CHAPTER 5

The Production Process and Costs

INTRODUCTION

Learning Objectives

After studying this chapter, you will be able to:

- Explain how to measure productivity of inputs and managers role in the production process.
- Calculate input demand function and explain how input substitution can minimize production costs.
- Calculate a cost function from production function and explain the difference between economic costs and accounting costs.
- Explain the relationship between fixed cost, variable cost, marginal costs and its importance in economics.
- Understand the impact of various costs on long run and short run production decision

The Production Function

- **Production function:** the relationship that describes how inputs like capital and labor are transformed into output.
- Firms produce maximum amount of output with a given set of inputs

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

Where, Q is the level of output,

-- K is the quantity of capital input

--L is the quantity of labour input

Use of Inputs in Short-Run and Long-Run

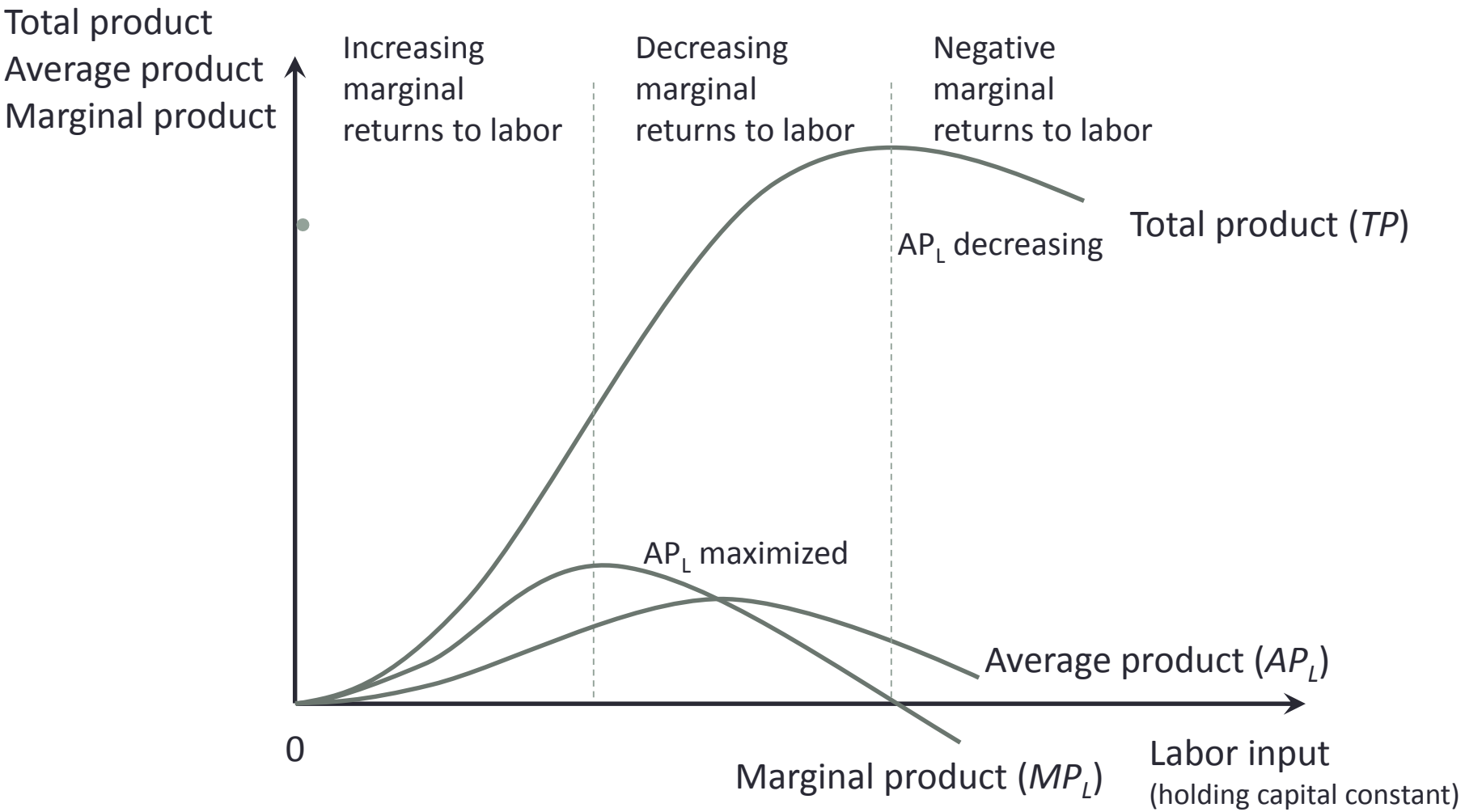
- Short-run: the period during which at least one factor input is fixed while other inputs are variable. The manager can not adjust the inputs to change production in the short run.

- Long-run: the period during which all factors of production (inputs) are variable. The manager can adjust the inputs to alter production in the long run.

How to measure Productivity?

- Total product (*TP*)
  - Maximum level of output that can be produced with a given amount of inputs.
- Average product (*AP*)
  - A measure of the output produced per unit of input.
    - Average product of labor: $AP_L = \frac{Q}{L}$
    - Average product of capital: $AP_K = \frac{Q}{K}$
- Marginal product (*MP*)
  - The change in total product (output) attributable to the last unit of an input.
    - Marginal product of labor: $MP_L = \frac{\Delta Q}{\Delta L}$
    - Marginal product of capital: $MP_K = \frac{\Delta Q}{\Delta K}$

Increasing, decreasing and negative marginal returns



Marginal Returns

- As more of the variable input is used, marginal product initially increases (increasing marginal returns), then starts to decline (decreasing marginal returns) then becomes negative.
- How to determine the optimal use of the variable input

Manager's role in production

- Maximum amount of output that can be produced with given inputs
- Managers can provide incentives to the workers that induces them to work hard
- Right mix of inputs to maximize profit:
- Value marginal product of labour, $VMP_L = P \times MP_L$

-Value marginal product of capital, $VMP_K = P \times MP_K$

Cobb – Douglas Production

- Suppose that a firm produces output according to the production function

$$Q = F(1, L) = (1)^{1/4} L^{3/4}$$

- Which is the fixed input?
  - Capital is the fixed input.
- What is the marginal product of labor when 16 units of labor is hired?

$$MP_L = 1 \times \frac{3}{4} L^{-\frac{1}{4}} = 1 \times \frac{3}{4} (16)^{-\frac{1}{4}} = \frac{3}{8}$$

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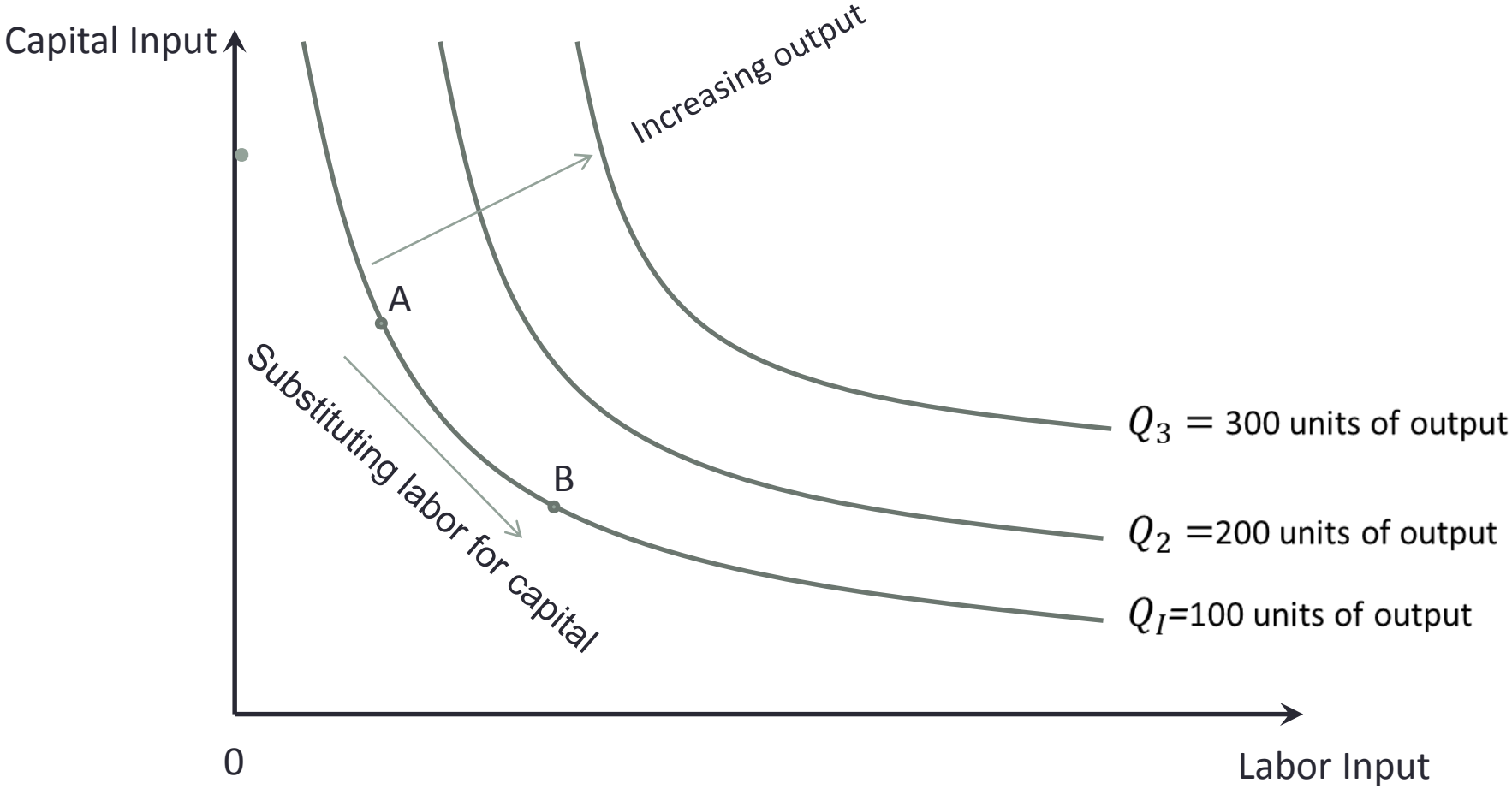
PRODUCTION COST

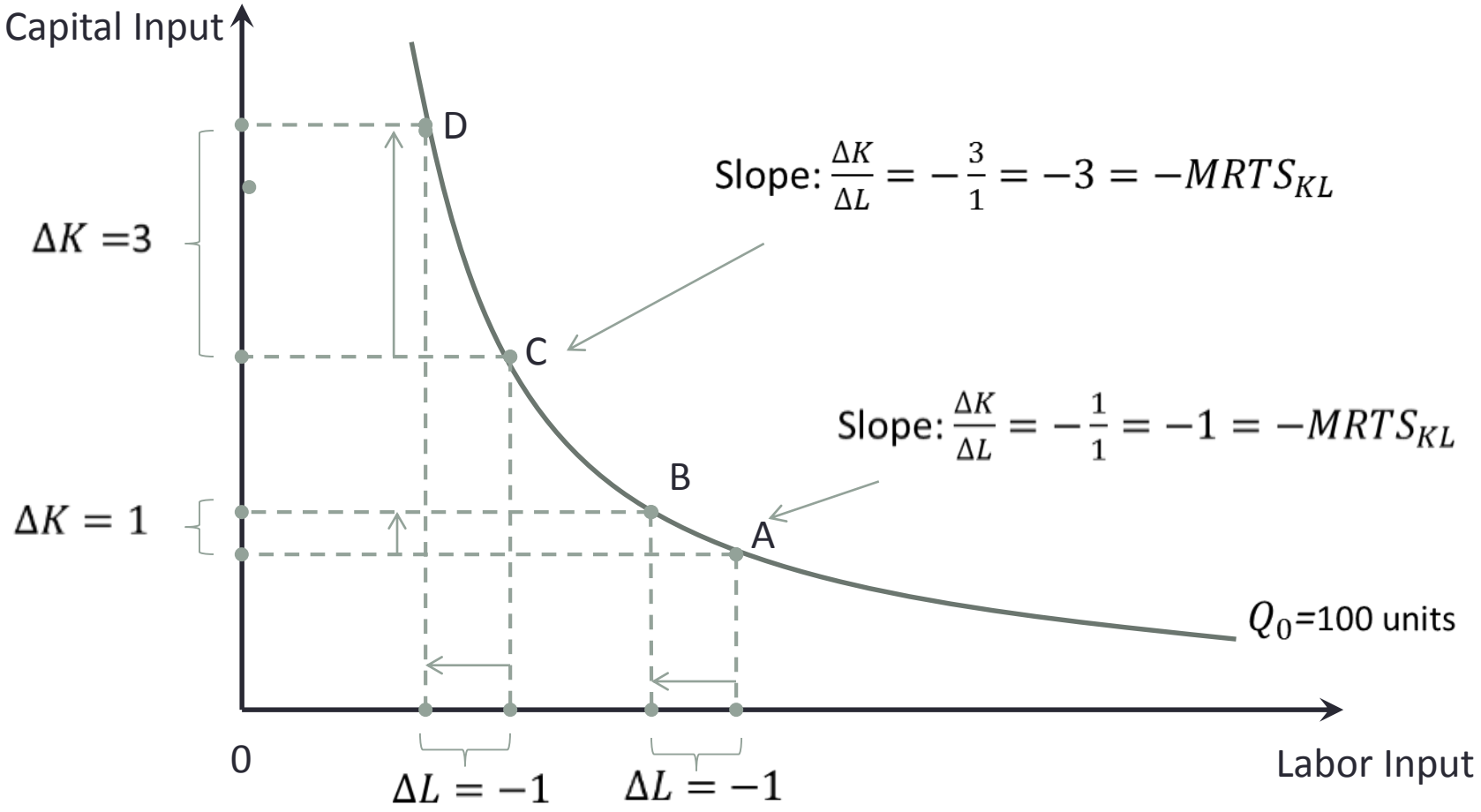
Isoquant and Marginal Rate of Technical Substitution

- An isoquant is a curve that shows various input combinations that yield the same total quantity of output
- The slope of the isoquant = the ratio of the marginal product of labor to the marginal product of capital. MP_L/MP_K
- Marginal rate of technical substitution: measures the amount of K the firm could give up in exchange for an additional L, in order to be able to produce the same output as before. $MRTS_{L,K}$

Isoquants and Marginal Rate of Technical Substitution



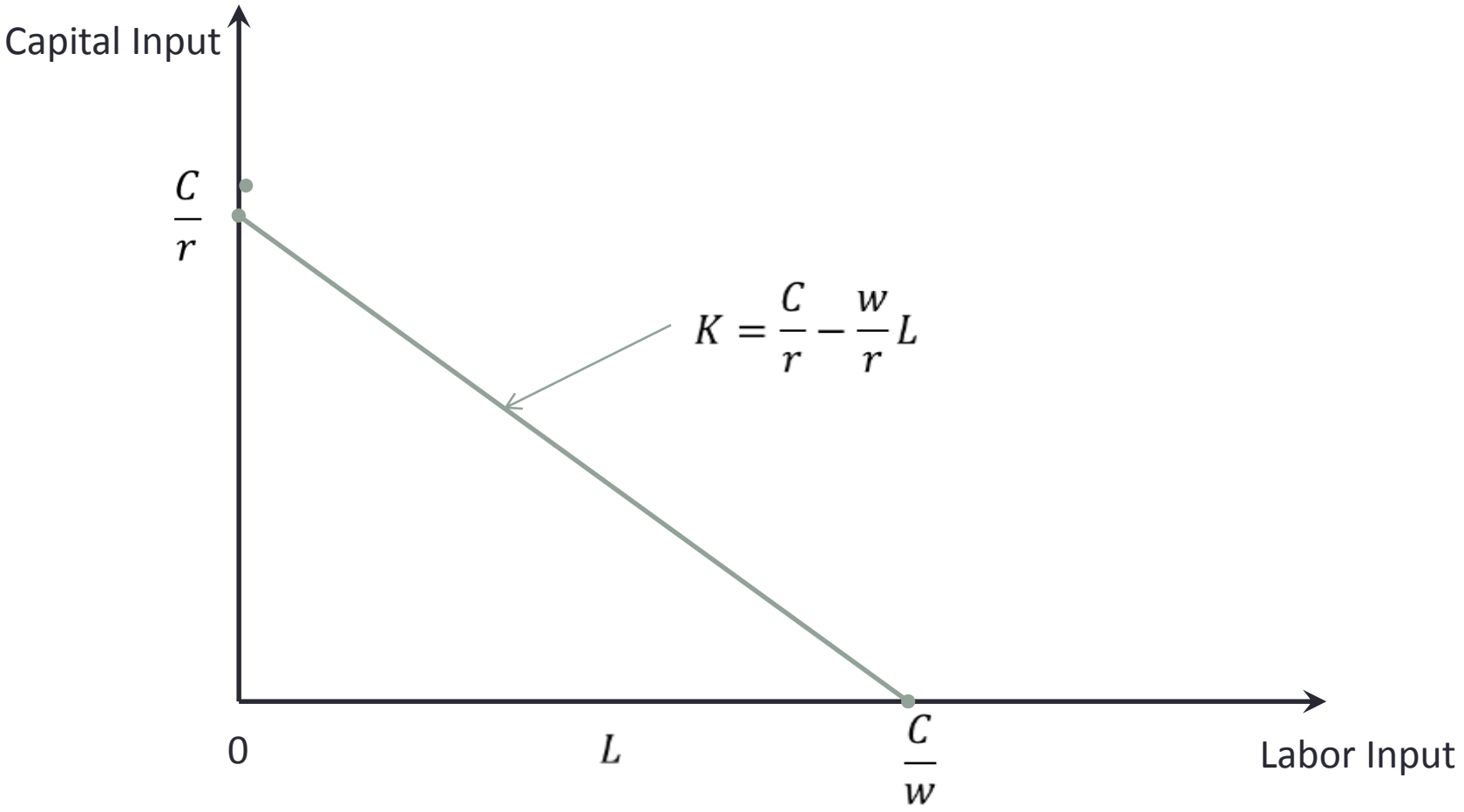
Diminishing MRTS



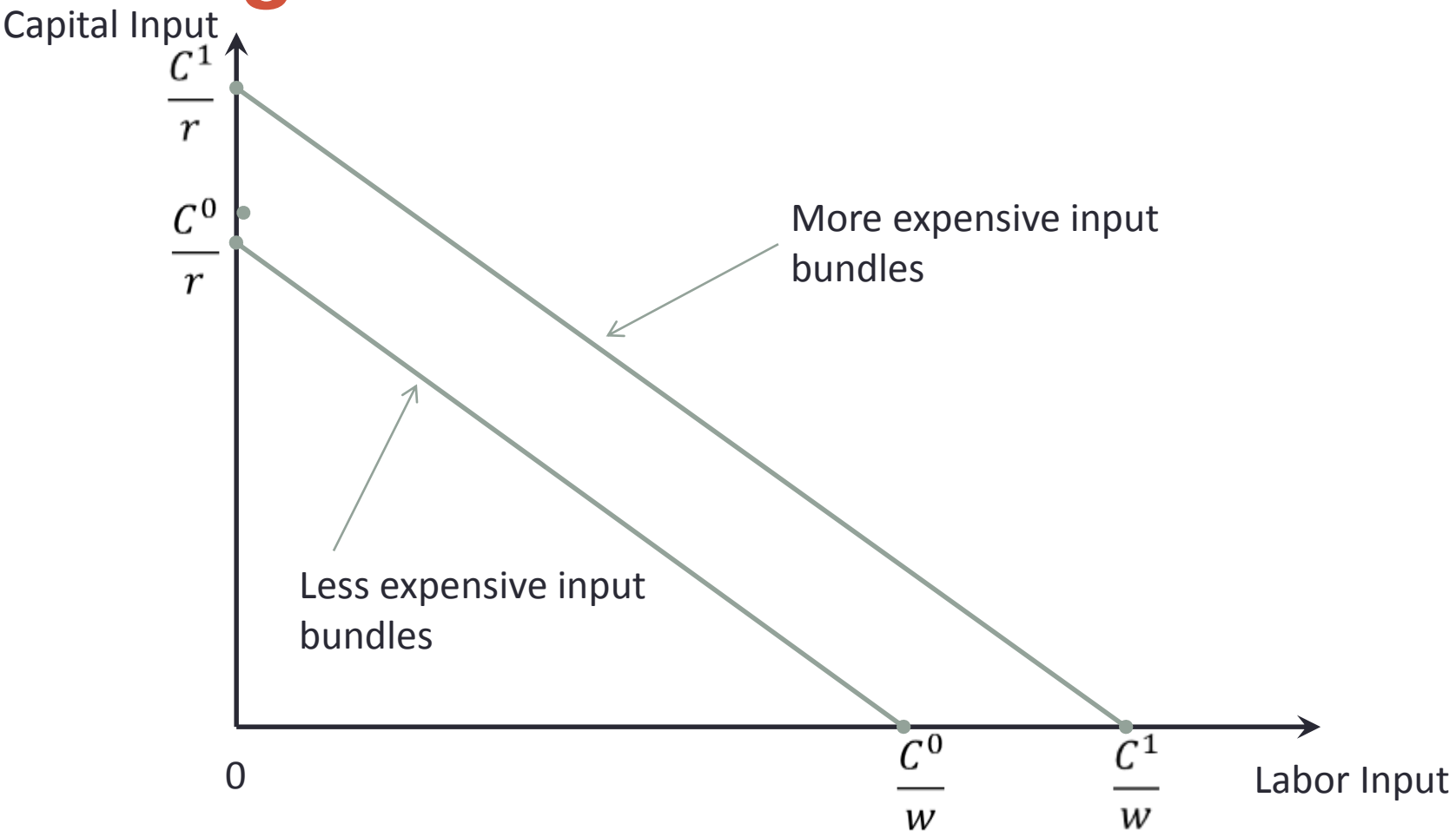
Isocost Line

- It is the different combinations of inputs that will cost the firm the same amount comprise an isocost line.
- the slope of the isocost line is given by the ratio of the input prices, PL/PK.
- Changes in isocost: slope of the isocost line change due to change in input prices

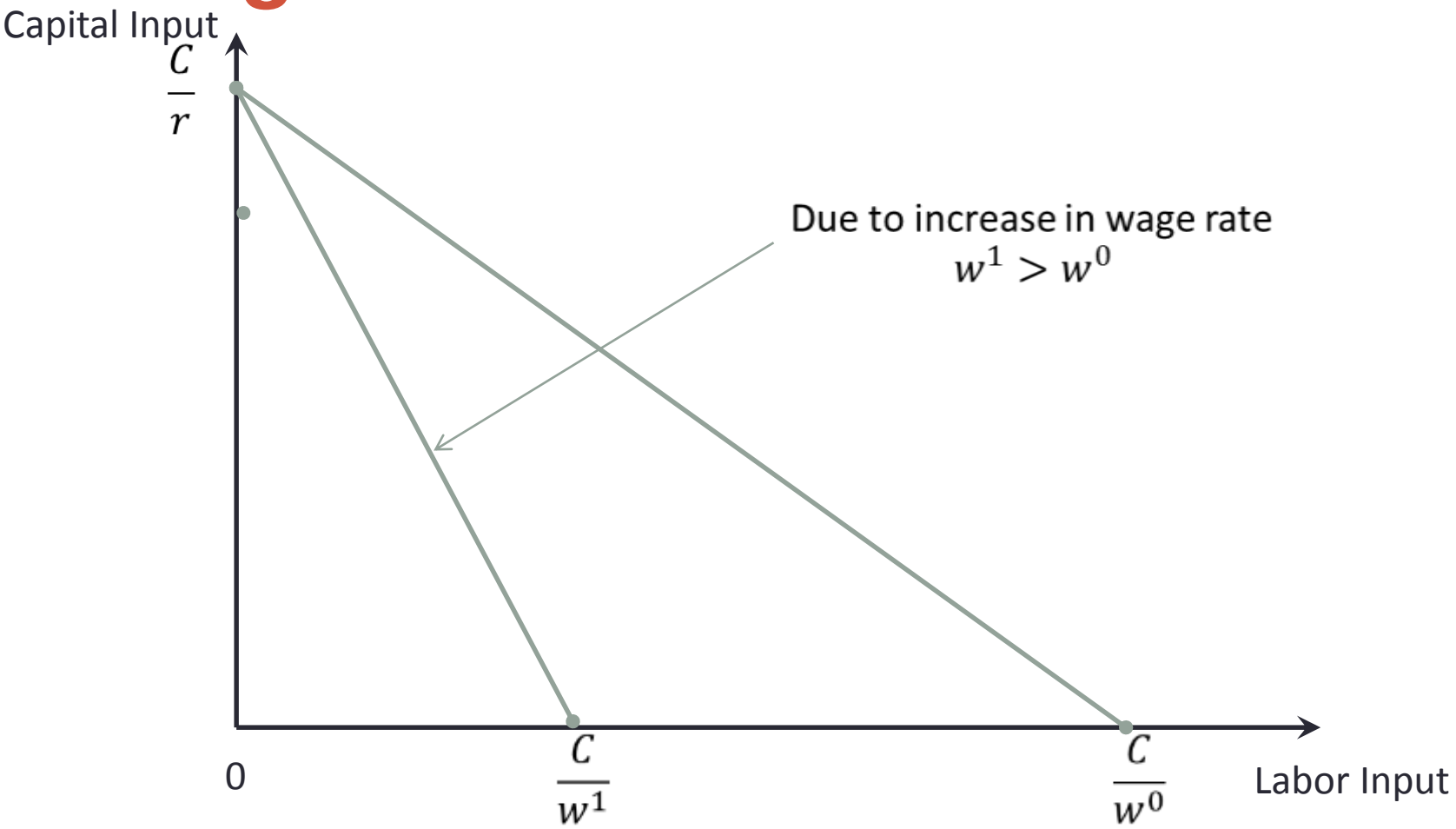
Isocost Line



Changes in the Isocost Line



Changes in the Isocost Line



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COST MINIMIZATION

Cost minimization

- the condition for optimality is that the isoquant is tangential to the **lowest isocost curve**.
- Producers are interested in **cost minimization**

A VIDEO ABOUT

For more Video on Cost Curve

https://www.youtube.com/watch?v=ucJBO9UTmwo

https://www.youtube.com/watch?v=qYKJdooEnwU

Cost Minimization

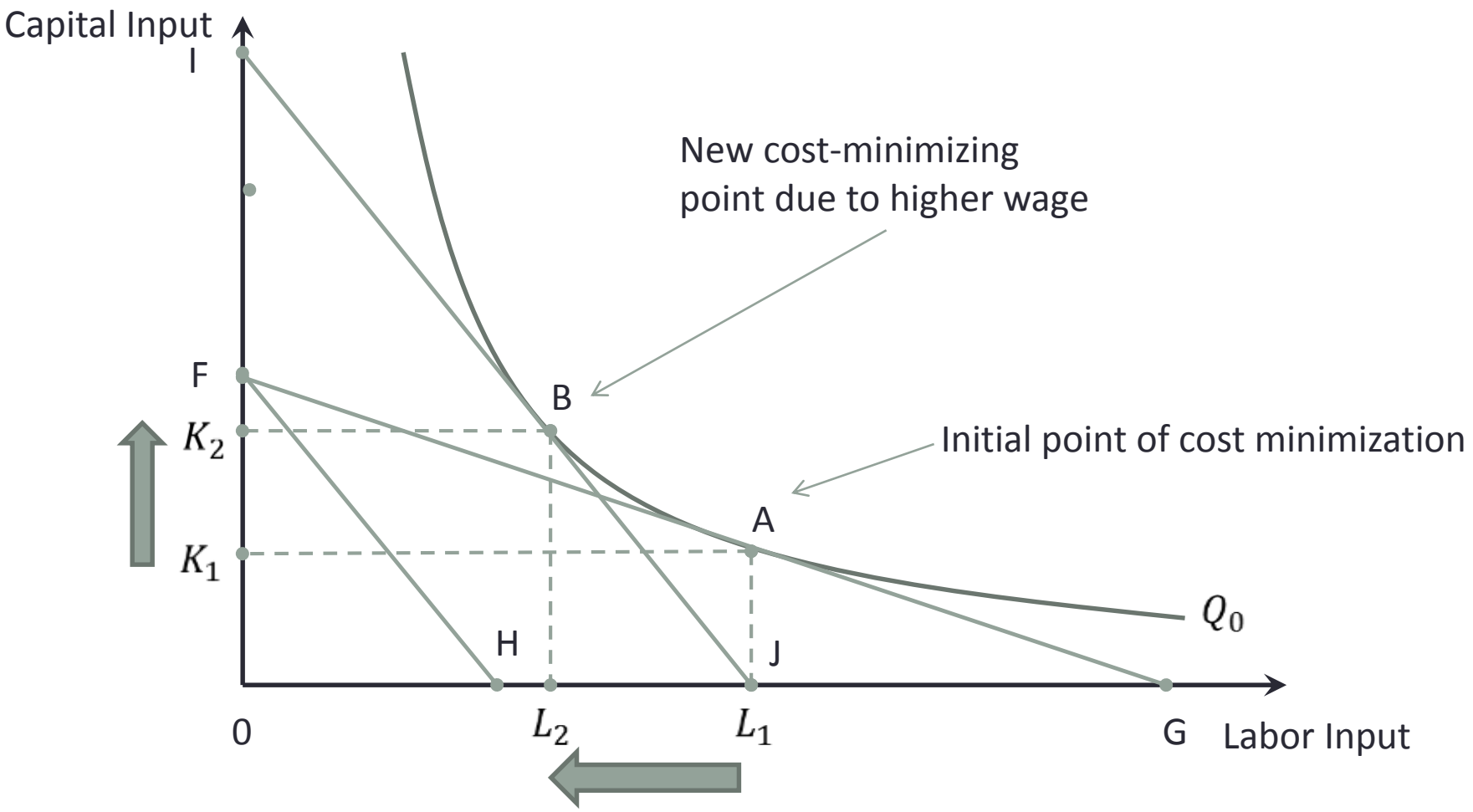
- Cost minimization
  - Producing at the lowest possible cost.
- Cost-minimizing input rule
  - Produce at a given level of output where the marginal product per dollar spent is equal for all input:

$$\frac{MP_L}{w} = \frac{MP_K}{r}$$

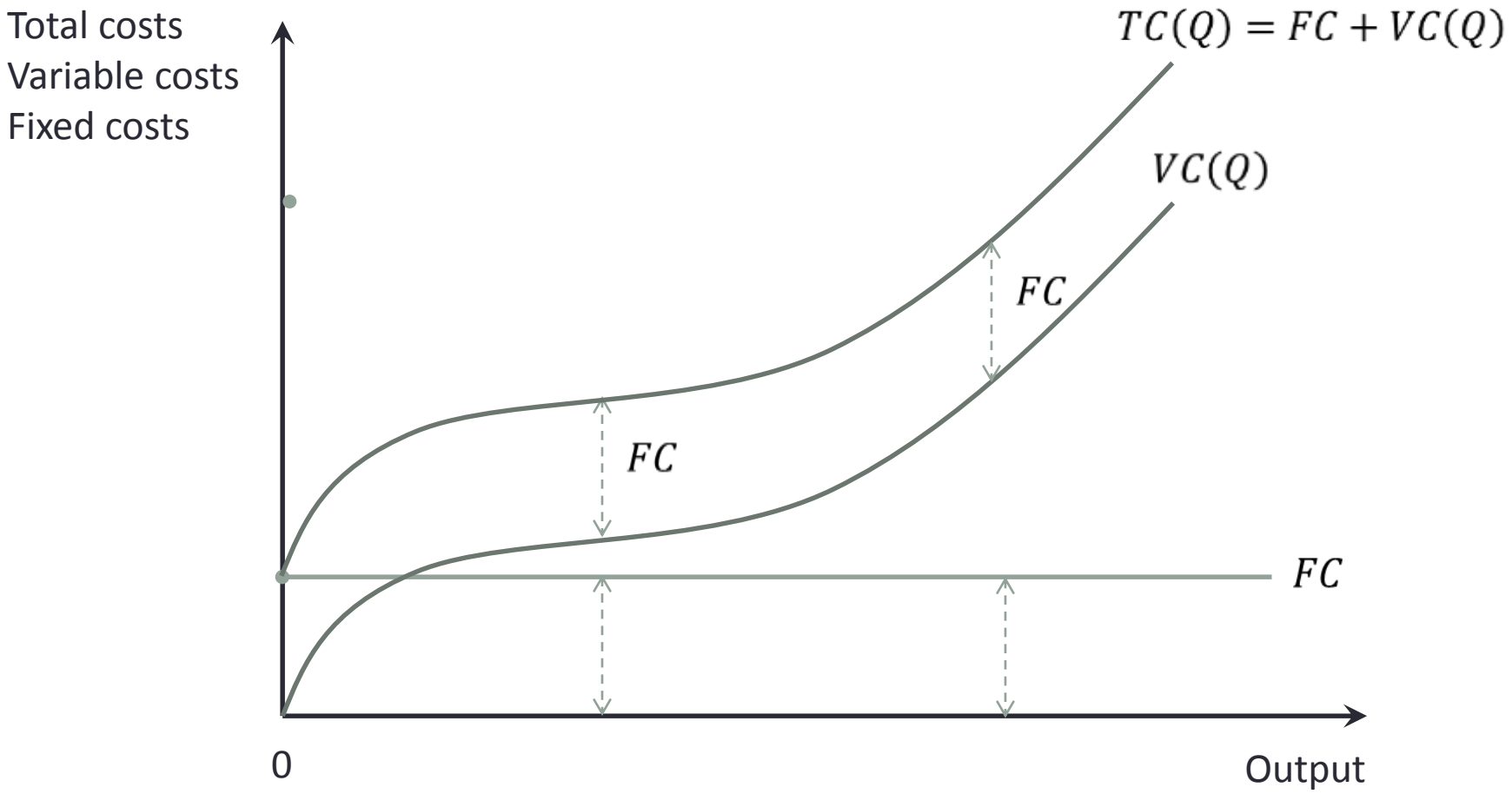
  - Equivalently, a firm should employ inputs such that the marginal rate of technical substitution equals the ratio of input prices:

$$\frac{MP_L}{MP_K} = \frac{w}{r}$$

Input Substitution



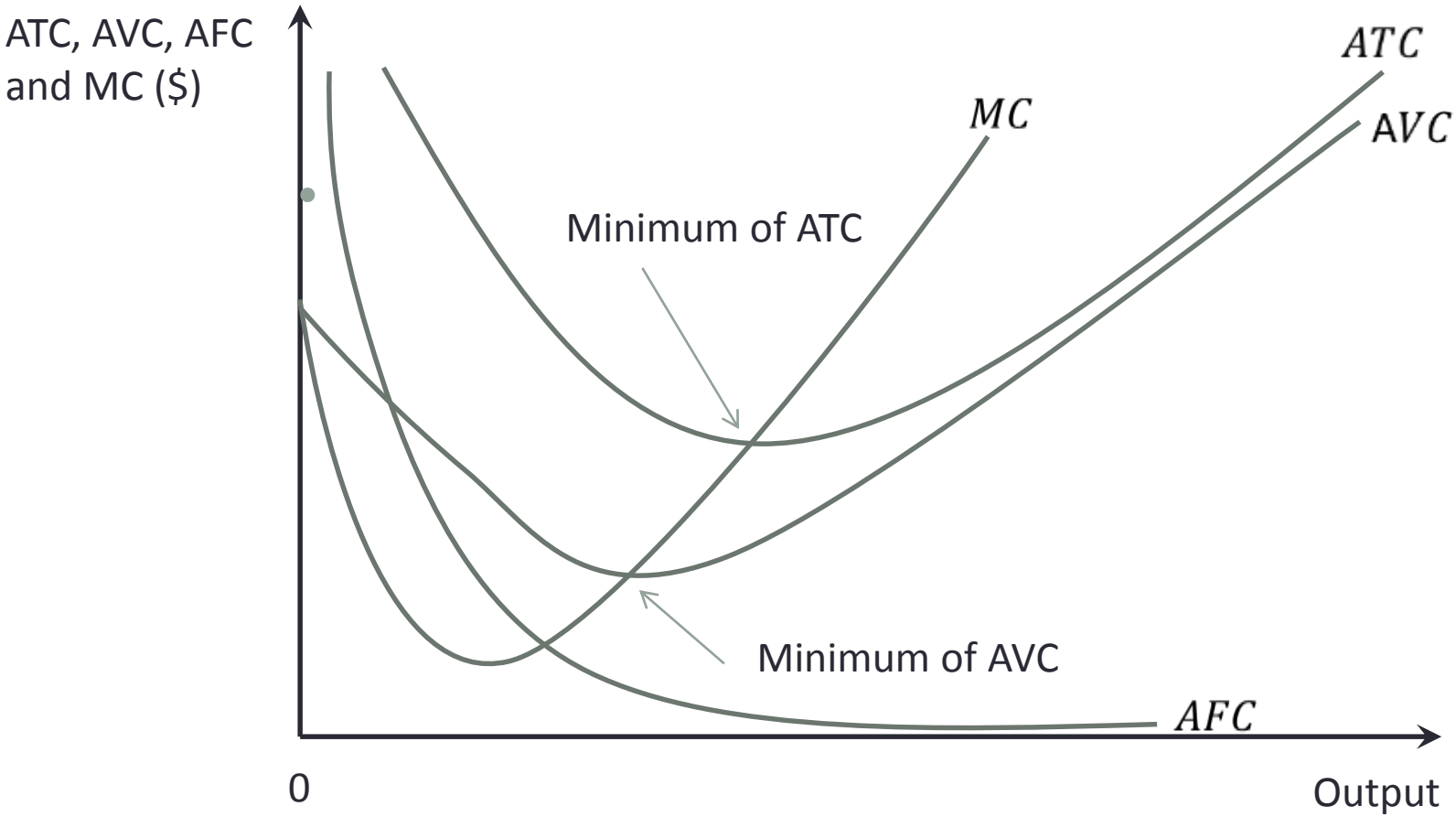
The Cost Function



Average and Marginal Costs

- Average costs
  - Average fixed: $AFC = \frac{FC}{Q}$
  - Average variable costs: $AVC = \frac{VC(Q)}{Q}$
  - Average total cost: $ATC = \frac{C(Q)}{Q}$
- Marginal cost
  - The (incremental) cost of producing an additional unit of output.
  - $MC = \frac{\Delta C}{\Delta Q}$

Average and Marginal Costs



Fixed and Sunk Costs

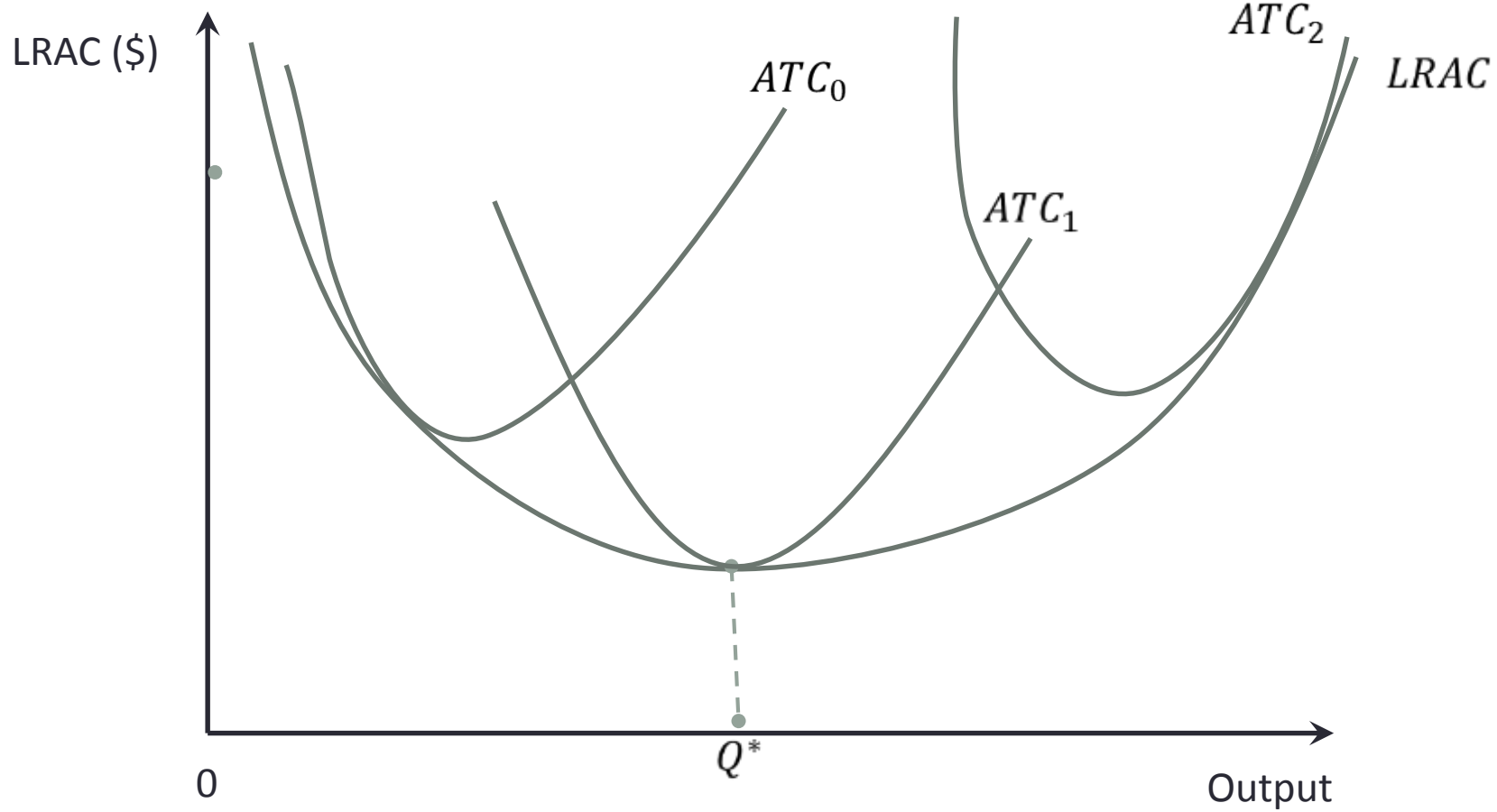
- Fixed costs
  - Cost that does not change with output.
- Sunk cost
  - Cost that is forever lost after it has been paid.

- Principle of Irrelevance of Sunk Costs
  - A decision maker should ignore sunk costs to maximize profits or minimize loses.

Long-Run Costs

- In the long run, all costs are variable since a manager is free to adjust levels of all inputs.
- Long-run average cost curve
  - A curve that defines the minimum average cost of producing alternative levels of output allowing for optimal selection of both fixed and variable factors of production.

Long-Run Average Total Costs in Action



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ECONOMIES OF SCALE

Economies of Scale

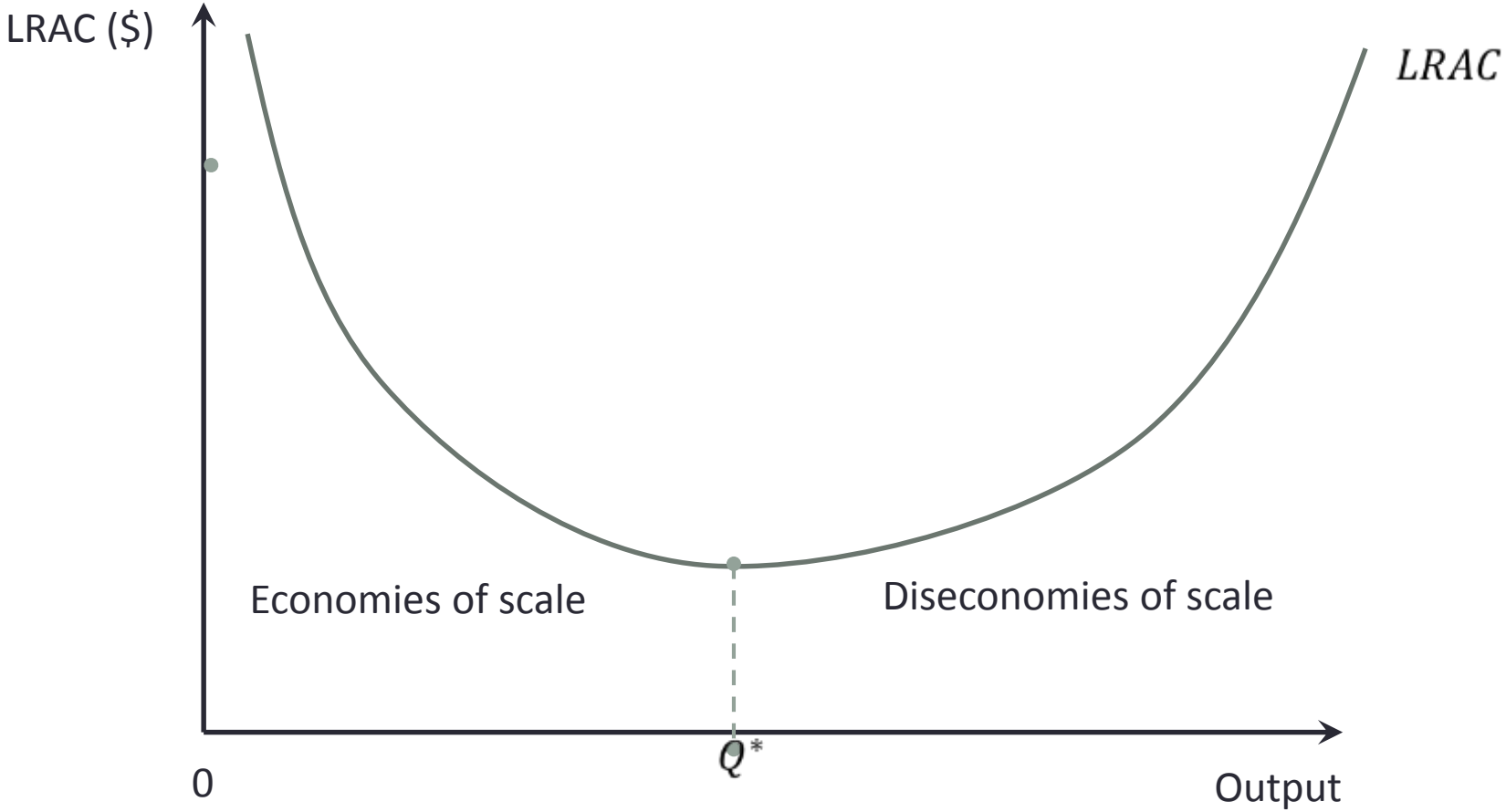
- Economies of scale
  - Declining portion of the long-run average cost curve as output increase.
- Diseconomies of scale
  - Rising portion of the long-run average cost curve as output increases.
- Constant returns to scale
  - Portion of the long-run average cost curve that remains constant as output increases.

A VIDEO ABOUT

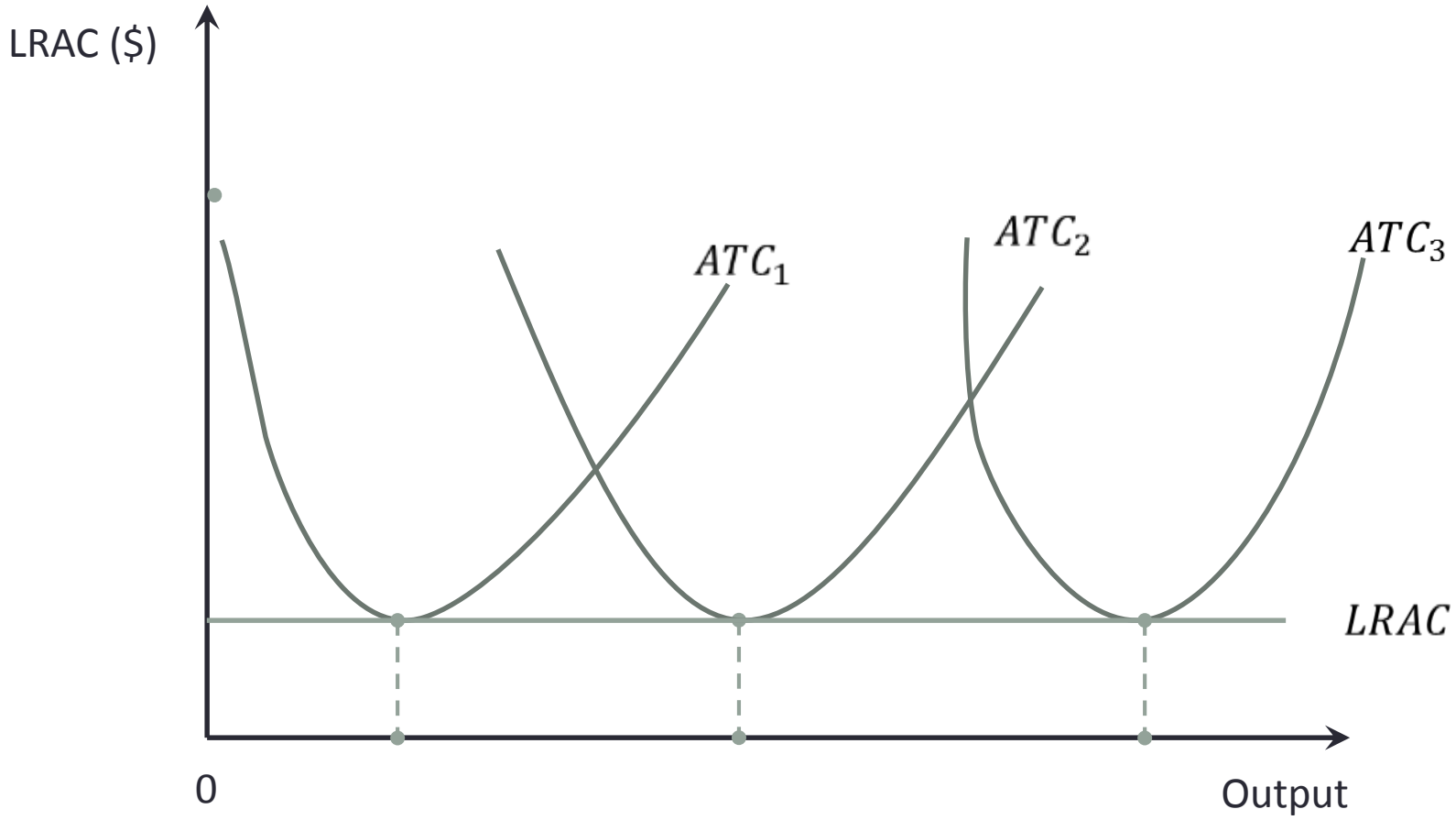
For more Video “Economies of Scale”

https://www.youtube.com/watch?v=JdCgu1sOPDo

Economies and Diseconomies of Scale in Action



Constant Returns to Scale in Action



Multiple-Output Cost Function in Action

- Suppose a firm produces two goods and has cost function given by

$$C = 100 - 0.5Q_1Q_2 + (Q_1)^2 + (Q_2)^2$$

- If the firm plans to produce 4 units of Q_1 and 6 units of Q_2
  - Does this cost function exhibit cost complementarities?
    - Yes, cost complementarities exist since

$$a = -0.5 < 0$$

  - Does this cost function exhibit economies of scope?
    - Yes, economies of scope exist since

$$100 - 0.5(4)(6) > 0$$

Conclusion

- To maximize profits (minimize costs) managers must use inputs such that the value of marginal product of each input reflects the price the firm must pay to employ the input.
- The optimal mix of inputs is achieved when the $MRTS_{KL} = \frac{w}{r}$.
- Cost functions are the foundation for helping to determine profit-maximizing behavior in future chapters.

CHAPTER 5

The Production Process and Costs

RECAP

On Key Terms and Concepts

Key terms and concepts

- Average Fixed Cost
- Average Product
- Average Variable Cost
- Cobb – Douglas production function
- Constant returns to scale
- Cost minimization
- Diminishing marginal returns
- Marginal rate of technical substitution
- Economies of scale
- Increasing marginal returns
- Isoquant
- Isocost
- Value marginal product
- Sunk cost
- Short run cost function
- Optimal input substitution
- Multiproduct cost function