LM 1 - Topics in Demand and Supply Analysis

KIA Fresh Graduates Program - Economics

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Learning Outcomes

The candidate should be able to:

1. calculate and interpret price, income, and cross-price elasticities of demand and describe factors that affect each measure;
2. compare substitution and income effects;
3. contrast normal goods with inferior goods;
4. describe the phenomenon of diminishing marginal returns;
5. determine and interpret breakeven and shutdown points of production;
6. describe how economies of scale and diseconomies of scale affect costs.

Overview

Overview

Demand

- Demand is the willingness and ability of consumers to purchase a given amount of a good or a service at a particular price.
- The quantity that consumers are willing to purchase depends on several factors.
- Most important factor is the product's own-price!
- Law of Demand: as the price of a product increases (decreases), consumers will be willing and able to purchase less (more) of it.

Demand Function

- A **demand function** is a mathematical expression that attempts to capture the variables that influence the demand for a good or service.
- These variables include for example own price, income level, other goods' price:

$$Q_x^d = f(P_x, I, P_y, ...)$$

- Often economists use simple linear functions as approximations.
- Example of Gazoline demand function:

$$Q_G^d = 7.5 - 0.5P_G + 0.1I - 0.05P_A$$

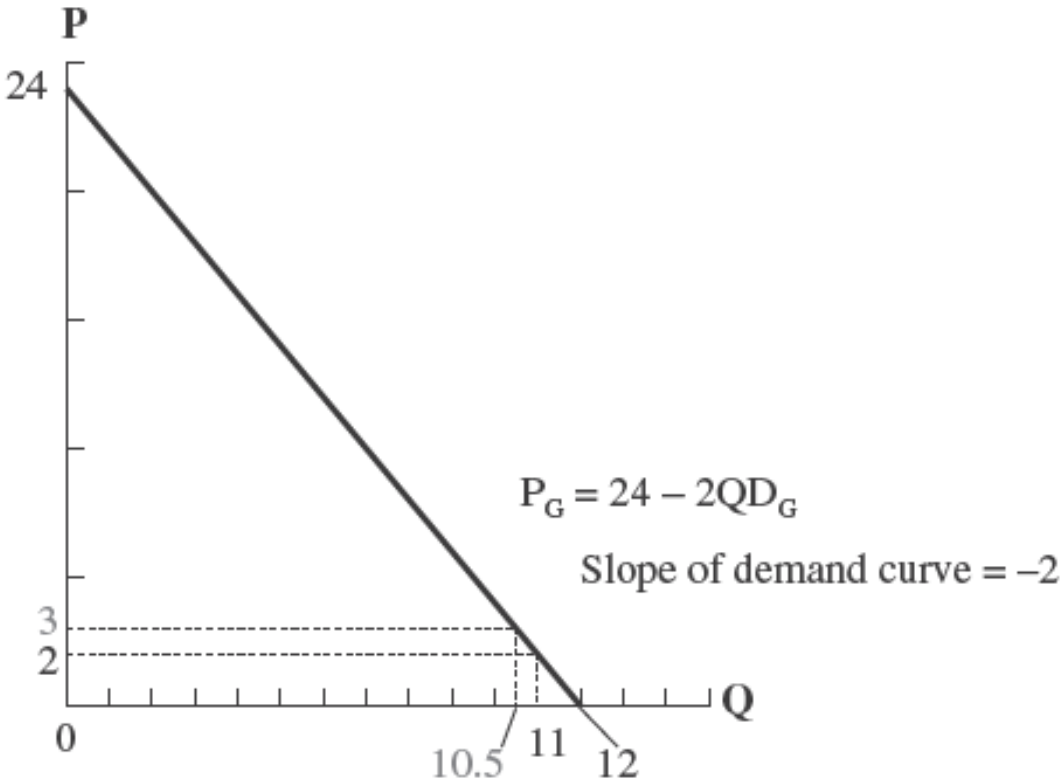
- We can focus on one of the variables by keeping the others constant. In our example, setting $I = 60$ and $P_A = 30$ yields

$$Q_G^d = 12 - 0.5P_G$$

- Solving for P_G as a function of Q_G^d yields the **inverse demand function**:

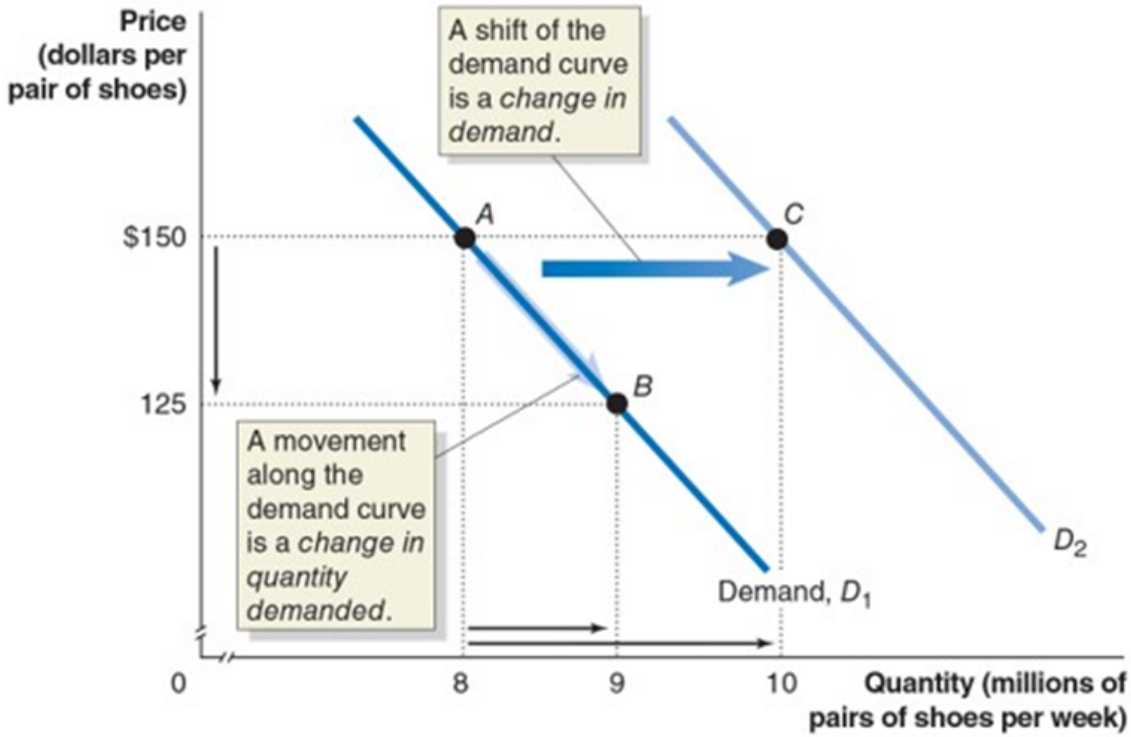
$$P_G = 24 - 2Q_G^d$$

Demand Curve



- The demand curve is a graphical depiction of the inverse demand function.
- It represents the highest quantity willingly purchased at each price as well as the highest price willingly paid for each quantity.

Change in Demand vs. Change in Quantity Demanded



- A movement along the demand curve (change in quantity demanded) happens when the good's price changes (keeping everything else constant).
- A shift of the demand curve (change in demand) happens when there is a change in anything else that affects demand.

Aggregating Demand Functions

- The aggregation of individual consumers' demand functions yields a **market demand function**.
- Going back to our Gazoline example, if we assume there are 1000 households in the market, we get

$$Q_G^D = 1000 \times Q_x^d = 12000 - 500P_G$$

- We can then get the market inverse demand function:

$$P_x = 24 - 0.002Q_x^D$$

Overview

Supply

- Supply refers to the willingness and ability of producers to sell a good or a service at a given price.
- In general, producers are willing to supply their output as long as the price is at least equal to the cost of producing an additional unit of output (marginal cost).
- The greater the (positive) difference between price and the cost of producing an additional unit, the greater the willingness to supply.

Supply Function

- Supply function captures the variables that affect the quantity supplied:

$$Q_x^s = f(P_x, W, ...)$$

- Example of Gazoline supply function for an individual supplier:

$$Q_G^s = -150 + 200P_G - 10W$$

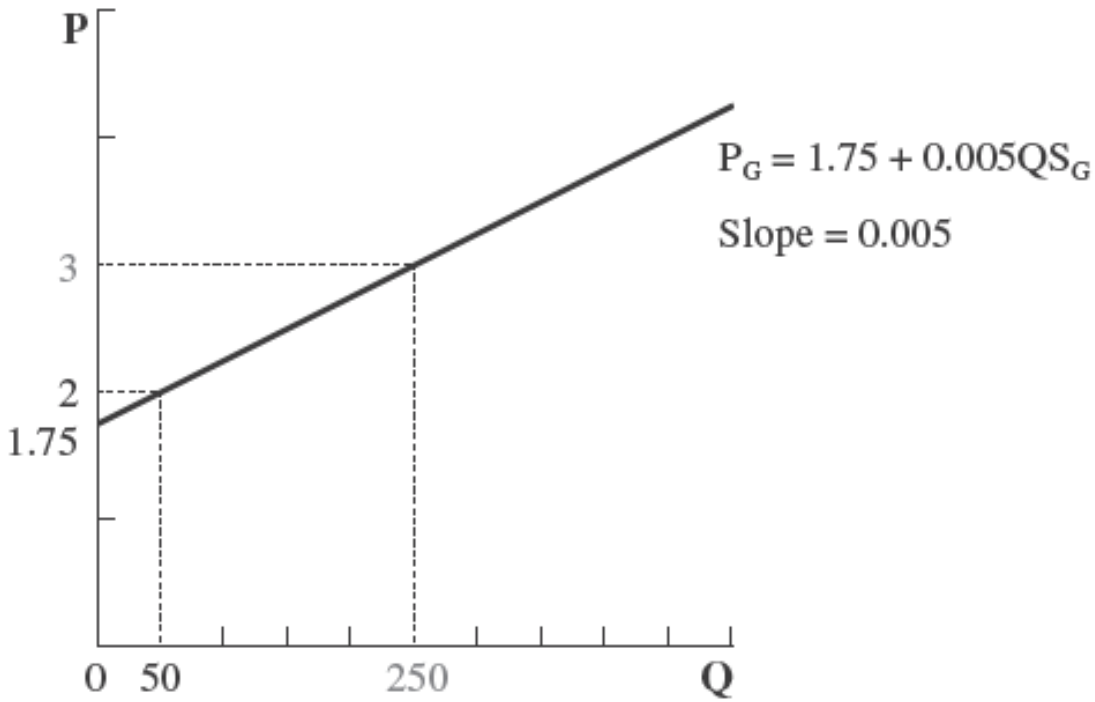
- To focus on price, we assume that the wage rate is constant at \$20 per hour:

$$Q_G^s = -350 + 200P_G$$

- Solving for P_x yields an inverse supply function:

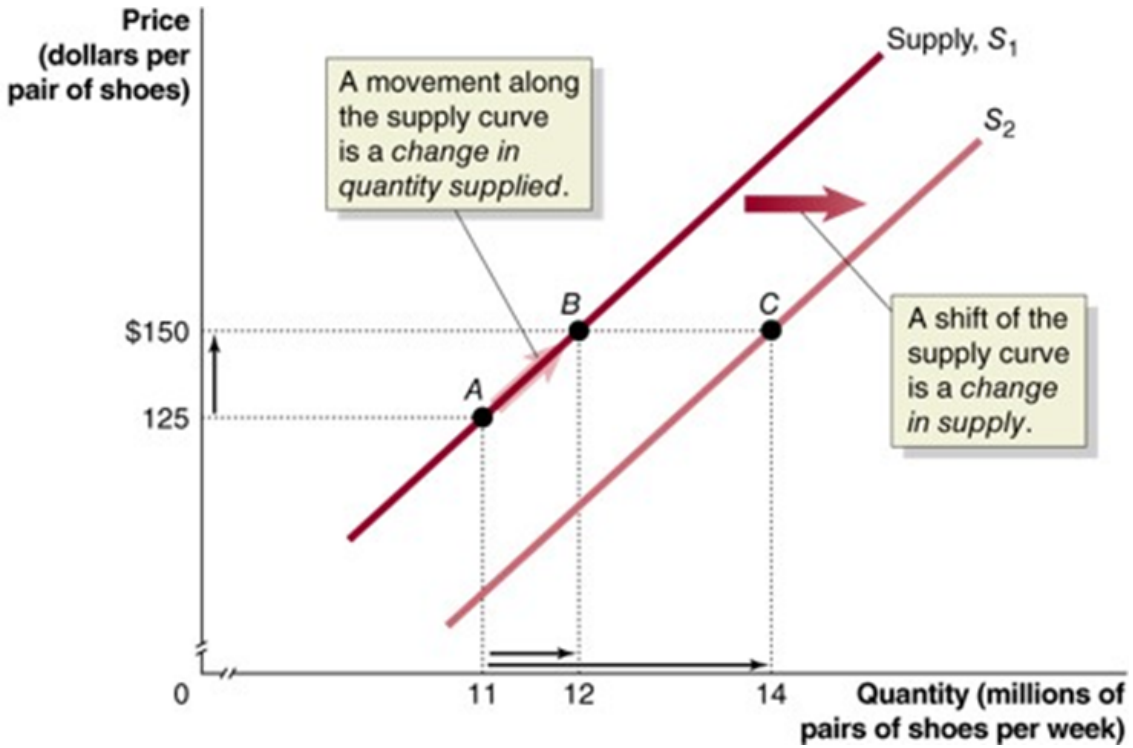
$$P_G = 1.75 + 0.005Q_G^s$$

Supply Curve



- The supply curve depicts the inverse supply function.
- The supply curve shows the highest quantity the seller is willing and able to supply at each price, and the lowest price at which the seller is willing and able to supply each quantity.

Change in Supply vs. Change in Quantity Supplied



- A movement along the supply curve (change in quantity supplied) happens when the good's price changes (keeping everything else constant).
- A shift of the supply curve (change in supply) happens when there is a change in anything else that affects supply.

Aggregating Supply Functions

- The aggregation of individual producers supply functions yields a **market supply function**.
- Going back to our Gazoline example, if we assume there are 20 identical suppliers in the market, we get

$$Q_G^S = 20 \times Q_G^s = -7000 + 4000 P_G$$

- We can then get the market inverse supply function:

$$P_G = 1.75 + 0.00025 Q_G^S$$

Overview

Market Equilibrium

- Market equilibrium is a situation in which quantity demanded equals quantity supplied.
- It occurs at the point of intersection between the market demand and supply curves.
- We can determine the point of equilibrium by equating the market (inverse) demand function to the market (inverse) supply function.

Market Equilibrium

- Back to our Gasoline example:

$$12000 - 500P_G = -7000 + 4000P_G$$

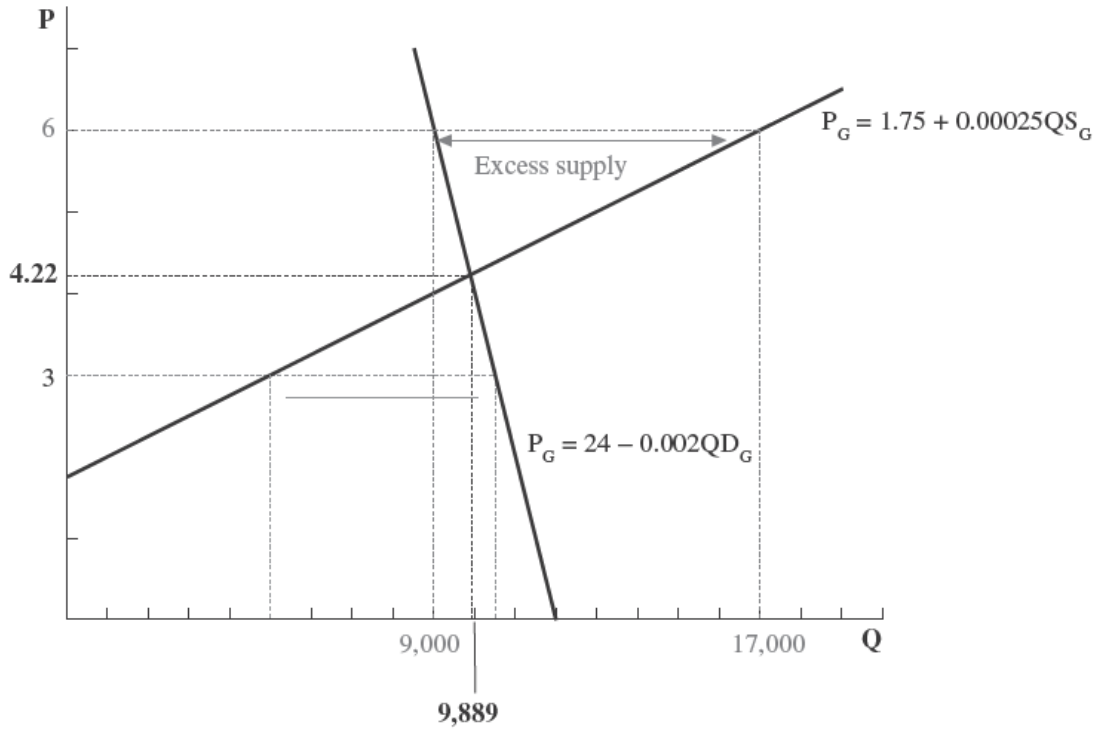
- We can then solve for the equilibrium price

$$P_G = 4.22$$

- We can recover the equilibrium quantity using either of the inverse demand or supply functions:

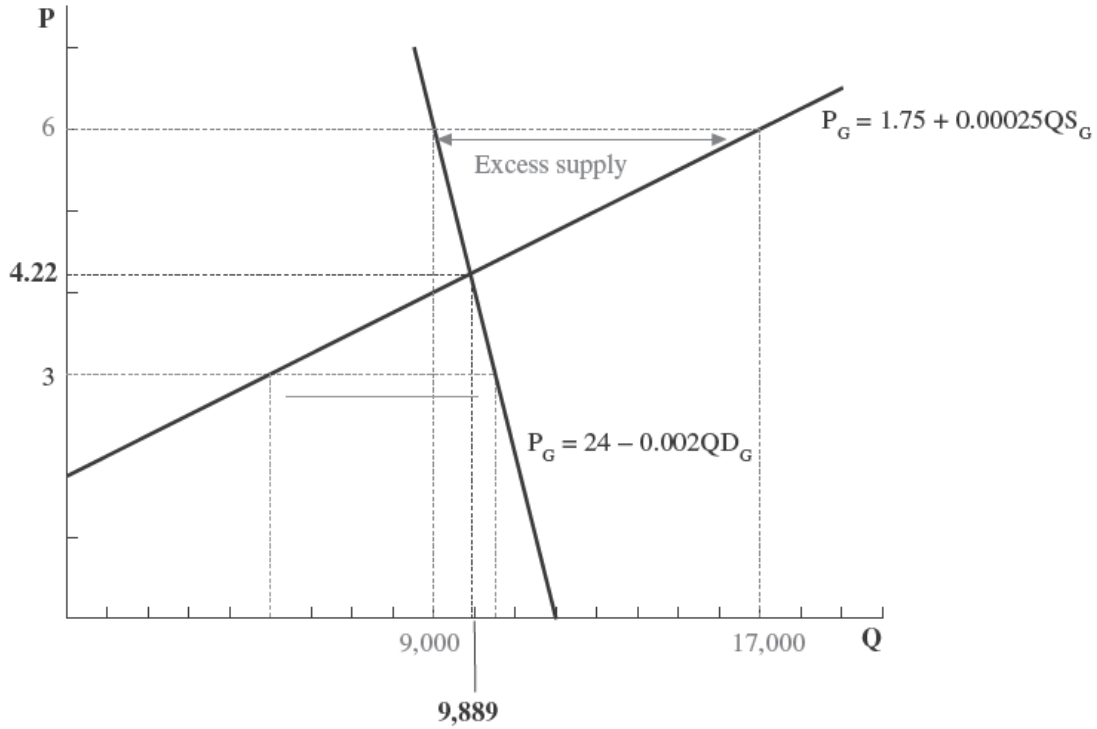
$$Q_G = 9888.89$$

Excess Demand and Excess Supply



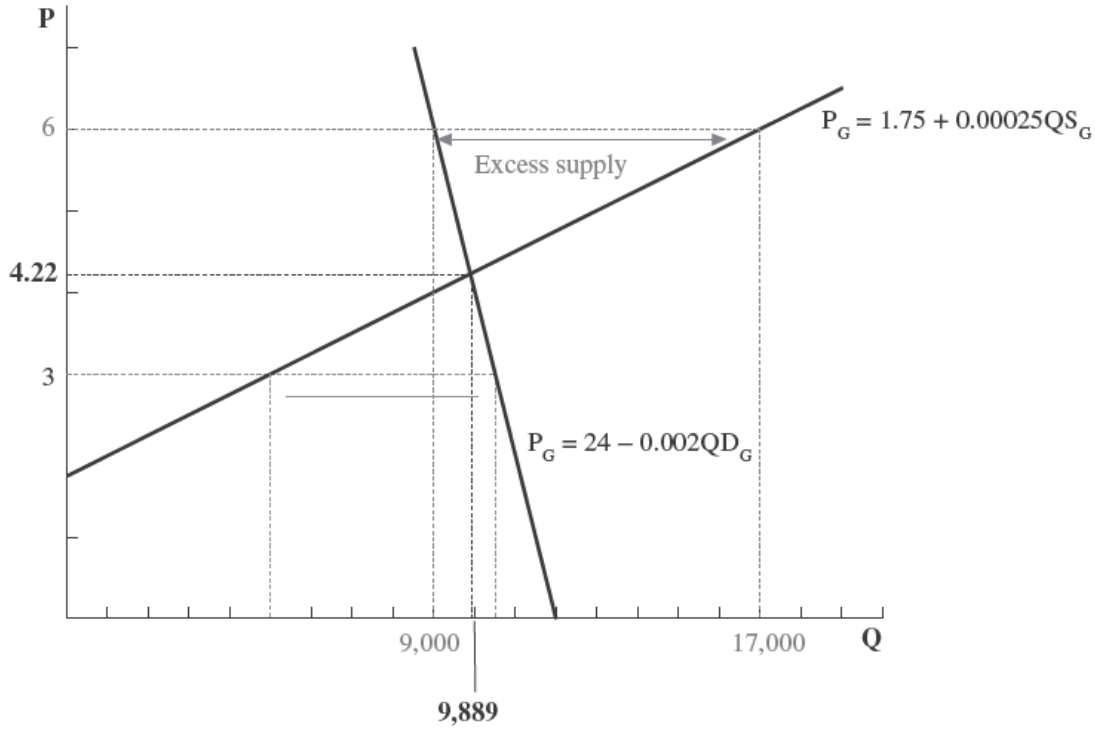
- Suppose that the price is actually \$6.
- Quantity demanded and quantity supplied would equal to 9,000 and 17,000 respectively.
- Since quantity supplied is greater than quantity demanded at this price, there is excess supply of gasoline.

Excess Demand and Excess Supply



- Suppose the price is actually \$3.
- Quantity demanded and quantity supplied would equal 10,500 and 5,000 respectively.
- Since quantity demanded is greater than quantity supplied at this price, there is a shortfall (excess demand) of gasoline.

Excess Demand and Excess Supply



- In both situation, once market prices have deviated (for whatever reason) from equilibrium levels, the market mechanism would direct the market back toward equilibrium over time.

Equilibrium Effects of Shifts in Demand and Supply Curves

	Supply Curve Unchanged	Supply Curve Shifts to the Right	Supply Curve Shifts to the Left
Demand Curve Unchanged	Q unchanged P unchanged	Q increases P decreases	Q decreases P increases
Demand Curve Shifts to the Right	Q increases P increases	Q increases P increases, decreases, or is Unchanged	Q increases, decreases, or is unchanged P increases
Demand Curve Shifts to the Left	Q decreases P decreases	Q increases, decreases, or is unchanged P decreases	Q decreases P increases, decreases, or is unchanged

Overview

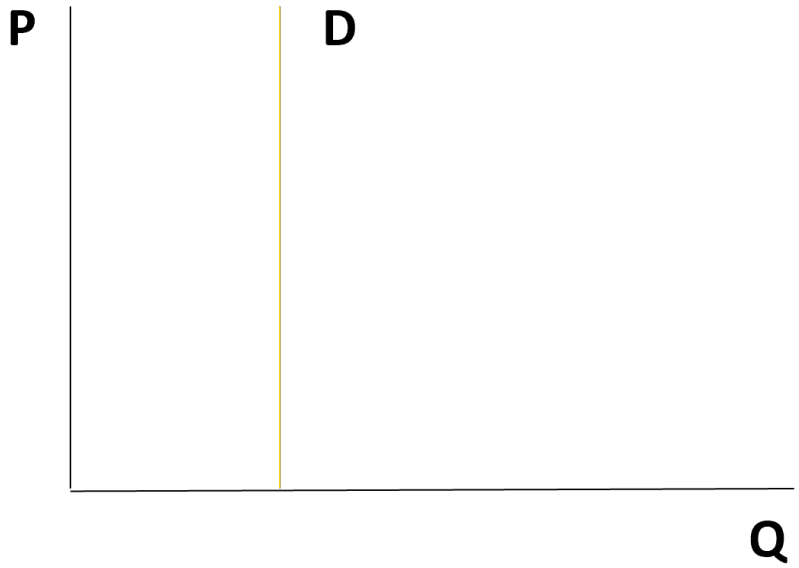
Own-Price Elasticity of Demand

- **Own-Price Elasticity of Demand** is a measure of how the quantity demanded changes (in %) in response to a (1%) change in its price:

$$\text{Own-Price Elasticity} = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}}$$

- The demand is said to be **elastic** when it reacts more than one-to-one to a change in price, i.e. $|\text{Own-Price Elasticity}| > 1$.
- The demand is said to be **inelastic** if it reacts less than one-to-one to a change in price, i.e. $|\text{Own-Price Elasticity}| < 1$.
- The demand is said to be **unit elastic** if it reacts one-to-one to a change in price, i.e. $|\text{Own-Price Elasticity}| = 1$.

Extremes of Price Elasticity



(a) Perfectly inelastic demand (elasticity $= 0$)

(b) Perfectly elastic demand (elasticity $= \infty$)

Factors Affecting Price Elasticity of Demand

- Availability and closeness of substitutes.
  - Few or no substitutes $\rightarrow$ Demand is relatively inelastic.
  - One or more substitutes $\rightarrow$ Demand is relatively elastic.
- Portion of income spent on a good.
  - The larger the portion of income that is spent on a good, the more elastic the demand for that good will be.
- Time allowed to respond to change in price.
  - Price elasticity tends to be greater, the longer the time elapsed since the price change.
- Discretionary or non-discretionary
  - The more a good is seen as a necessity, the less elastic its demand is likely to be.

Income Elasticity of Demand

- **Income Elasticity of Demand** is a measure of how the quantity demanded changes (in %) in response to a (1%) change in consumer income:

$$\text{Income Elasticity} = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in income}}$$

- Income elasticity can be positive, negative or zero.
- Normal goods: An increase in income will lead to an increase in demand, i.e. Income Elasticity > 0.
- Inferior goods: An increase in income will lead to a decrease in demand, i.e. Income Elasticity < 0.
- Changes in income shift the demand curve.

Cross-Price Elasticity of Demand

- **Cross-Price Elasticity of Demand** is a measure of how the quantity demanded of one good changes (in %) in response to a (1%) change in the price of another good:

$$\text{Cross-Price Elasticity} = \frac{\%\text{ change in quantity demanded of good 1}}{\%\text{ change in price of good 2}}$$

- Substitute goods: An increase in the price of good 2 will lead to an increase in the demand of good 1, i.e. Cross-Price Elasticity > 0.
- Complement goods: An increase in the price of good 2 will lead to an decrease in the demand of good 1, i.e. Cross-Price Elasticity < 0.

Income Effect vs. Substitution Effect

- When the price of a good falls, that good becomes relatively less costly compared to other goods $\rightarrow$ **substitution effect** shifts consumption towards more of that good (always positive)
- When the price of a good falls, total expenditure decreases (higher purchasing power) $\rightarrow$ **income effect** can result in more or less consumption of the good.
- Three possible cases for the net effect of a decrease in price:
  1. Both substitution and income effects are positive $\rightarrow$ Consumption of the good will increase.
  2. Income effect is negative but not large enough to dominate substitution effect $\rightarrow$ Consumption of the good will increase.
  3. Income effect is negative and large enough to dominate substitution effect $\rightarrow$ Consumption of the good will decrease.

Special Types of Goods

- Veblen good: A good for which a higher price can make it more desirable (e.g. luxury goods). $\rightarrow$ The demand curve can be upward sloping over a certain price range.
- Giffen good: An inferior good for which the negative income effect outweighs the positive substitution effect $\rightarrow$ the demand curve is upward sloping. (e.g. potatoes during the Irish Great Famine)

Overview

Production and Costs

- Cost of production depends on the amount of inputs (factors of production) and input prices.
- Examples of inputs: employee hours, machine hours, raw materials, etc.
- To keep things simple, economists typically focus on two inputs: labor, L, and capital, K.
- In this simple case, total cost is given by

$$TC = wL + rK$$

- Input productivity measures output per unit of input.
- Cost minimization and profit maximization require maximizing productivity.

Total, Average and Marginal Product

- Total product: sum of the output from all inputs during a period of time, typically denoted Q.
- Average product: total product divided by the quantity of a given input, e.g. Q/L.
- Marginal product: the additional production output resulting from a one unit increase in input keeping other inputs constant.
- Marginal product of labor:

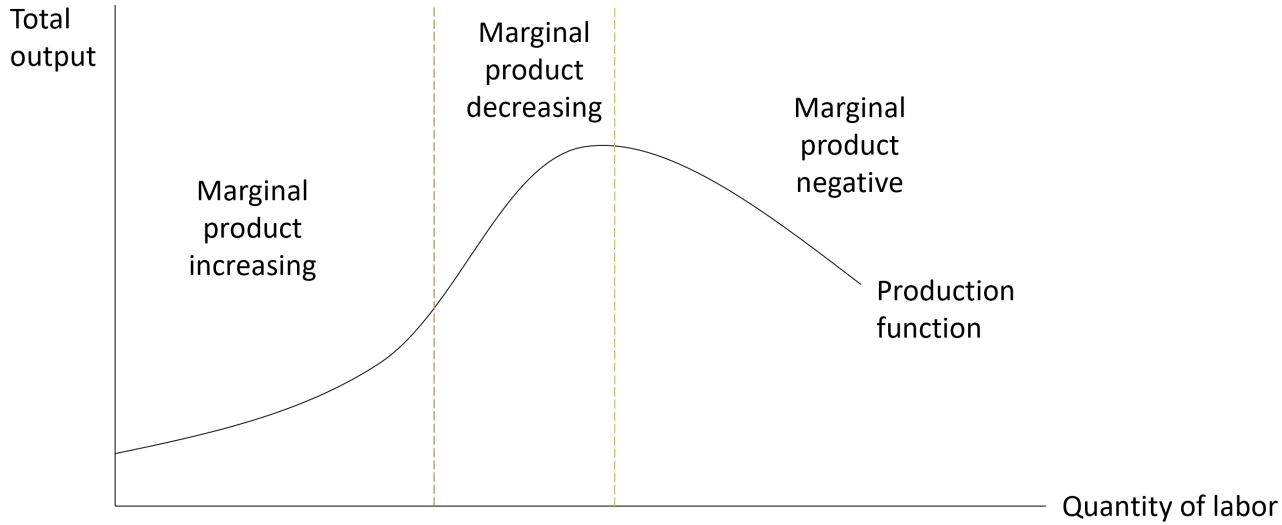
$$MPL = \frac{\Delta Q}{\Delta L}$$

- Diminishing marginal returns occur when the addition of an incremental unit of one production input, keeping other inputs constant, results in a progressively smaller increase in output.

Total, Average and Marginal Product: Example

	Output (Q)	Number of Worker Hours (L)	Average Product of Labor (AP_L)
Company A	100,000	100	1,000
Company B	180,000	200	900
Company C	200,000	250	800

Increasing vs. Diminishing Marginal Returns



- Increasing marginal returns occur when the addition of an incremental unit of one production input, keeping other inputs constant, results in a progressively larger increase in output.
- Diminishing marginal returns occur when the addition of an incremental unit of one production input, keeping other inputs constant, results in a progressively smaller increase in output.

Total, Average and Marginal Product: Example

Labor (L)	Total Product (Q_L)	Average Product (AP_L)	Marginal Product (MP_L)
0	0	—	—
1	100	100	100
2	210	105	110
3	300	100	90
4	360	90	60
5	400	80	40
6	420	70	20
7	350	50	–70

Economic Profit vs. Accounting Profit

- Economic Profit = Total Revenue - Economic Cost.
- Accounting Profit = Total Revenue - Accounting Cost.
- Economic Cost is forward looking and relies on the concept of opportunity cost.
- Opportunity cost is the benefit foregone by not implementing the next best alternative.
- Economic Cost includes shareholders' required return.

Profit Maximization

- Firm's management objective is to maximize shareholders' wealth.
- This is done by maximizing economic profit.
- Two very important concepts for profit maximization:
  - Marginal revenue;
  - Marginal cost.

Marginal Revenue

- Marginal revenue (MR) is the additional revenue the firm realizes from the decision to increase output by one unit per time period:

$$MR = \frac{\Delta TR}{\Delta Q} = \frac{\Delta(P \times Q)}{\Delta Q}$$

- It's easy to show that for a very small ΔQ we can write:

$$MR \approx \frac{P \times \Delta Q + \Delta P \times Q}{\Delta Q} = P + \frac{\Delta P}{\Delta Q} Q$$

- Relationship between MR and P depends on the slope of the demand curve facing the firm $\frac{\Delta P}{\Delta Q}$.
- This in turn depends on the structure of market competition between firms.

Marginal Revenue

- Under perfect competition, firm faces perfectly elastic (firm-specific) demand curve $\Rightarrow \frac{\Delta P}{\Delta Q} = 0$.
- In this case firm can sell as much as it wants at the market price $\Rightarrow MR = P$.
  - Setting price above market price implies no sales.
  - Firm has no incentive in selling below market price.
- Under imperfect competition, firm faces negatively sloped (market) demand curve $\Rightarrow \frac{\Delta P}{\Delta Q} < 0$.
- Firm must lower the price in order to sell an additional unit $\Rightarrow MR < P$.

Marginal Cost

- Marginal cost (MC) is the increase to total cost resulting from the firm's decision to increase output by one additional unit per time period:

$$MC = \frac{\Delta TC}{\Delta Q}$$

- Economists usually distinguish between short-run marginal cost (SMC) and long-run marginal cost (LMC).
- Over the short run, labor (L) is assumed to be variable while capital (K) is assumed to be constant.
- Over the long run, all inputs are assumed to be variable.

Marginal Cost

- When the change in output is very small, SMC can be written as:

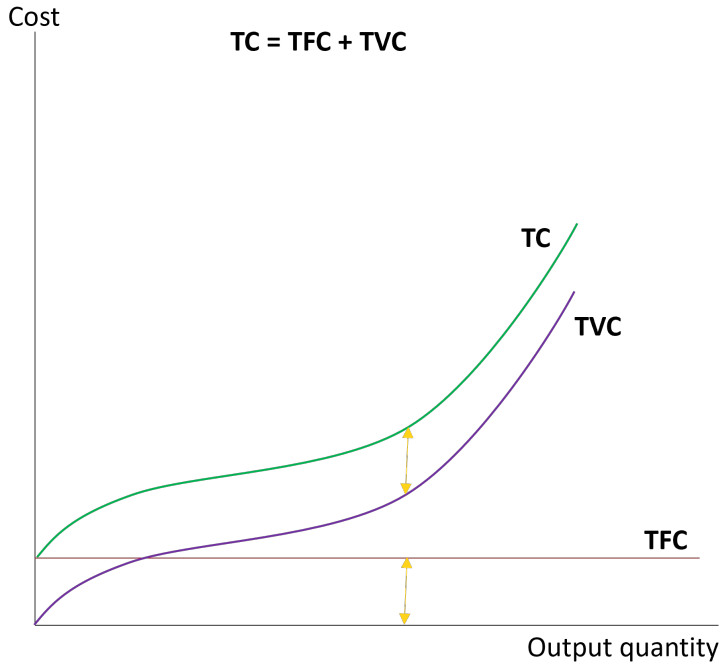
$$SMC \approx \frac{w}{MPL}$$

- SMC is decreasing in labor productivity and increasing in the wage rate.
- Increasing marginal returns to labor imply a decreasing SMC.
- Diminishing marginal returns to labor imply an increasing SMC.

Profit Maximization

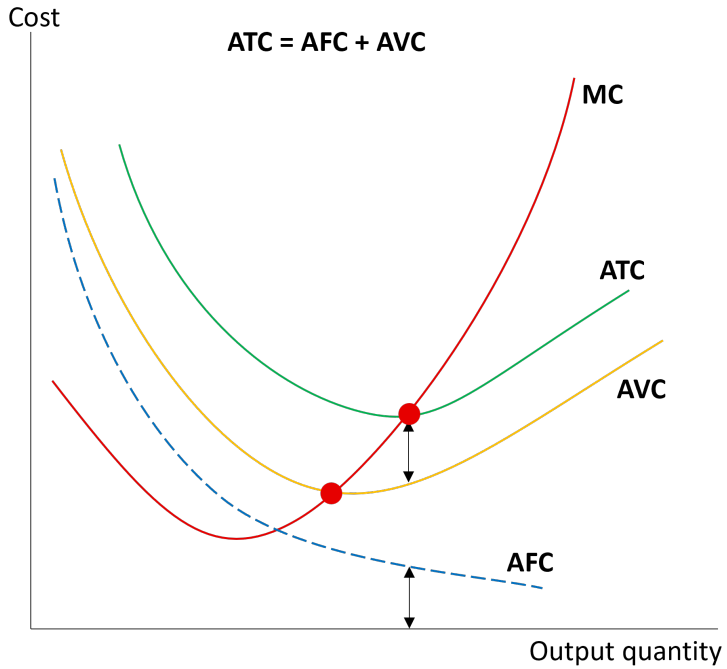
- What is the quantity of production that maximizes profit?
- An additional unit of output increases profit if $MR > MC \Rightarrow$ Firm should increase output.
- An additional unit of output reduces profit if $MR < MC \Rightarrow$ Firm should lower output.
- A profit maximizing firm should increase output until $MR = MC$ (first-order condition) and MC is not falling (second-order condition).

Total Costs



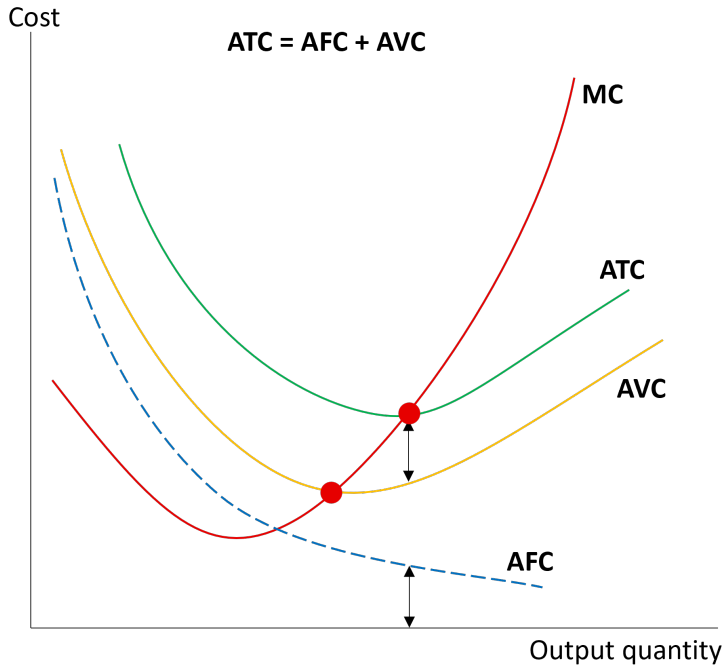
- Total fixed cost (TFC): costs that do not vary with the quantity of output and cannot be avoided over the period of analysis.
- Total variable cost (TVC): costs that vary with output over the period of analysis.
- Total cost (TC): the sum of fixed and variable costs.

Average Costs



- Average fixed cost (AFC) $= \frac{\text{TFC}}{\text{Q}}$
- Average variable cost (AVC) $= \frac{\text{TVC}}{\text{Q}}$
- Average total cost (ATC) $= \frac{\text{TC}}{\text{Q}} = \text{AFC} + \text{AVC}$

Relationship between Production and Costs

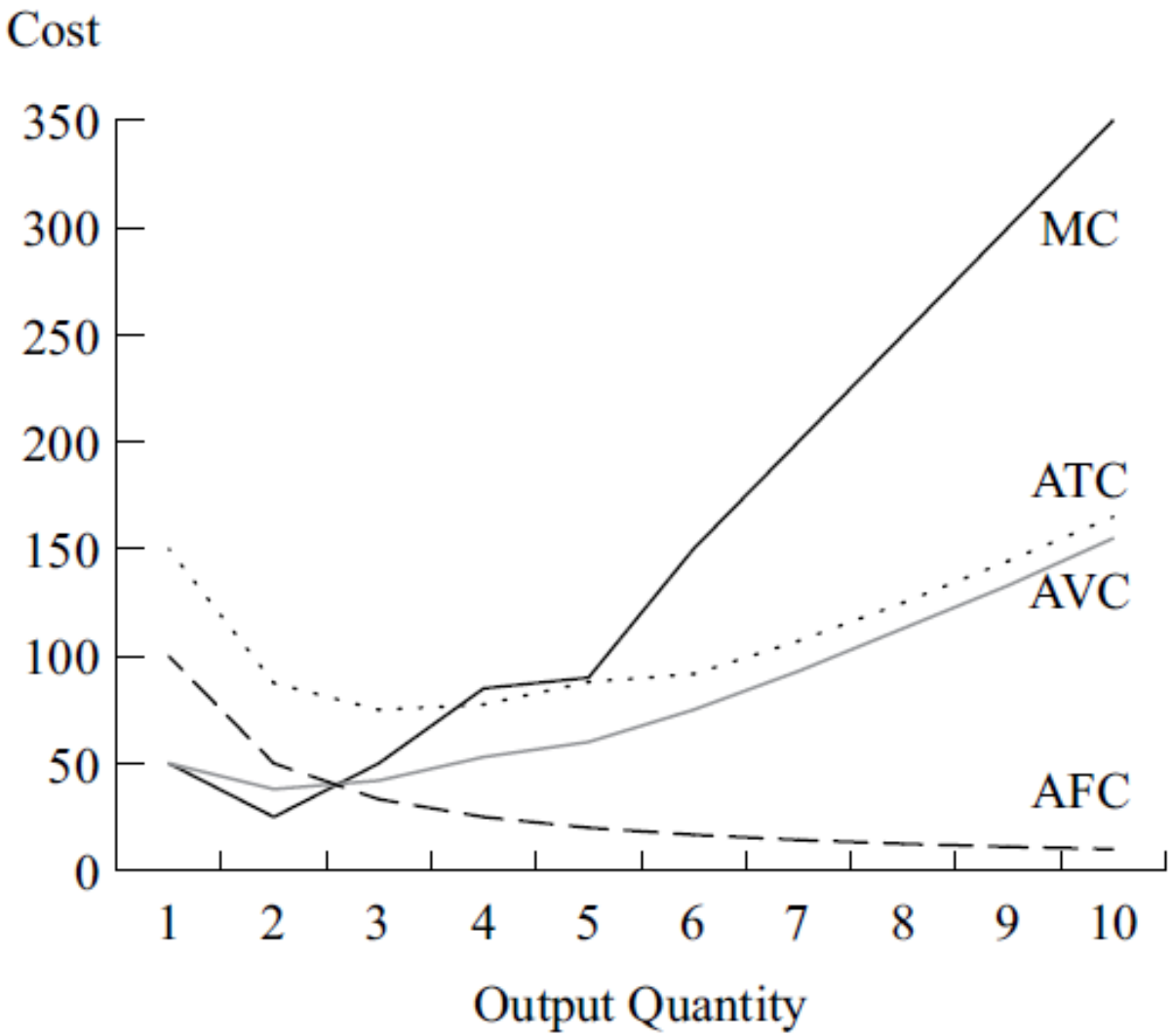


- As output increases, AFC decreases as TFC are spread over a larger quantity.
- MC intersects both ATC and AVC in their minimum points.
- When MC is below AVC, AVC is decreasing. When MC is above AVC, AVC is increasing.

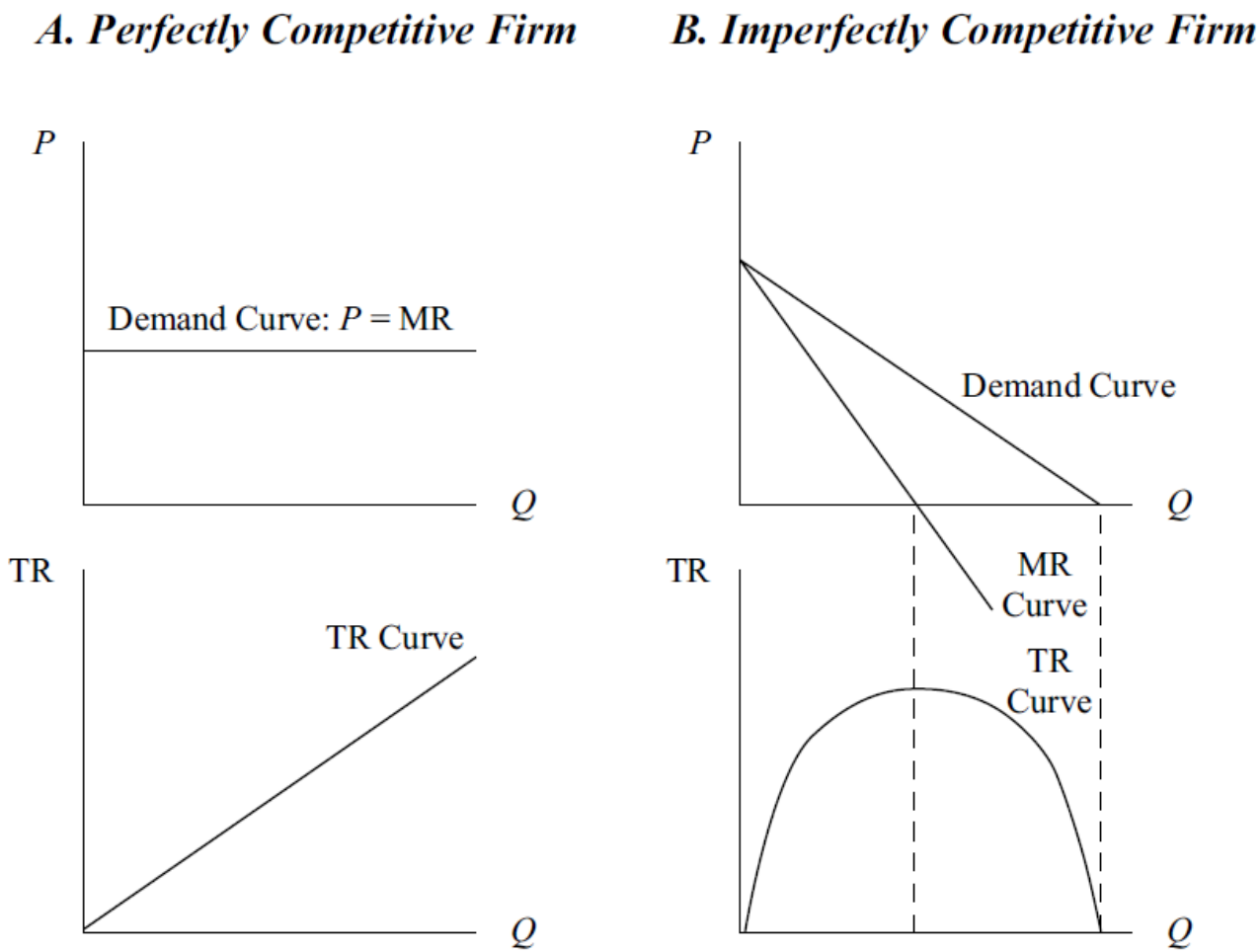
Relationship between Production and Costs: Example

Quantity (Q)	TFC[a]	AFC	TVC	AVC	TC	ATC	MC
0	100	—	0	—	100	—	—
1	100	100.0	50	50.0	150	150.0	50
2	100	50.0	75	37.5	175	87.5	25
3	100	33.3	125	41.7	225	75.0	50
4	100	25.0	210	52.5	310	77.5	85
5	100	20.0	300	60.0	400	80.0	90
6	100	16.7	450	75.0	550	91.7	150
7	100	14.3	650	92.9	750	107.1	200
8	100	12.5	900	112.5	1,000	125.0	250
9	100	11.1	1,200	133.3	1,300	144.4	300
10	100	10.0	1,550	155.0	1,650	165.0	350

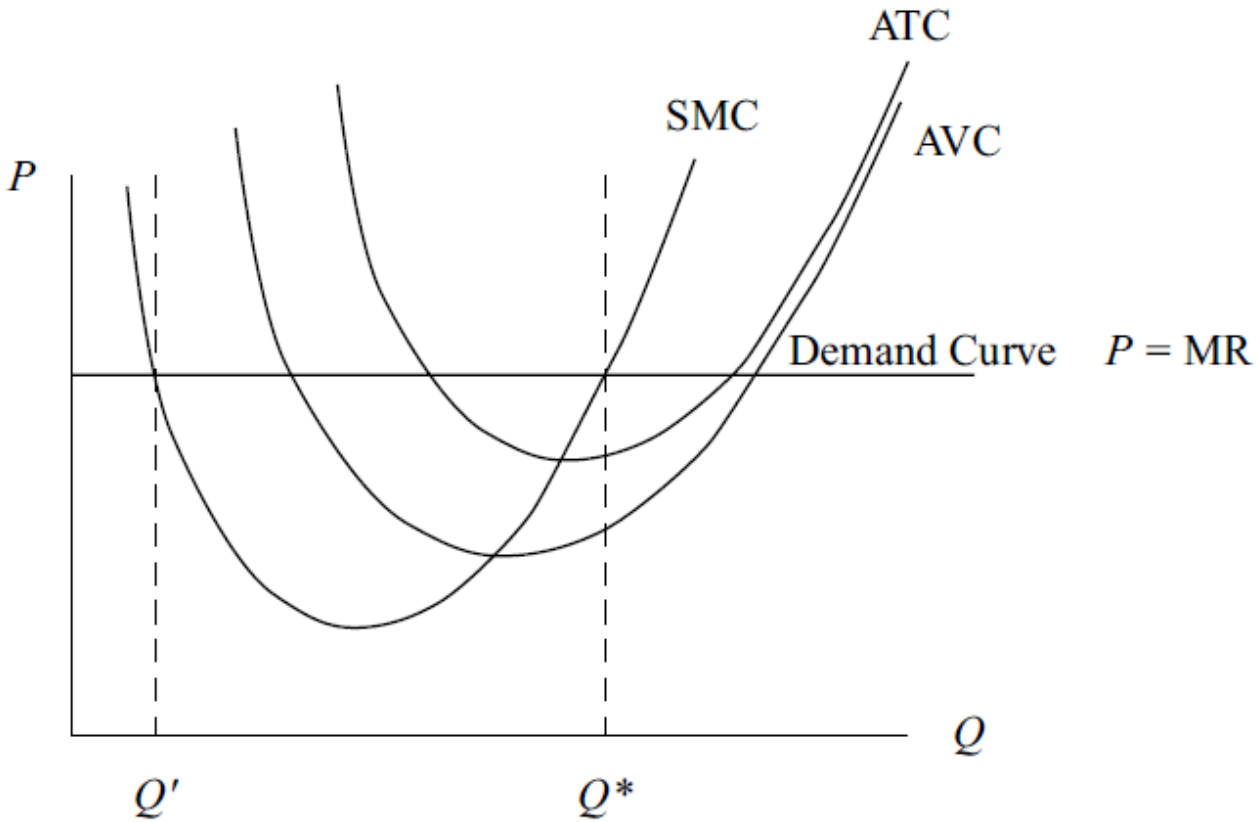
Relationship between Production and Costs: Example



Perfect vs. Imperfect Competition

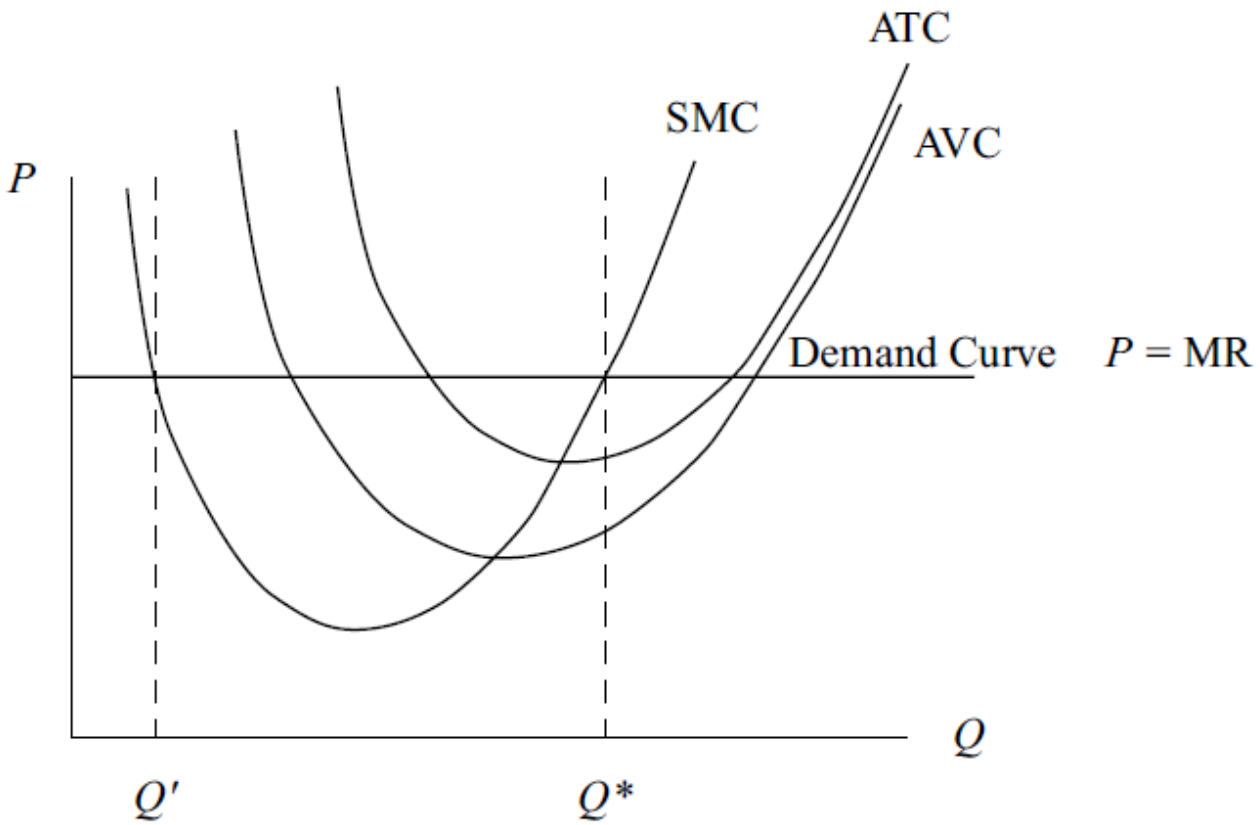


Profit Maximization under Perfect Competition



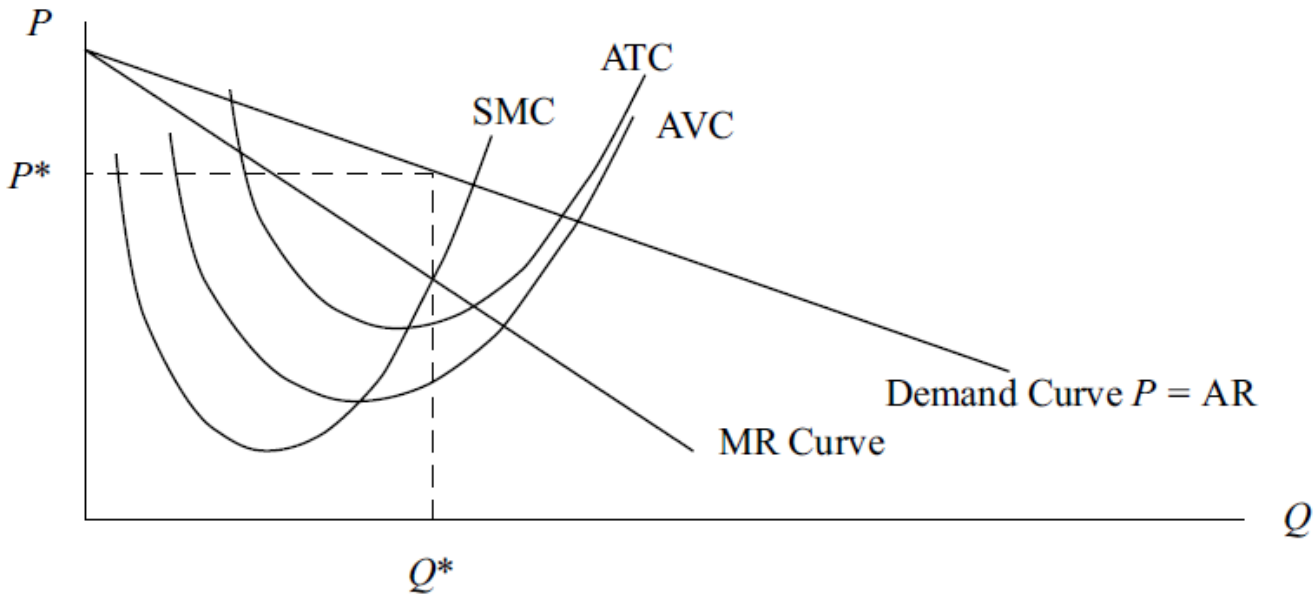
- Firm maximizes profits by producing Q^* where $SMC = MR = P$ and SMC is increasing.
- Shifts in the demand curve result in changes in Q^*.

Profit Maximization under Perfect Competition



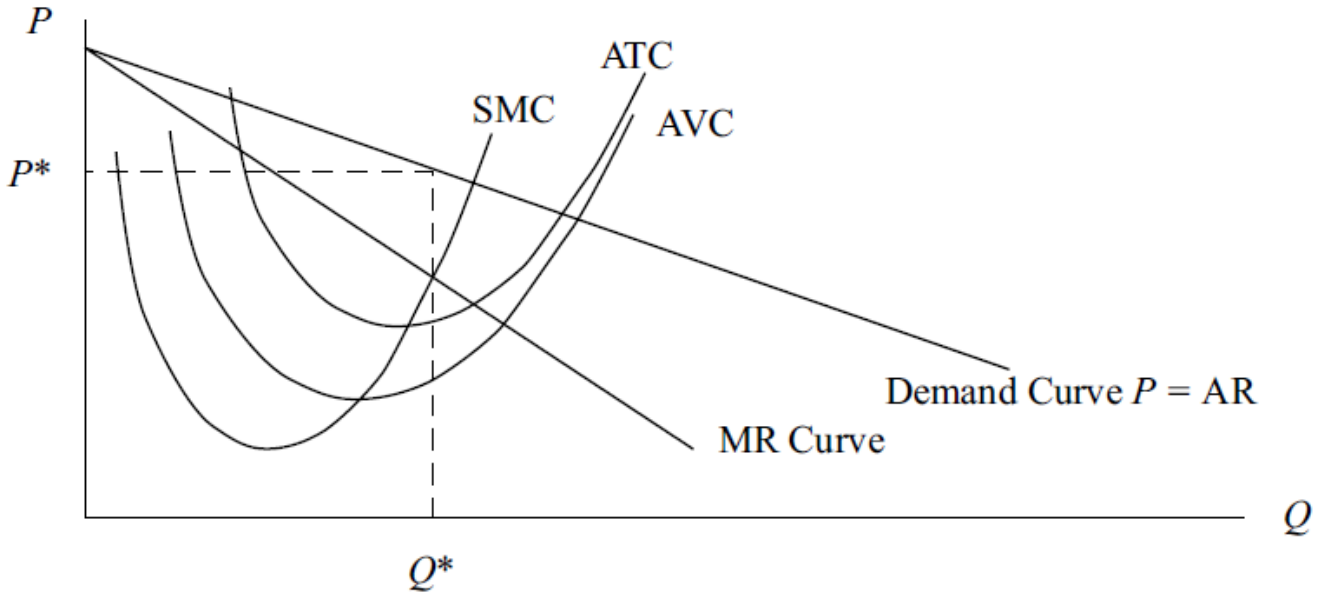
- In the short run, firm is earning a positive economic profit at Q^* since $ATC < P$.
- In the long run, entry of new competitors will shift demand curve down to the level where $P = ATC = MC \Rightarrow$ economic profit $= 0$.

Profit Maximization under Imperfect Competition



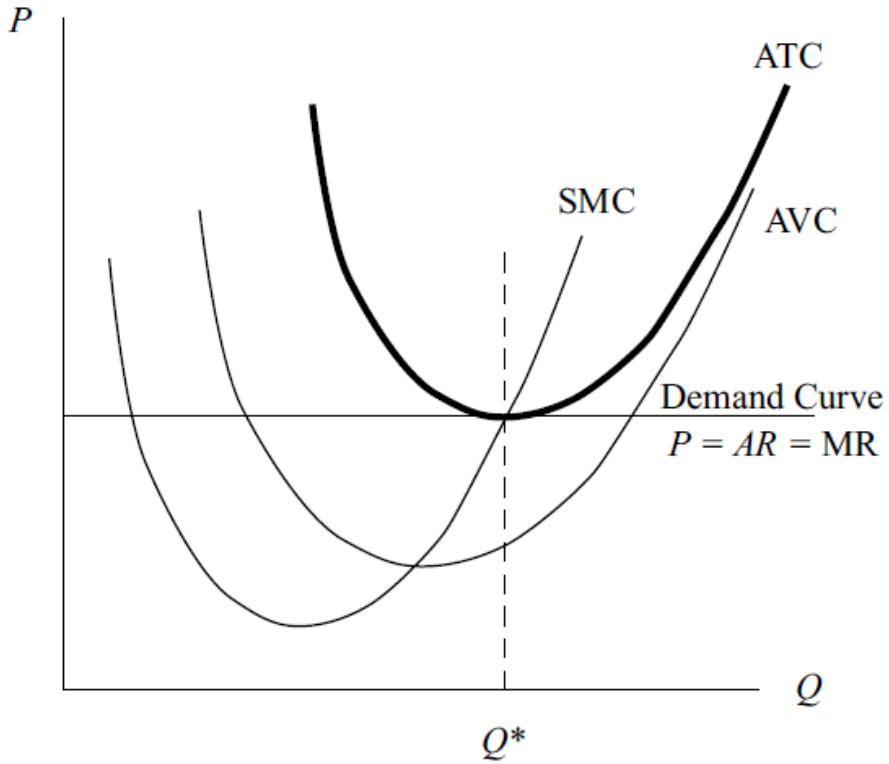
- Firm maximizes profits by producing Q^* where $SMC = MR$ and SMC is increasing.
- Once Q^* is determined, the optimal price P^* is determined on the demand curve.
- Shifts in the demand curve result in shifts in MR curve and changes in Q^*.

Profit Maximization under Imperfect Competition



- Monopolist firm is earning a positive economic profit at Q^* since $ATC < P^*$.
- Barriers to entry prevent new competitors from entering the market and keep economic profits positive in the long run.

Breakeven under Perfect Competition



- A firm is said to **breakeven** if $TR = TC \Rightarrow AR = ATC$.
- At the breakeven point, the firm covers its economic costs (accounting costs + implicit opportunity costs) and just earns a normal profit (zero economic profits).

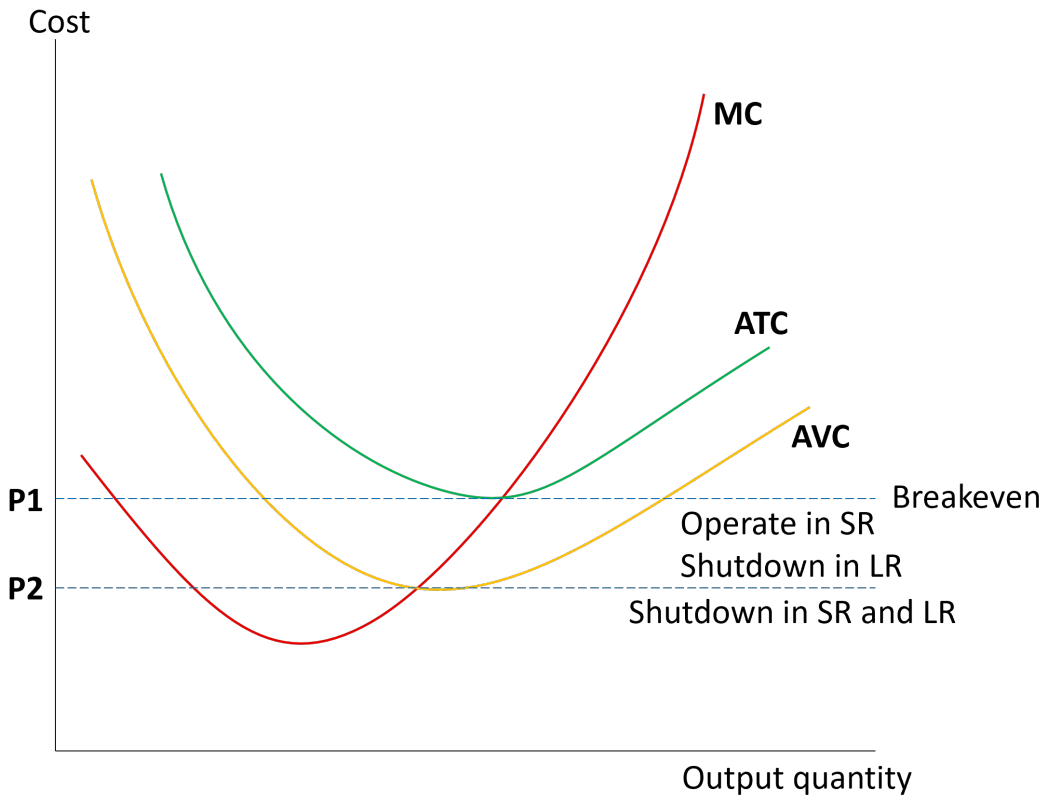
Shutdown and Breakeven Under Perfect Competition

- We need to distinguish between breakeven analysis in the **short run (SR)** and in the **long run (LR)**.
  - Short run (SR): time period over which some factors of production (costs) remain fixed.
  - Long run (LR): time period over which all factors of production (costs) are considered variable i.e. can be adjusted.
- In the LR, a firm will not operate if it cannot earn at least zero economic profit.
- In the SR, a firm might find it advantageous to operate even if it cannot earn at least zero economic profits.
- The difference stems from the fact that fixed costs are considered "sunk costs" in the SR.

Short Run Example

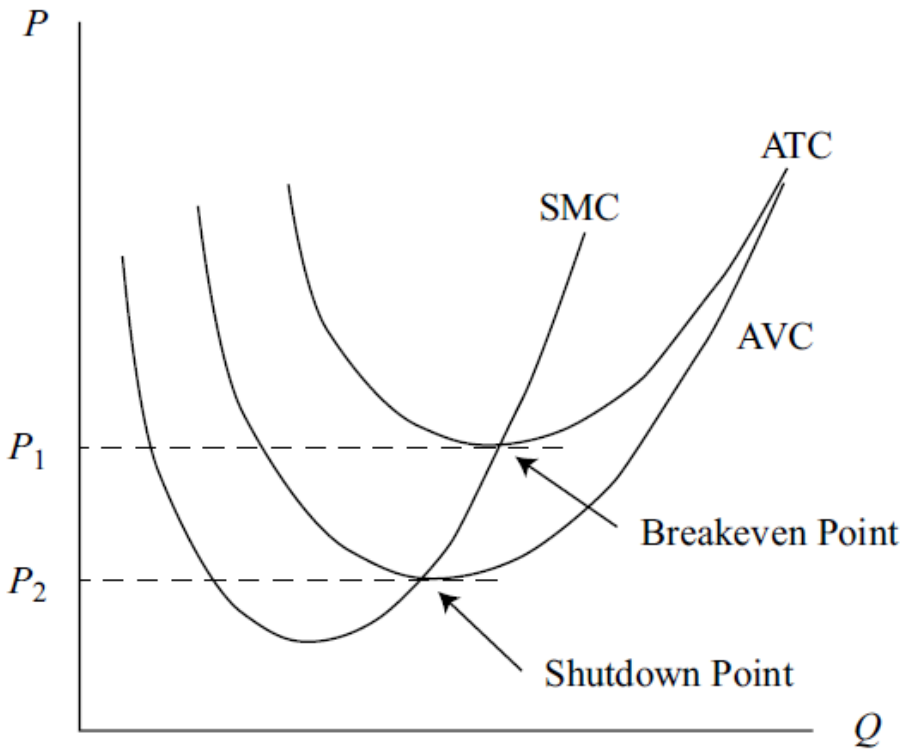
- Firm is producing 100 units sold at a price of 4\$.
- TR = 400\$.
- Assume at $Q = 100$, $AVC = 3.75$ and $AFC = 3.25$
- $ATC = AVC + AFC = 7$
- Firm is earning negative economic profits of 300\$ (economic loss).
- Should the firm shut down immediately?
- Assume fixed cost is unavoidable: $TFC = 325$.
- If firm shuts down without producing $\Rightarrow$ Economic profit = -325\$.
- If the firm continues to operate $\Rightarrow$ Economic profit = -300\$.
- The loss is lower because revenues from production cover TVC and part of TFC.
- The key point here is that TFC for the period is already incurred and the firm can cover part of it by operating.

Shutdown and Breakeven Under Perfect Competition



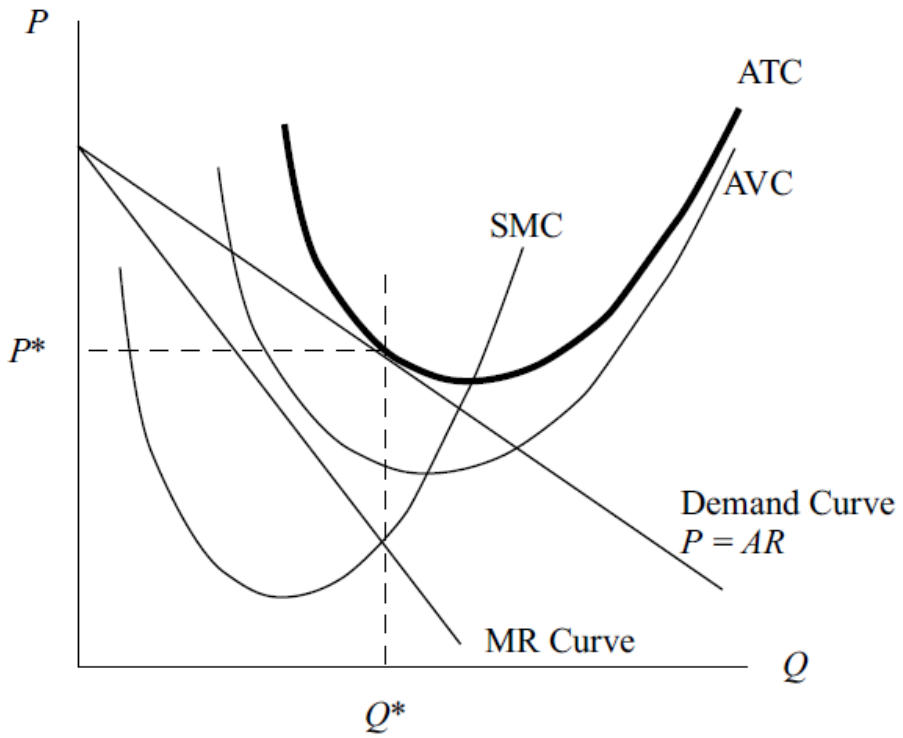
- If P $\geq$ ATC: the firm should operate in both SR and LR.
- If P $\geq$ AVC but P $<$ ATC: the firm should operate in SR but exit in LR.
- If P $<$ AVC: the firm should shutdown in SR and exit in LR.

Shutdown and Breakeven Under Perfect Competition



- Breakeven point = minimum ATC.
- Shutdown point = minimum AVC.

Shutdown and Breakeven Under Imperfect Competition



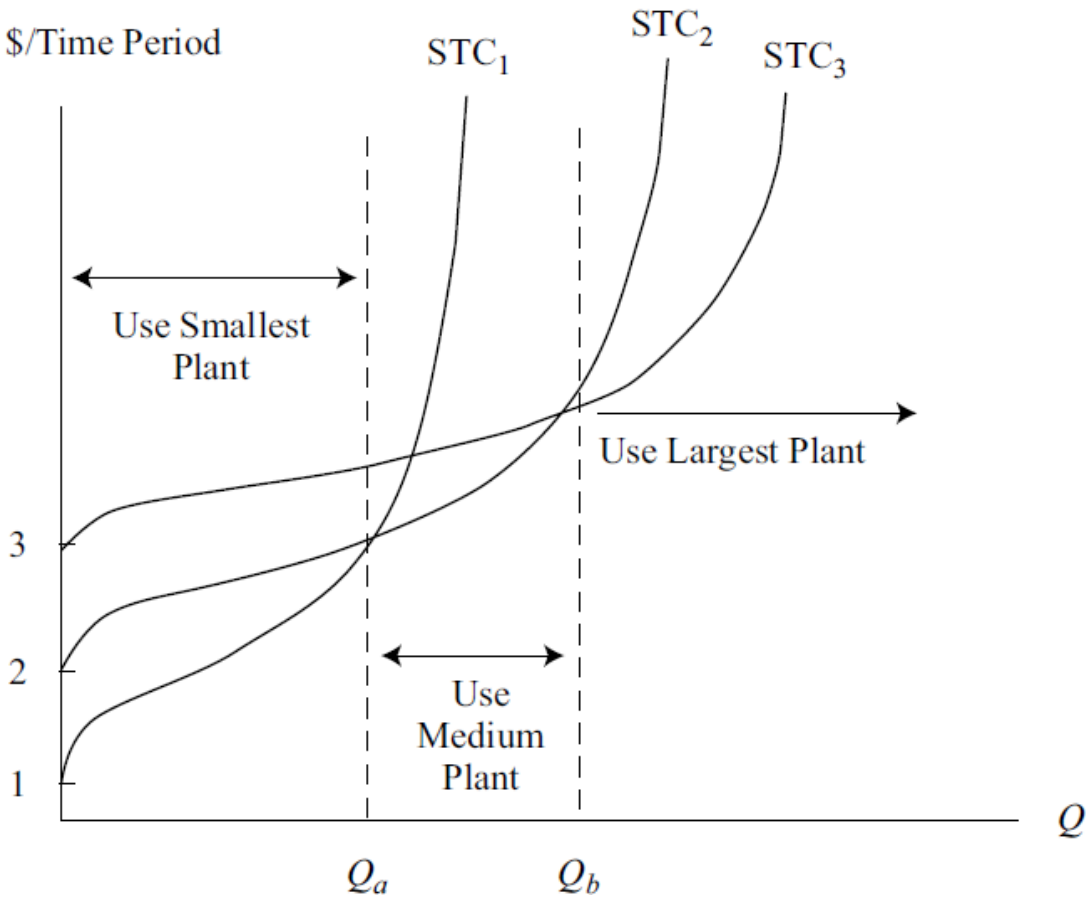
- If P $\geq$ ATC: the firm should operate in both SR and LR.
- If P $\geq$ AVC but P $<$ ATC: the firm should operate in SR but exit in LR.
- If P $<$ AVC: the firm should shutdown in SR and exit in LR.

Shutdown and Breakeven Under Imperfect Competition

- Analysis can also be done in terms of TR, TC and TVC.

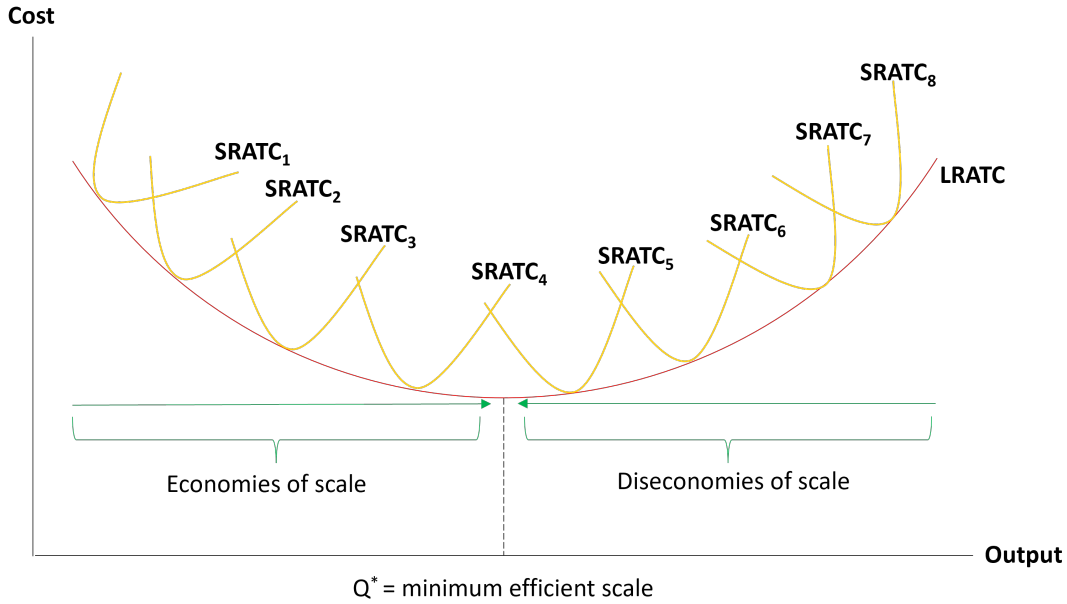
Situation	**SR decision**	**LR decision**
TR $\geq$ TC	Stay in market	Stay in market
TR $\geq$ TVC but TR $<$ TC	Stay in market	Exit market
TR $<$ TVC	Shut down production	Exit market

Short Run Total Cost and Plant Size



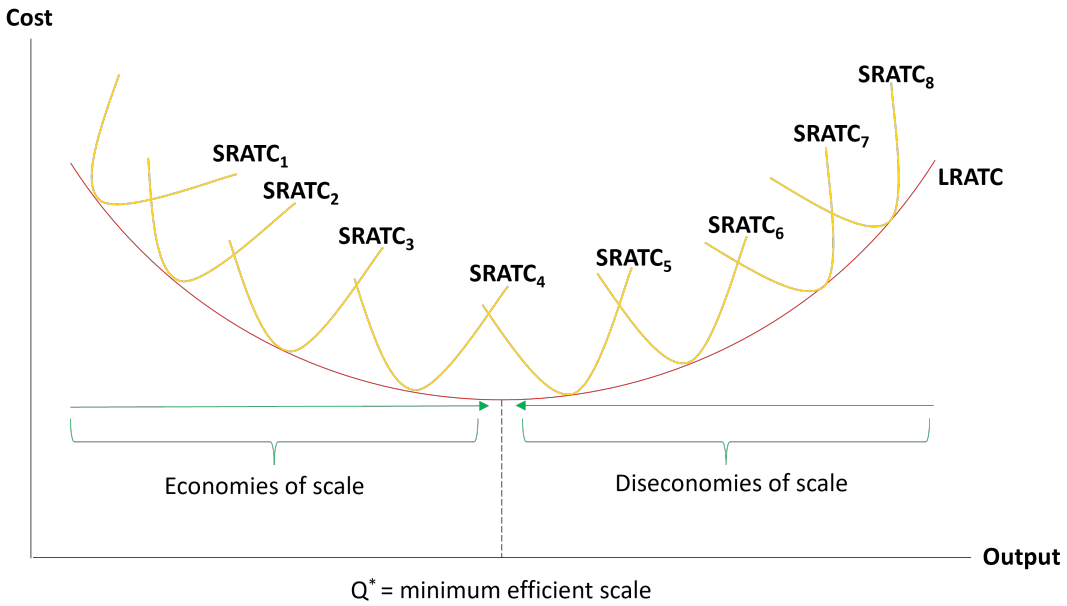
- Change in capital input changes the short run total cost (STC) curve.
- The choice of capital input (scale or plant size) depends on the level of output chosen by the firm.

Economies and Diseconomies of Scale



- Scale of operations (e.g. plant size) is fixed in SR but can be adjusted in LR.
- Each point along the ATC curve in the LR corresponds to the minimum ATC for a given scale in the SR.

Economies and Diseconomies of Scale



- **Economies of scale** result from factors such as labor specialization, mass production, and investment in more efficient technology.
- **Diseconomies of scale** may result as the increasing bureaucracy of larger firms and regulation leads to inefficiencies, issues coming with a larger workforce, greater barriers to innovation.

Overview

Question 1

- The demand for membership at a local health club is determined by the following equation: $Q^d_{hm} = 400 - 5P_{hm}$
  where Q^d_{hm} is the number of health club members and P_{hm} is the price of membership.
  If the price of health club membership is \$35, the price elasticity of demand is closest to:
  - A. –0.778.
  - B. –0.500.
  - C. –0.438.

Question 2

- Price elasticity of demand for a good will most likely be greater if:
  - A. there are no substitutes for the good.
  - B. consumers consider the good as discretionary.
  - C. consumers spend a small portion of their budget on the good.

Question 3

- In the case of a normal good with a decrease in own price, which of the following statements is most likely true?
  - A. Both the substitution and income effects lead to an increase in the quantity purchased.
  - B. The substitution effect leads to an increase in the quantity purchased, while the income effect has no impact.
  - C. The substitution effect leads to an increase in the quantity purchased, while the income effect leads to a decrease.

Question 4

- The short-term shutdown point of production for a firm operating under perfect competition will most likely occur when:
  - A. price is equal to average total cost.
  - B. marginal revenue is equal to marginal cost.
  - C. marginal revenue is equal to average variable costs.

Question 5

- Normal profit is best described as:
  - A. zero economic profit.
  - B. total revenue minus all explicit costs.
  - C. the sum of accounting profit plus economic profit.

Question 6

- Diseconomies of scale most likely result from:
  - A. specialization in the labor force.
  - B. overlap of business functions and product lines.
  - C. discounted prices on resources when buying in larger quantities.