

# Intermediate Microeconomics

## Chapter 9 *Cost*

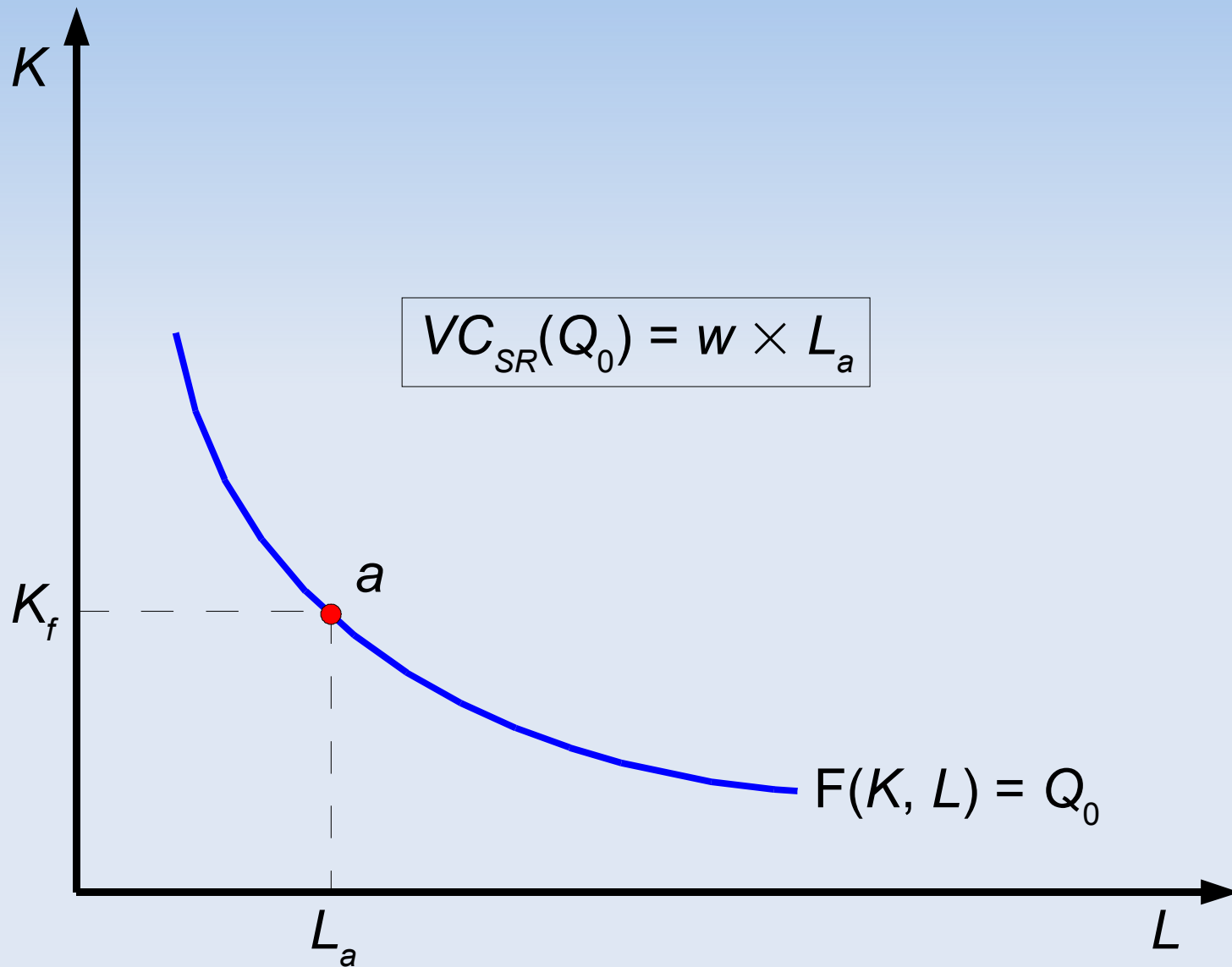
# Cost

- In order to attain production efficiency, firms need to be able to minimize cost
- In this chapter, we will look at how the firm chooses its optimal input combination for a given level of output
- We will distinguish between short and long run

# Cost in the short run

- *Short run economic cost* = the minimal level of expenditures (measured in opportunity-cost terms) needed to produce a given amount of output in the short run
- In the short run, some factors are fixed (sunk costs)  $\Rightarrow$  no alternative uses  $\Rightarrow$  no economic costs  $\Rightarrow$  short-run economic cost entirely driven by the variable factor  $\Rightarrow$  *short-run variable cost*

# Short-run variable cost



# Other costs in the short-run

- *Short-run fixed cost* ( $FC_{SR}$ ) = expenditures on factor that are fixed in the short run
- *Short-run total cost* ( $TC_{SR}$ ) = sum of short-run variable and fixed costs

$$TC_{SR} = VC_{SR} + FC_{SR}$$

- Only short-run variable cost is an economic cost (remember that the economic cost of fixed inputs is zero)  $\Rightarrow$  only  $VC_{SR}$  matters in short-run decisions

# Short-run variable cost

- Properties:
  - ◆ must slope upward
  - ◆ level depends on the level of fixed factor (capital)
  - ◆ higher capital means lower short-run cost of labor (although it might sound counter-intuitive, remember it is because capital is fixed in the short run)

# Short-run marginal cost

- *Short-run marginal cost* ( $MC_{SR}$ ) = change in the short-run variable cost due to the production of one more unit of output (depends on technology)
- *Marginal factor cost* ( $MFC$ ) = additional amount the firm has to pay for a factor when it hires one more unit of the factor
- One more unit of labor produces  $MPP_L$  more units of output  $\Rightarrow$  one unit of output is produced by  $1/MPP_L$  units of labor  $\Rightarrow$

$$MC_{SR} = \frac{MFC_L}{MPP_L}$$

# Marginal cost for a price taker

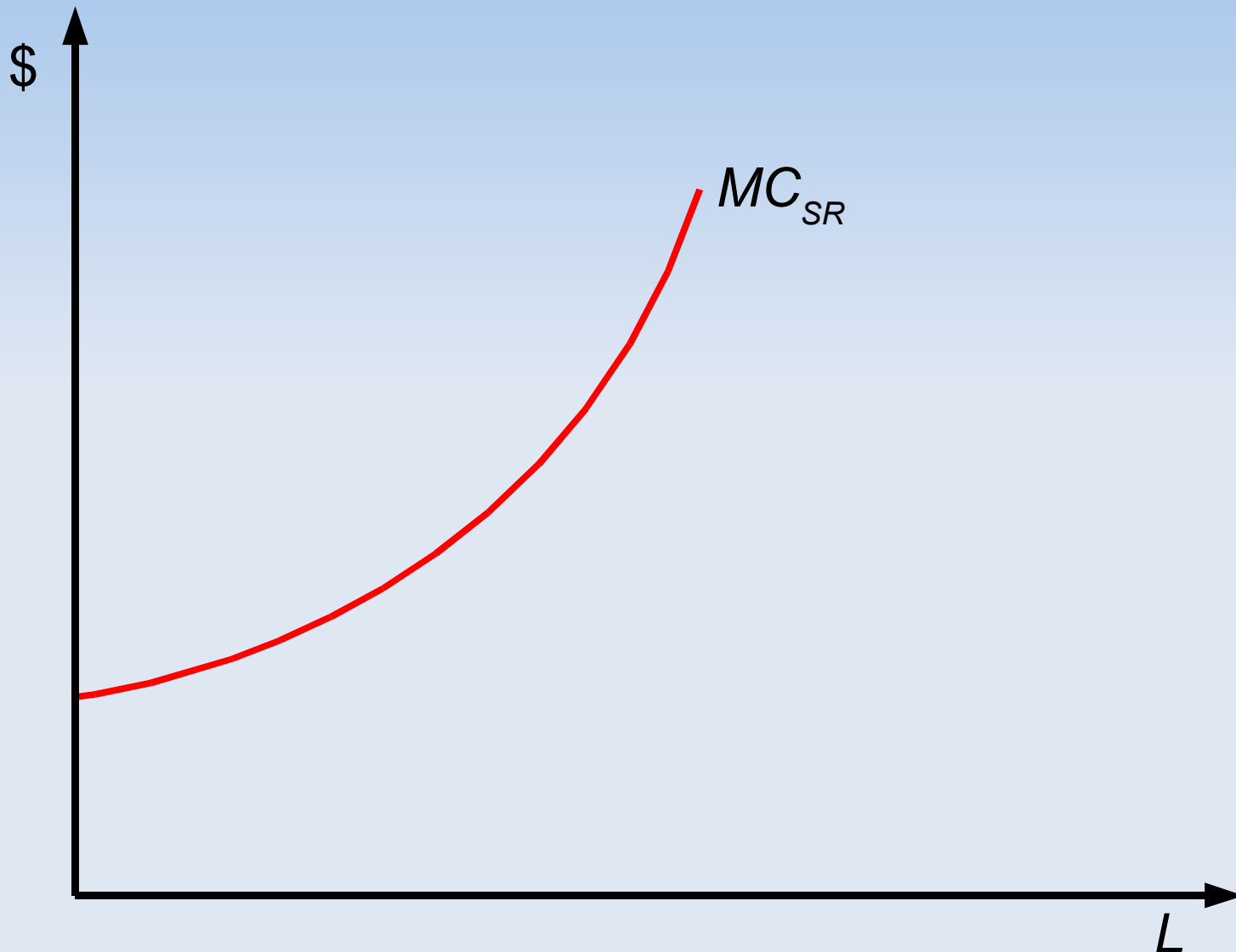
- Price taking firm  $\Rightarrow$  price of factors (wage) is not influenced by its demand (for labor)  $\Rightarrow MFC_L = w$
- In this case, then:

$$MC_{SR} = \frac{w}{MPP_L}$$

- The higher the  $MPP$ , the lower the  $MC$ 
  - ◆ diminishing  $MPP$  (of labor)  $\Rightarrow MC_{SR}$  is upward sloping
  - ◆ increasing  $MPP$  (of labor)  $\Rightarrow MC_{SR}$  is downward sloping



# Short-run marginal cost



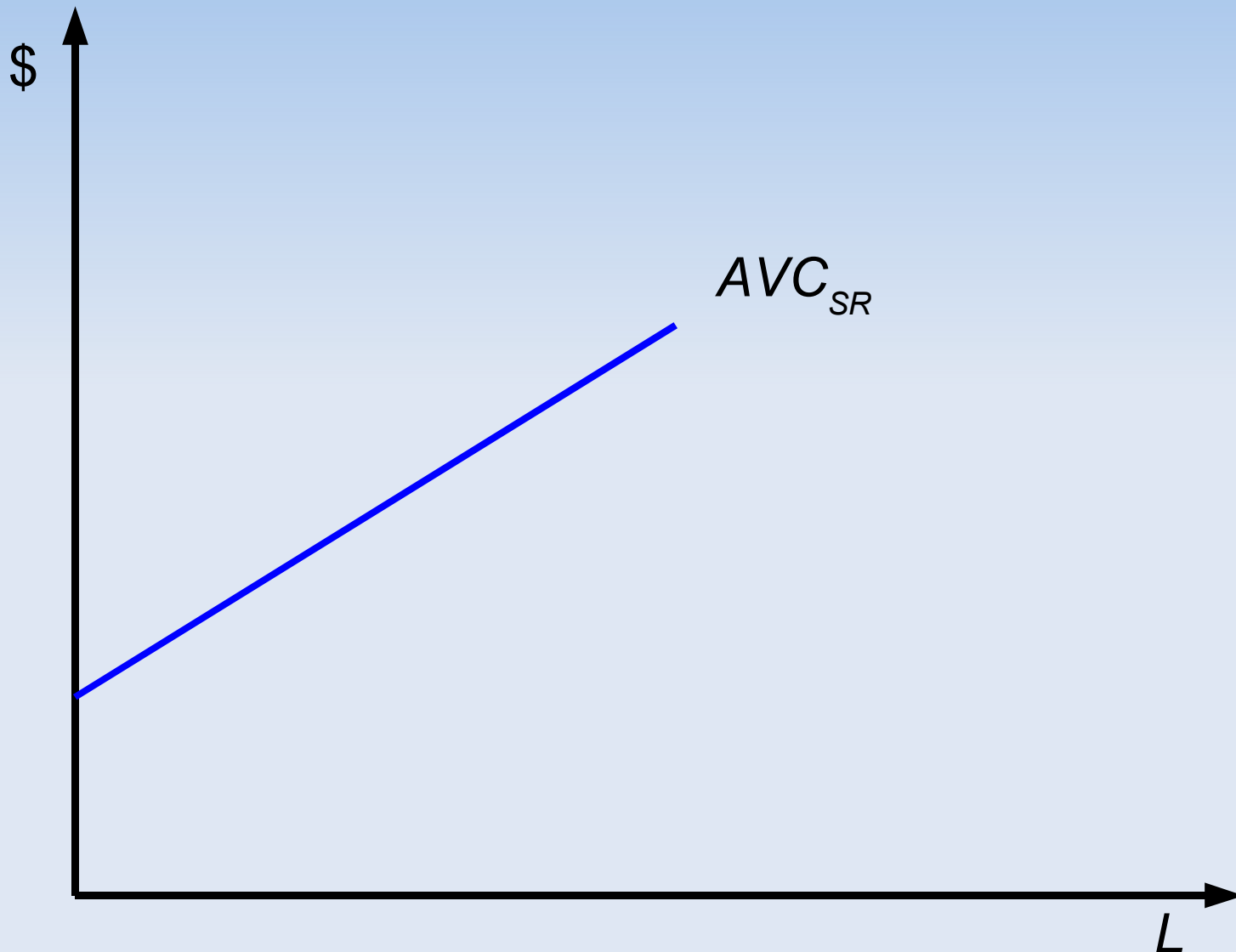
# Average cost in the short run

- *Short-run average variable cost* ( $AVC_{SR}$ ) = short-run variable cost per unit of output produced:

$$AVC_{SR} = \frac{VC_{SR}}{Q}$$

- Again, depends on marginal product:
  - ◆ increasing marginal returns  $\Rightarrow$   $AVC_{SR}$  is downward sloping
  - ◆ diminishing marginal returns  $\Rightarrow$   $AVC_{SR}$  is upward sloping

# Short-run marginal cost



# Other average costs

- *Short-run average fixed cost* ( $AFC_{SR}$ ) = short-run fixed cost per unit of output produced:

$$AFC_{SR} = \frac{FC_{SR}}{Q}$$

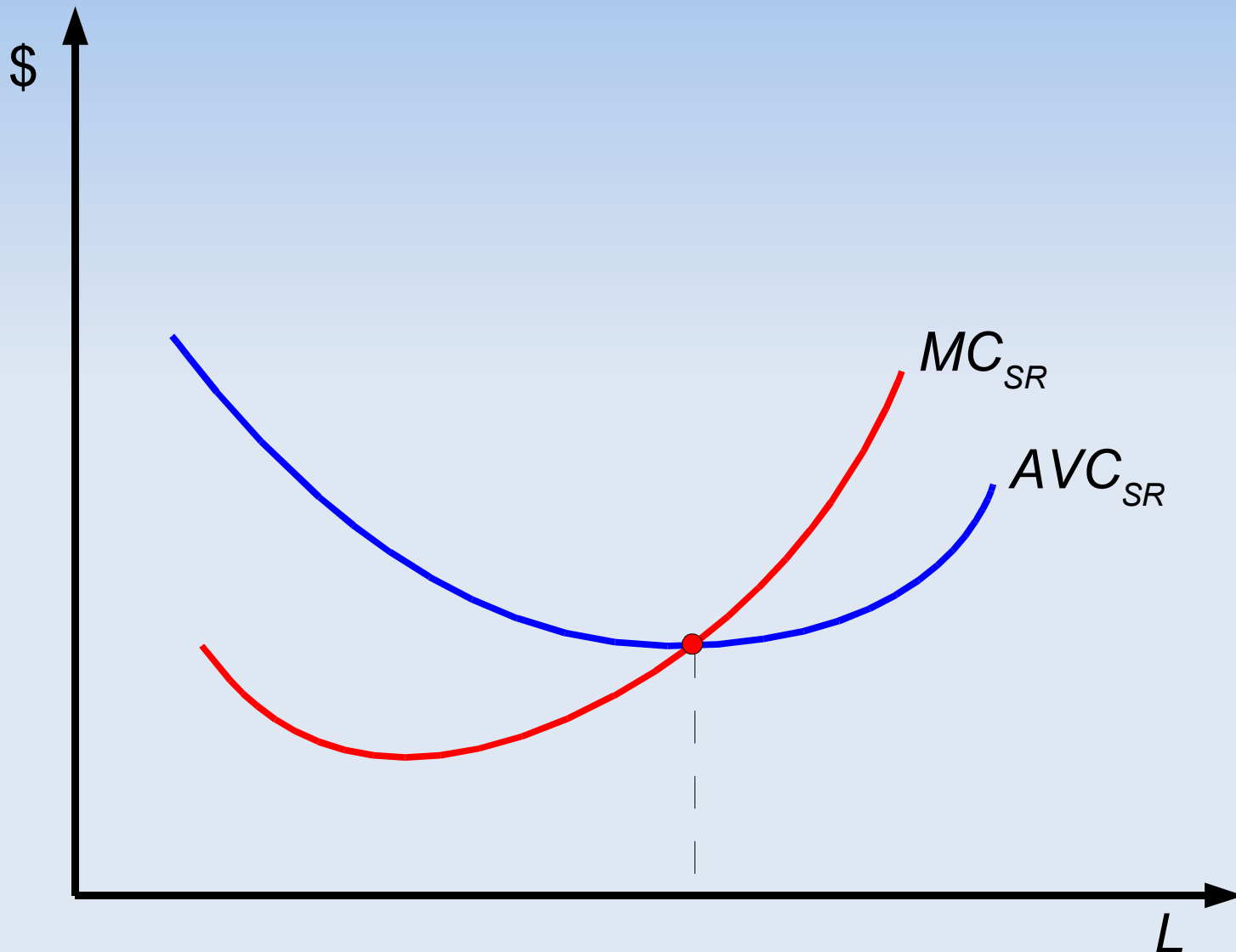
- *Short-run average total cost* ( $ATC_{SR}$ ) = short-run total cost per unit of output produced:

$$ATC_{SR} = \frac{TC_{SR}}{Q} = AVC_{SR} + AFC_{SR}$$

# Relationship between MC and AVC

- Since average variable cost and marginal cost are both derived from variable costs, they are related (hint: think of GPA):
    - ◆ when  $MC_{SR} < AVC_{SR}$ ,  $AVC_{SR}$  falls
    - ◆ when  $MC_{SR} > AVC_{SR}$ ,  $AVC_{SR}$  rises
- ⇒  $MC_{SR}$  crosses  $AVC_{SR}$  at the point where  $AVC_{SR}$  is at a minimum

# MC and AVC



# Cost in the long run

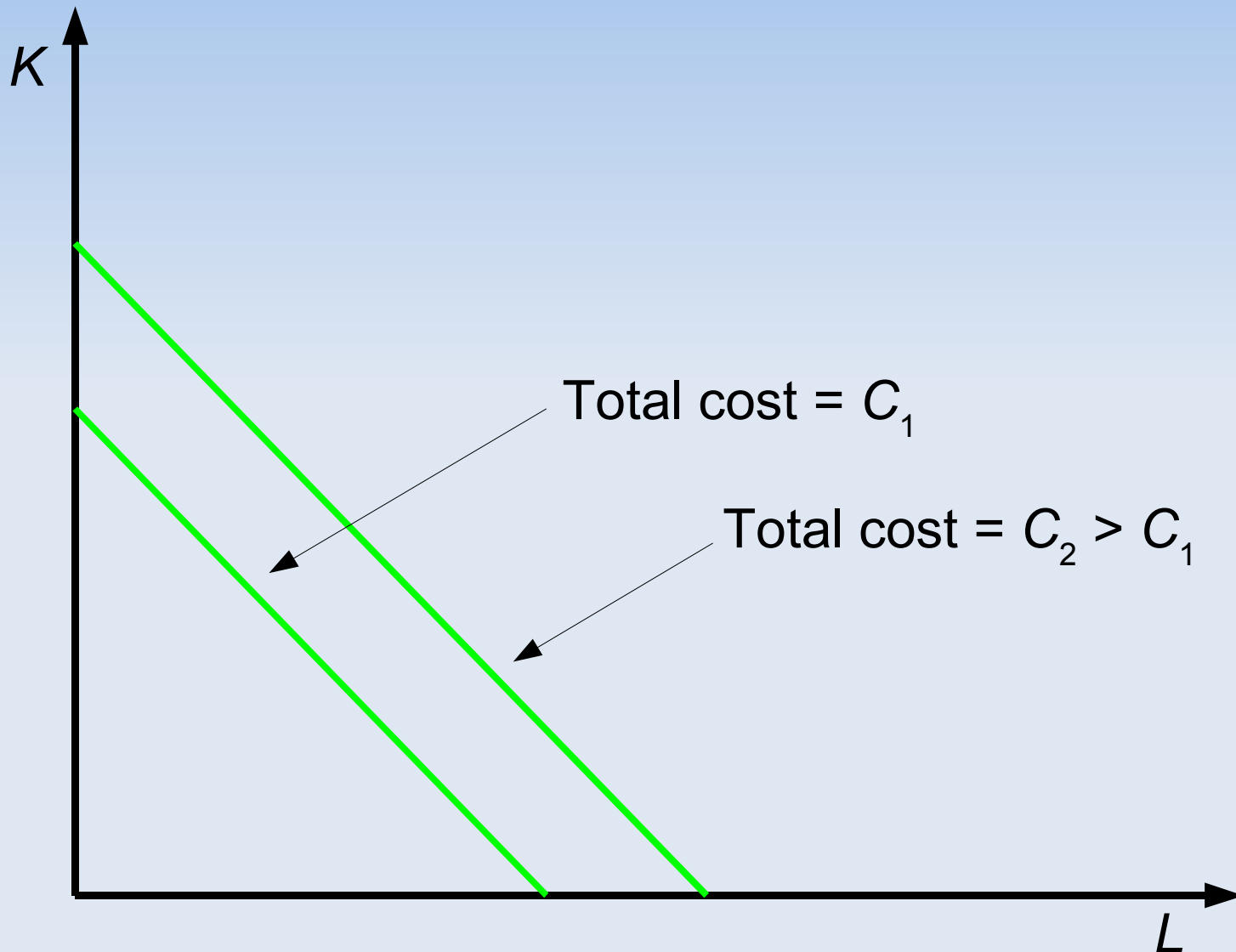
- In the long run, all factors are variable  $\Rightarrow$  expenditures on all factors are economic costs
- Also, firms can substitute among factors (since they are all variable)
- An input combination is *economically efficient* when it has the lowest opportunity cost among the input combinations that can be used to produce the desired output

# Isocost lines and map

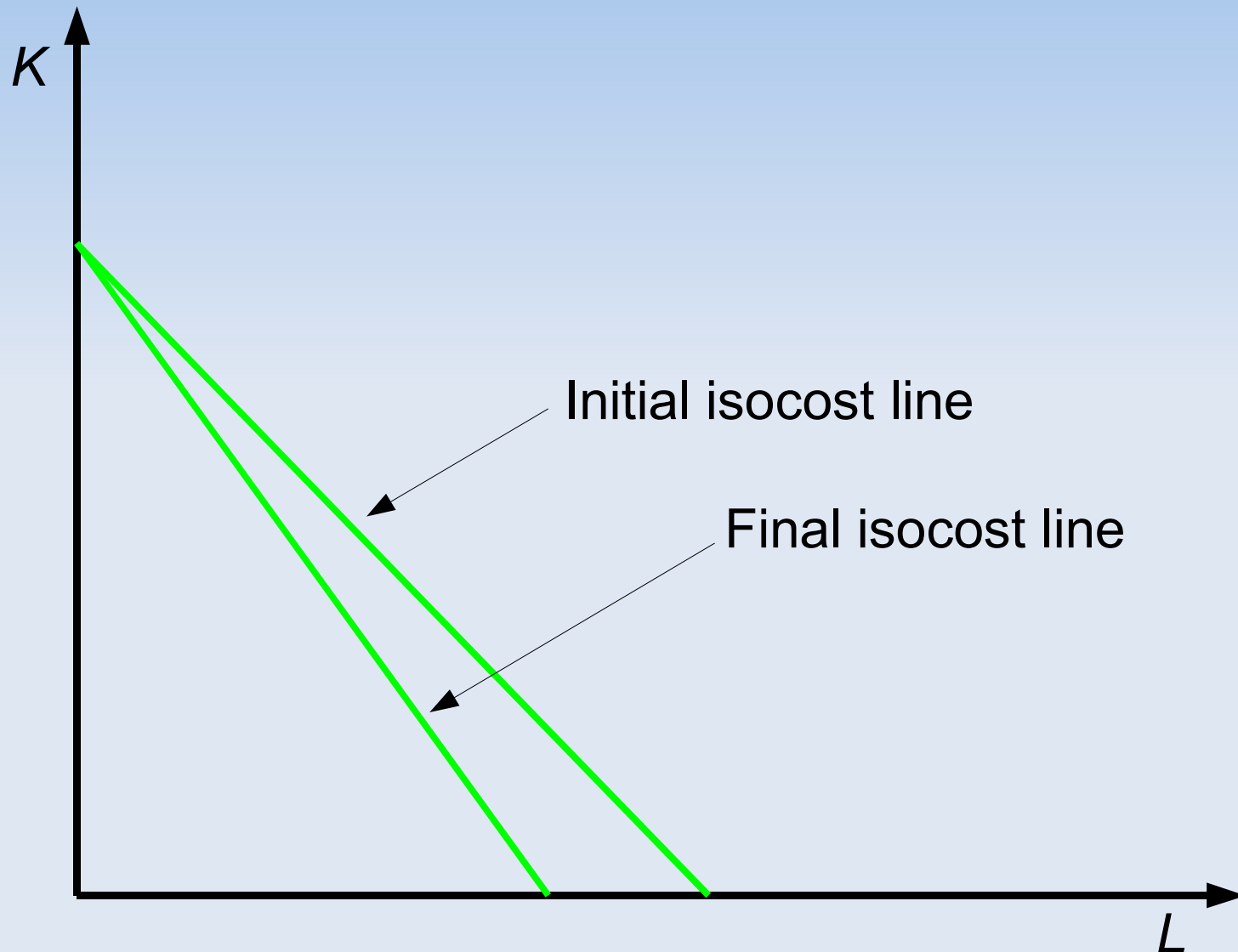
- *Isocost line* = line representing all input combinations that cost the firm the same amount
- *Isocost map* = set of all isocost lines that exist for a given set of factor prices
- Analogous to the budget line in utility theory (but a bit more complicated):
  - ◆ change in factor price tilts the line around the intercept for the *other* factor
  - ◆ no equivalent of “income limit”



# Isocost map



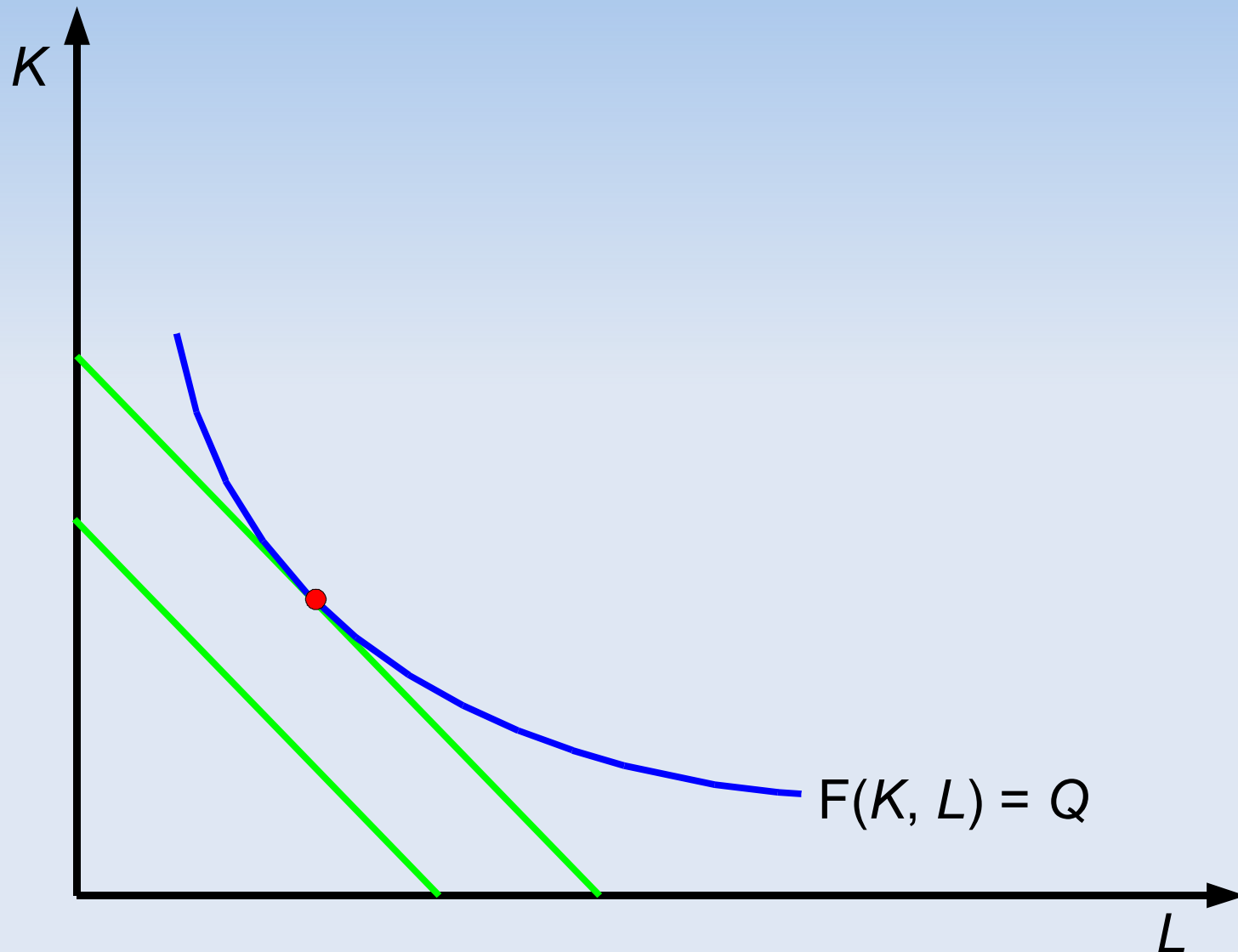
# Effect of a wage increase



# The economically efficient input mix

- In utility theory, we combined the budget line with the indifference curves to obtain optimal consumption (consumer knew income)
- Here, we combine isocost lines with isoquants (firm knows production level)
- The difference is that what shifts around is the isocost line (the “budget constraint”)!
- Optimal mix of inputs: the tangency point

# The economically efficient input mix



# Algebraic interpretation

- At the optimum, isocost line and isoquant are tangent  $\Rightarrow$  slopes are equal:

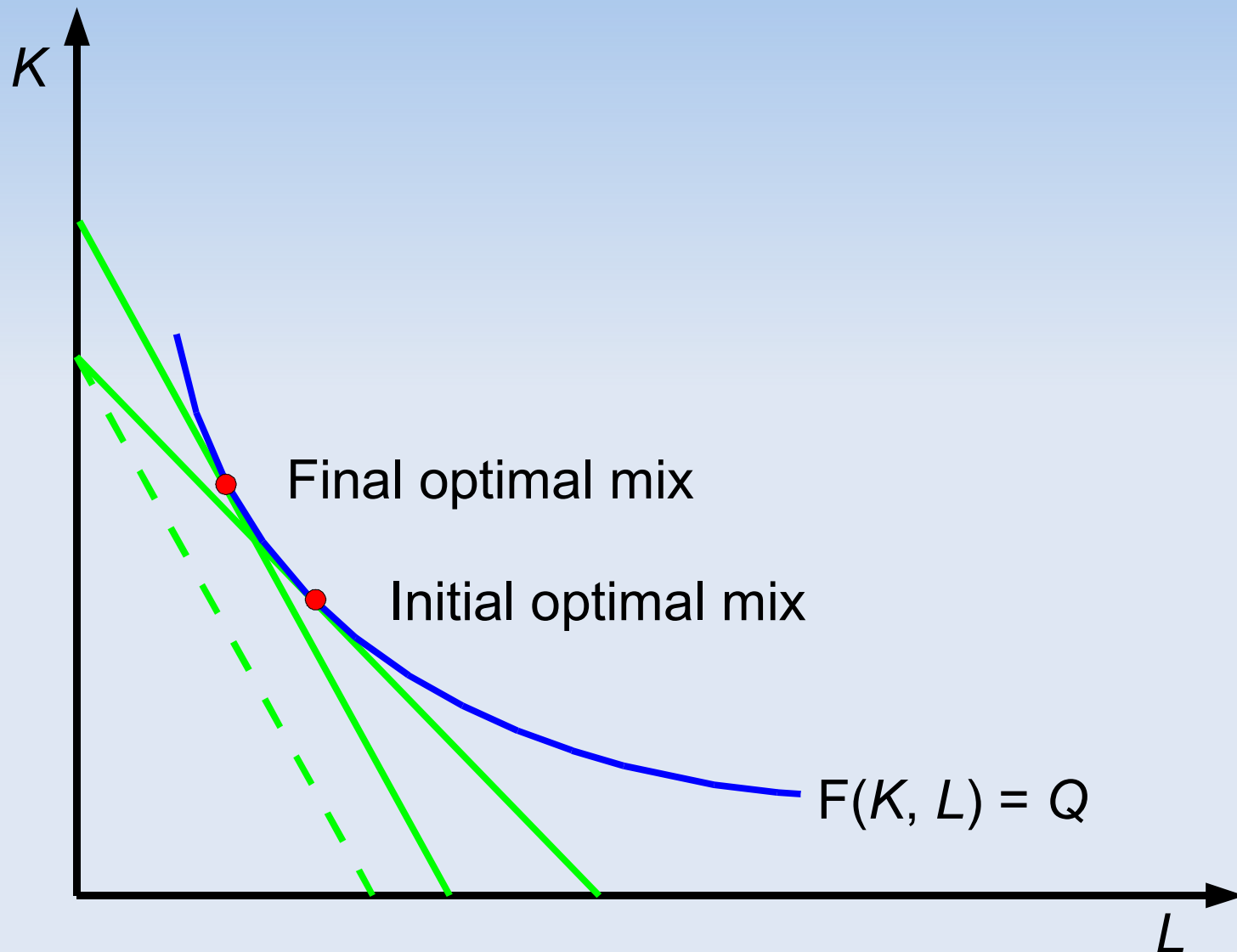
$$MRTS = \frac{w}{r} \Rightarrow \frac{MPP_L}{MPP_K} = \frac{w}{r} \Leftrightarrow \frac{MPP_L}{w} = \frac{MPP_K}{r}$$

- A price-taking firm should operate at a point where, at the margin, the marginal products of the inputs are proportional to their prices
- Thus, a manager can determine the optimal input combination without needing to know the production function (just the MPP's)

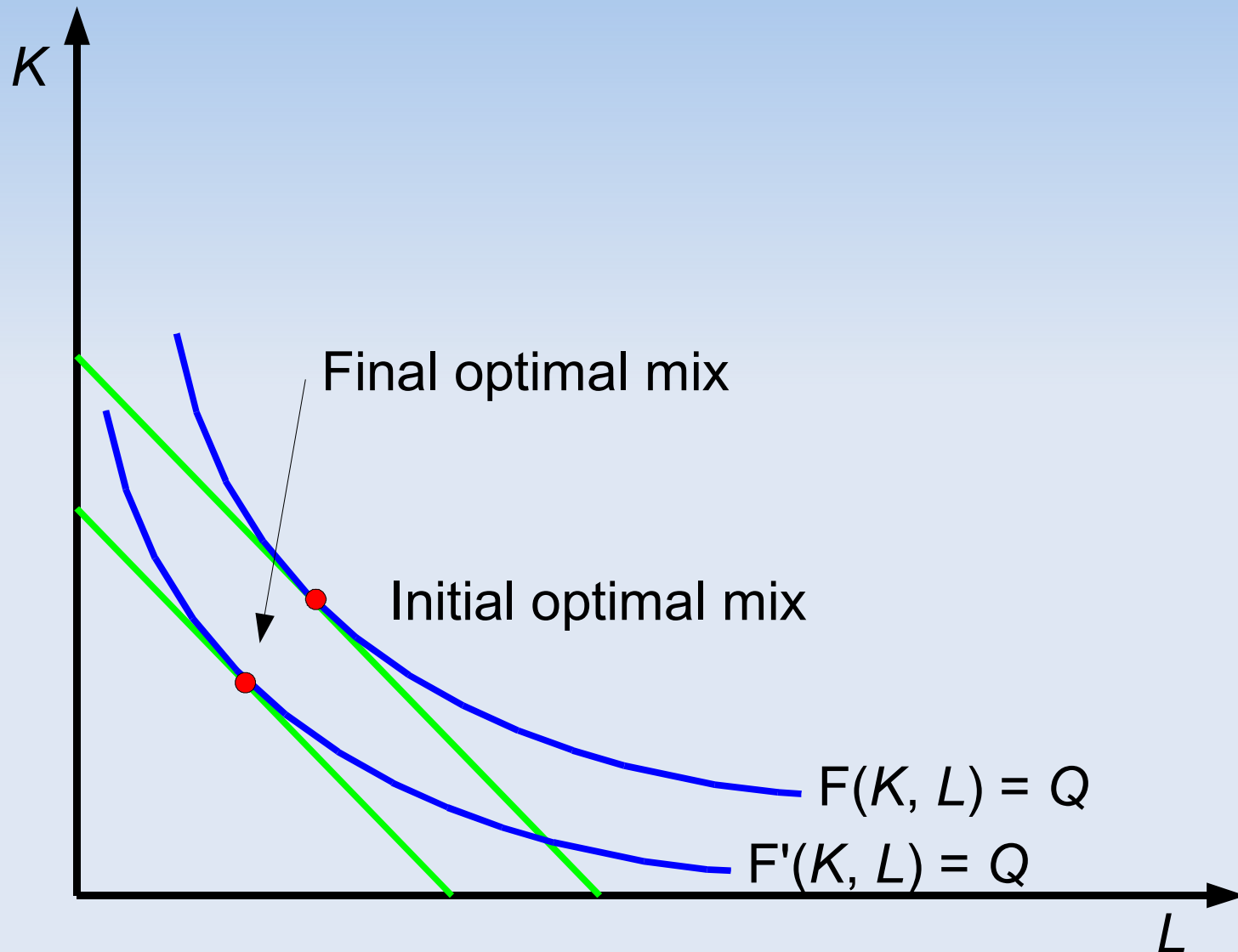
# Comparative statics

- Increase in factor price:
  - ◆ isocost line tilts  $\Rightarrow$  firm substitutes away from the factor whose price has risen
  - ◆ total cost must rise
  - ◆ reverse happens when factor price falls
- Better technology:
  - ◆ shift isoquant inward
  - ◆ lower total cost
- Better quality or higher output: can be interpreted as a more costly technology (outward shift of isoquant)

# Increase in wage



# Better technology





# Long-run costs

- *Long-run total cost* ( $TC_{LR}$ ) = minimal level of total expenditures (measured in opportunity-cost terms) needed to produce a given level of output in the long run
- *Long-run marginal cost* ( $MC_{LR}$ ) = the change in long-run total cost due to the production of one more unit of output
- *Long-run average cost* ( $AC_{LR}$ ) = long run total cost per unit of output produced

# Long-run vs short-run costs

- Fixed factors:
  - ◆ short run: some factors are fixed  $\Rightarrow$  any expenditure on them is not an economic cost
  - ◆ long run: all factors are variable  $\Rightarrow$  no fixed costs  $\Rightarrow$  higher economic costs than in the short run
- Substitution of factors:
  - ◆ short run: not (fully) possible because of fixed factors  $\Rightarrow$  higher costs
  - ◆ long run: fully possible  $\Rightarrow$  lower costs
- In the end: long-run costs can be higher *or* lower than short-run costs

# Economies of scale and of scope

- *Economies of scale* = long-run average cost falls as output rises
  - ◆ production function has increasing returns to scale
  - ◆ when there are setup costs (have to be incurred regardless of how much output is produced)
- *Diseconomies of scale* = long-run average cost rises as output rises (e.g., decreasing returns to scale)
- *Economies of scope* = cheaper to produce two products in the same firm rather than in two specialized firms