# Firms' Behaviors and Output Markets

Xi Wang

University of Georgia

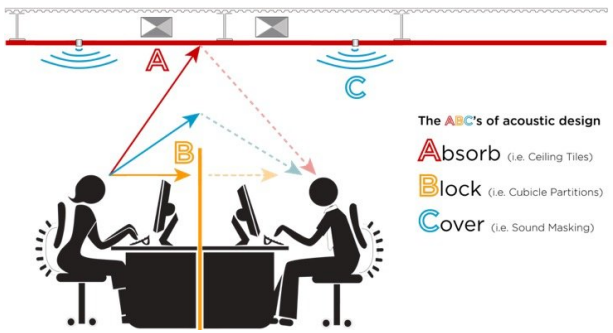
# Lesson 1: Production

# Starting with an Example

- Suppose you are considering sell iPhone cases.
- You locate a Taiwanese manufacturer who will sell you the cases for $10 each.
- You plan to sell each case at $15.
- Your friend Joe is also selling cases now for only $13 each.
- You wonder how Joe makes a profit at the lower price. Also, you wonder whether his costs will be lower than your costs as he selling more cases.

# Technology

- **Definition**: The technology is processes a firm uses to turn inputs into outputs of goods and services. (narrow)
  - The skills of its managers
  - The training of its workers
  - The speed and efficiency of its equipment.
- **Example**: Segment.com company improved its productivity by measuring sound levels and lowering its open-office noise.



# Short run and Long run Decisions

- **Short run**: The period of time for which two conditions hold: The firm is operating under a fixed scale (fixed factor) of production, and firms can neither enter nor exit an industry.
- **Long run**: That period of time for which there are no fixed factors of production: Firms can increase or decrease the scale of operation, and new firms can enter and existing firms can exit the industry.

# Example

- Example: We are owners of a family restaurant which only has 10 tables. If our restaurant becomes popular.
- Our short-run strategy might be: Increase more tables and more chairs. However, maybe it is not enough because we realize there are still many customers waiting in line.
- Our long-run strategy: Open more restaurants; or rent a large house that could contain more than 50 tables and chairs.

# Firm's Decision-Making Process

- Firm's decisions include:
  - $Q^*$: Total quantity of output to supply
  - $K^*$ and $L^*$: How much of each input to demand
  - Price, but here we assume that the price is given by the market.
- **Profits**= Total revenue - Total cost
- **Total revenue** $TR = P \times Q$
- **Total cost**
  - Total cost = Fixed cost + Variable cost
    - **Total costs**: the costs of all the inputs a firm uses in production.
    - **Variable costs**: Costs that change as output changes. (ex: labor costs, raw material costs, utilities.)
    - **Fixed costs**: Costs that remain constant as output changes. (ex: Payments for fire insurance, payments for online advertising, lease payments for factory. )

# Firm's Decision-Making Process

- **Opportunity cost**: The best alternative that must be given up, when we make the decision.
- **Explicit cost**: A cost that involves spending money. Sometimes, it is called as accounting cost.
- **Implicit cost**: A non-monetary opportunity cost.
- Economics cost = Explicit costs + Implicit costs

# Example

- We want to produce a drink: Mocha Cola. We spent $\$10,000$ buying a machine to product cola.
- However, this $\$10,000$ could have been saved in our bank account, and we know that 1-year interest rate at the local bank is: $3\%$.
- What is the implicit cost in this example?

# Production Process

- For the Mocha-Cola company, if we have inputs: Sugar, water, cans, machines, workers....., we want to produce outputs: Mocha-cola.
- **Production technology**: The quantitative relationship between inputs and outputs.
  - **Labor-intensive technology**: Technology that relies heavily on human labor instead of capital.
  - **Capital-intensive technology**: Technology that relies heavily on capital instead of human labor.

# Production Function

Idea: Use mathematical equation to express production process

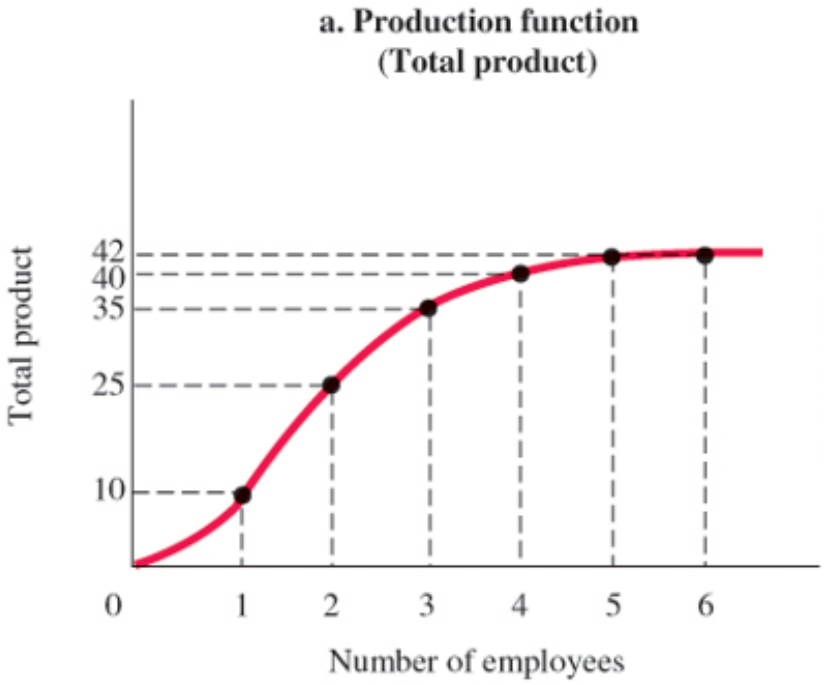
- Production function: $\underbrace{Q}_{\text{Output}} = F(\underbrace{A, K, L}_{\text{Input}})$
- $Q$: total product Graph
- Example:
  - Cobb-Douglas production function: $q = AK^{\alpha}L^{1-\alpha}$
  - Leontief production function: $q = \min\{L, K\}$, where z represents input amount
  - Production with perfect substitute inputs: $q = L + K$

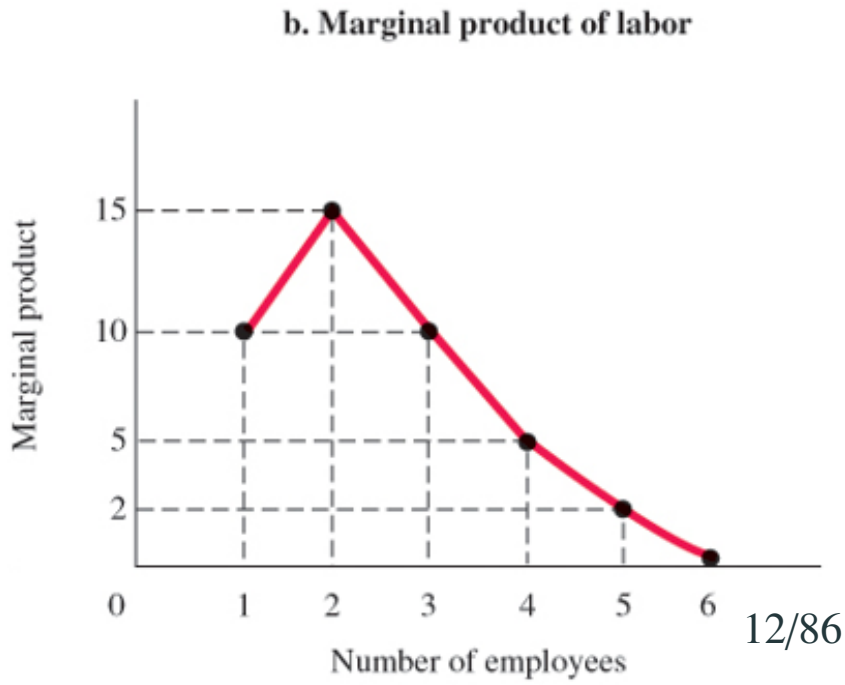
# Marginal Product and the Law of Diminishing Returns

- **Marginal product**: The additional output that can be produced by hiring one more unit of a specific input, holding all other inputs constant.
- **The law of diminishing returns**: After a certain point, when additional units of a variable inputs are added to fixed inputs,the marginal product of the variable input declines.
- **Intuition**: In the short run, given fixed inputs, every firm finds it progressively more difficult to increase its output as it approaches capacity production.

# Example

- We have a restaurant and we hired 6 workers to work (Input: labor), and spend $10,000$ buying all machines (Input: Capital). The following graph shows the diminishing marginal returns.
- Diminishing returns are setting in not because the third worker is worse than others, but because as we added staff, each has a smaller amount of capital to work with.



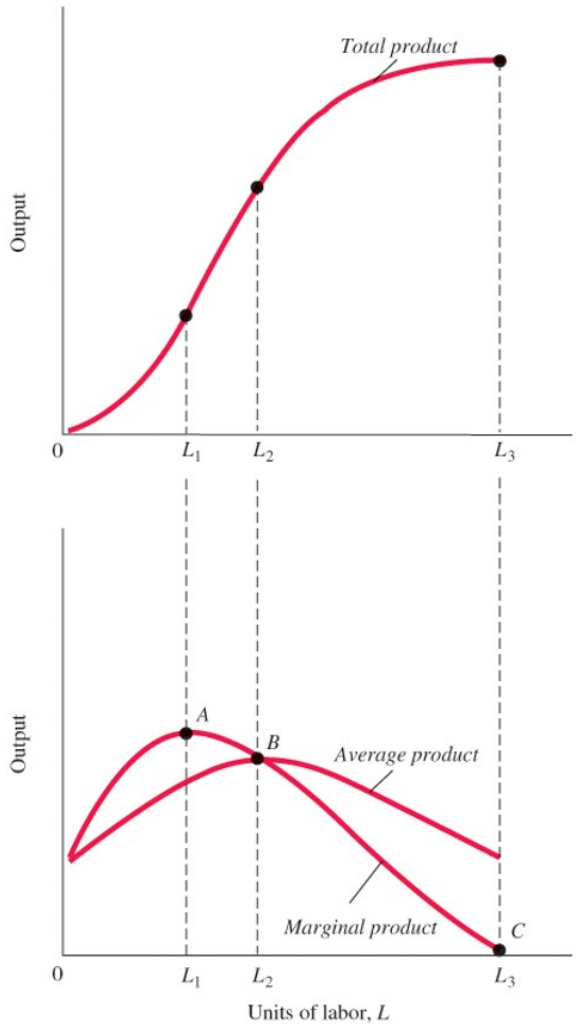



# Average Products and Marginal Products

- **Average Product**: The average amount produced by each unit of a variable factor of production.

$$\text{AP of labor} = \frac{\text{TP}}{\text{Units of labor}}$$

- Marginal and average product curves can be derived from total product curves.
- Average product is at its maximum at the point of intersection with marginal product. Go

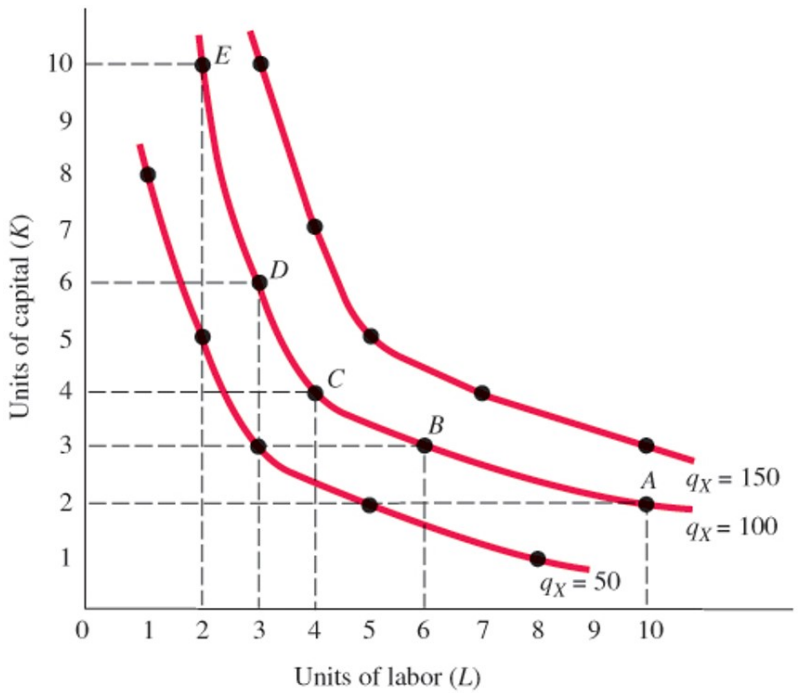


# Lesson 2: Iso-quant and Isocost Curves

# Iso-quant Curve

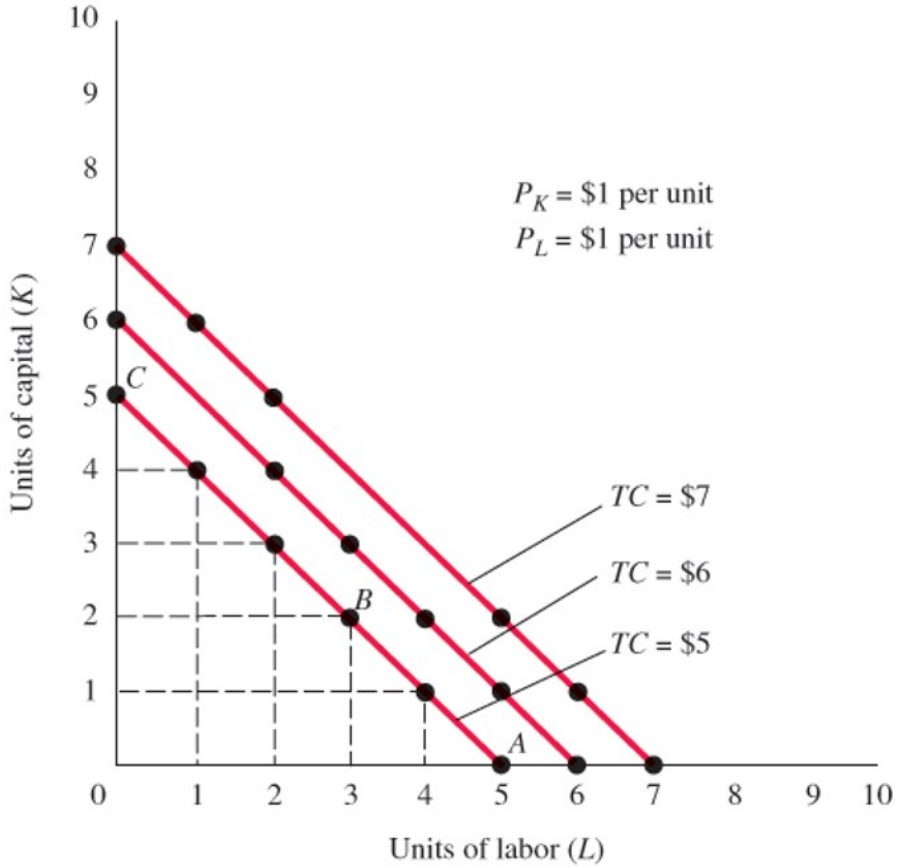
Idea: Use the graph to express firm's profit-maximization problem

- Every point on isoquant curve yield the same quantities for the output.
- The upper-right isoquant curves represent higher level of outputs.
- Firm's goal: Total quantity of output becomes larger, or iso-quant lines are in upper-right.



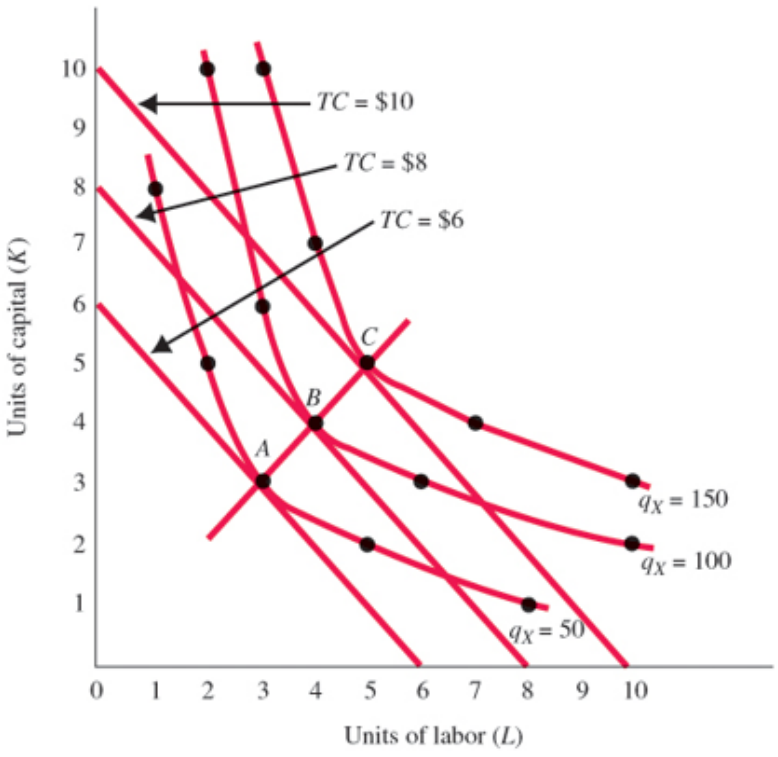
# Isocost Curve

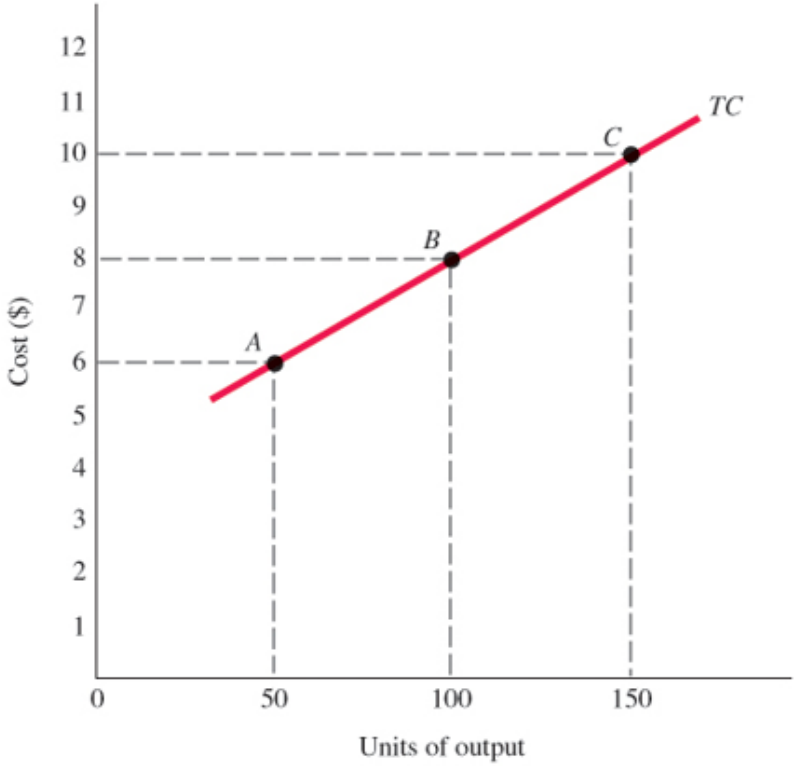
- Every point on isocost curve yield the same cost for the output.
- The upper-right isocost curves represent higher costs.
- Firm's goal: Total costs become smaller, or iso-cost lines are in bottom-left.



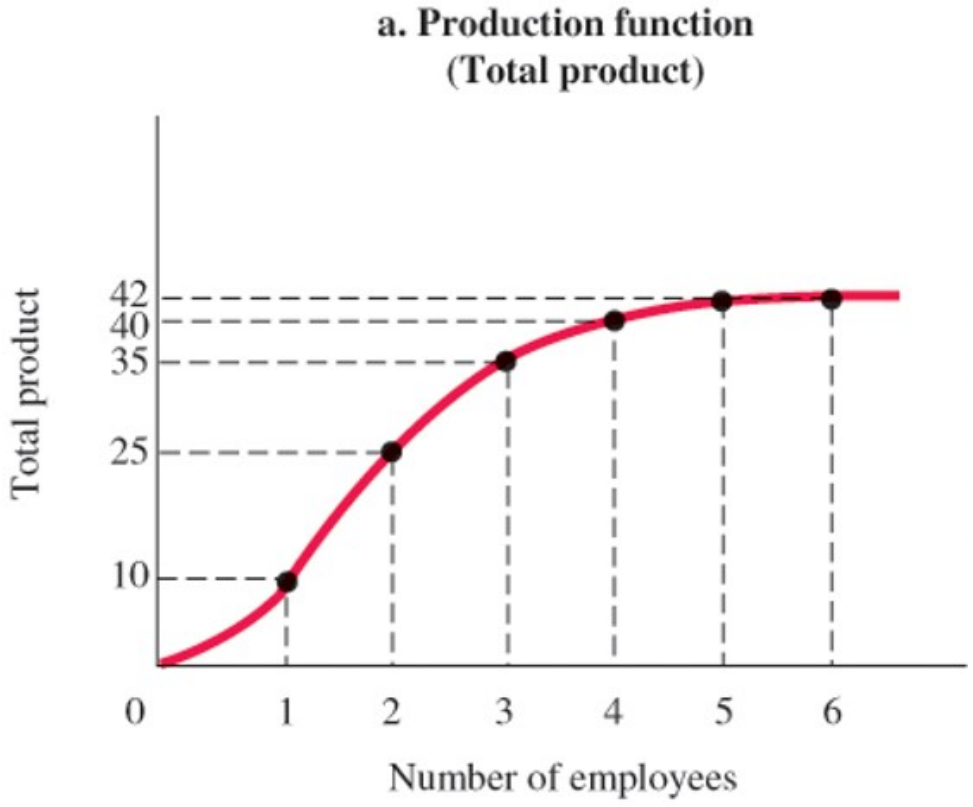
# Profit-Maximization

- The set of intersection of isoquants and isocosts yield the supply curve under different input levels.



# Total Product Graph

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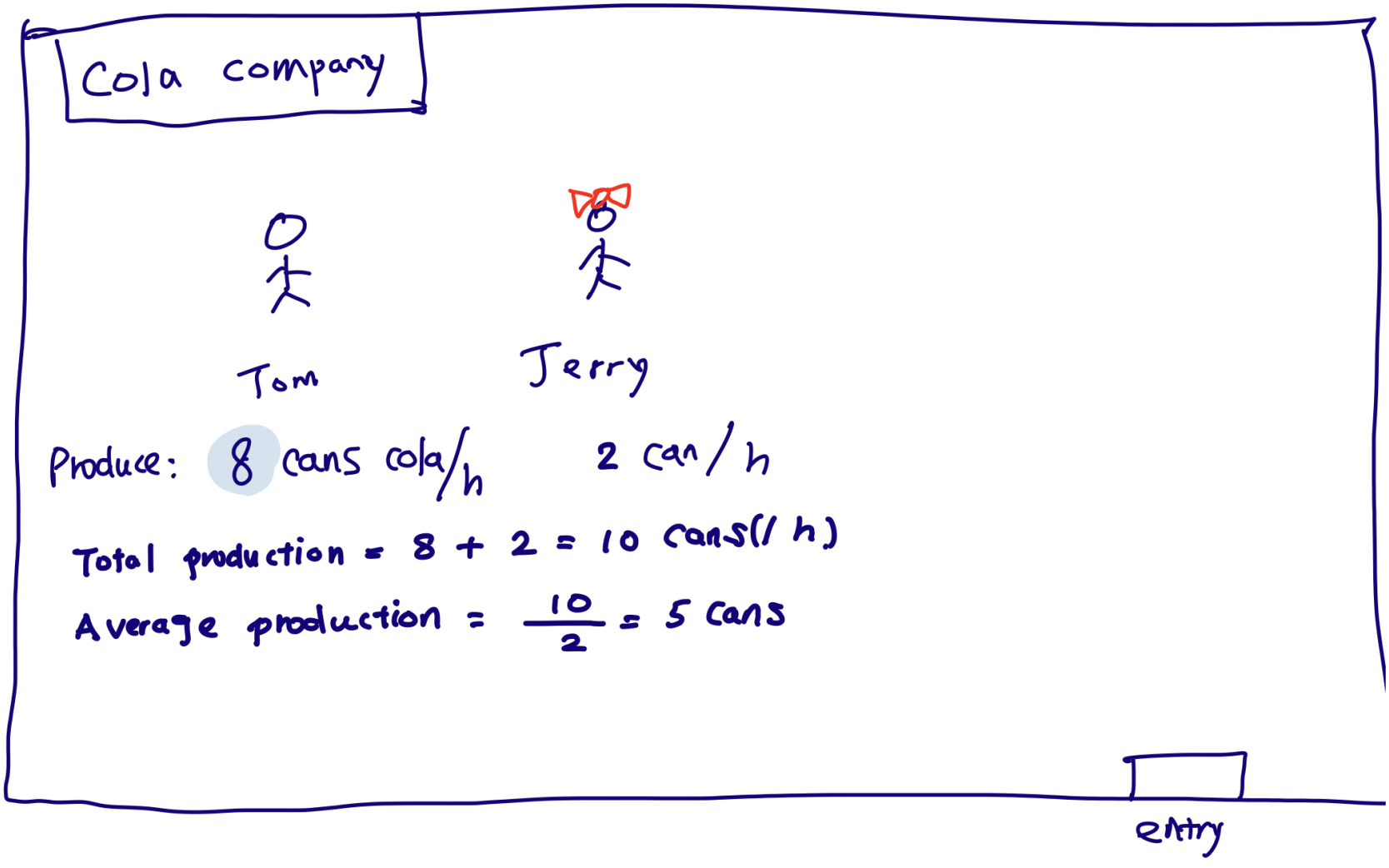
# Average Products and Marginal Products



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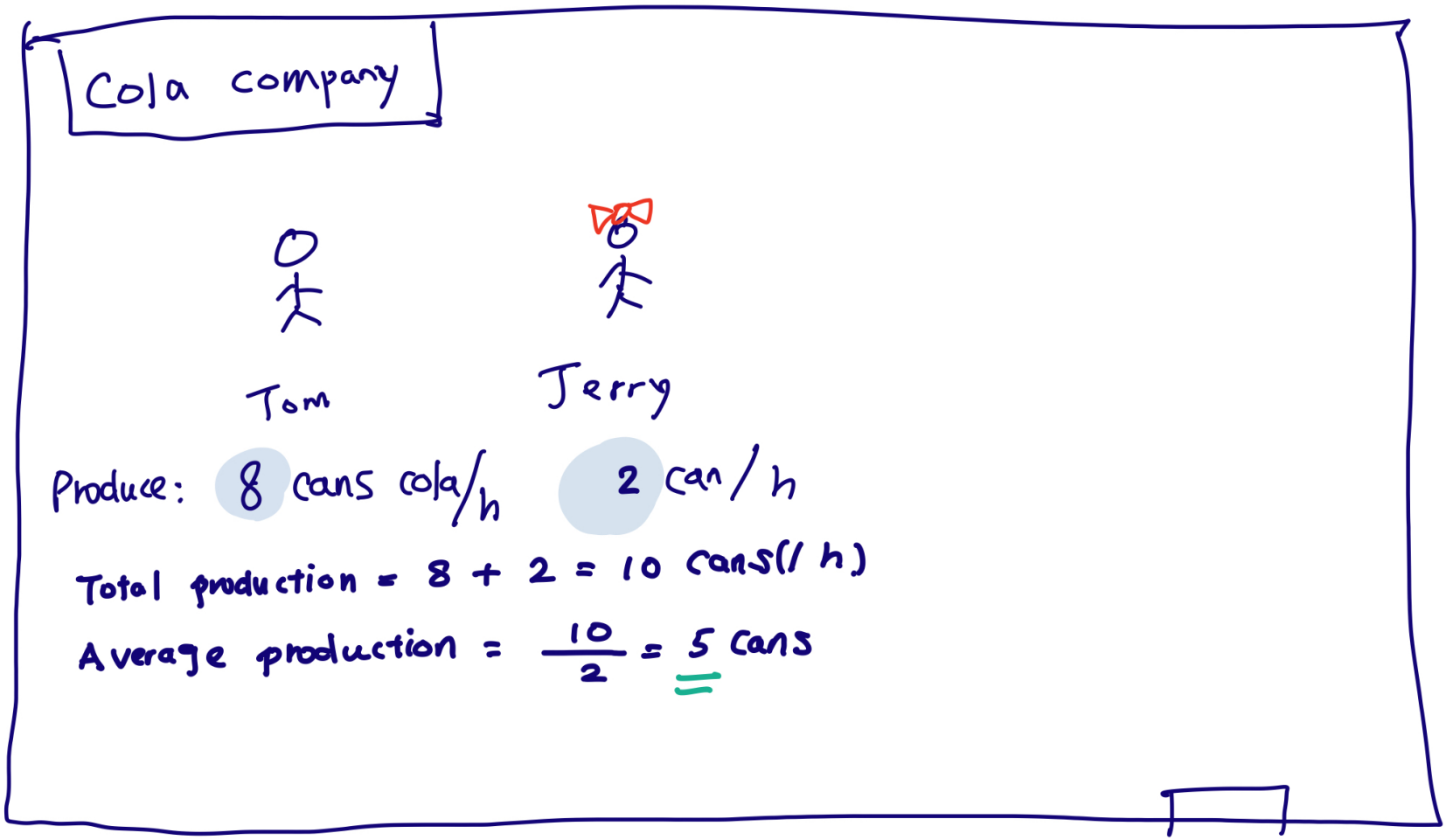

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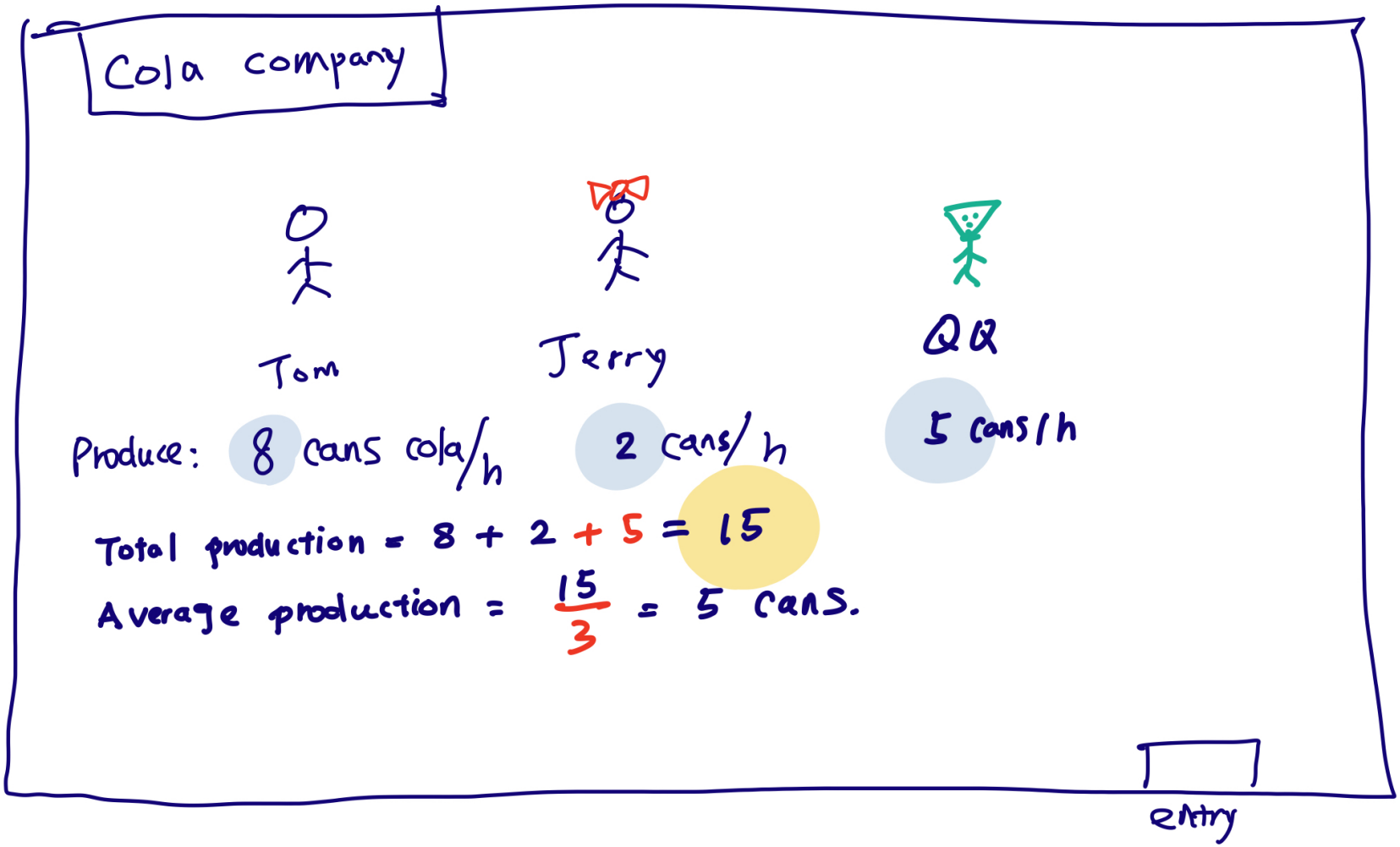

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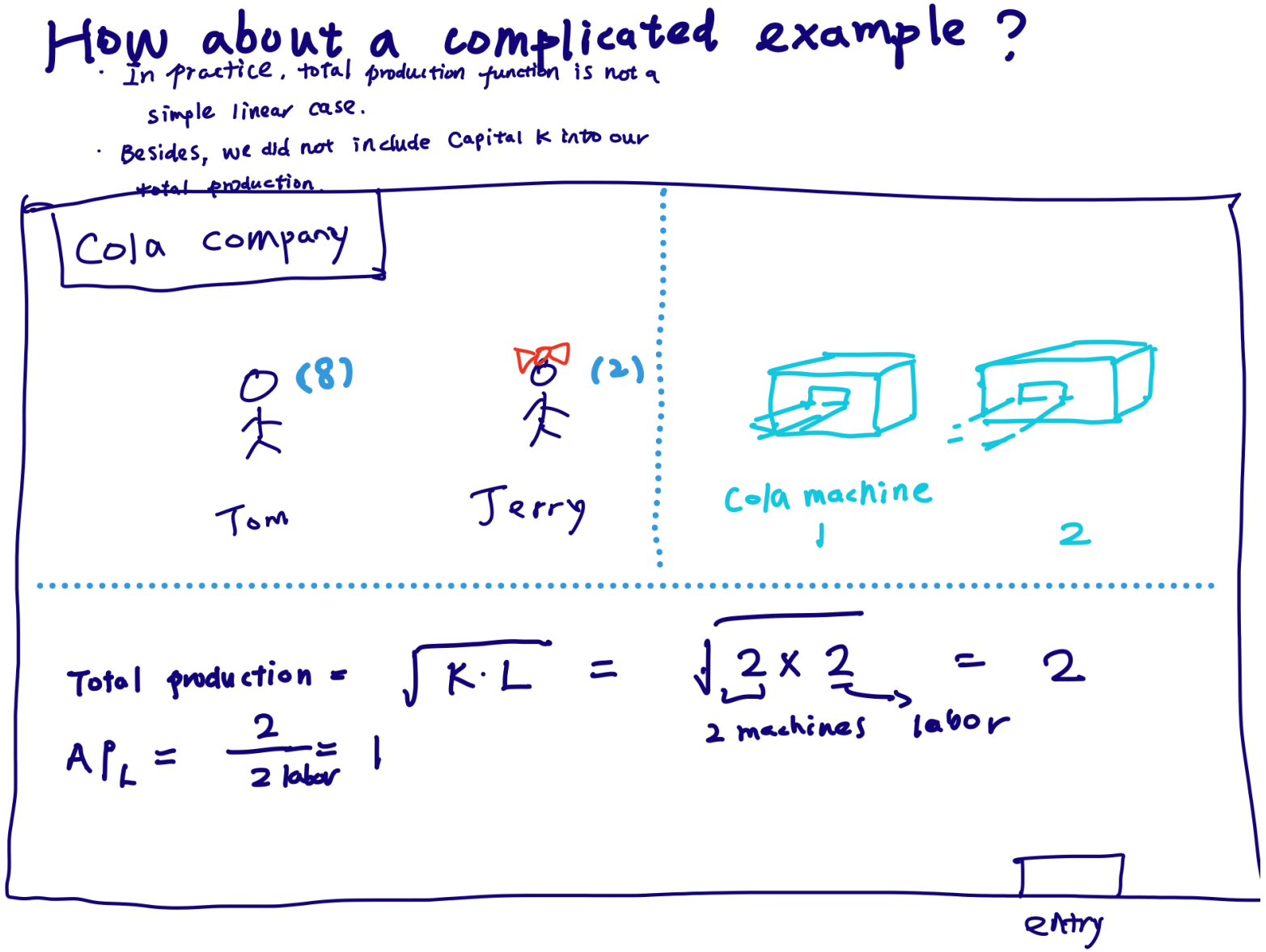

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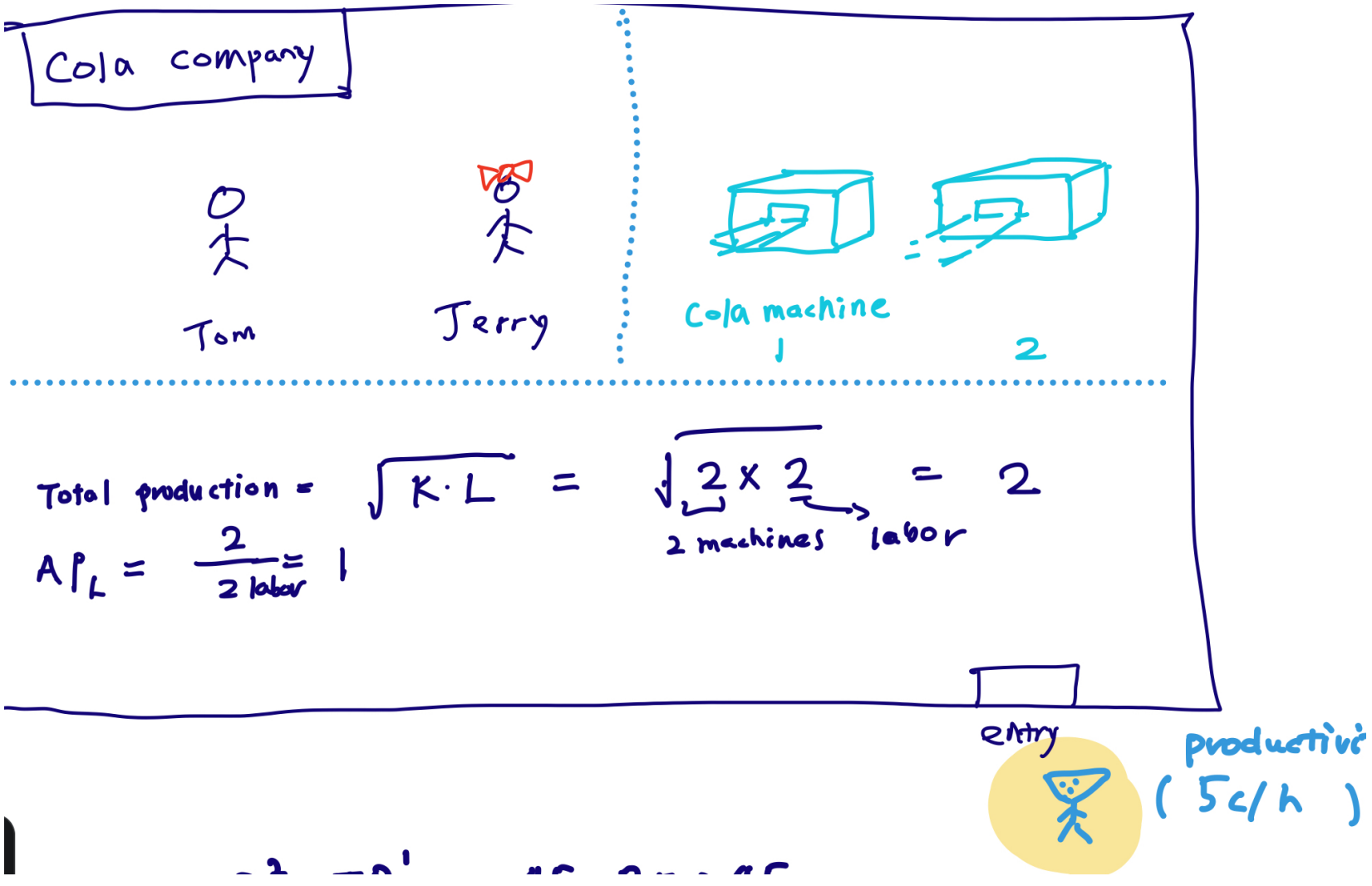

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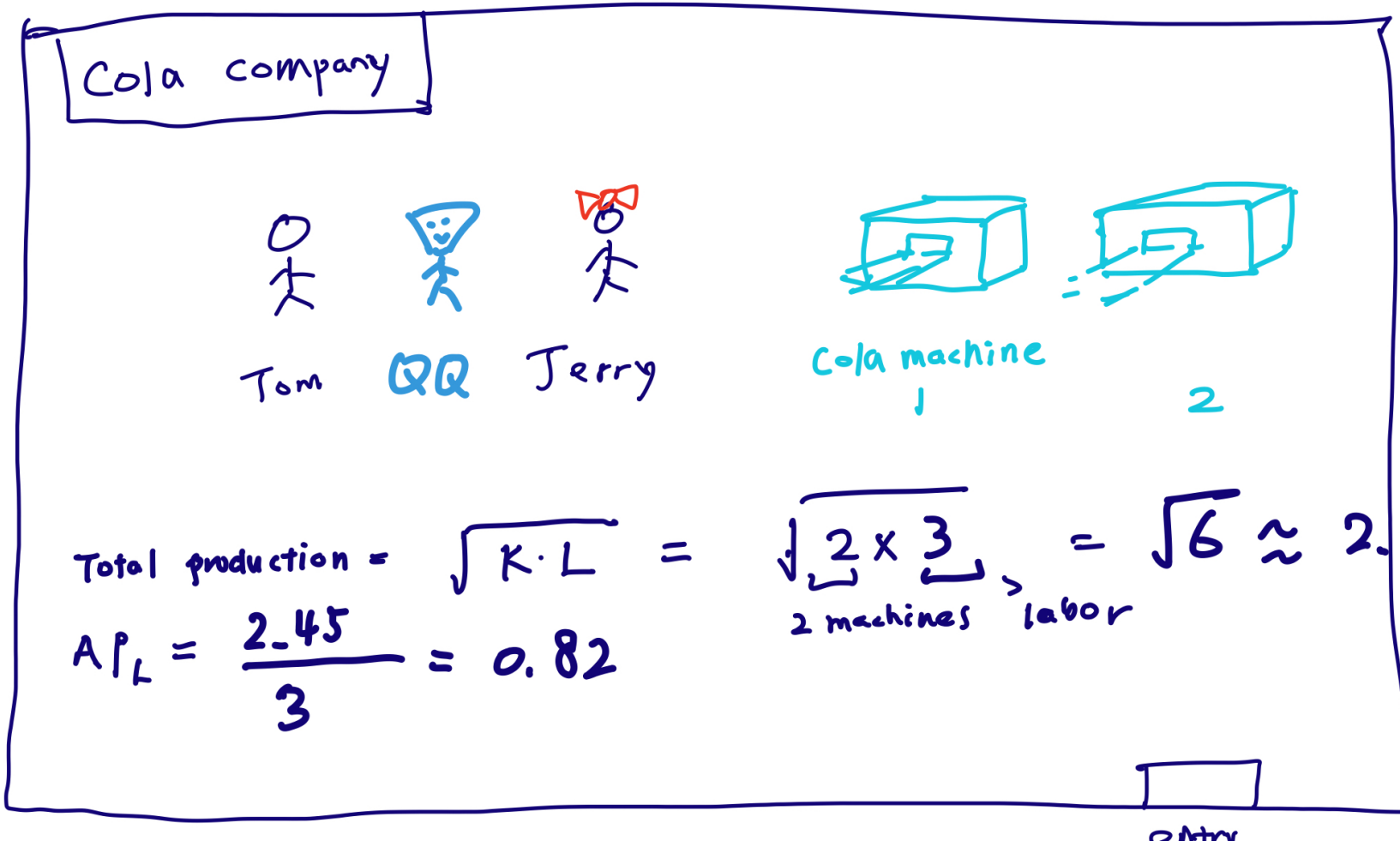


# Average Products and Marginal Products

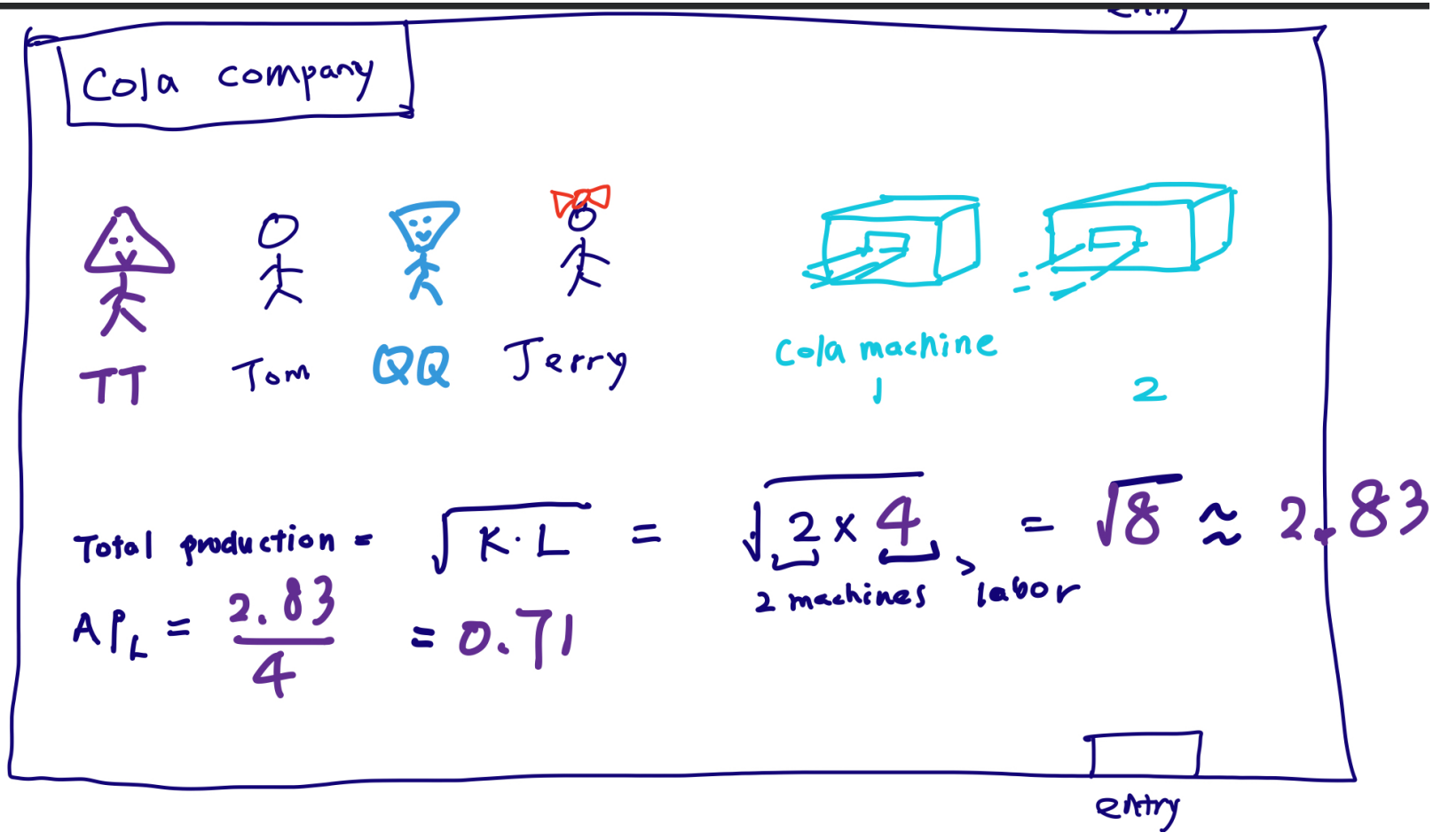
$MP_2 = TP^2 - TP^1 = 2.45 - 2 = 0.45.$

$AP_2 = 0.82$

$\Rightarrow AP_2 > MP_2$

Find: MP is not about what people thought their productivity. It's more about what's your productivity after working several months / years.

# Average Products and Marginal Products

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# Quiz for Fun

1. Use your electronic devices to search this website: `www.kahoot.it`
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# Lesson 3: The Law of Diminishing Returns

# Production Process

- **Production technology**: The quantitative relationship between inputs and outputs.
  - **Labor-intensive technology**: Technology that relies heavily on human labor instead of capital.
  - **Capital-intensive technology**: Technology that relies heavily on capital instead of human labor.

# Production Process

- In choosing a technology, firms try to minimize the cost of production of a given quantity of output.
- Firms in an economy with high labor costs have an incentive to substitute away from labor and to use more capital-intensive, or labor saving techniques.

# Production Function

Idea: Use mathematical equation to express production process

- Production function: $\underbrace{Q}_{\text{Output}} = F(\underbrace{A, K, L}_{\text{Input}})$
- $Q$: total product
- Example:
  - Cobb-Douglas production function: $Q = AK^{\alpha}L^{1-\alpha}$ $(0 \leq \alpha \leq 1)$
  - Leontief production function: $Q = \min\{L, K\}$
  - CES production function (constant elasticity substitution):

$$Q = A \times [\alpha \times K^{-\beta} + (1 - \alpha) \times L^{-\beta}]^{-\frac{1}{\beta}}$$

  - CES displays a constant change produced in the output due to change in input of production.

# Marginal Product and the Law of Diminishing Returns

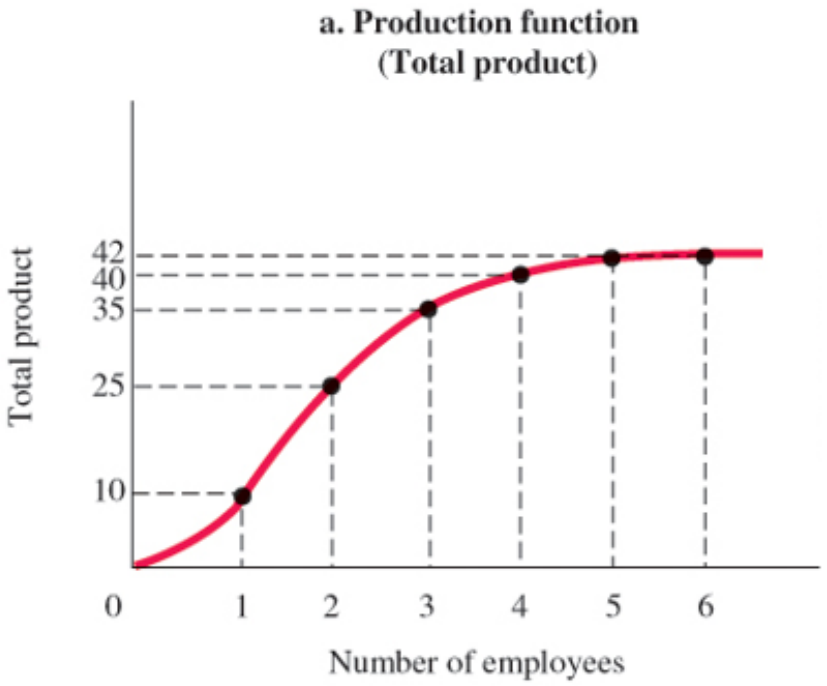
- **Marginal product**: The additional output that can be produced by hiring one more unit of a specific input, holding all other inputs constant.
- **The law of diminishing returns**: After a certain point, when additional units of a variable inputs are added to fixed inputs,the marginal product of the variable input declines.
- **Intuition**: In the short run, given fixed inputs, every firm finds it progressively more difficult to increase its output as it approaches capacity production.

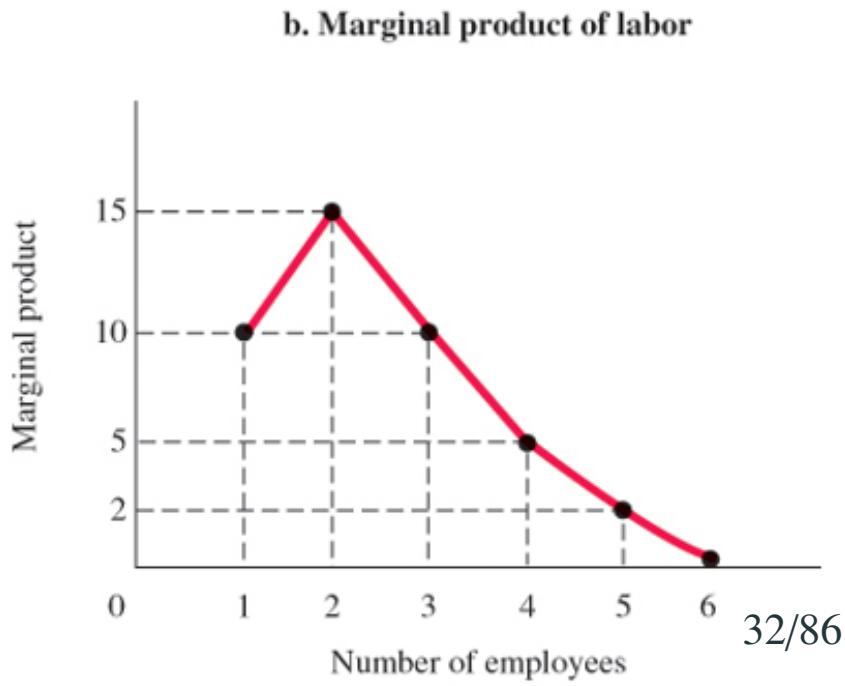
# Intuition and Example

- **Proof by contradiction**:
  - **Assumption**: Suppose the law of diminishing marginal product is wrong. In other words, now we assume that marginal product will keep increasing, when additional units of a input are added.
  - **Contradiction**: Suppose I have 1 square feet land (Fixed input: Land). I keep adding water and hiring labor forces to plant this land. If the assumption is correct, my 1 square feet land could supply rices to the whole world. However, we have never seen it happens in reality. (Contradiction )
  - Hence, the law of diminishing marginal return is correct.
- **Note**: Fixing one types of input is the key requirement behind the law. In other words, the ratio between inputs is important.

# Example

- We have a restaurant and we hired 6 workers to work (Input: labor), and spend 10, 000 buying all machines (Input: Capital). The following graph shows the diminishing marginal returns.
- Diminishing returns are setting in not because the third worker is worse than others, but because as we added staff, each has a smaller amount of capital to work with.



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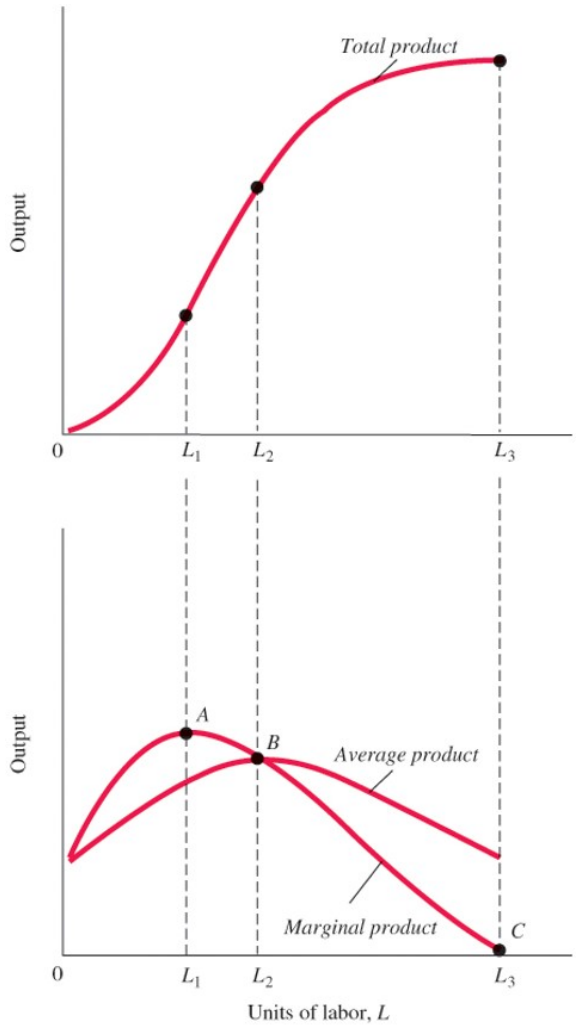
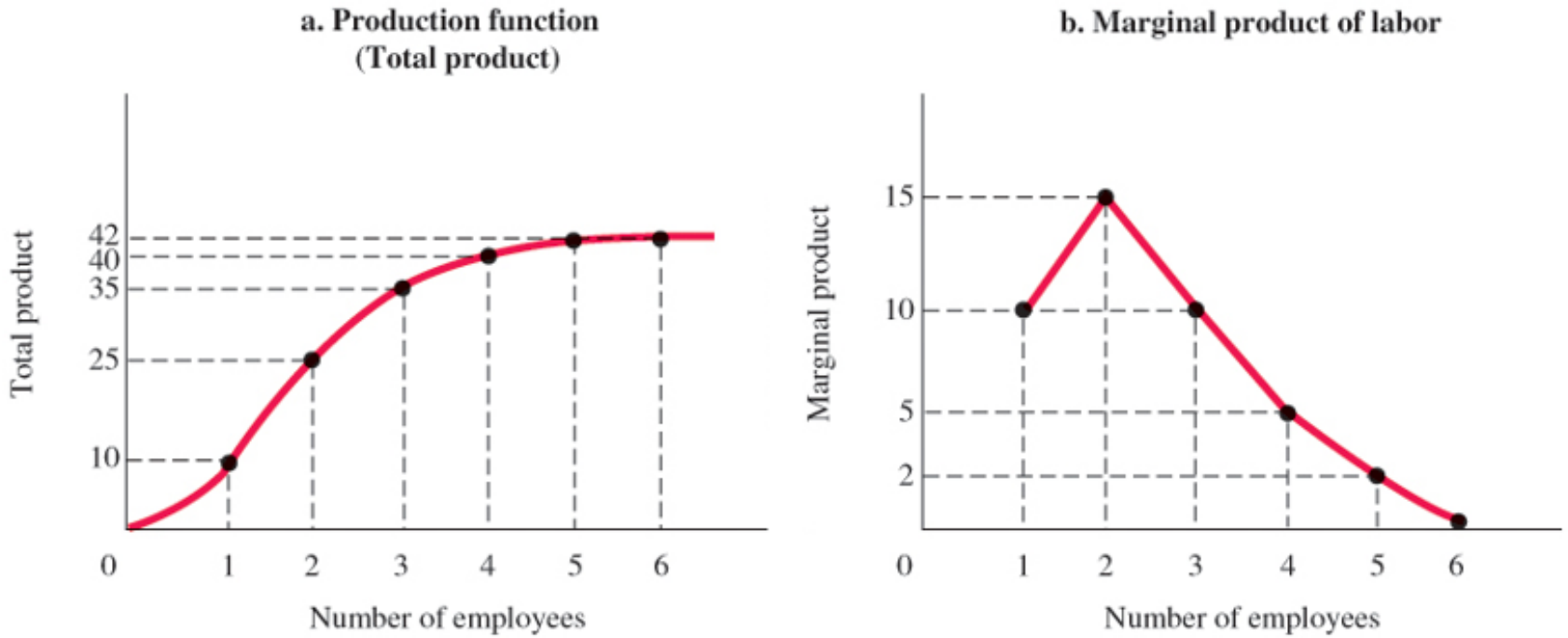


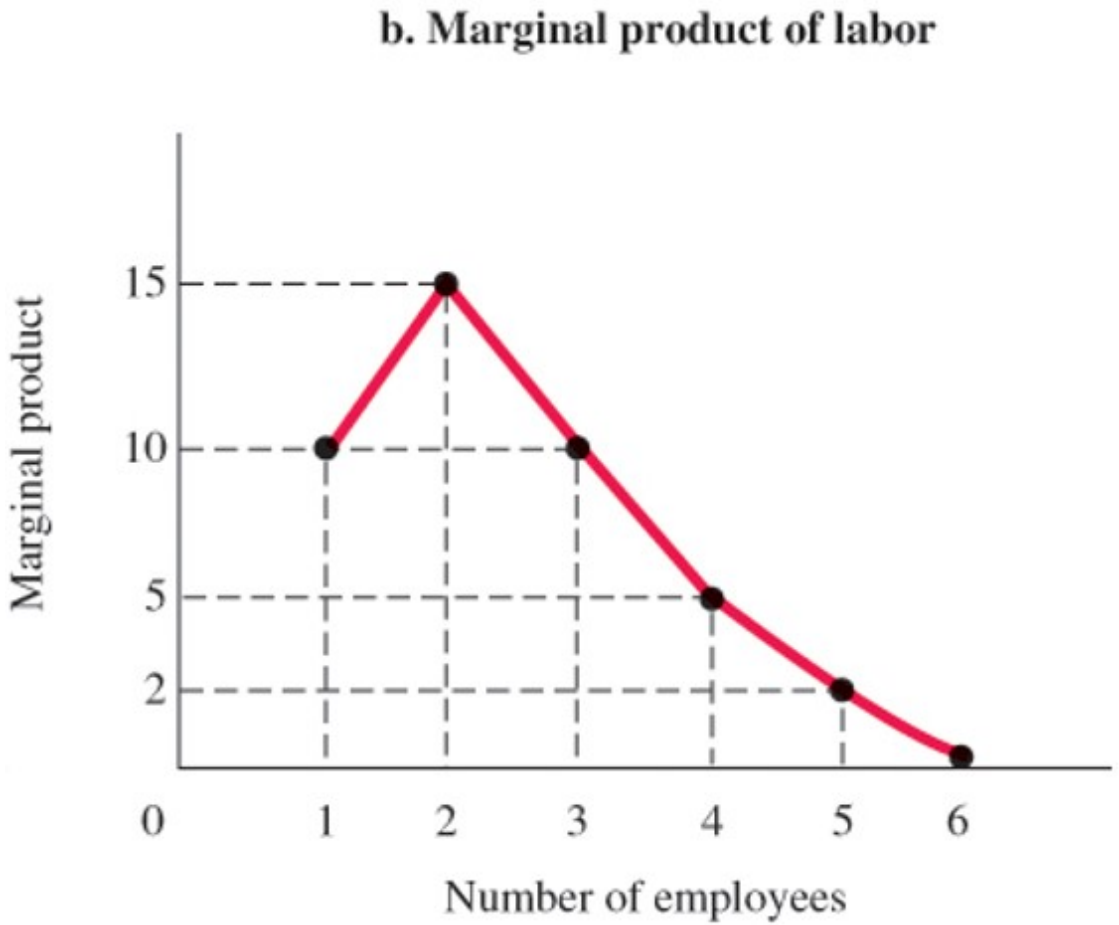
# The Law of Diminishing Marginal Productivity

- Go
- Below graph shows how we obtain the marginal product.



# The Law of Diminishing Marginal Productivity

- Before $q = 2$, MP increases;
- After $q = 2$, MP declines. $\Rightarrow$ The Law of diminishing marginal productivity



# Lesson 4: Short-Run Costs

# Short-Run and Long-Run Costs

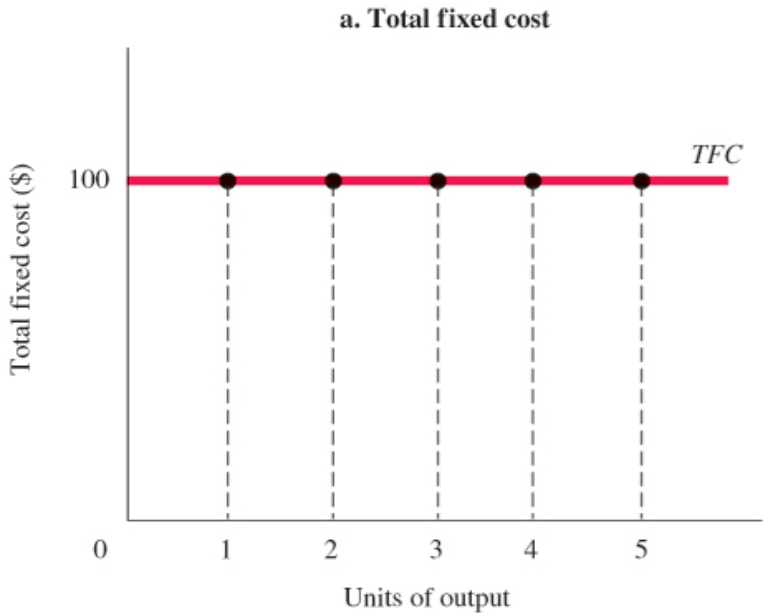
- **Short-run costs**
  - One type of input could change, but the other one must be fixed.
  - Existing firms face limits imposed by the law of diminishing marginal productivity.
  - Existing firms cannot exit, and new firms cannot entry.
- **Long-run costs**
  - In the long-run, firms are not limited by the law of diminishing marginal productivity.
  - All inputs could change.
  - Existing firms can exit, and new firms can entry.

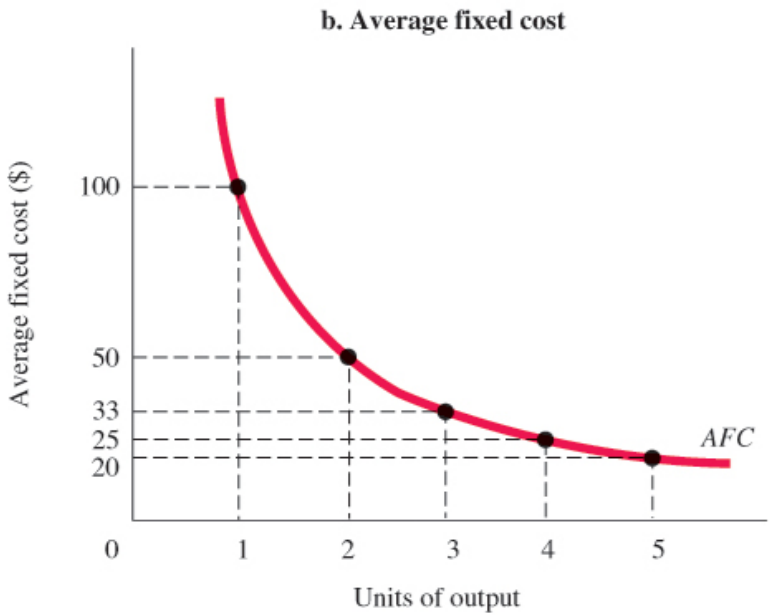
# Short-Run Costs

- **Total costs** = Total fixed costs+Total variable costs
- **Fixed costs**: Any cost that does not depend on the firm's level of output. These costs are incurred even if the firm produces nothing. There are no fixed cost in the long run.
  - Total fixed costs, or overhead Go
  - Average fixed costs, or spreading overhead $= \frac{TFC}{q}$
- **Variable costs**: A cost that depends on the level of production chosen.
  - Total variable costs
  - Marginal costs: $= \frac{\triangle TVC}{\triangle q}$ Go
  - Average variable costs: $= \frac{TVC}{q}$ Go
  - **Marginal costs**: The increase in total cost that results from producing one more unit of output.

# Fixed Costs

- Imagine that you have a company. Before producing the product, you have to pay for all utility fees, and purchasing desks, chairs...




$$AFC = \frac{TFC}{q}$$



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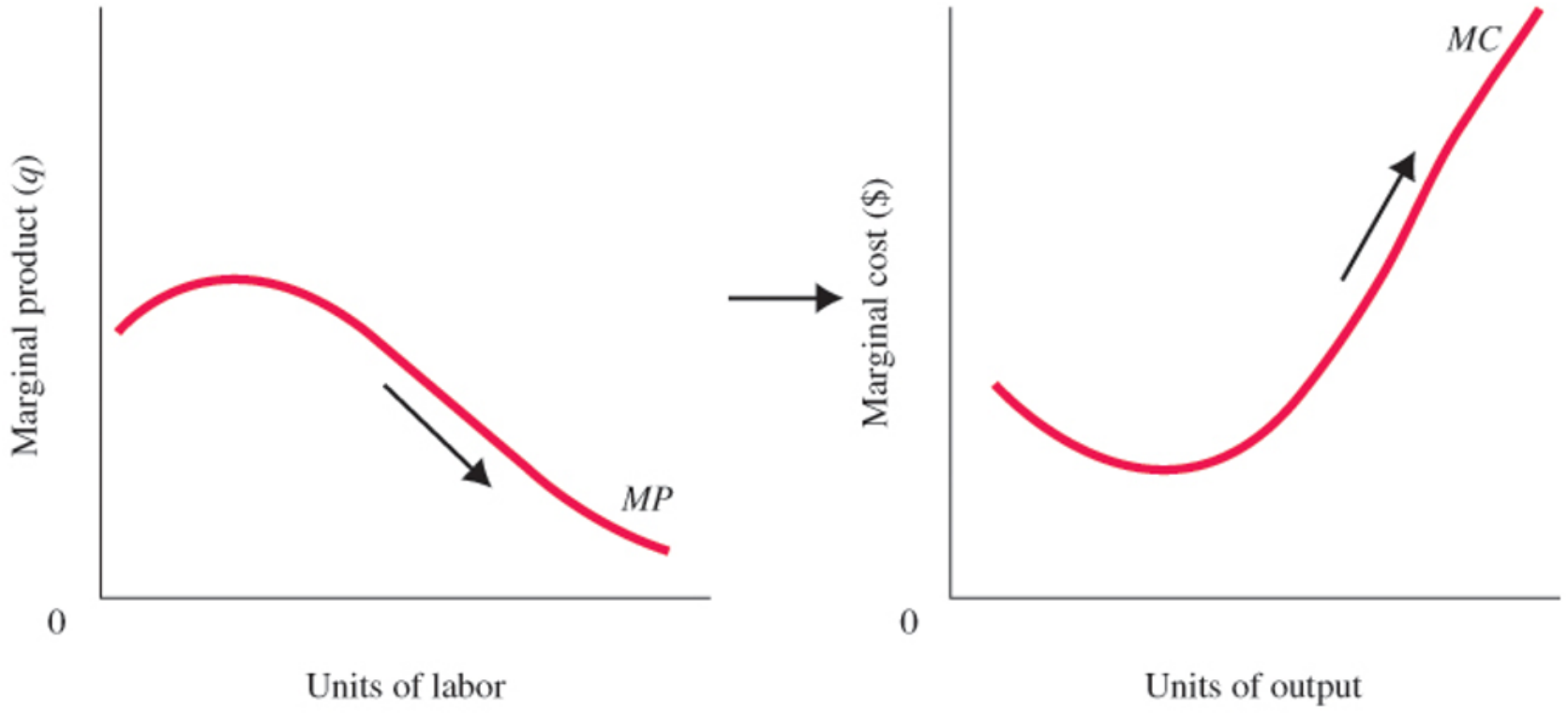
# Marginal Costs

- The trend of MC corresponds to the law of diminishing marginal productivity

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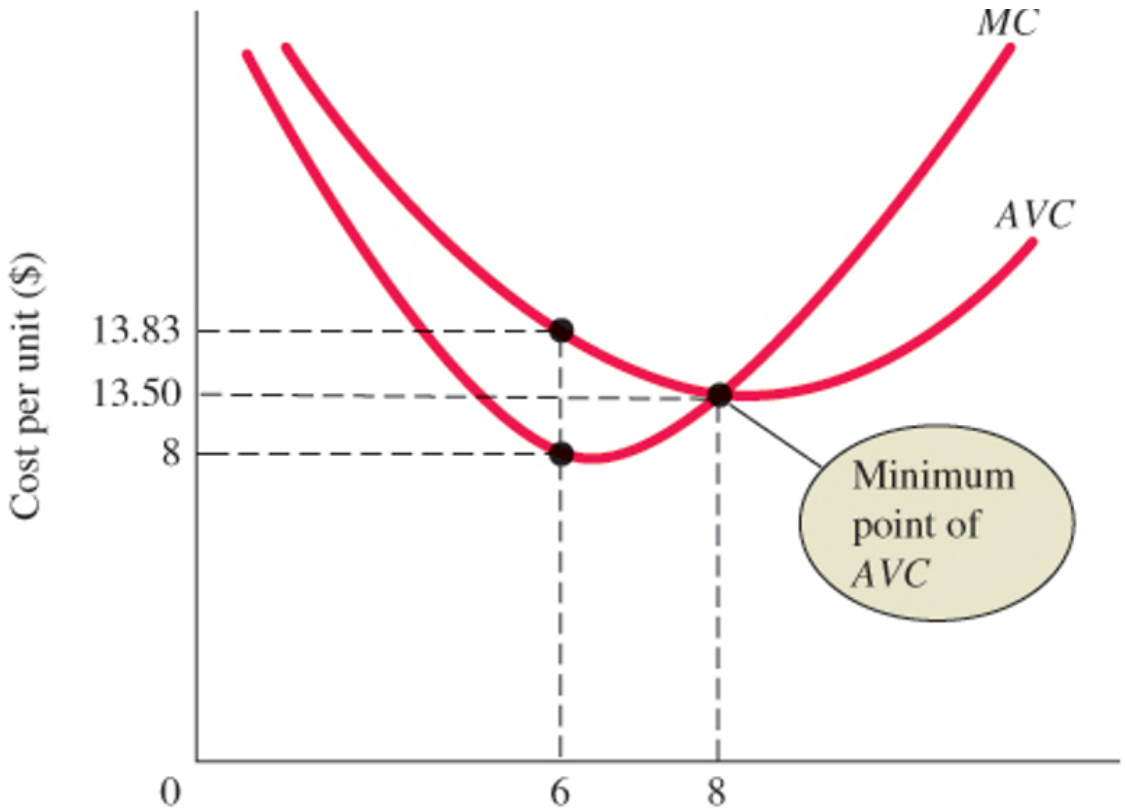
# Marginal Costs and Average Variable Costs

- Average variable costs are driven by the changes in marginal costs.
- Example: A firm's variable cost of hiring 3 temporary workers: \$100, \$200, \$300. If hiring one additional worker (MC), Go back
- If MC = \$50, then the AVC = $\frac{100+200+300+50}{4}$ =\$162.5
- If MC = \$400, then the AVC = $\frac{100+200+300+400}{4}$ =\$250



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# Example

- Inputs, costs: TC, AVC, AFC,MC.
- Outputs, products

# Review

Before analyzing short-run and long-run decisions, we introduce some concepts:

- Total product (Q), average product, and marginal product;
- Total cost ( TC= TVC + TFC) , average cost ($AC = \frac{TC}{Q}$), and marginal cost ($MC = \frac{\triangle TC}{\triangle Q}$)
- The law of diminishing marginal productivity $\Rightarrow$ The marginal cost will increase as output increasing
- **Variable cost**: the cost that vary with the level output in the short run. Or, costs that are related to K and L Go
- **Fixed cost**: Costs that must be paid even if output is zero.

# Example

- In the short run, one input is fixed.
- In the Mocha-cola's example, our capital input is: machines used to produce cola. Hence, assume that we do not purchase any more machines now.
- However, we plan to hire more workers. Assume: The marginal cost of hiring one more worker is equal to the marginal cost of producing one more cola.
- Our decisions:
  - How many workers should we hire?
  - How many cola should we produce?
- Before answering these questions, we need to know the market price.
- Suppose we accept the given market price for one bottle of cola is $P = \$3$.
- Also, assume the marginal cost of producing one more cola is: \$2

# Question

- If P > MC, what will happen? If you were the firm's owner, what will you do?
- If P< MC, what will happen? If you were the firm's owner, what will you do?

# Example

- **Price**: the exchange value for one cola
- **Marginal cost**: In order to produce one more cola, the additional cost that the firm need to afford.
- If P > MC, you realize it is profitable, so you keep producing the output until...?
- Since MC is increasing (Why?), when the firm keep producing outputs, $q \to \infty$, $MC \uparrow$
- If P< MC, you realize it is not profitable to produce one more output, so you stop producing.
- At $P = MC$, it is the profit-optimization point in the perfect competition market.

# Setup: Perfect Competition

- **Perfect Competition**: exists in an industry that contains many relatively small firms producing identical or homogeneous products.
- **Note**: In a perfect competition market, no single firm has any control over prices. We say competitive firms are "price takers".
- **Question**: In a perfect competition market of corns, all firms provide identical corns. For consumers, what is the best description of the price elasticity of demand for the corn?
- **Answer**: Perfectly elastic demand curve.

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# General results

- In the perfect competition market, profit is maximized at $P = MC$
- In general case, $MR = MC$ is the optimal solution in a perfect competition market.

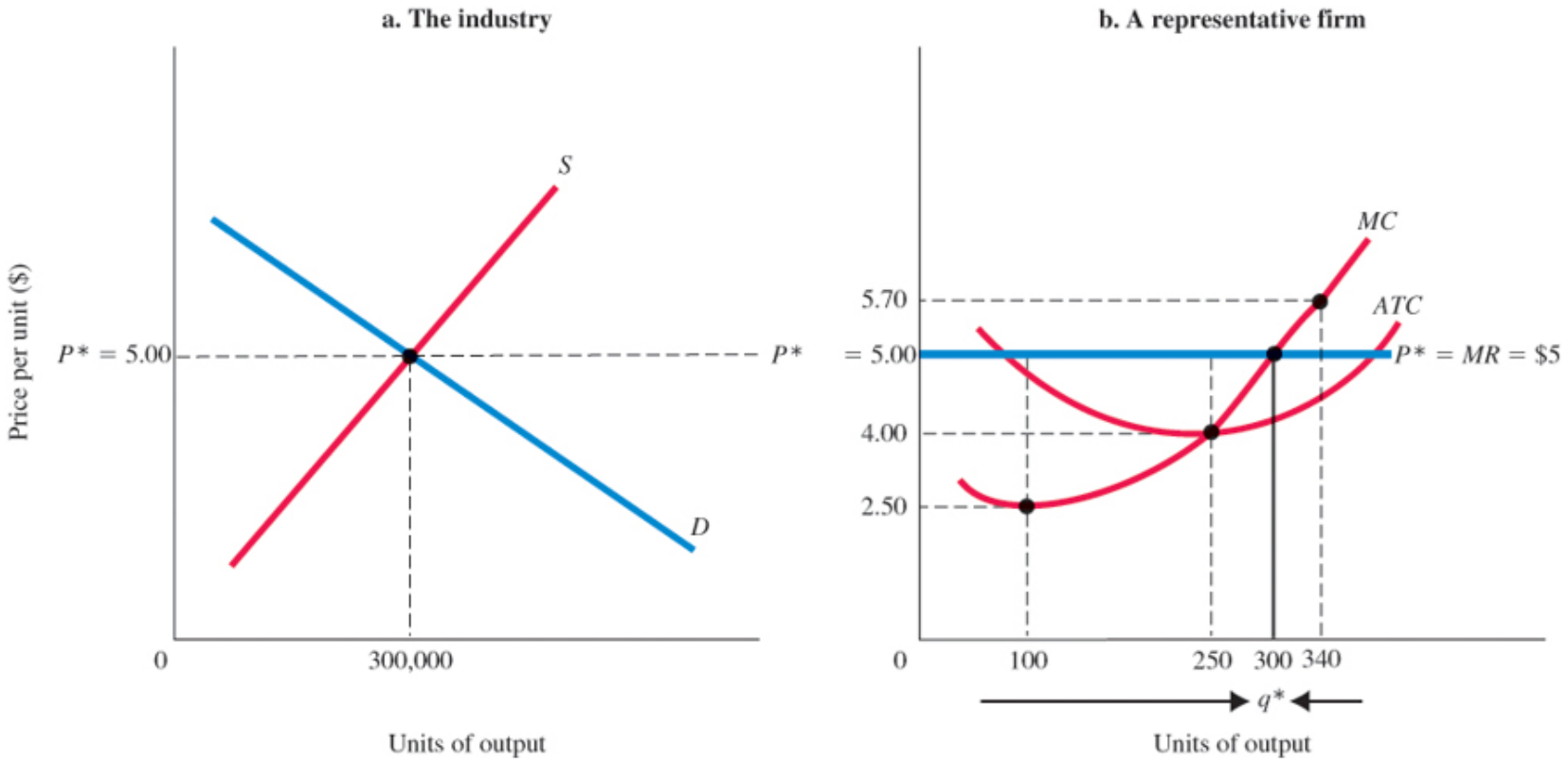
$$\max_{Q} P \times Q - C(Q)$$

- Taking First-order condition on Q:

$$P = MC(Q)$$

- Here, $P = MR = \frac{\partial TR}{\partial Q}$

# Marginal Cost and Supply Curve



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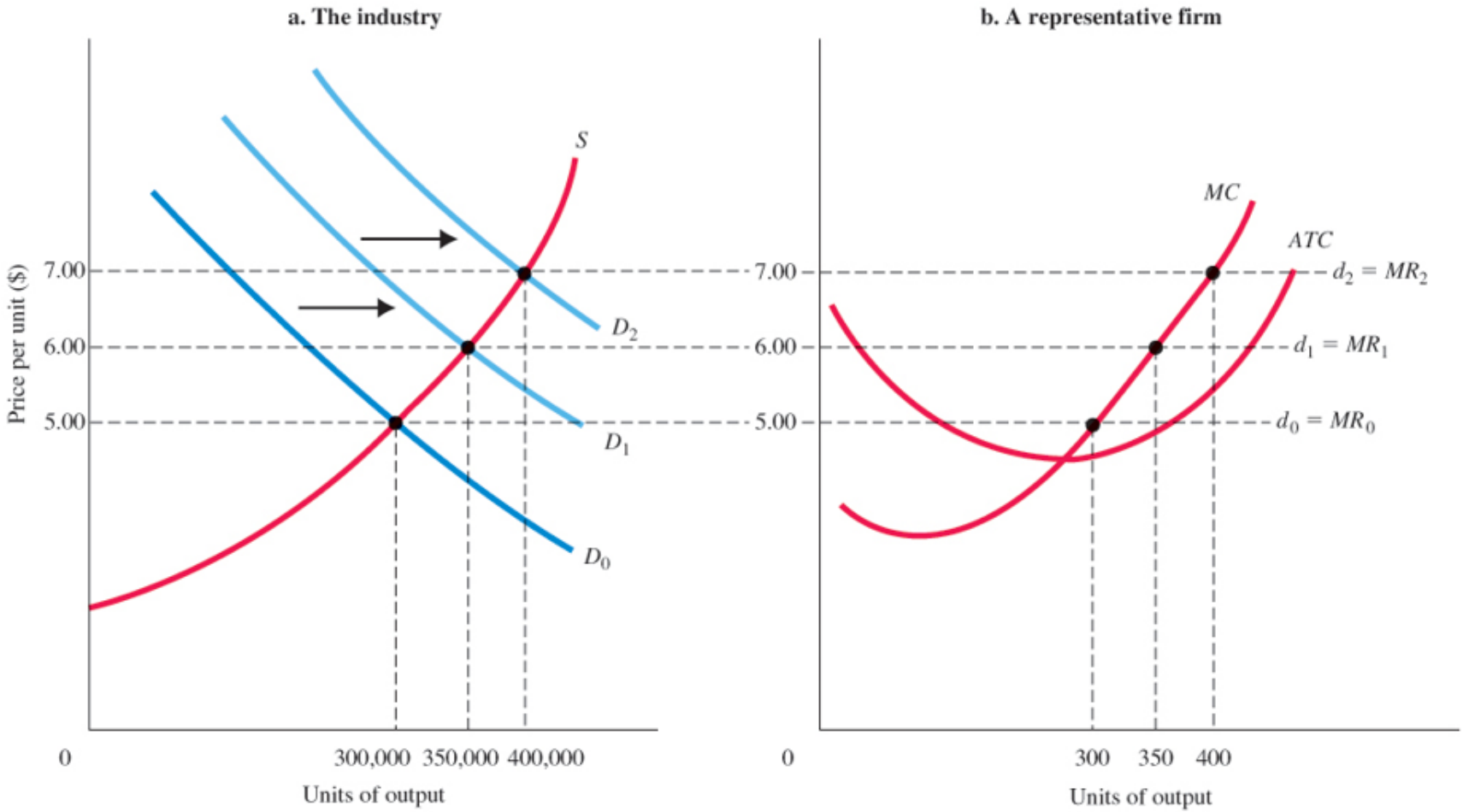
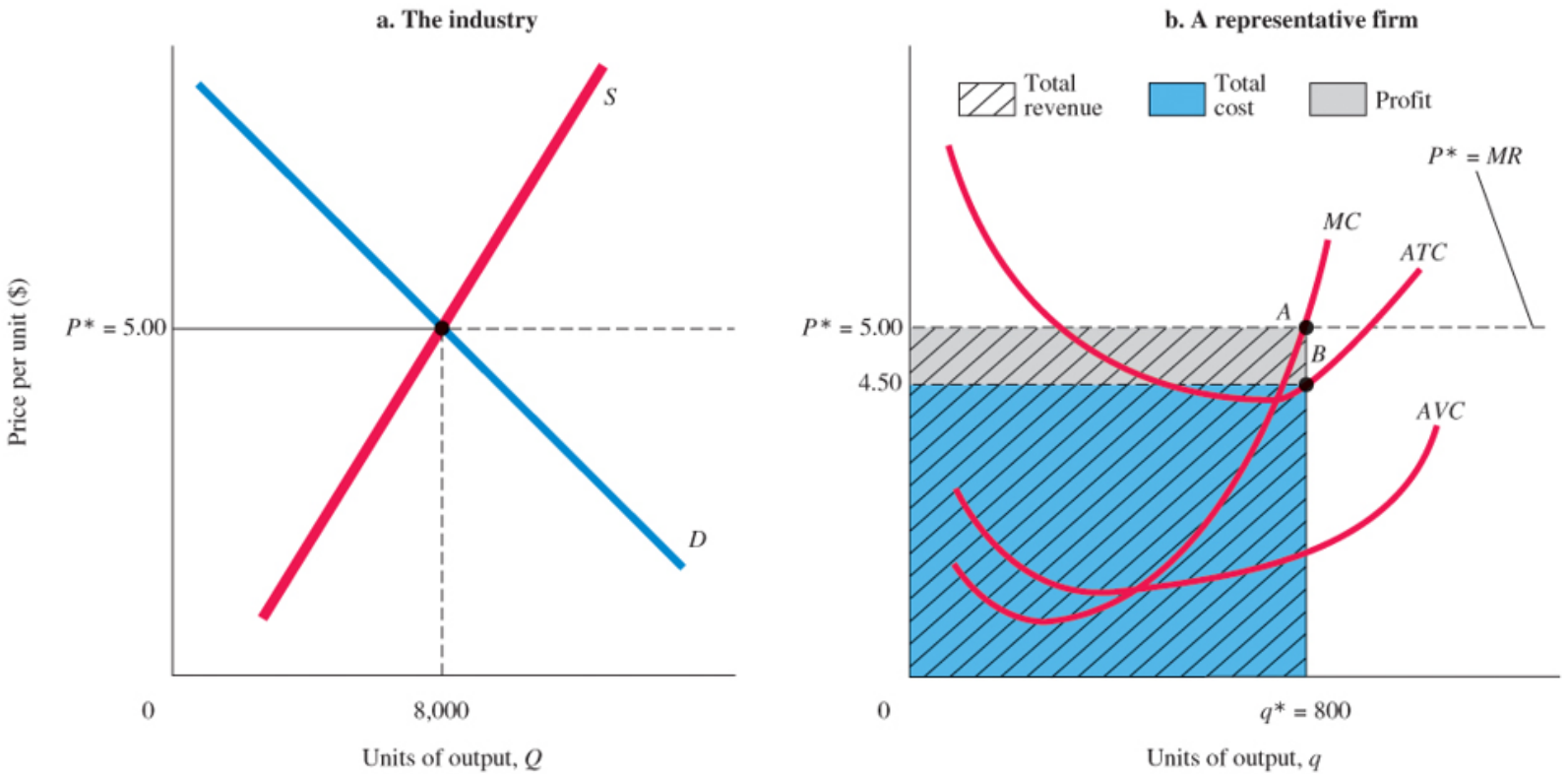


# Short-run profit

- What is the equation for the Average Variable cost?
- AVC = $\frac{TVC}{Q}$
- $TVC = AVC \times Q$
- TR = P × Q
- Profit = TR-TC



# Short-run Decisions

- In the short run, firm could not exit the market.
- Economic Profit = Total revenue - accounting costs - opportunity costs
- Production's opportunity cost: is the normal rate of return.
- There are three conditions for the firm:
  1. The firm is making positive profits, or a firm is earning an above-normal rate of return
  2. The firm is suffering losses, or a firm's earning is below normal rate of return.
     - 2.1 **Shut down point**: The lowest point on the average variable cost curve. When price falls below the minimum point on AVC, total revenue is insufficient to cover variable costs and the firm will shut down and bear losses equal to fixed costs.
     - 2.2 Those firms that continue to operate in the short run to minimize the cost
  3. The firm is just **breaking even**.
- **Breaking even**: A firm that is breaking even, or earning a zero level of profit, is one that is earning a normal rate of return (its opportunity cost)

# Short-run Decisions

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  3. The firm is just **breaking even**.
- **Breaking even**: A firm that is breaking even, or earning a zero level of profit, is one that is earning a normal rate of return (its opportunity cost).

# Short-run Decisions

- In the short run, firm could not exit the market.
- Economic Profit = Total revenue - accounting costs - opportunity costs
- Production's opportunity cost: is the normal rate of return.
- There are three conditions for the firm:
  1. The firm is making positive profits, or a firm is earning an above-normal rate of return
  2. The firm is suffering losses, or a firm's earning is below normal rate of return.
     - 2.1 **Shut down point**: The lowest point on the average variable cost curve. When price falls below the minimum point on AVC, total revenue is insufficient to cover variable costs and the firm will shut down and bear losses equal to fixed costs.
     - 2.2 Those firms that continue to operate in the short run to minimize the cost
  3. The firm is just **breaking even**.
- **Breaking even**: A firm that is breaking even, or earning a zero level of profit, is one that is earning a normal rate of return (its opportunity cost)

# Short-run Decisions

- If total revenue exceeds total variable cost, the excess revenue can be used to offset fixed costs and reduce losses, and it will pay the firm to keep operating.
- If total revenue is smaller than total variable cost, the firm that operates will suffer losses in excess of fixed costs. In this case, the firm can minimize its losses by shutting down.
- **shutdown point**: The lowest point on the average variable cost curve. When price falls below the minimum point on AVC, total revenue is insufficient to cover variable costs, and the firm will shut down and bear losses equal to fixed costs.

# Short-run Decisions

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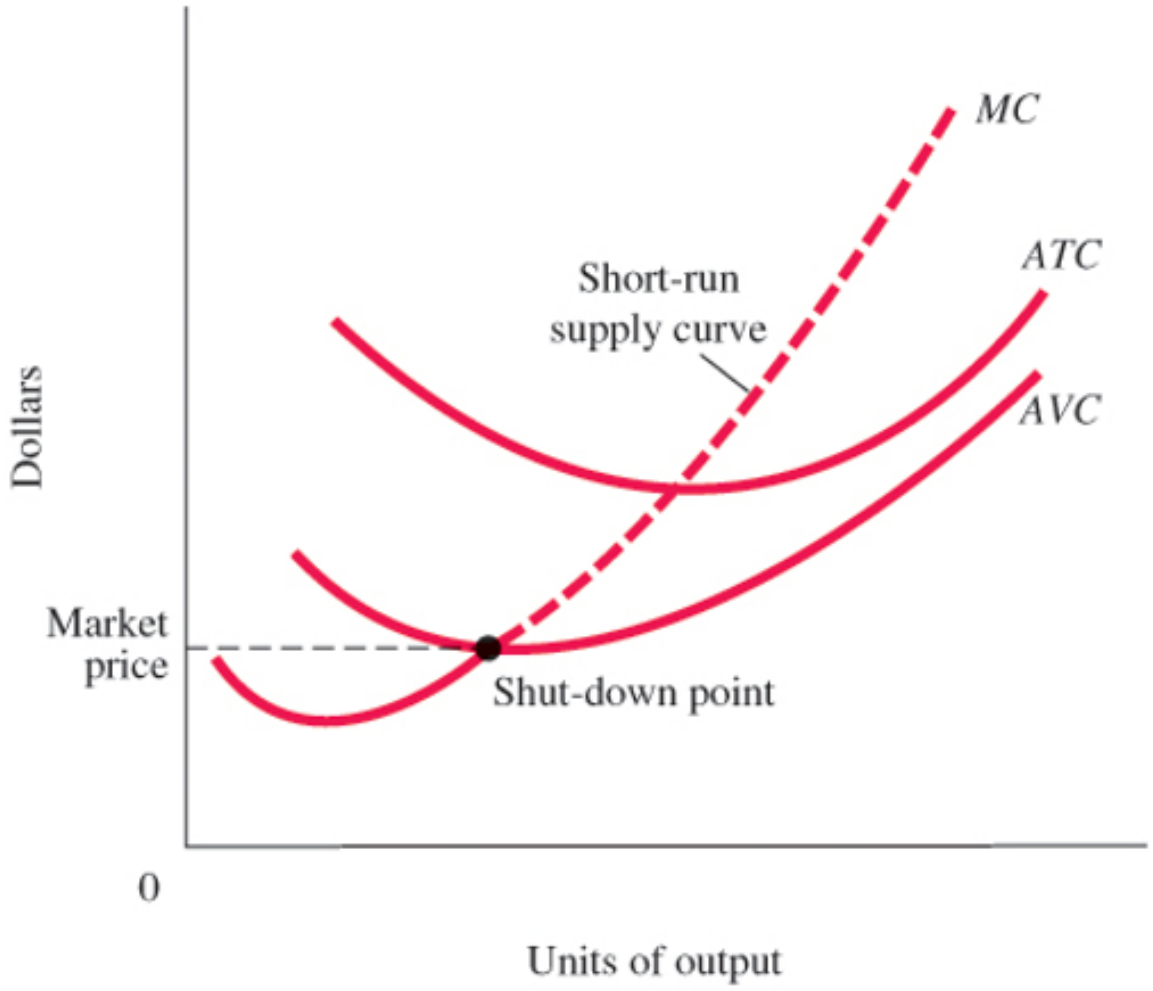
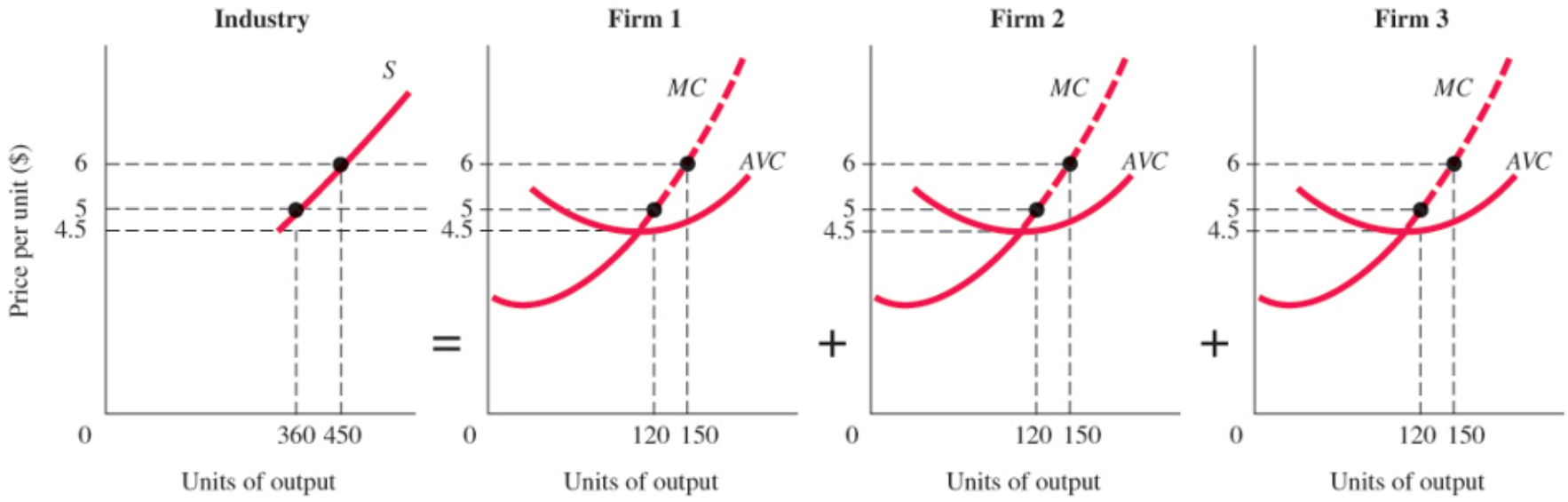
# Short-run Decisions



# Short-run Decisions



# Total Variable Costs

- **Definition**: TVC is the sum of those costs that vary with the level of output in the short run.
- The cost of hiring more labor forces, or the cost of purchasing more machines.
- Example: Start with different techniques.

**Table 1:** Inputs Required to Produce 100 Diapers Using Alternative Technologies

| Technology | Units of Capital(K) | Units of Labor(L) | $P_L$ = \$1<br>$P_K$ = \$1 |
|---|---|---|---|
| A | 2 | 10 | 12 |
| B | 3 | 6 | 9 |
| C | 4 | 4 | 8 |
| D | 6 | 3 | 9 |
| E | 10 | 2 | 12 |

Go Back

# Lesson 5: Long-Run Costs

# Long-run Decisions

# Long run vs Short run decisions

- The distinction between fixed cost and variable cost applies to the short run but not to the long run.
  - Example: Jill operates a pizza restaurant. She has a fixed cost of $800 per week because she signed a loan agreement with a bank when she bought pizza ovens. But in the long run (5 years/10 years/20 years), the cost of buying more pizza ovens becomes variable because she can choose whether to expand her business by buying more.
  - Example 2: Once a company has purchased a fire insurance policy, the costs of the policy is fixed. But when the policy expires, the company must decide whether to renew it, and the cost becomes variable.
- In the long run, all costs are variable. There are no fixed cost in the long run.
  - $\Rightarrow$ Total cost = Total Variable costs

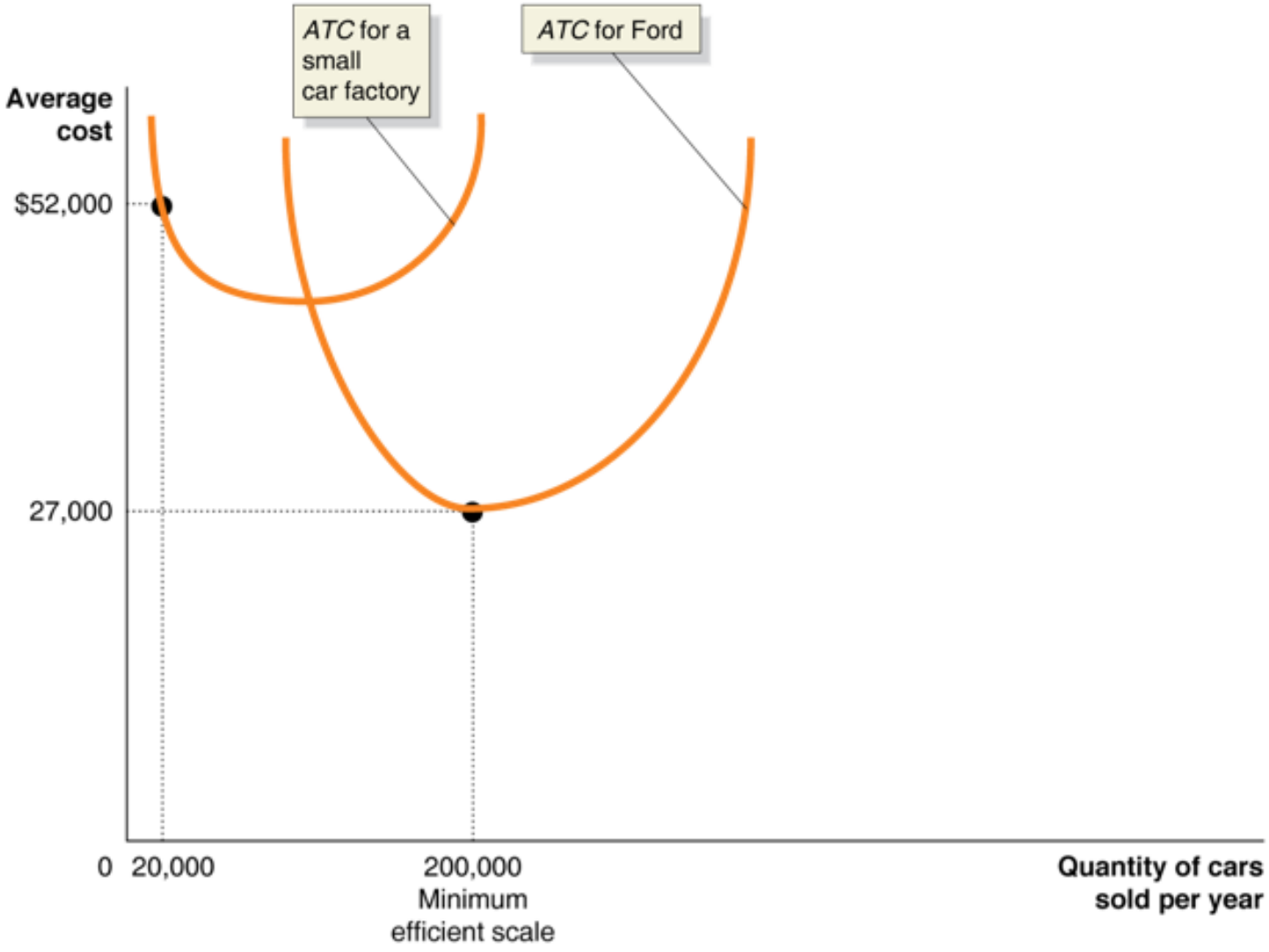
# Example

- The year 2008 was not good for airlines.
  1. Six airlines declared bankruptcy.
  2. Four major airline mergers: Delta-Northwest, United-Continental, Southwest-AirTran, and the ongoing American-US Airways merger.
  3. Other airlines are reducing the number of flights.
  4. American Airlines began charging $15 for each piece of luggage checked in to a flight.
- Cutting flights, declaring bankruptcy, and mergers are long-run decisions.

# Long run Decision

- **Long-run average cost curve**: Shows the lowest cost at which a firm is able to produce a given quantity of output in the long run, when no inputs are fixed.
- **The minimum efficient scale (MES)**: is the smallest size at which long-run average cost is at its minimum.
- Increasing returns to scale or Economies of scale: The firm's long-run average cost falls as it increases the quantity of output it produces.
- Constant returns to scale: An increase in a firm's scale of production has no effect on costs per unit produced.
- Decreasing returns to scale: An increase in a firm's scale of production leads to higher costs per unit produced.

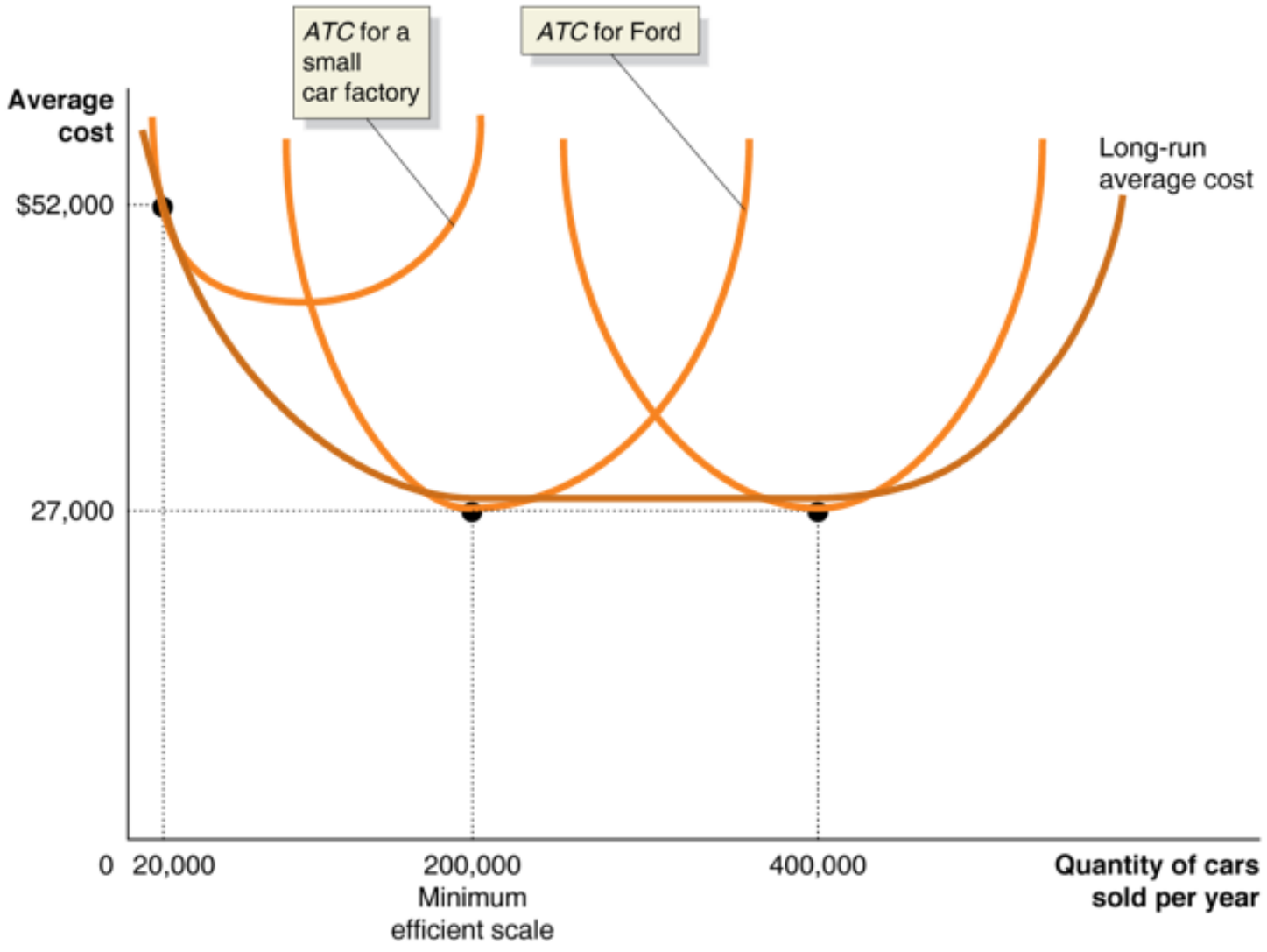
# Long run average costs



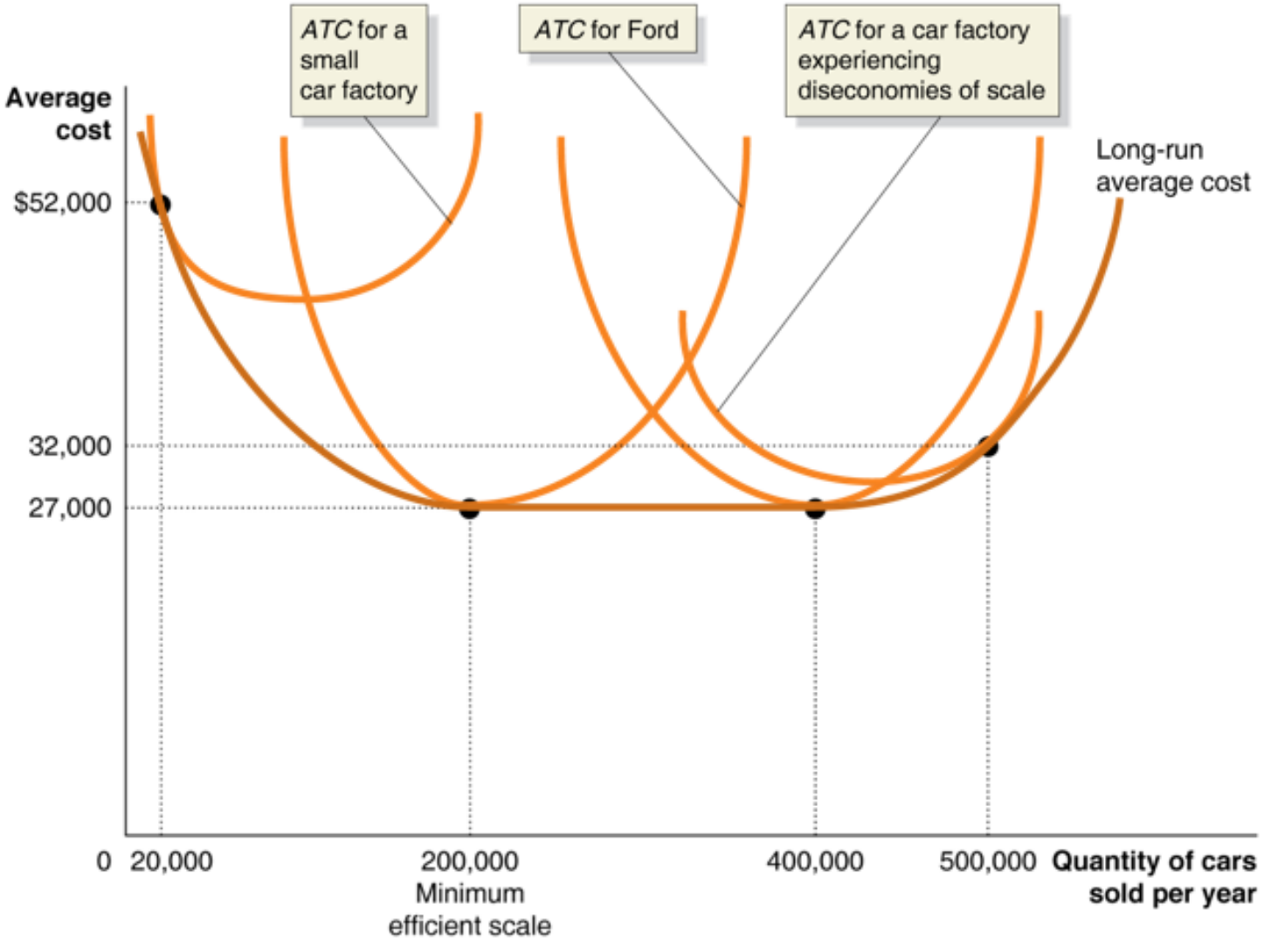
# Long run average costs

- Figure below shows long-run average cost in the automobile industry.
  - Small car factory: Sell only 20,000 cars in 2016 (Tesla Motors), then it will be able to assemble cars at the lowest average cost of $\$52,000$.
  - Large car factory: Sell 200,000 cars in 2016 (Ford, Toyota) at a lower average cost of $\$27,000$.
- This decline in average cost represents the *economies of scale* that exist in manufacturer industry.

# Long run average costs



# Long run average costs

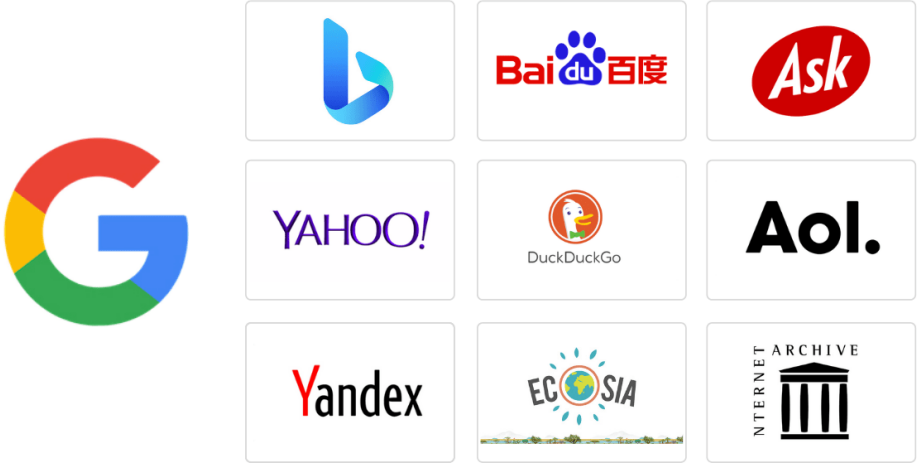


# Long run average costs

- **Why would some firms experience economies of scale?**
  1. The firm's technology may take it possible to increase production with a smaller proportional increase in at least one input.
  2. Both workers and managers can become more specialized, enabling them to become more productive, as output expands.
  3. Large firms, like Ford, Walmart, or Apple, may be able to purchase inputs at lower costs than smaller competitors.
  4. As a firm expands, it may be able to borrow money at a lower interest rate, thereby lowering its costs.

# Increasing returns to scale

- Increasing returns to scale: refers to the relationship between inputs and outputs.
- Meaning: a given percentage of increase in inputs leads to a larger percentage of increase in the production of output.
- If a firm doubled or tripled input quantities, it would **more than** double or triple output.
- Example: Setting up an internet search engine is largely a matter of huge fixed costs. Revenue is almost certain to rise faster than costs.

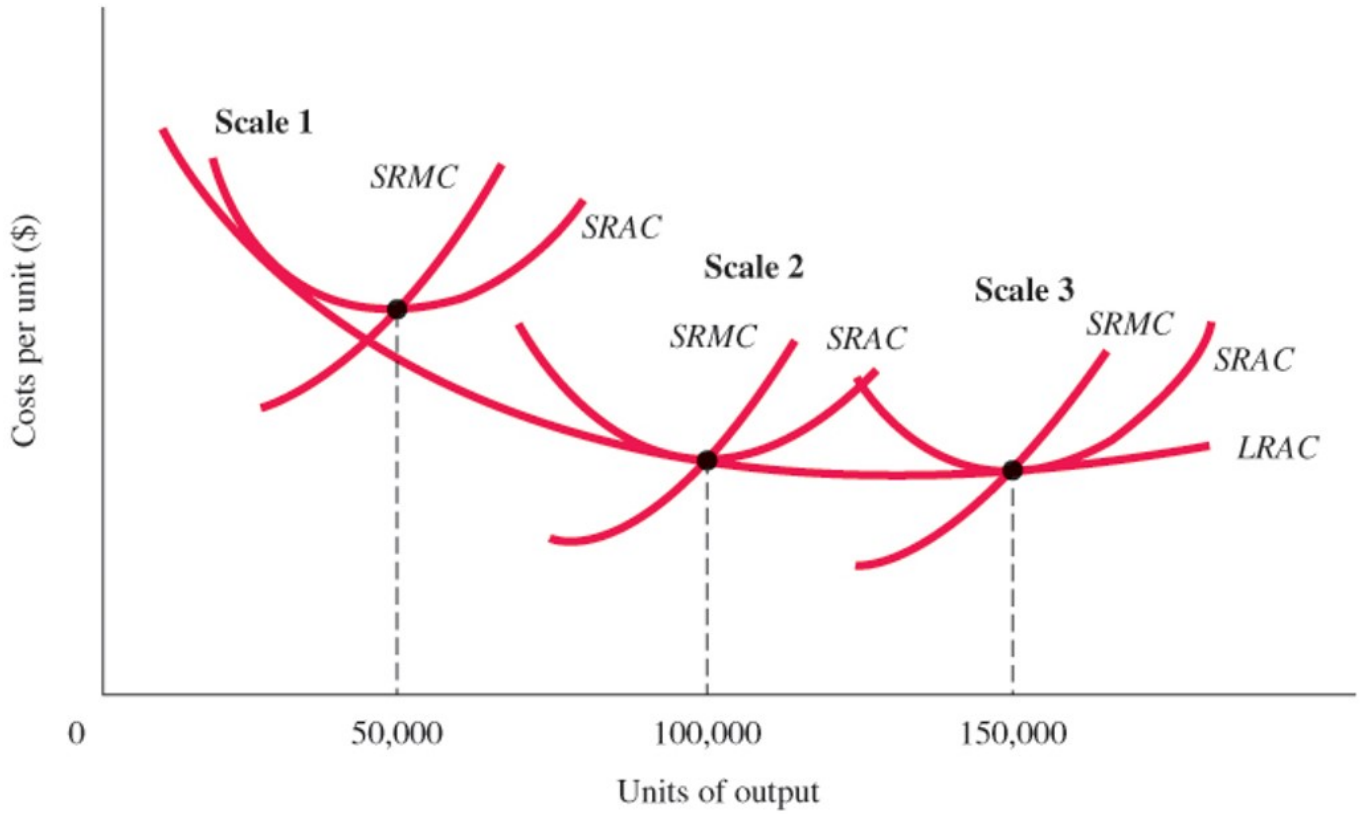


# Decreasing returns to scale

- **Constant returns to scale**: means the quantitative relationship between input and output stays constant, or the same, when output is increased.
- **Dis-economies of Scale**: means average costs increase with scale of production. The most often cited cause is bureaucratic inefficiency.
- Example: In secondary school education, doubling the graduation rates (output) would require more teachers and more classrooms (inputs). Although there are lots of inputs, it may not be obvious to see the improvement.

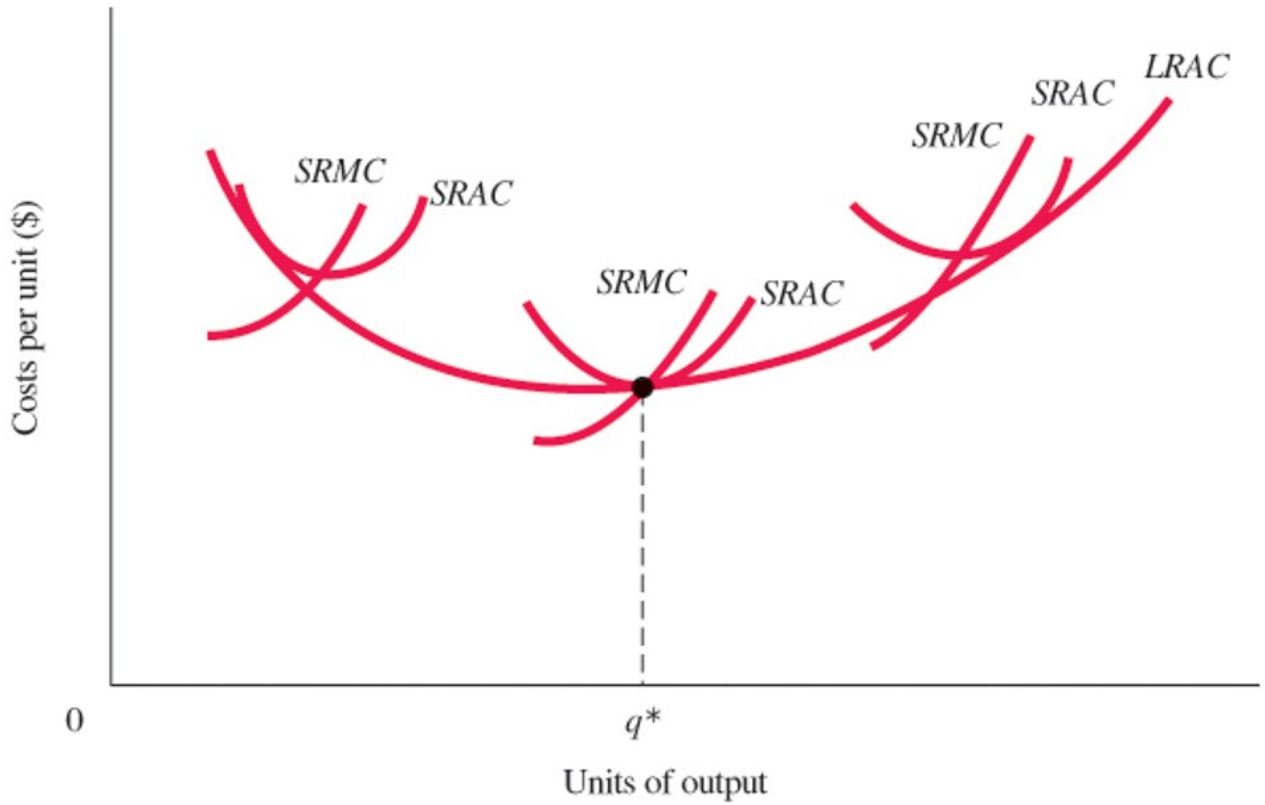
# U-Shaped Long-Run Average Costs

- LRAV shows the different scales on which the firm can choose to operate in the long run.
- Each scale of operation defines a different short run. Here we see a firm exhibiting economies of scale;
- Moving from scale 1 to scale 3 reduces average cost.



# U-Shaped Long-Run Average Costs

- **The optimal scale of plant**: is the scale of plant that minimizes long-run average cost.
- Economies of scale push this firm's average costs down to $q^*$.
- $q^*$ is the level of production at lowest long-run average costs, using optimal scale.



# Short-run Condition and Long run decision

Short-run Profits:

- **Moves In and out of equilibrium**: A firm will continue to expand and new firms will enter the industry as long as there are economic profits to be earned.
  - This shifts the industry supply curve out, increasing output and lowering price.
  - In long-run equilibrium each firm will choose the scale of plant that produces its product at minimum long-run average cost (optimal scale of plant).
  - Competition drives firms to adopt not just the most efficient technology in the short run but also the most efficient scale of operation in the long run.

# Short-run Condition and Long run decision

Short-run profits:

- Now suppose an industry is earning economic losses. Some firms will exit the industry.
    - The industry supply curve shifts inward, reducing output and increasing price.
    - This reduces losses for those firms remaining in the industry. The adjustment will continue until losses are zero.

# Short-run Condition and Long run decision

The Long-Run Adjustment Mechanism:

- **Investment Flows Toward Profit Opportunities**:
  - In the long run, investment will favor those industries in which profits are being made; industries in which firms undergo losses will gradually contract from disinvestment.
  - In long-run competitive equilibrium

$$P = SRMC = SRAC = LRAC$$

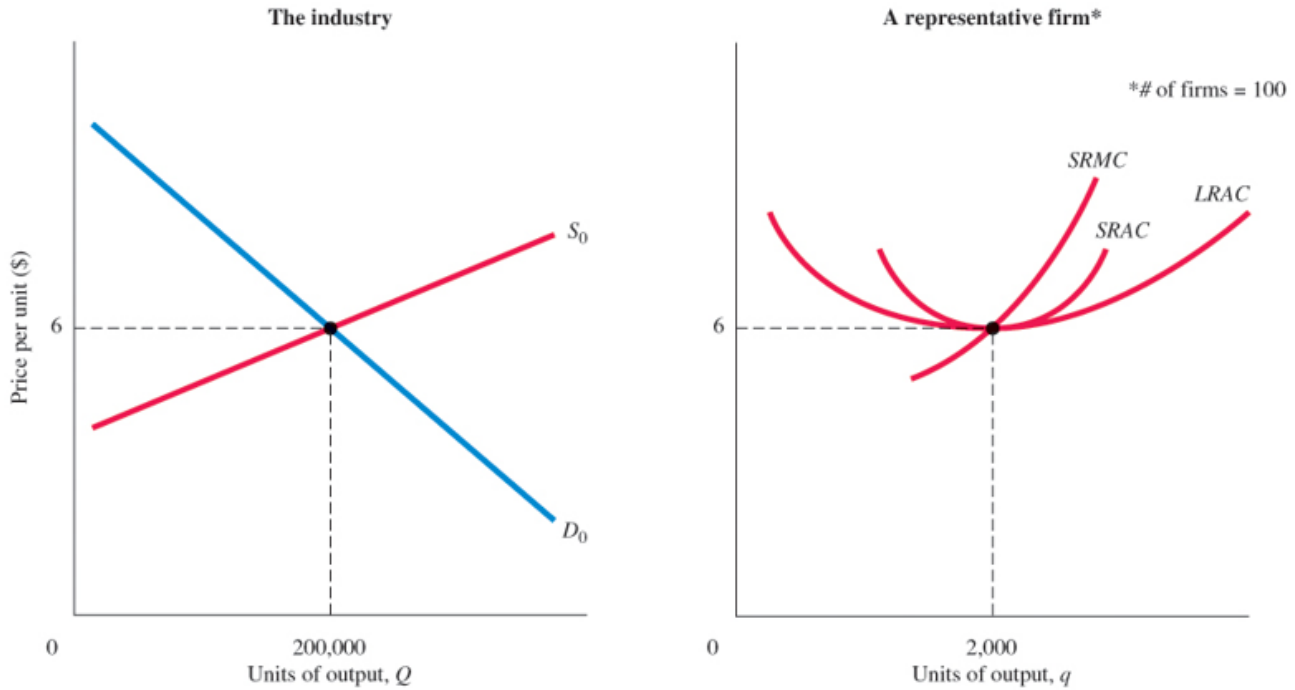
  - Profits are zero.

# Short run and Long run Decision

| | Short run condition | Short run decision | Long run decision |
|---|---|---|---|
| Profits | TR > TC | P=MC: operate | Expand: new firms enter |
| Losses | TR ≥ TVC | P=MC: operate<br>(loss < total fixed cost) | Contract: firms exit |
| | TR < TVC | shut down<br>(loss = total fixed cost) | Contract: firms exit |

# Long-Run Equilibrium

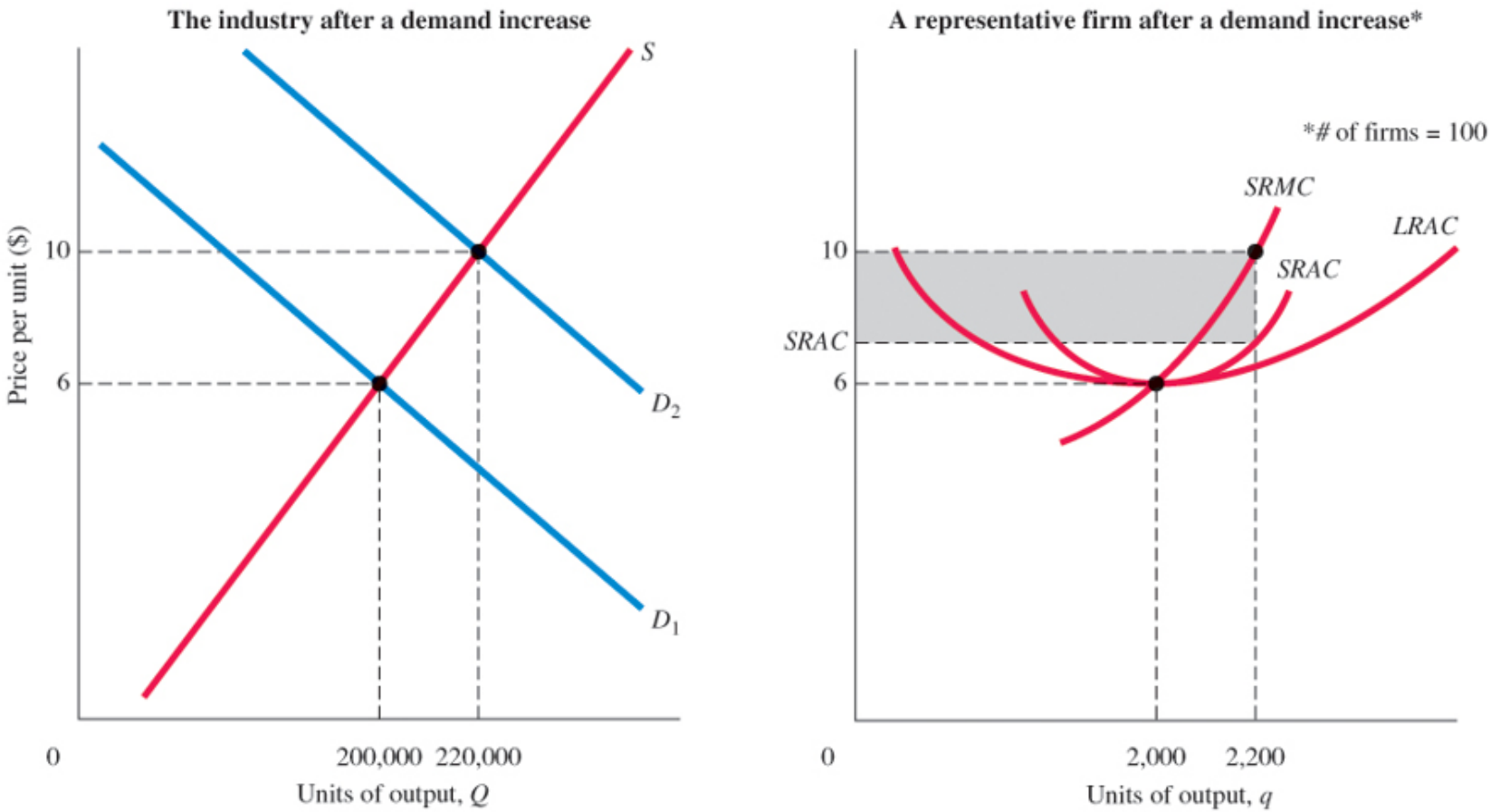
## Equilibrium for an Industry with U-Shaped Cost Curves




- The individual firm on the right is producing 2,000 units, and we also know that the industry consists of 100 firms.
- All firms are identical, and all are producing at the uniquely best output level of 2,000 units.

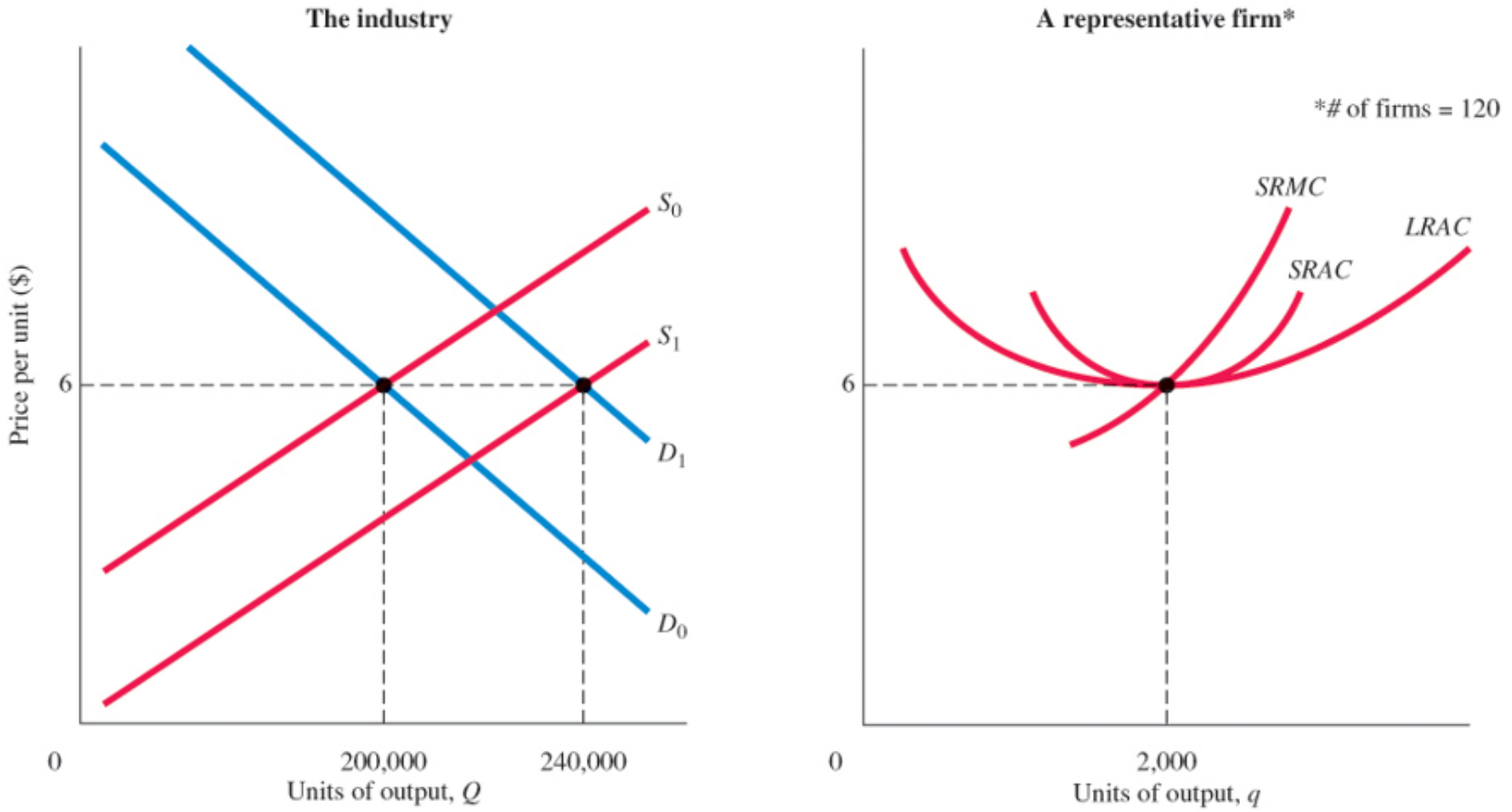
# Long-Run Equilibrium

## Industry Response to an Increase in Demand



# Long-Run Equilibrium

## New Equilibrium with Higher Demand



# Lesson 6: Combine Long-Run and Short-Run Curves

# Review: Example

There are also variable costs associated with the business.

- To run a car wash, one needs workers and soap.
- Every car that is washed costs \$0.75 in soap.
  - *If* 800 *car washes are done in a week, what are variable costs in soaps?*
- Workers are hired by the hour for \$10 an hour. On average, a worker can wash 8 cars an hour.
  - *If* 800 *car washes are done in a week, how many hours should they work per week?*
  - *If* 800 *car washes are done in a week, what are variable costs in paying workers?*
- *Calculate total variable costs, and total costs.*

# Review: Example

There are also variable costs associated with the business.

- Now, the market price of each car wash is \$5.
  - *What is your profit from washing 800 cars per week?* Click
  - *Given the short-run profit, what are you going to do in the long run?*
- Now, suppose the market price of each car wash is $P_1$. At $P_1$, your firm is not earning a positive profit or breaking even. You are suffering a loss in the short run.
  - *Under which condition, you will shut down the business?*
- Your long-run decisions should depend on short-run profits. If short run profit is positive or breaking even, then the firm would expand their scale of plant (factories of varying sizes).
  - *We learned three types of scales: Increasing returns to scale, constant returns to scale, and decreasing returns to scale. If you were a profit-maximizing firm owner, which scale do you prefer?*

# Review: Long-run average costs

The firm chooses the scale that it wants to operate in the long run.

- **Long-run Average Cost (LRAC)**: The curve shows how costs vary with scale of operation.
  - **Increasing returns to scale**: An increase in a firm's scale of production leads to lower costs per unit produced.
    - Ex: If F(K,L) = Q, then F(2K,2L) = 4Q
  - **Constant returns to scale**: An increase in a firm's scale of production has no effect on costs per unit produced.
    - Ex: If G(K,L) = Q, then G(2K,2L) = 2Q
  - **Diseconomics of scale**: An increase in a firm's scale of production leads to higher costs per unit produced.
    - Ex: If S(K,L) = Q, then S(2K,2L) = Q

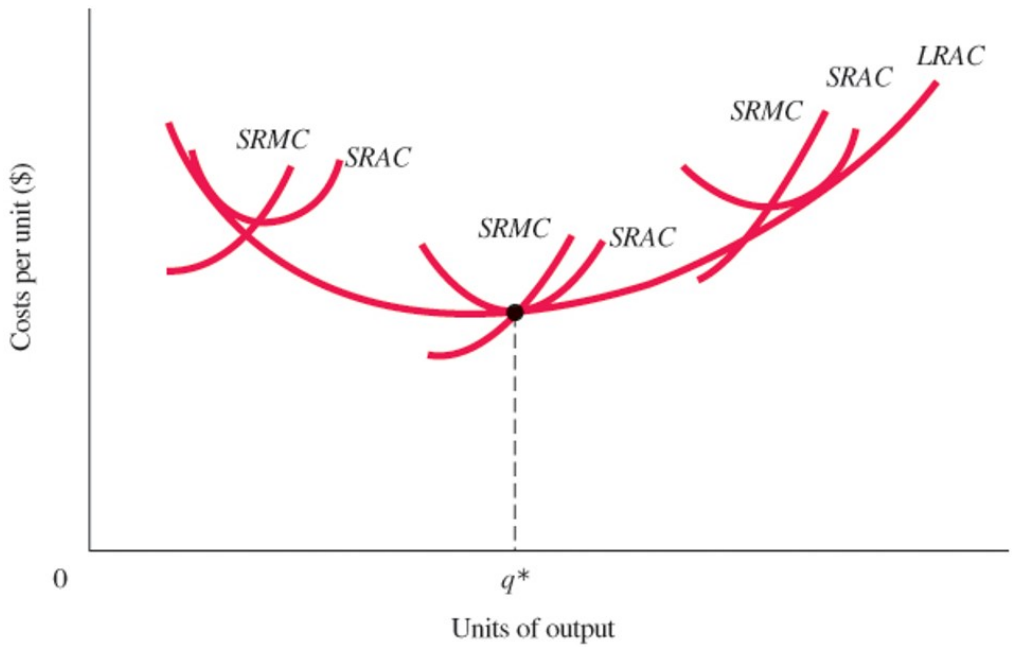
# Review: Why could we have IRS?

The sources of increasing returns to scale:

- Technology.
  - Automobile production would be more costly if a firm produce 100 cars per year by hand.
  - In the 1900s, Henry Ford introduced standardized production techniques that increased output, and reduced costs per car.
- Firm-level efficiencies and bargaining power.
  - Large companies can buy inputs at discounted prices.
- Larger firm size
  - Most electronic companies produce their output in multiple moderate-sized plants to achieve cost savings.

# Review: U-Shaped Long run average costs

- Below shows a firm that exhibits both increasing returns to scale and decreasing returns to scale.
- Notice: Although short-run average cost curves are also U-Shaped, short run and long run have different meanings.
- $q^*$ is the **Optimal scale of plant** that minimizes long-run average cost, or minimum efficient scale.



# Long-run adjustments to short-run conditions

- When firms are earning economic profits or suffering economic losses, the industry is not at long-run equilibrium and firms have an incentive to change their behaviors.
- Long-run competitive equilibrium:

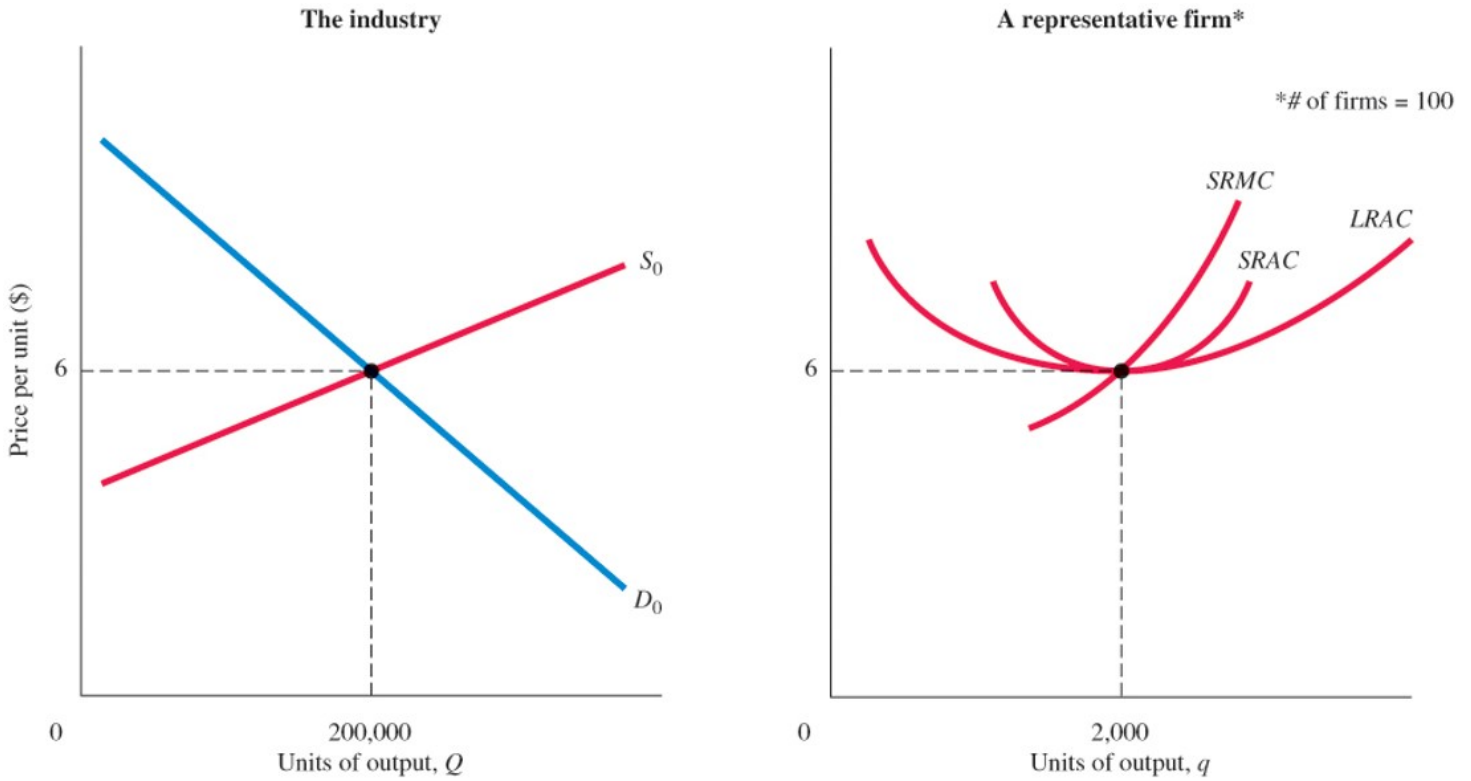
$$P = SRMC = SRAC = LRAC$$

- Before showing it is true, let us review the condition for the short-run equilibrium: $P = MC$.
- In the short run, marginal cost curve is always intersects AVC at the minimum point of AVC. (Proof)

# Long-run adjustments to short-run conditions

$$P = SRMC = SRAC = LRAC$$

- Example: Green tea industry. At the beginning, it is an equilibrium.



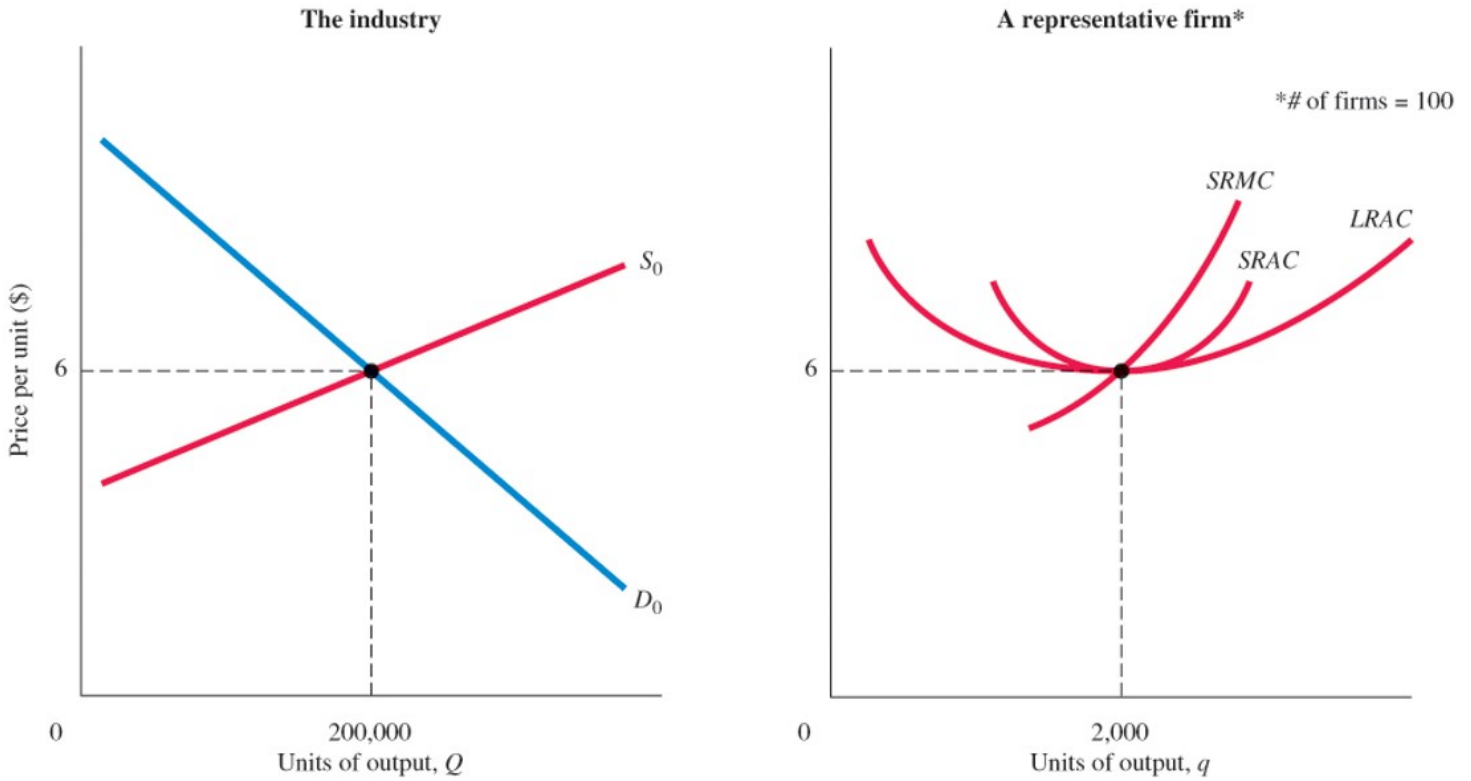
# How do we get the industry supply curve and industry demand curve?

- **Industry demand curve**: At each given price, the sum of willingness to buy across all households. → Household's utility maximization problem
- **Industry supply curve**: At each given price, the sum of willingness to sell across all firms. → Firm's profit maximization problem
- Industry supply curve could be shifted by two things:
  1. In the short run, a decrease or increase in the price of some input could shift the marginal cost curves.
  2. In the long run, an increase or decrease in the number of firms. If new firms enter the industry, the industry supply curve moves to the right.

# Long-run adjustments to short-run conditions

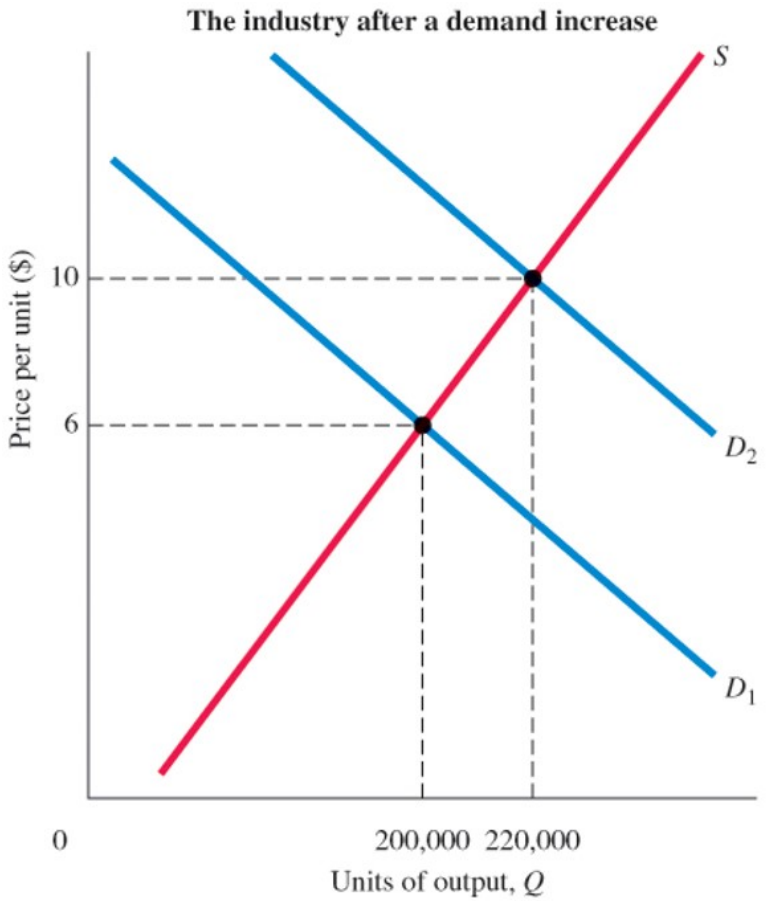
$$P = SRMC = SRAC = LRAC$$

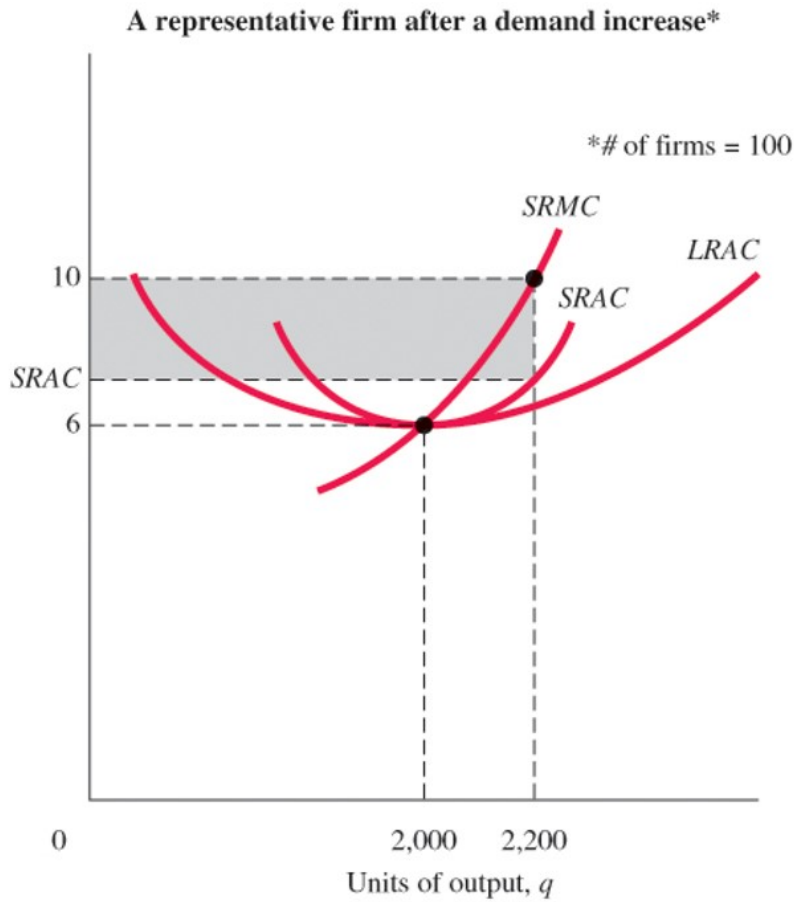
- Example: Green tea industry. At the beginning, it is an equilibrium.



# Long-run adjustments to short-run conditions

- Now suppose: There has been a news report on the health benefits of the tea. It leads to the demand increasing.



# Long-run adjustments to short-run conditions

- Other entrepreneurs observing the industry see the excess profits and enter. The industry supply curve shifts to the right. The price is back to \$6, there are no longer economic profits and no further entry.