficiently
- The production function for two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

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

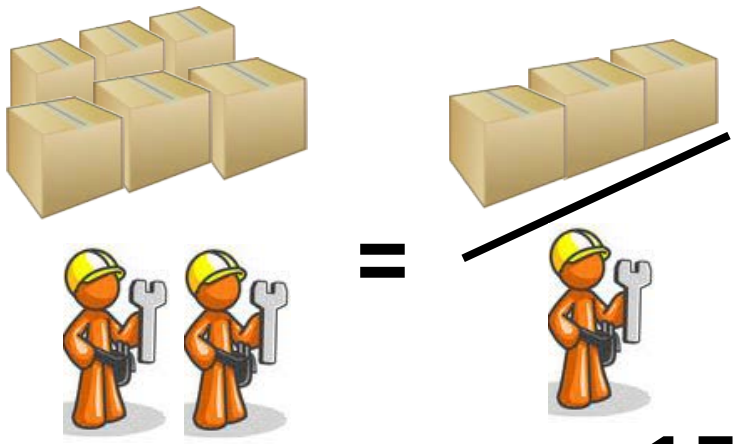
S-R Production: One Variable Input

- 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

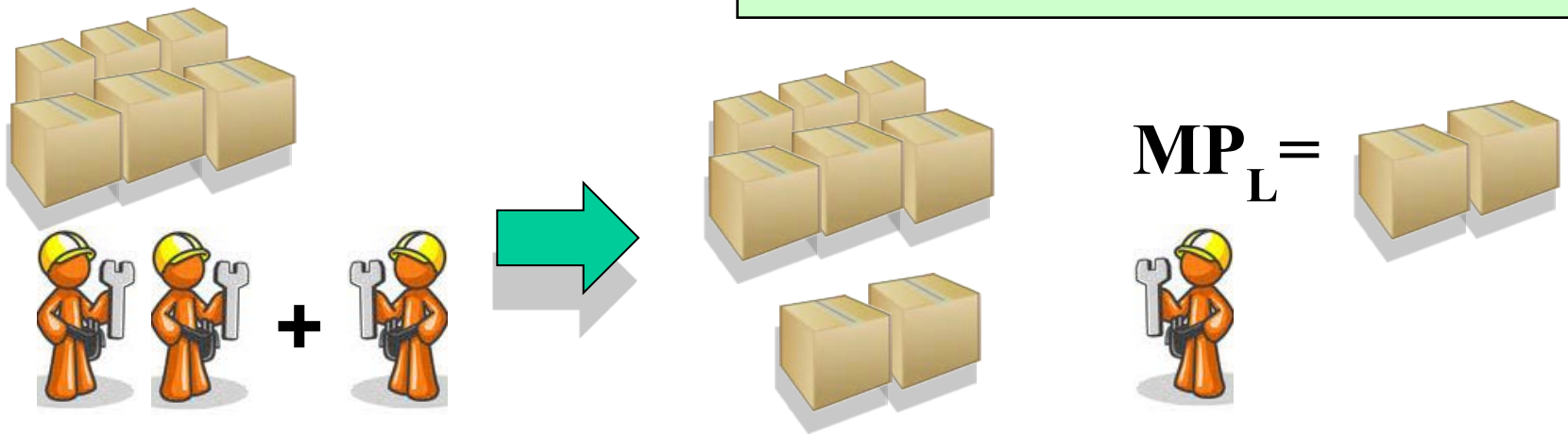
$$AP_L = \frac{\text{Output}}{\text{Labor Input}} = \frac{q}{L}$$



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

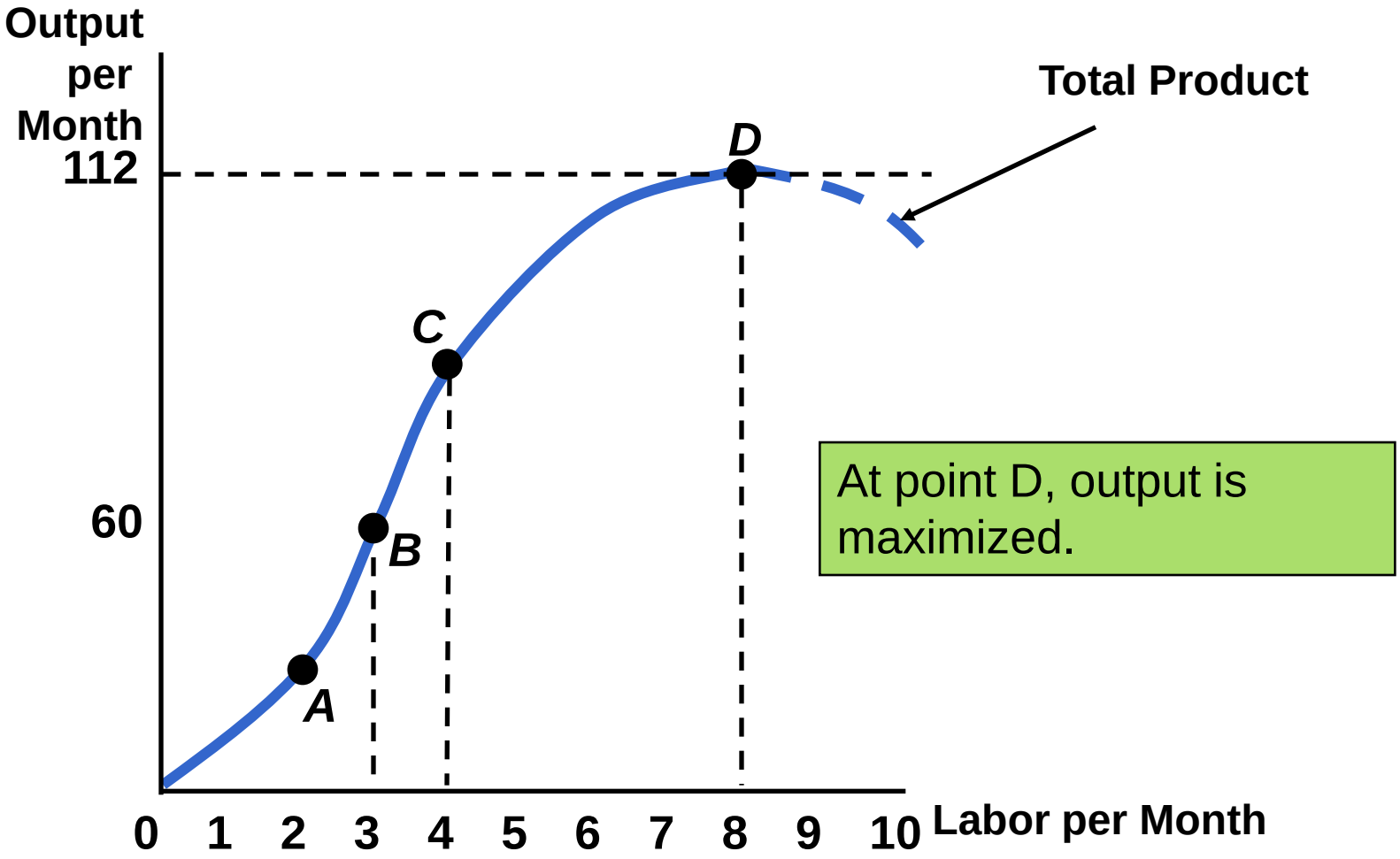
$$MP_L = \frac{\Delta \text{Output}}{\Delta \text{Labor Input}} = \frac{\Delta q}{\Delta L}$$



S-R Production: One Variable Input

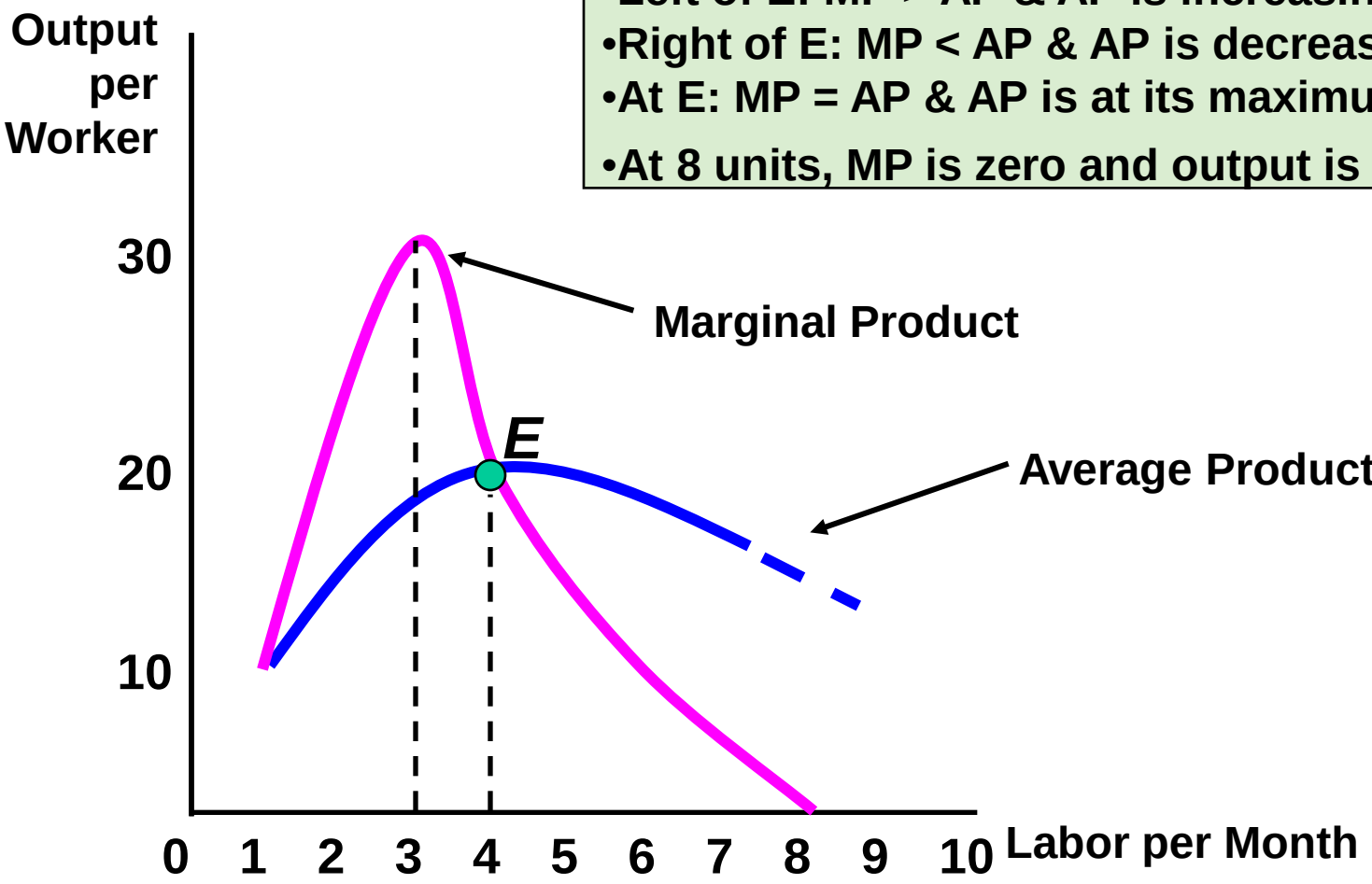
- We can graph the information in the Table to show
  - How output varies with changes in labor
    - Output is maximized at 112 units
  - Average and Marginal Products
    - Marginal product is positive as long as total output is increasing
    - Marginal Product crosses Average Product at its maximum

S-R Production: One Variable Input



S-R Production: One Variable Input

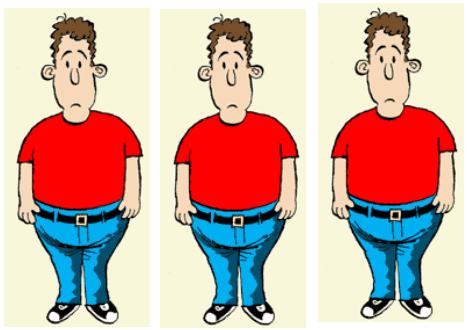
- Left of E: MP > AP & AP is increasing
- Right of E: MP < AP & AP is decreasing
- At E: MP = AP & AP is at its maximum
- At 8 units, MP is zero and output is at max



Marginal & Average Product

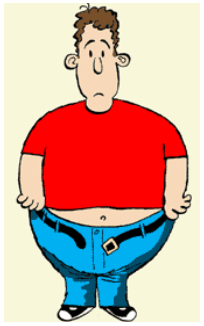
- When MP > AP, AP is increasing
- When MP > AP, AP is decreasing
- MP crosses AP at its maximum
- When MP = 0, TP is at its maximum

Example



= 70kg/person

\+  50 kg → < 70kg/Person

\+  90 kg → > 70kg/Person

Marginal & Average Product

From $TP_L = L \times AP_L$

$$\frac{dTP_L}{dL} = \frac{dL}{dL} AP_L + L \frac{dAP_L}{dL}$$

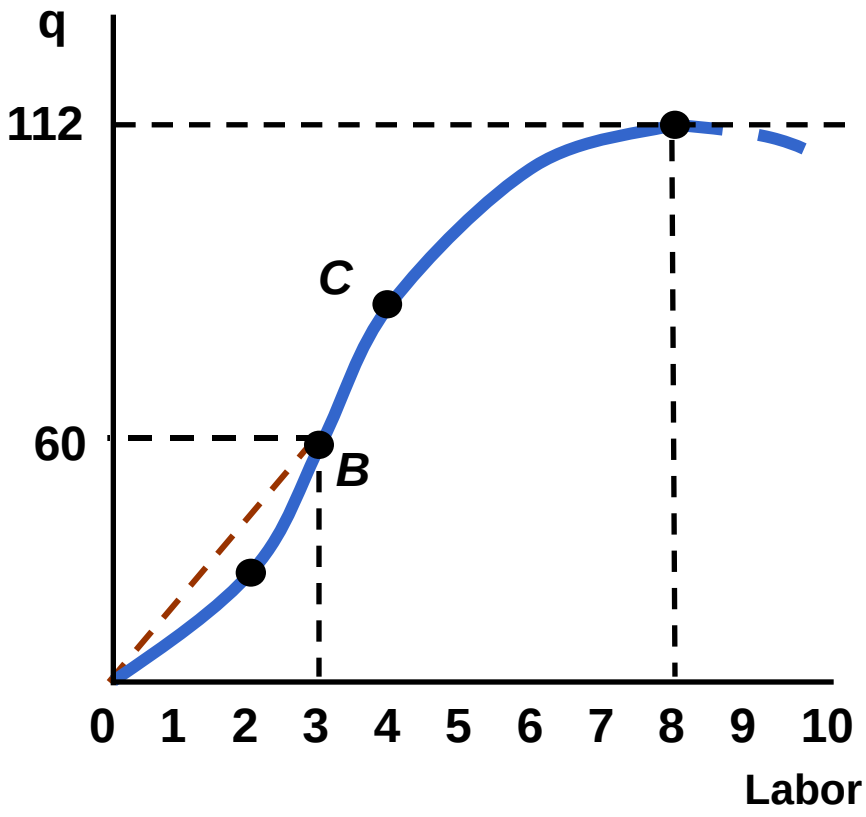
$$MP_L = AP_L + L \cdot \text{slope of } AP_L$$

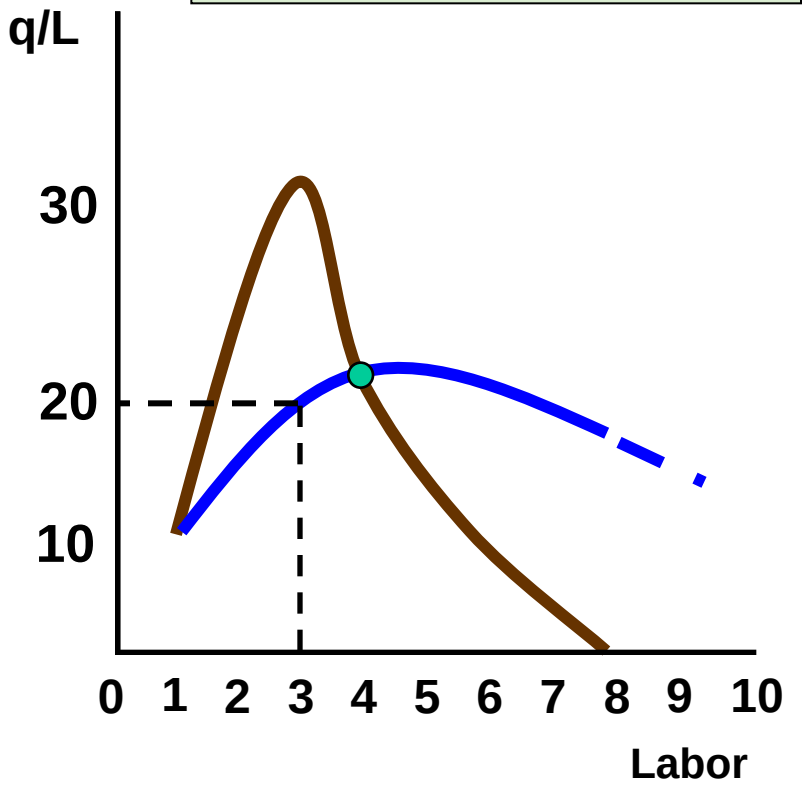
Product Curves

- 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

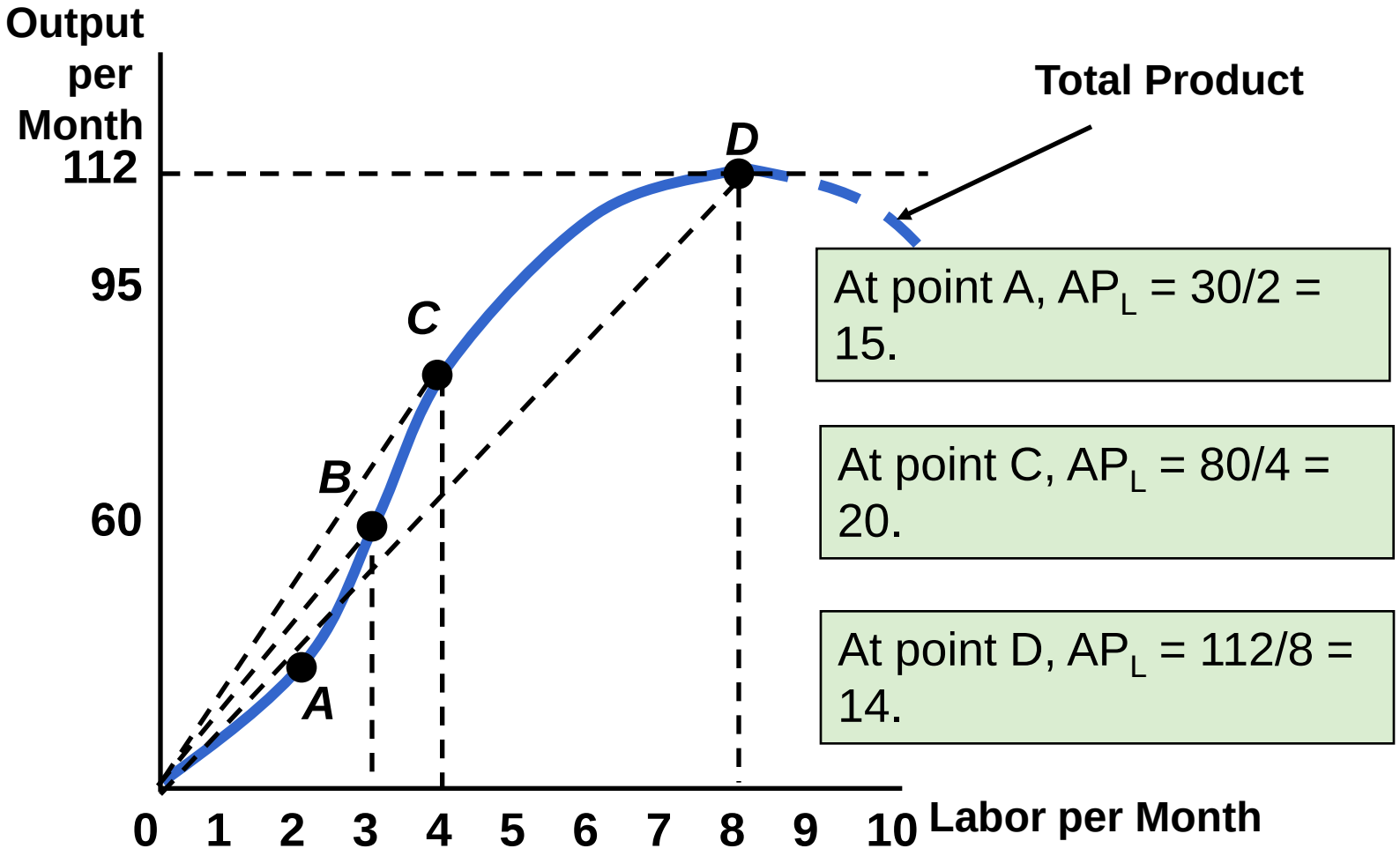
Product Curves

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





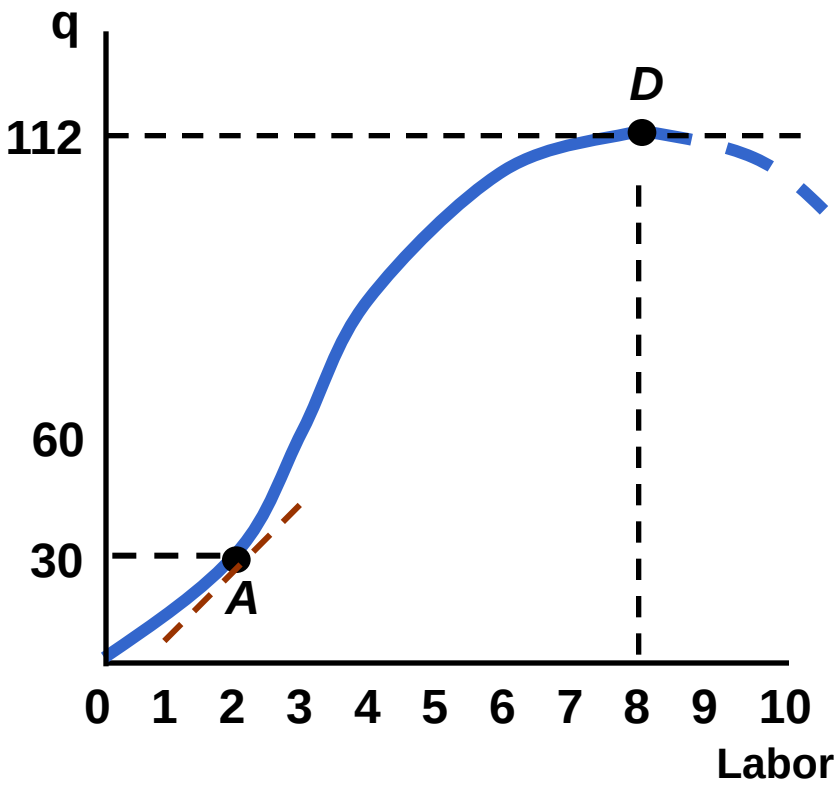
AP_L = the slope of the line from the origin to the point on TP_L curve.



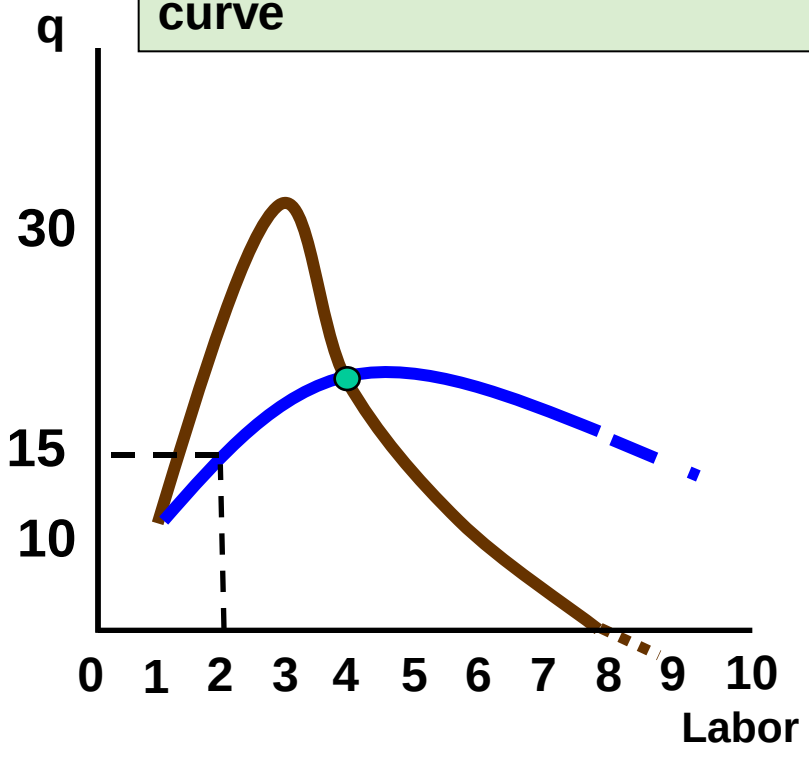
Product Curves

- 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

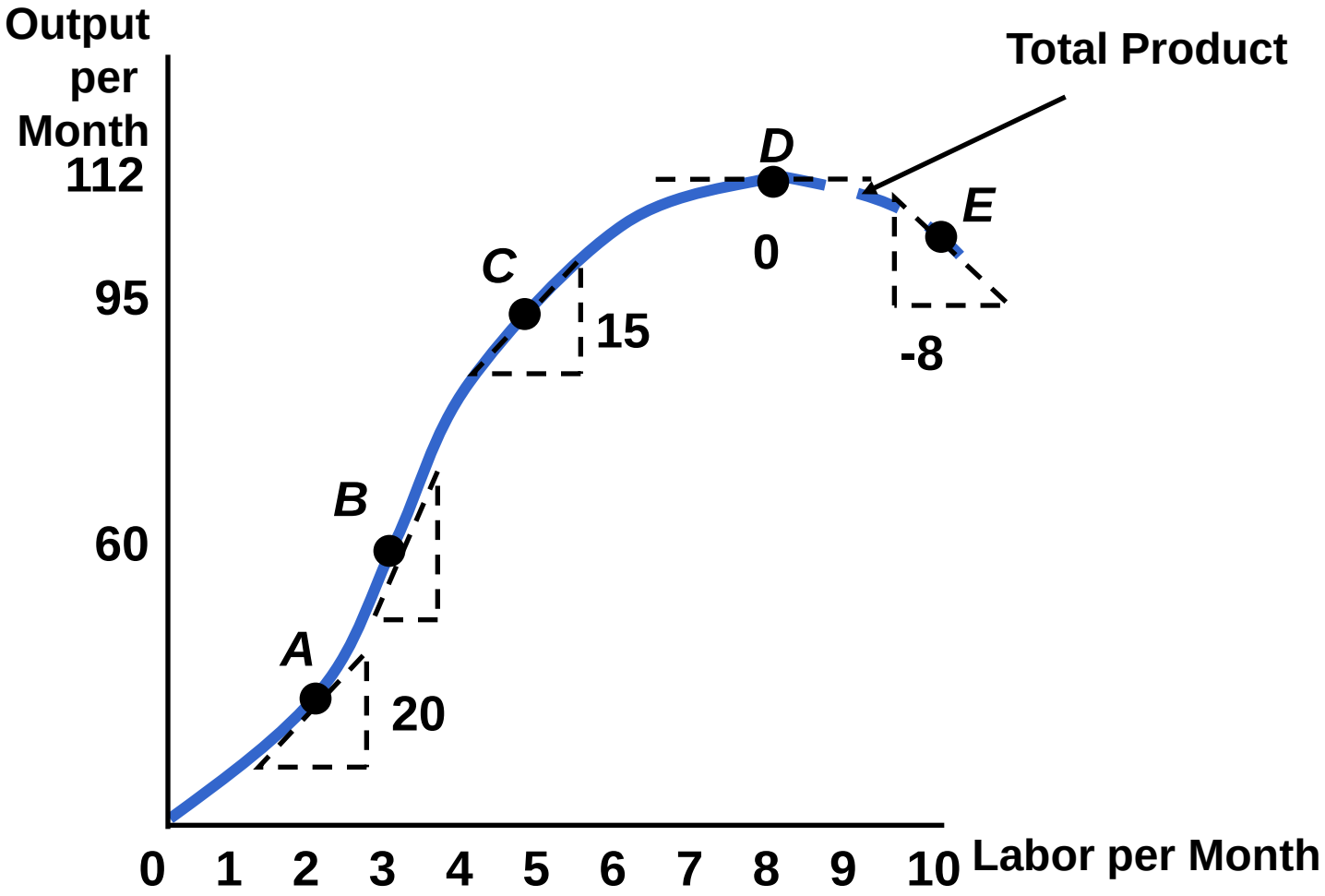
Product Curves



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.

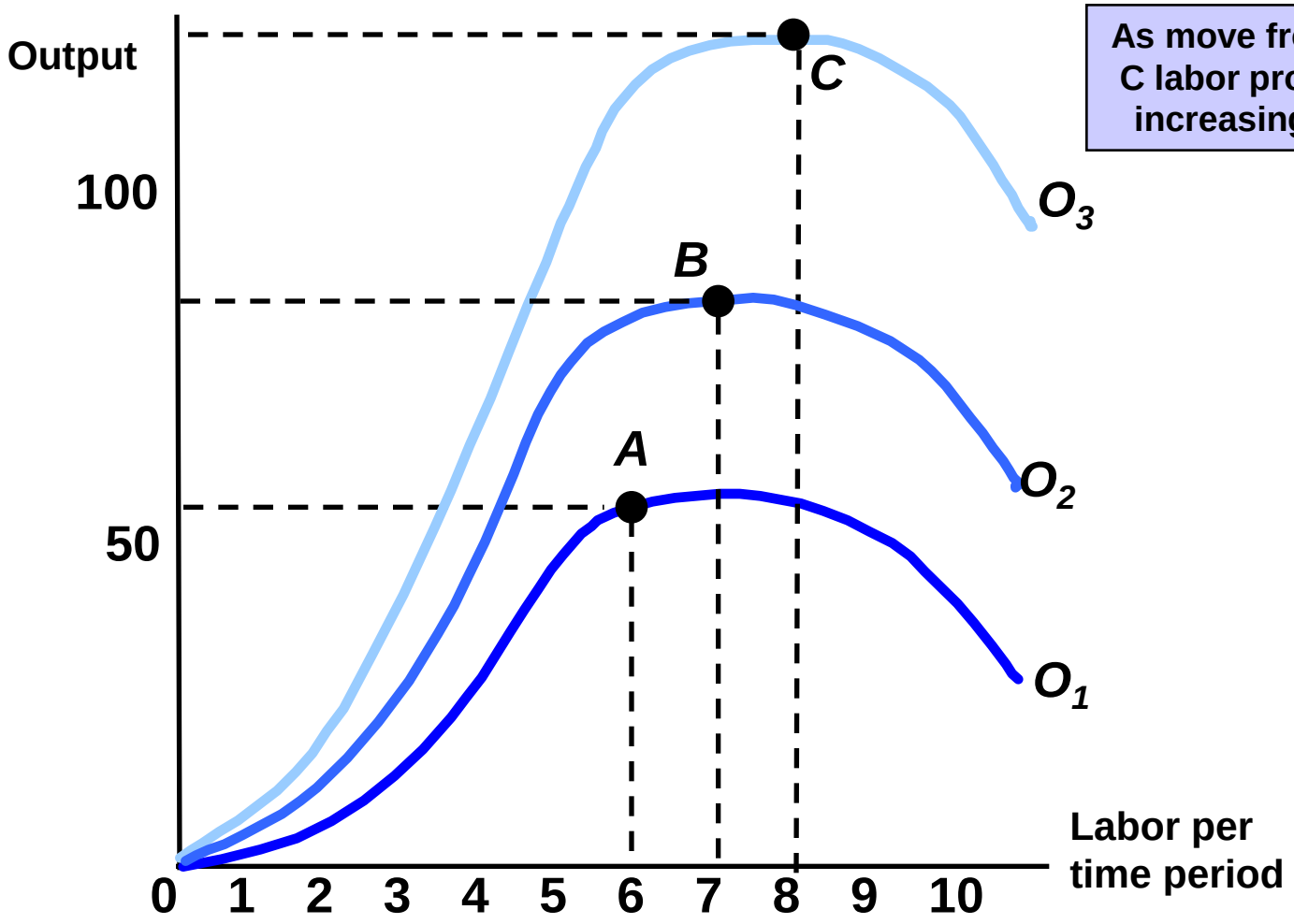
Law of Diminishing Marginal Returns

- 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

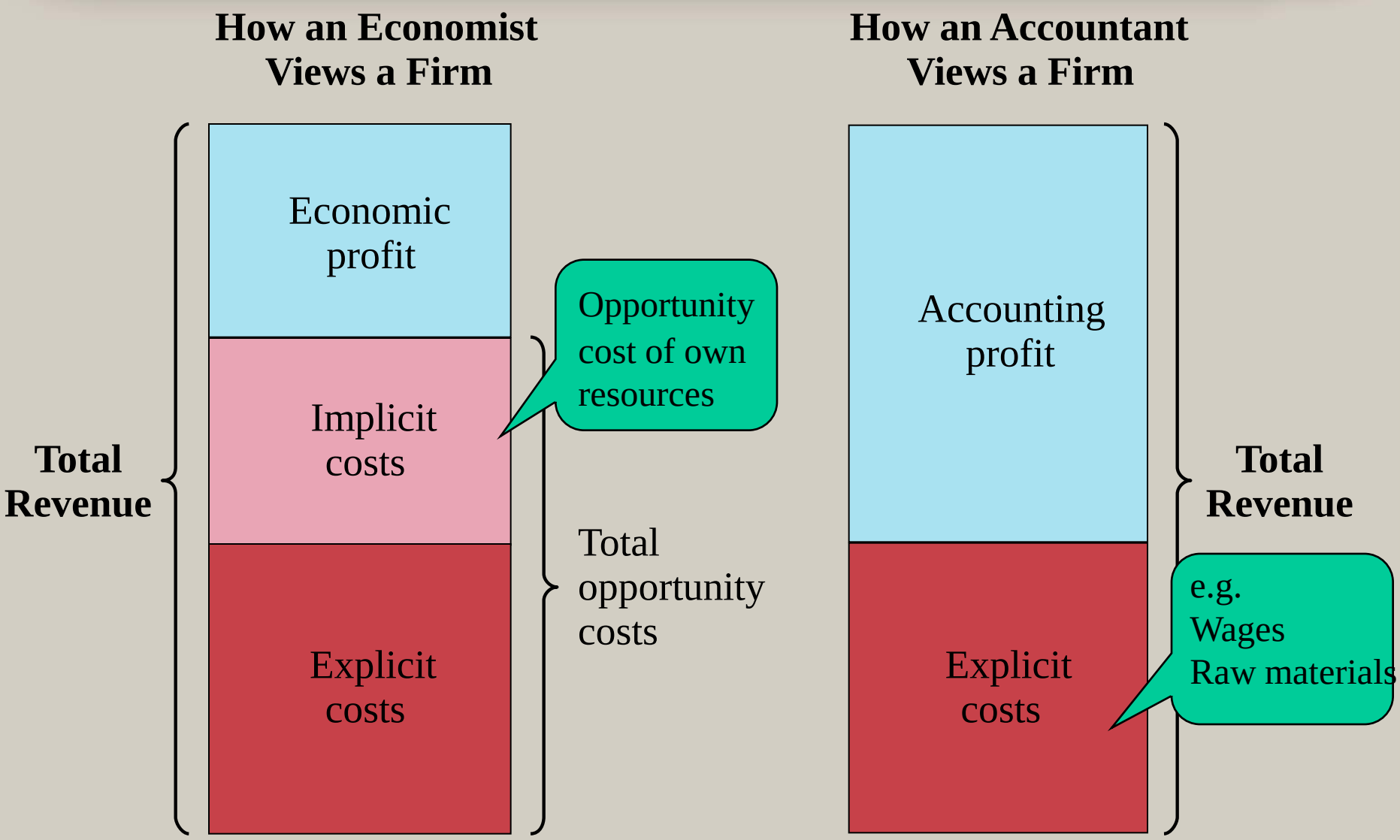
Measuring Cost: Which Costs Matter?

- For a firm to minimize costs, we must clarify what is meant by *cost* and how to measure them
  - It is clear that if a firm has to rent equipment or buildings, the rent they pay is a cost
  - What if a firm owns its own equipment or building?
    - How are costs calculated here?

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.

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

Sunk Cost

- Example: You have already pay ฿1,000 for a concert ticket.
- As you are driving to the concert you find that the ticket is lost. What should be the cost you use to decide whether to attend the concert or not?
- Suppose you decide to buy a new ticket and get in. After 15 minutes pass, you find the concert is boring. What should be be the cost you use to decide whether to get out or not?

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

$$TC = FC + TVC$$

$$TC = rK + wL$$

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

Example

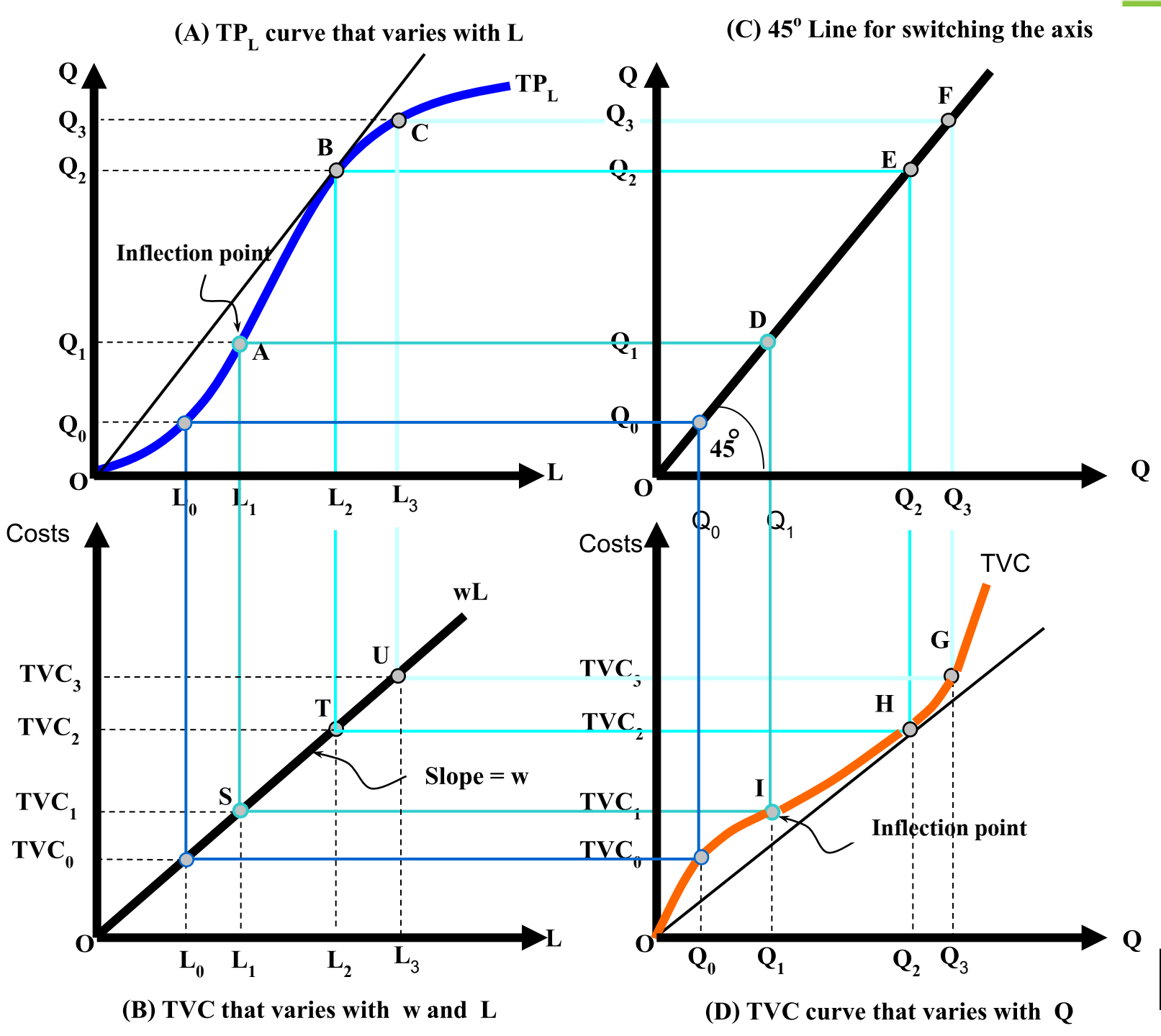
- From $Q = K^{0.5}L^{0.5}$. Capital is fixed, K = 4; hence

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

- 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
Costs
wL
TVC$_3$
TVC$_2$
TVC$_1$
TVC$_0$
U
T
S
Slope = w
TVC
G
H
I
Inflection point
(B) TVC that varies with w and L
(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).

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

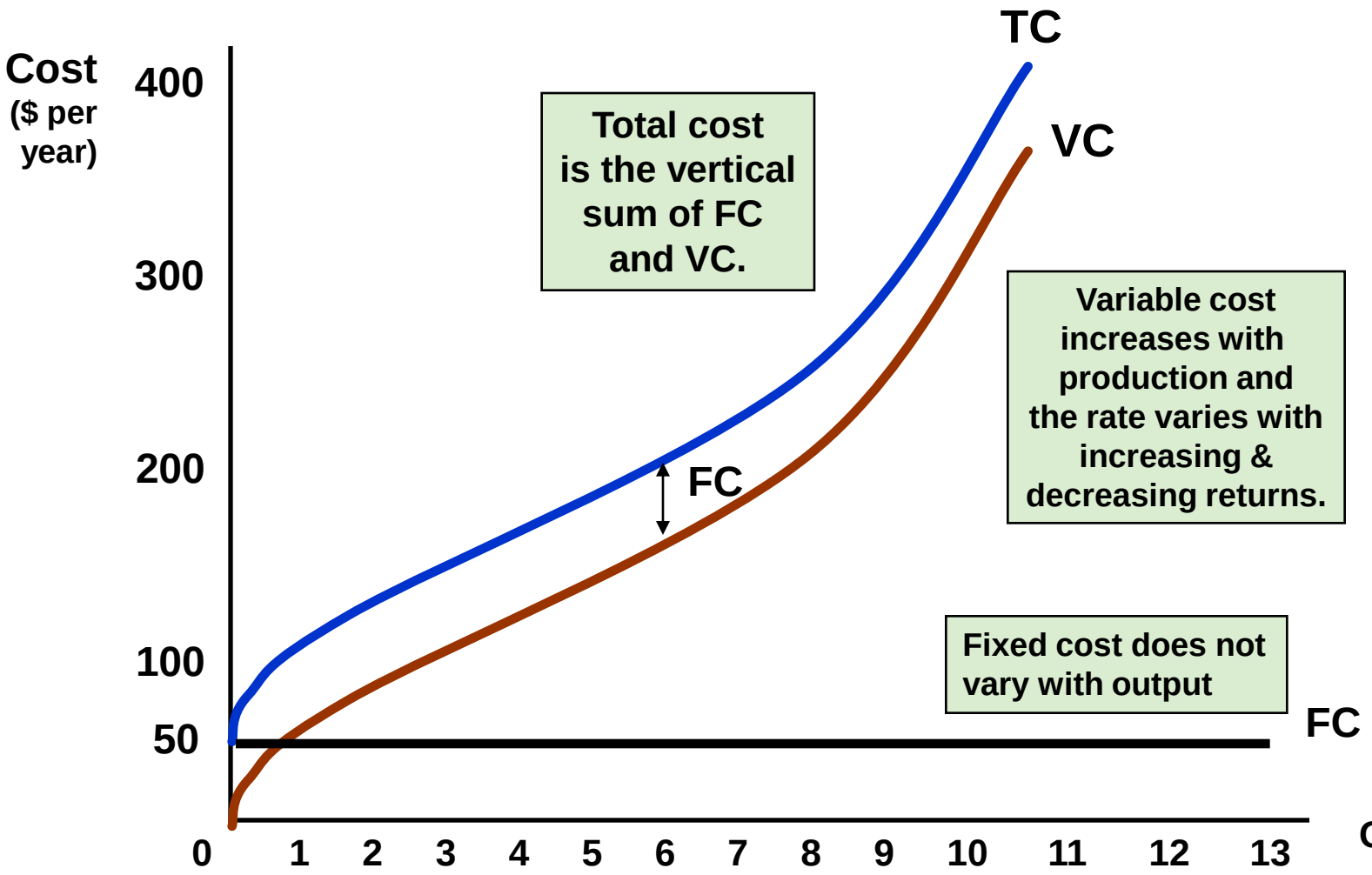
$$ATC = \frac{TC}{q} = \frac{TFC}{q} + \frac{TVC}{q}$$

Measuring Costs

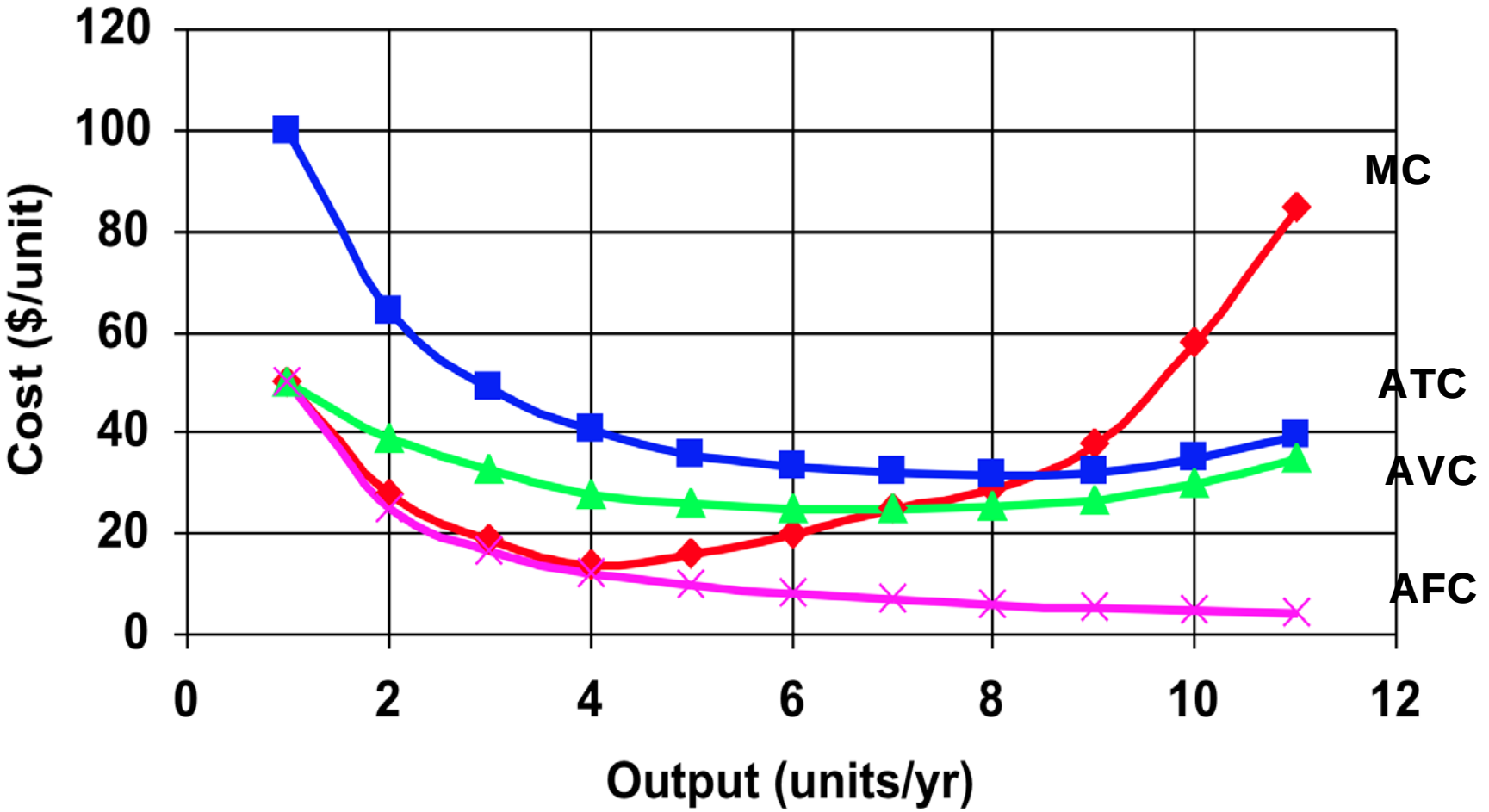
- Marginal Cost (MC):
  - The cost of expanding output by one unit.
  - Fixed cost have no impact on marginal cost, so it can be written as:

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

Cost Curves for a Firm

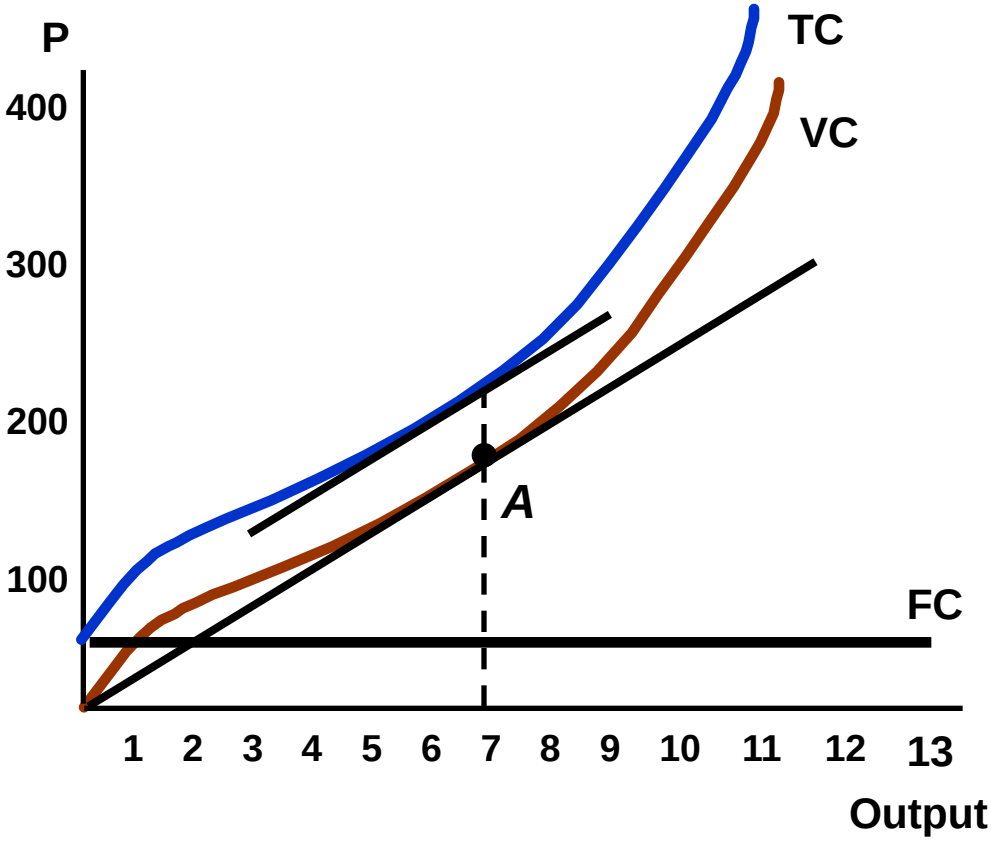


Cost Curves


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

The average-marginal relationship

$$TVC = AVC(Q) \times Q$$

$$\Delta TVC = AVC \times \Delta Q + Q \times \Delta AVC$$

$$\Delta TVC/\Delta Q = AVC \times \Delta Q/\Delta Q + Q \times \Delta AVC/\Delta Q$$

$$MC = AVC + Q \times \text{slope of } AVC$$

Similarly, from $TC = AC(Q) \times Q$ we can show

$$MC = AC + Q \times \text{slope of } AC$$

Exercise

- Draw TP_L, AP_L, MP_L และ TC, TFC, TVC, ATC, AFC, AVC, and MC

  when the production function is given by

1. $Q = KL$
2. $Q = K^{0.5}L^{0.5}$

- with $K = 4$, $r = 10$, $w = 4$

1. Q = KL

- with K = 4
  - Q = 4L
  - Q/L = 4, dQ/dL = 4
- with r = 10 and w = 4
  - TC = rK + wL = 10(4) + 4L
  - from above L = Q/4
  - TC = 40 + Q
  - TC/Q = 40/Q + 1, AFC = 40/Q, AVC = 1, MC = 1

2. $Q = K^{0.5}L^{0.5}$

- with $K = 4$
  - $Q = 2L^{0.5}$
  - $Q/L = 2L^{-0.5}$, $dQ/dL = L^{-0.5}$
- with $r = 10$ and $w = 4$
  - $TC = rK + wL = 10(4) + 4L$
  - from above $L = Q^2/4$
  - $TC = 40 + Q^2$
  - $TC/Q = 40/Q + Q$, $AVC = Q$, $MC = 2Q$