INTRODUCTORY ECONOMICS: LECTURE 1

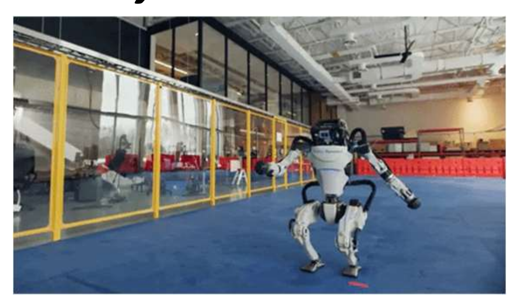
The Fundamentals of Economics

Highlights

- *What is Economics?*
- *Microeconomics*
- *Opportunity cost*
- *Accounting vs. Economic Profit*
- *Time value of money*
- *Marginal Analysis*
- *Positive & Normative Analysis*

Economics

- The science of *making decisions* in the presence of *scarce resources*.
  - Who makes decisions? Micro: firms, individuals; Macro: governments, countries
  - *Resources* are anything used to produce a good or service, or achieve a goal.
  - *Decisions* are important because **scarcity** implies **trade-offs**.
  - ***Essentially a constrained optimization, like engineering.***



Economics as constrained optimization

- **For consumers (consumer theory):**
- Consumers maximize their well-being
- Constraints:
  - Limited incomes
  - Prices of goods or service
  - E.g., With 50 DKK in hand , how many apples and bananas to buy?

Economics as constrained optimization

- **For firms (managerial economics):**
- Firm’s overall goal is to maximize profits
- Constraints make it difficult to achieve goals
  - Available technology
  - Prices of inputs used in production

Opportunity cost

- **Opportunity cost**
  - The opportunity cost of any item is whatever must be given up to obtain it.
  - Explicit cost + implicit cost: The explicit cost of a resource plus the implicit cost of giving up its best alternative.
  - Examples: sleeping at home; doing PhD

Profits

- **Accounting profit**
  - Total amount of money taken in from sales (total revenue) minus the dollar cost of producing goods or services.
- **Economic profit**
  - The difference between total revenue and *opportunity* cost.

Markets

- Market is the place for the two sides (buyer and seller) to make transactions.
- Bargaining position of consumers and producers is limited by three rivalries in economic transactions:
  - Consumer-producer rivalry
  - Consumer-consumer rivalry
  - Producer-producer rivalry
- Government and the market

Time Value of Money

- Often a gap exists between the time when costs are borne and benefits received.
  - Managers can use *present value analysis* to properly account for the timing of receipts and expenditures.

Present Value Analysis 1

- Present value of a *single* future value
  - The amount that would have to be invested today at the prevailing interest rate to generate the given future value:

$$PV = \frac{FV}{(1+i)^n}$$

  - Present value reflects the difference between the *future value* and the *opportunity cost of waiting*:

$$PV = FV - OCW$$

Present Value Analysis II

- Present value of a *stream of* future values

$$PV = \frac{FV_1}{(1+i)^1} + \frac{FV_2}{(1+i)^2} + \cdots + \frac{FV_n}{(1+i)^n}$$

or,

$$PV = \sum_{t=1}^{n} \frac{FV_t}{(1+i)^t}$$

The Time Value of Money in Action

- Consider a project that returns the following income stream:
  - Year 1, \$10,000; Year 2, \$50,000; and Year 3, \$100,000.
  - At an annual interest rate of 3 percent, what is the present value of this income stream?

$$PV = \frac{\$10{,}000}{(1+0.03)^1} + \frac{\$50{,}000}{(1+0.03)^2} + \frac{\$100{,}000}{(1+0.03)^3}$$
$$= \$148{,}352.70$$

Net Present Value

- The present value of the *income stream* generated by a project minus the current cost of the project:

$$NPV = \frac{FV_1}{(1+i)^1} + \frac{FV_2}{(1+i)^2} + \cdots + \frac{FV_n}{(1+i)^n} - C_0$$

Rational People Think at the Margin

- Examples:
  - When a student considers whether to go to college for an additional year, he compares the fees & foregone wages to the extra income he could earn with the extra year of education.
  - When a manager considers whether to increase output, she compares the cost of the needed labor and materials to the extra revenue.

Use Marginal Analysis

- Given a control variable, Q, in a managerial objective, denote the
  - total benefit as $B(Q)$.
  - total cost as $C(Q)$.
- Manager's objective is to maximize net benefits:

$$N(Q) = B(Q) - C(Q)$$

Use Marginal Analysis

- How can the manager maximize net benefits?
- Use marginal analysis
  - **Marginal benefit:** $MB(Q)$
    - The change in total benefits arising from a change in the managerial control variable, Q.
  - **Marginal cost:** $MC(Q)$
    - The change in the total costs arising from a change in the managerial control variable, Q.
  - Marginal net benefits: $MNB(Q)$

$$MNB(Q) = MB(Q) - MC(Q)$$

Use Marginal Analysis

- Marginal principle
  - To maximize net benefits, the manager should increase the managerial control variable up to the point where marginal benefits equal marginal costs. This level of the managerial control variable corresponds to the level at which marginal net benefits are zero; nothing more can be gained by further changes in that variable.

Marginal Analysis In Action

- It is estimated that the benefit and cost structure of a firm is:

$$B(Q) = 250Q - 4Q^2$$
$$C(Q) = Q^2$$

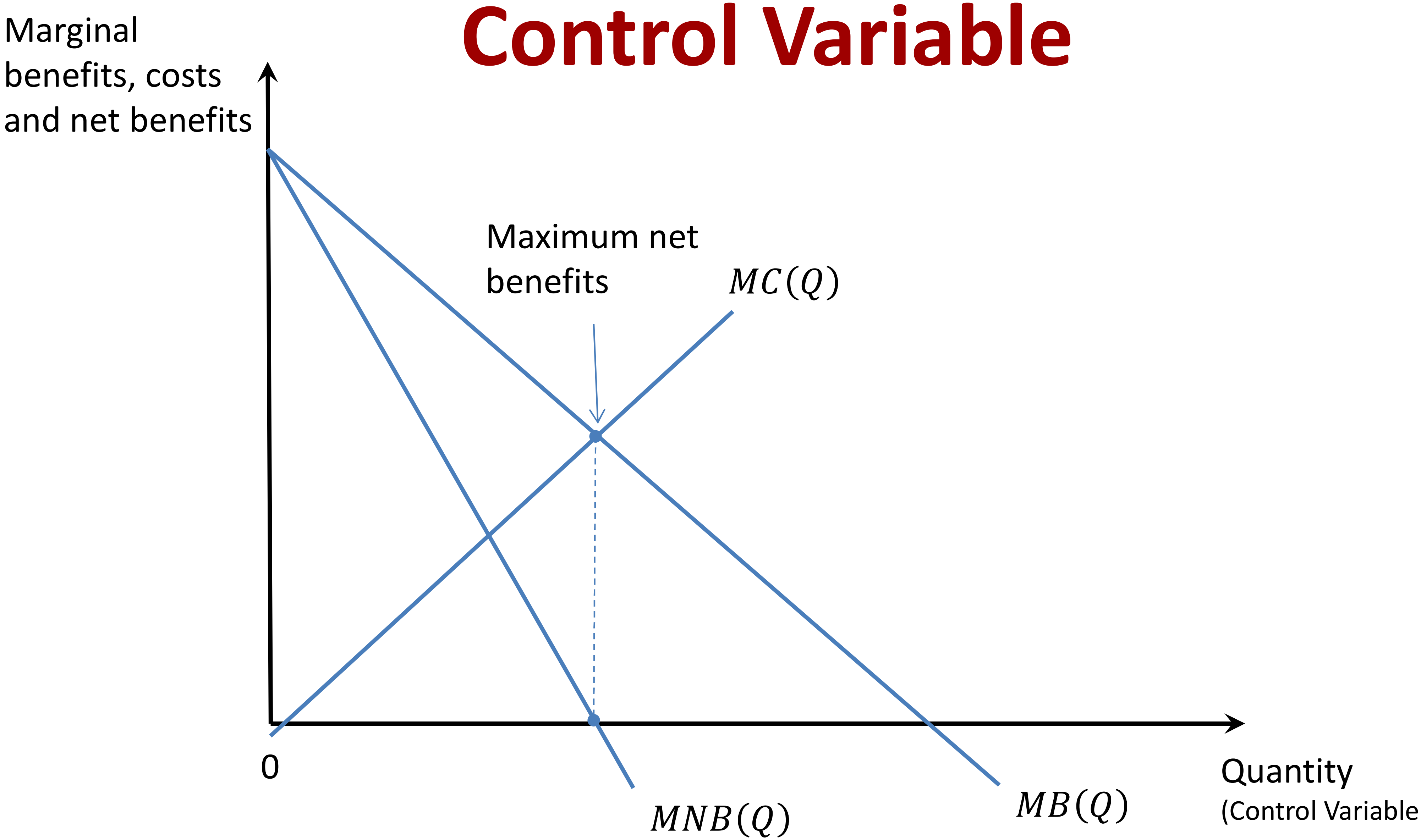
- Find the $MB(Q)$ and $MC(Q)$ functions.

$$MB(Q) = 250 - 8Q$$
$$MC(Q) = 2Q$$

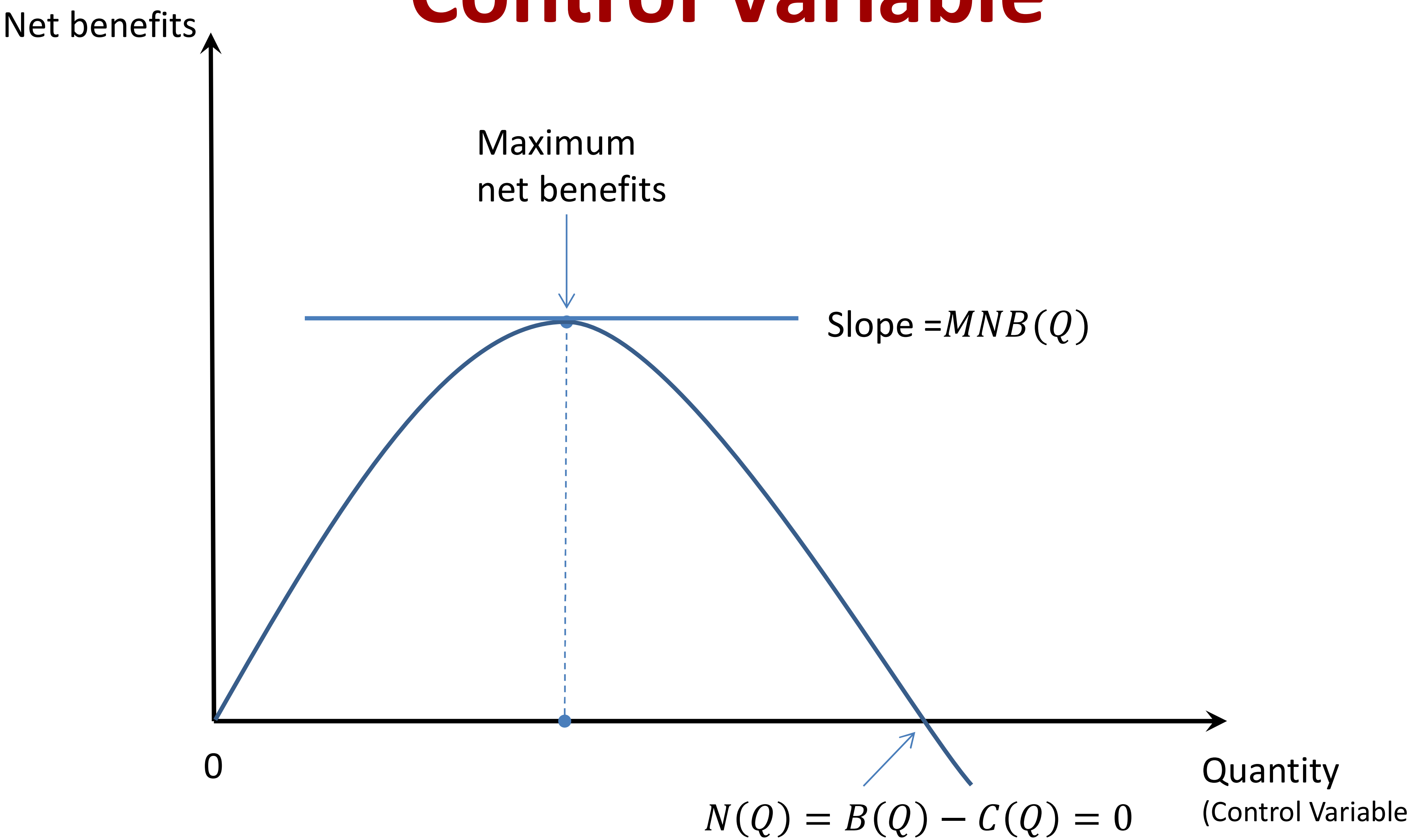
- What value of Q makes $MNB(Q)$ zero?

$$250 - 8Q = 2Q \Rightarrow Q = 25$$

Determining the Optimal Level of a Control Variable



Determining the Optimal Level of a Control Variable



Marginal Value Curves Are the Slopes of Total Value Curves

- **A calculus alternative**
  - Slope of a continuous function is the derivative /marginal value of that function:

$$MB = \frac{dB(Q)}{dQ}$$

$$MC = \frac{dC(Q)}{dQ}$$

$$MNB = \frac{dN(Q)}{dQ}$$

Incremental Decisions

- **Incremental revenues**
  - The additional revenues that stem from a yes-or-no decision.
- **Incremental costs**
  - The additional costs that stem from a yes-or-no decision.
- "Thumbs up" decision
  - $MB > MC$.
- "Thumbs down" decision
  - $MB < MC$.

Positive & Normative Analysis

- Positive Analysis – statements that describe the relationship of cause and effect
  - Questions that deal with explanation and prediction
    - What will be the impact of an import quota on foreign cars?
    - What will be the impact of an increase in the gasoline excise tax?

Positive & Normative Analysis

- Normative Analysis – analysis examining questions of what ought to be
  - Often supplemented by value judgments
    - Should the government impose a larger gasoline tax?
    - Should the government decrease the tariffs on imported cars?

Discussion

- A kidney market?

The New York Times

Auction for a Kidney Pops Up on Ebay's Site

Share full article

By Amy Harmon

Sept. 3, 1999

Bidding for a human kidney, described on the Internet auction site Ebay as ''fully functional,'' began at $25,000 and reached $5,750,100 before the company abruptly ended the auction yesterday afternoon.

Take-home messages

- Make sure you include all costs and benefits when making decisions (**opportunity costs**).
- When decisions span time, make sure you are comparing apples to apples (**present value analysis**).
- Optimal economic decisions are made at the margin (**marginal analysis**).

INTRODUCTORY ECONOMICS: LECTURE 2

Market Forces: Demand and Supply

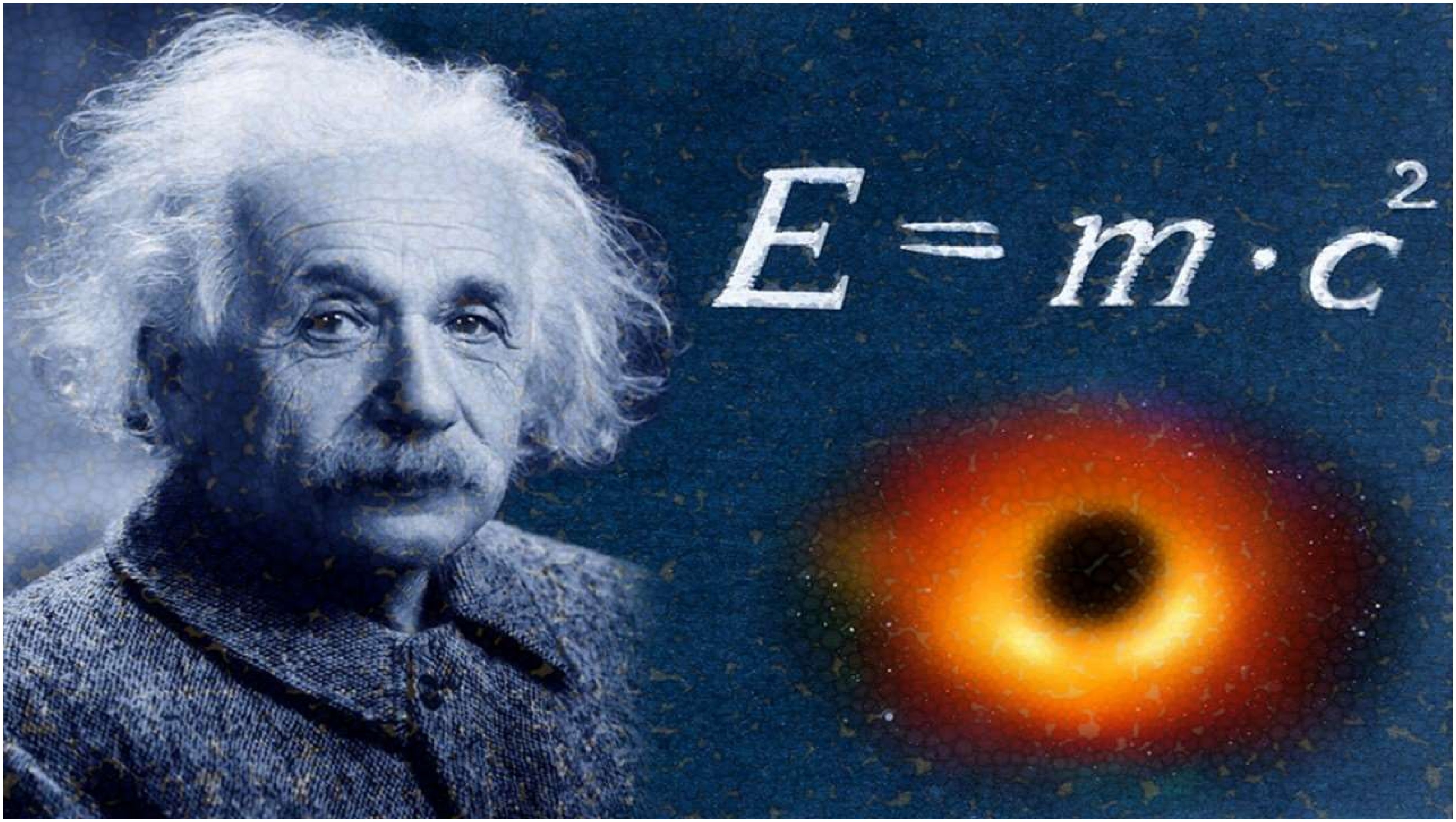
Highlights

- *Demand*
- *Supply*
- *Consumer surplus*
- *Producer surplus*
- *Market equilibrium*
- *Role of government policies*
- *Supply and demand analysis*

Economists use models to study economic issues

- **Model:** a highly simplified representation of a more complicated reality.
- Assumptions simplify the complex world, make it easier to understand.
- Example: To study international trade, assume two countries and two goods.

A model from hard science



First Economic Model: Demand-Supply

- Different from the models from natural science, economics models are not always true, but "pretty" true.

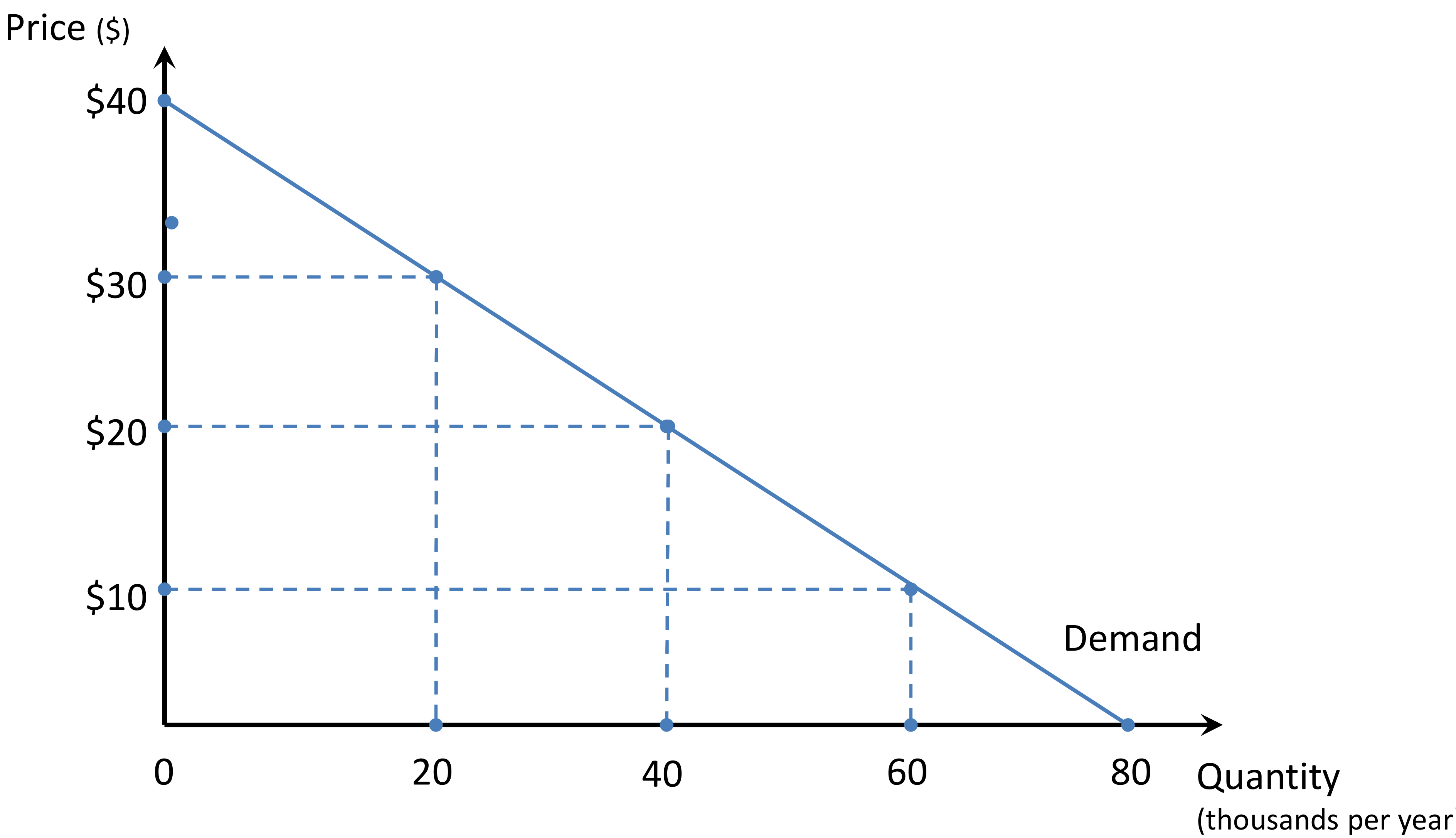
Demand

- **Demand**
  – The quantity demanded of a good is the amount of the good that consumers are willing and able to purchase.
- **Law of demand**
  – The quantity demanded of a good increases (decreases) as the price falls (rises).
  – Price and quantity demanded are inversely related.

Demand

- **Market demand curve**
  - Illustrates the relationship between the total quantity demanded and price of a good, holding other variables constant.

Market Demand Curve



Willingness to Pay (WTP)

- A consumer's **willingness to pay** for a good is the maximum amount the buyer will pay for that good.
- WTP measures how much the buyer values the good.

Example:
4 buyers' WTP
for an iPad

name	*WTP*
Anthony	$250
Chad	175
Flea	300
John	125

WTP and the Demand Curve

Q: If price of iPad is \$200, who will buy an iPad, and what is quantity demanded?

name	*WTP*
Anthony	\$250
Chad	175
Flea	300
John	125

A: Anthony & Flea will buy an iPad, Chad & John will not.

Hence, $Q^d = 2$ when $P = \$200$.

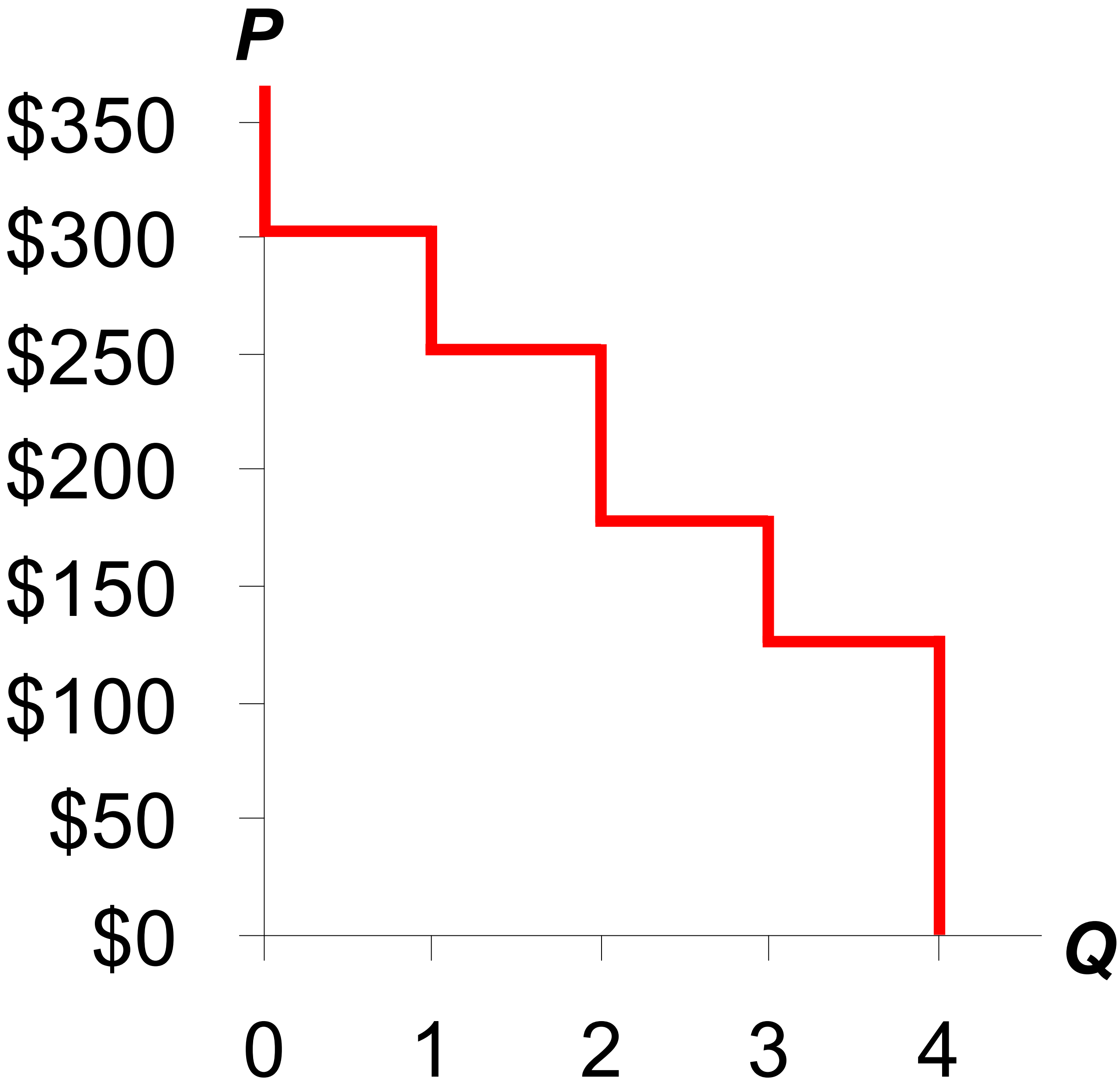
WTP and the Demand Curve

Derive the demand schedule:

name	*WTP*
Anthony	$250
Chad	175
Flea	300
John	125

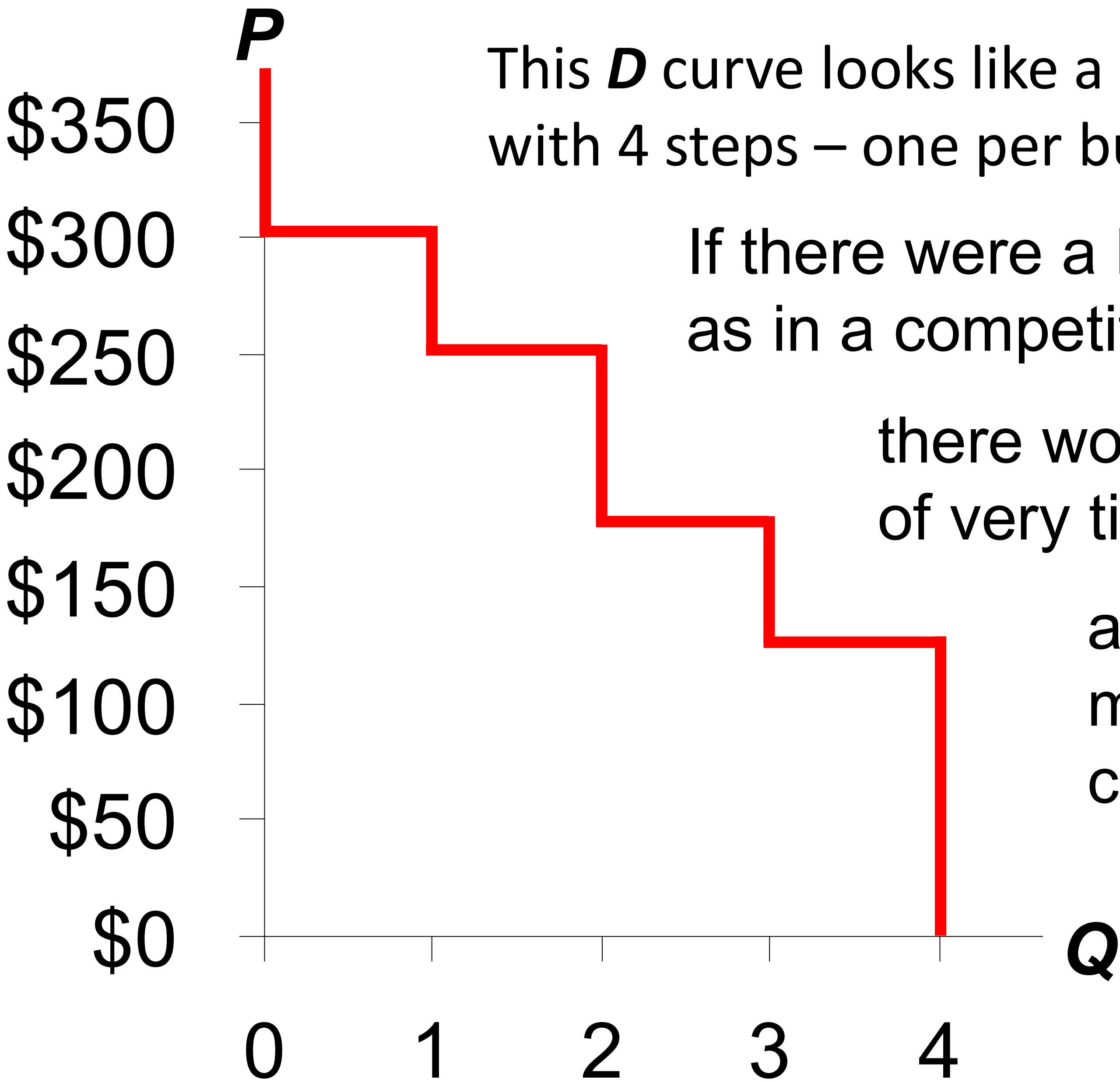
P (price of iPad)	who buys	Q^d
$301 & up	nobody	0
251 – 300	Flea	1
176 – 250	Anthony, Flea	2
126 – 175	Chad, Anthony, Flea	3
0 – 125	John, Chad, Anthony, Flea	4

WTP and the Demand Curve



P	Q^d
$301 & up	0
251 – 300	1
176 – 250	2
126 – 175	3
0 – 125	4

About the Staircase Shape…



This ***D*** curve looks like a staircase with 4 steps – one per buyer.

If there were a huge # of buyers, as in a competitive market,

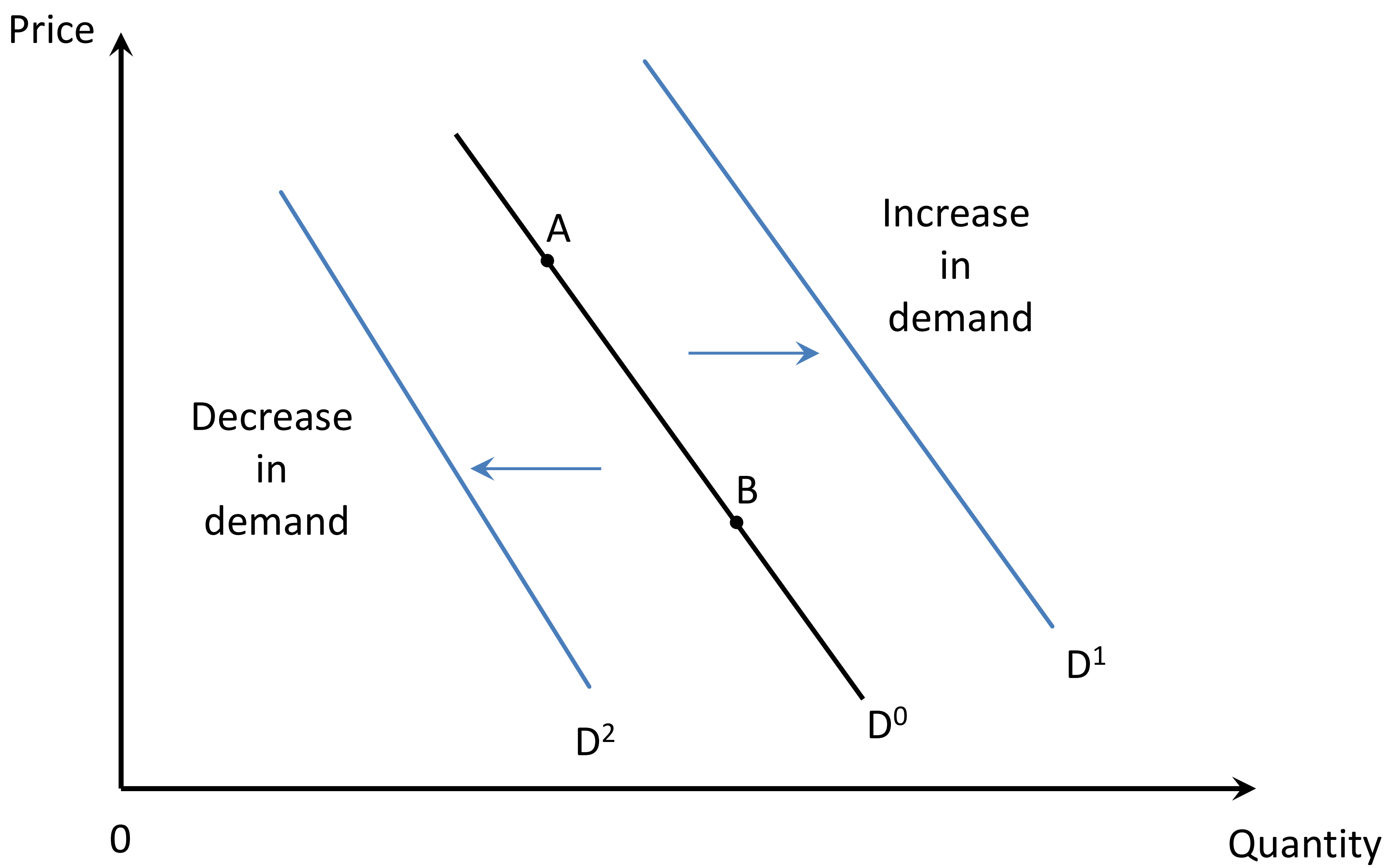
there would be a huge # of very tiny steps,

and it would look more like a smooth curve.

Changes in Demand

- Changing *only* price leads to **changes in *quantity demanded***.
  - This type of change is graphically represented by a movement along a given demand curve, holding other factors that impact demand constant.
- Changing factors other than price lead to ***changes in demand***.
  - These types of changes are graphically represented by a shift of the entire demand curve.

Changes in Demand



Demand Shifters

- Income
  - ***Normal good***: Demand ↑ as income ↑
    - Very common in reality, e.g., fruits, cloth; electronics..
  - ***Inferior good***: Demand ↓ as income ↑
    - Examples?

Demand Shifters

- Prices of related goods
  - ***Substitute goods***: Demand ↑ as price of related good ↑
    - Example: *pizza and hamburgers*; *Coke and Pepsi, laptops and desktop computers*
  - ***Complement goods***: Demand ↓ as price of related good ↑
    - Example: smartphone and apps; automobile and gasoline

Demand Shifters (cont.)

- Advertising and consumer tastes
- Population
- Consumer expectations
- Other factors

Consumer Surplus (CS)

- **Consumer surplus** is the amount a buyer is willing to pay minus the amount the buyer actually pays:

$$\boxed{CS = WTP - \boldsymbol{P}}$$

name	*WTP*
Anthony	$250
Chad	175
Flea	300
John	125

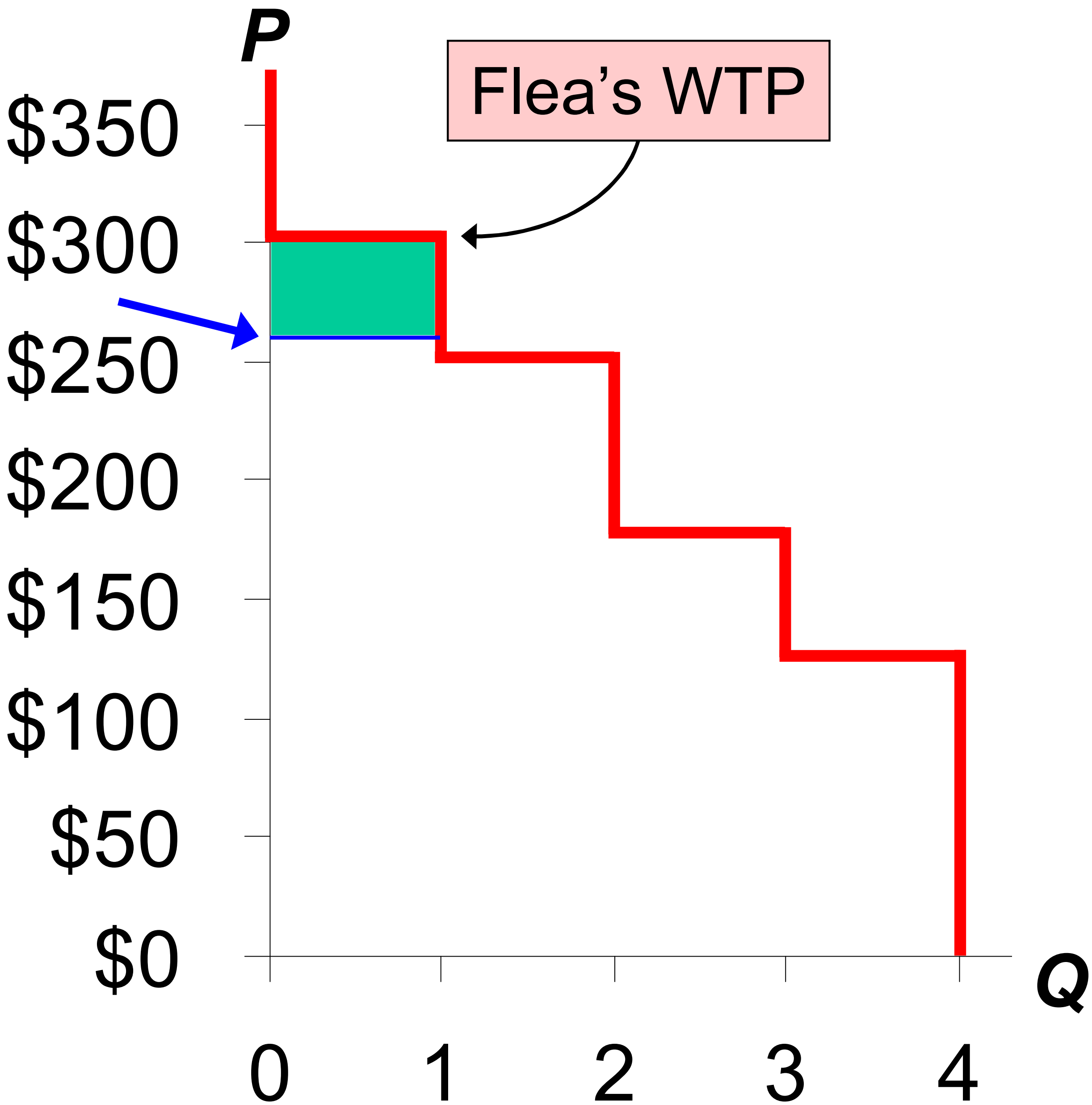
Suppose ***P*** = $260.

Flea's CS = $300 – 260 = $40.

The others get no CS because they do not buy an iPad at this price.

Total CS = $40.

CS and the Demand Curve

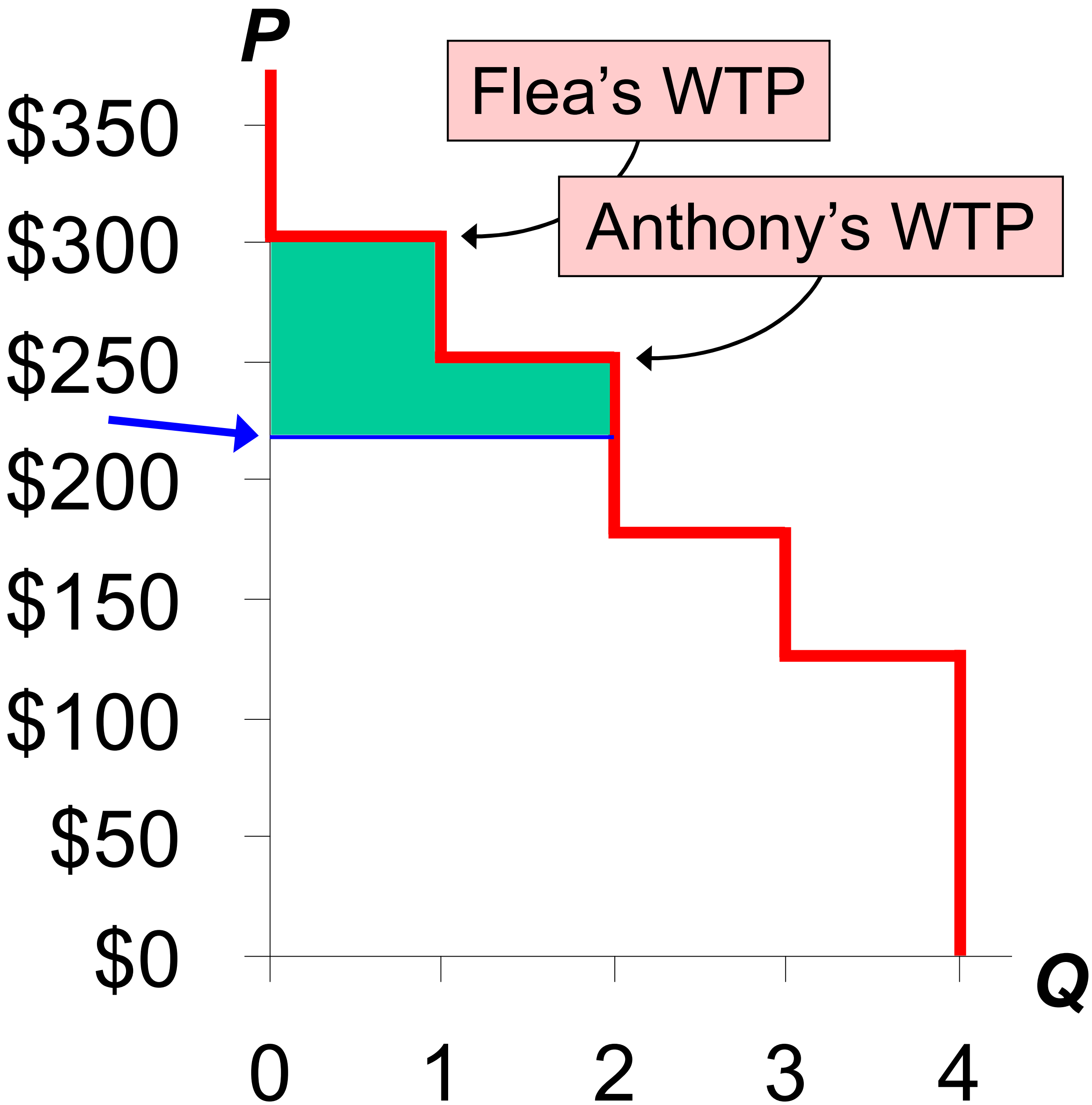


P = $260

Flea's CS =
$300 – 260 = <u>$40</u>

Total CS = <u>$40</u>

CS and the Demand Curve



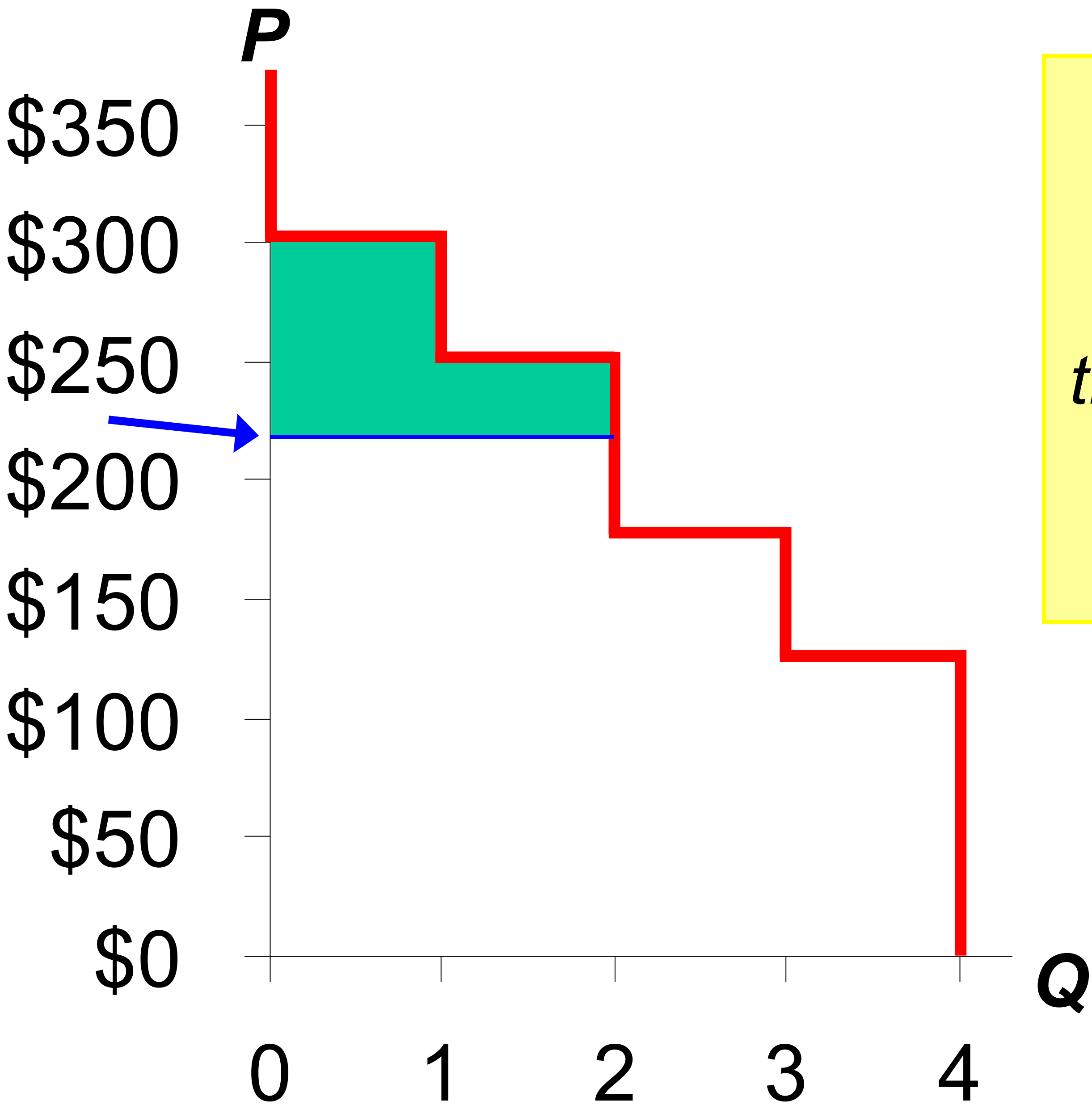
Instead, suppose
P = $220

Flea's CS =
$300 – 220 = <u>$80</u>

Anthony's CS =
$250 – 220 = <u>$30</u>

Total CS = <u>$110</u>

CS and the Demand Curve



The lesson:

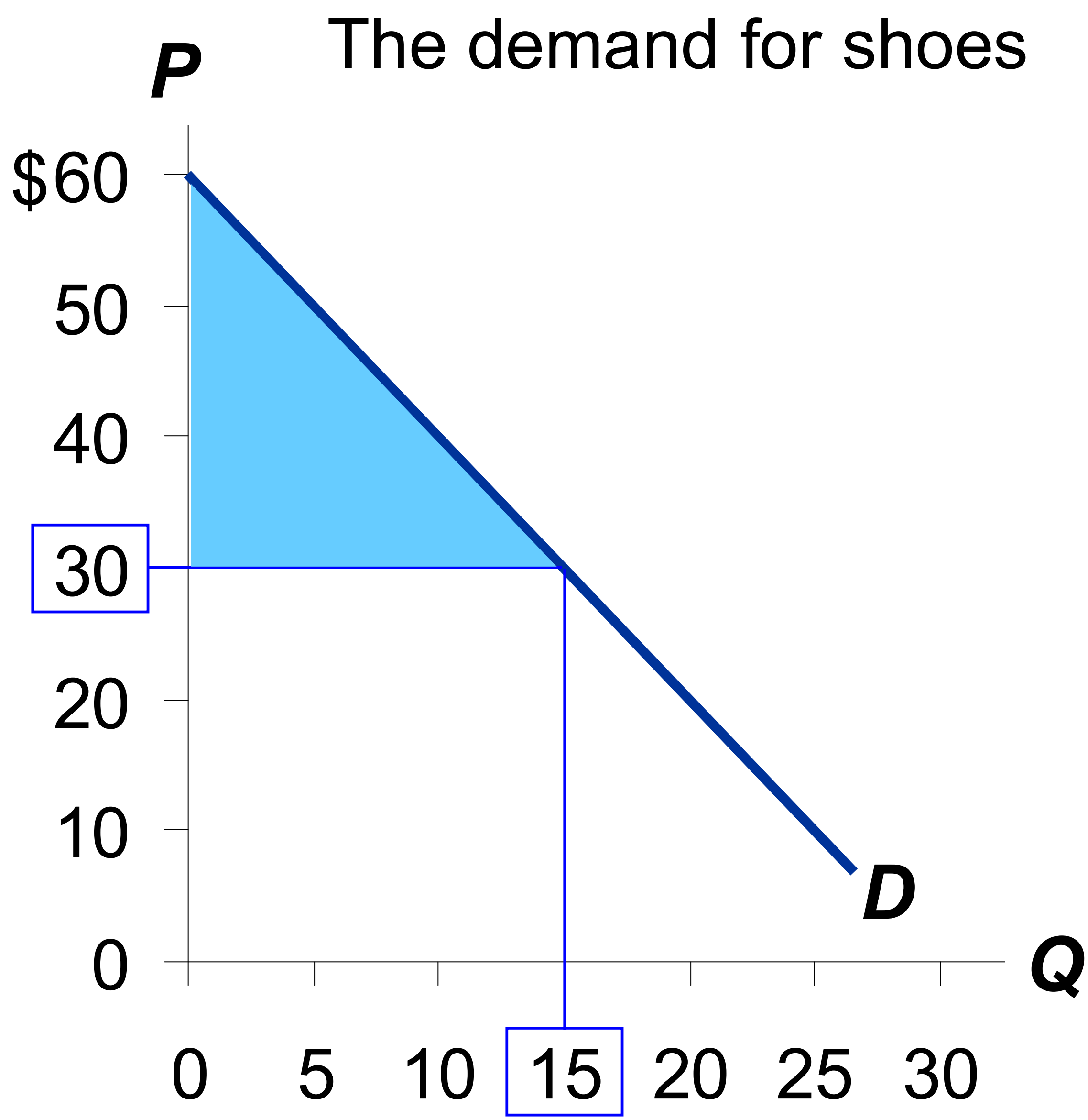
*Total CS equals the area under the demand curve above the price, from 0 to **Q**.*

Consumer Surplus

- Marketing strategies – like value pricing and price discrimination – rely on understanding consumer value for products.
  - ***Total consumer value*** is the sum of the maximum amount consumers are willing to pay at different quantities.
  - ***Total expenditure*** is the per-unit market price times the number of units purchased.
  - ***Consumer surplus*** is essentially the excess value that consumers derive from a good but do not pay extra for.

CS and Demand Curve

- **In this example:**
  - Which area is the total consumer value?
  - Which area is the total expenditure?
  - Which area is consumer surplus?
- Recall: area of a triangle equals ½ x base x height
- CS = ½ x 15 x $30
  = <u>$225</u>.

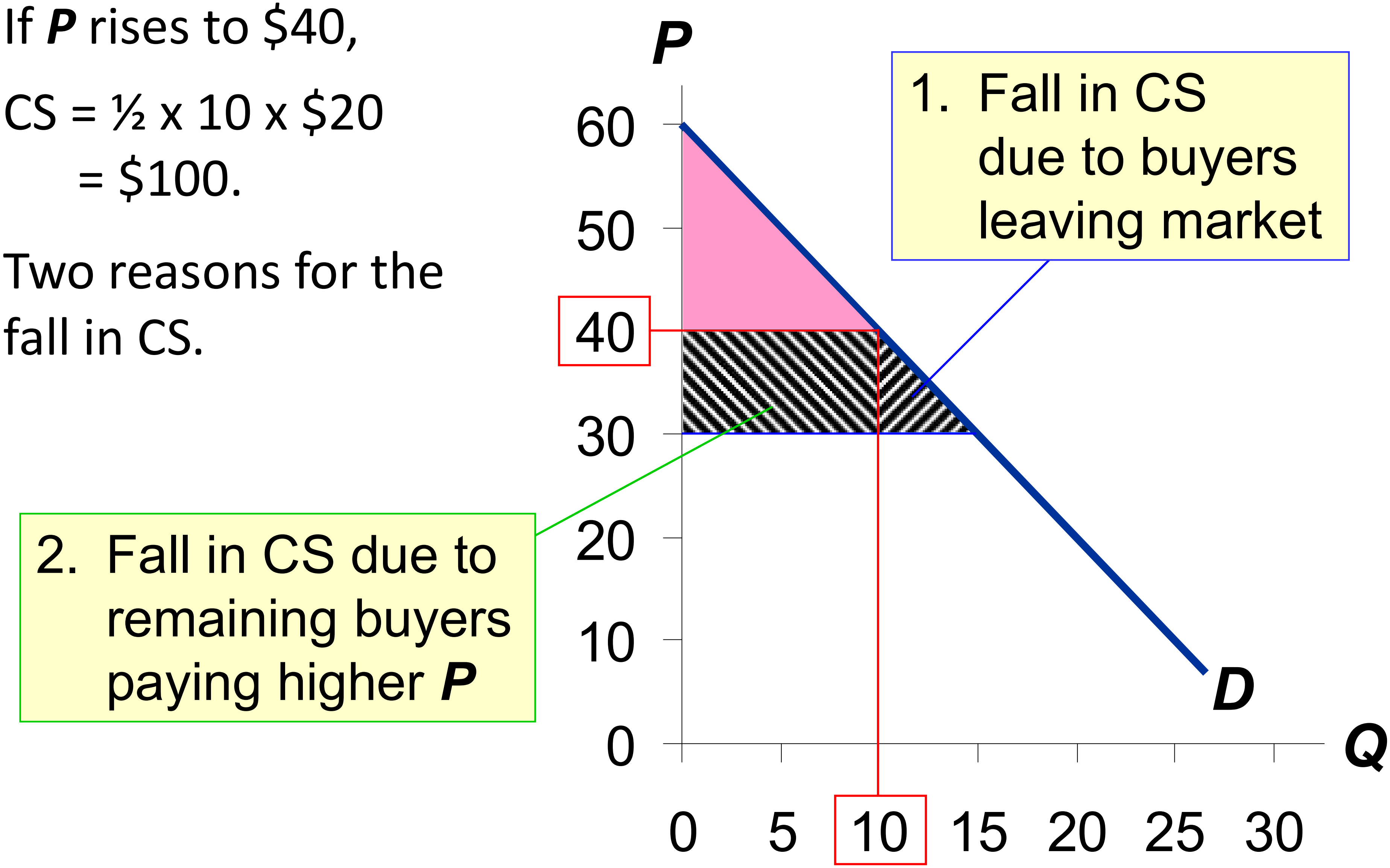


How a Higher Price Reduces CS

If ***P*** rises to \$40,

CS = ½ x 10 x \$20
= \$100.

Two reasons for the fall in CS.



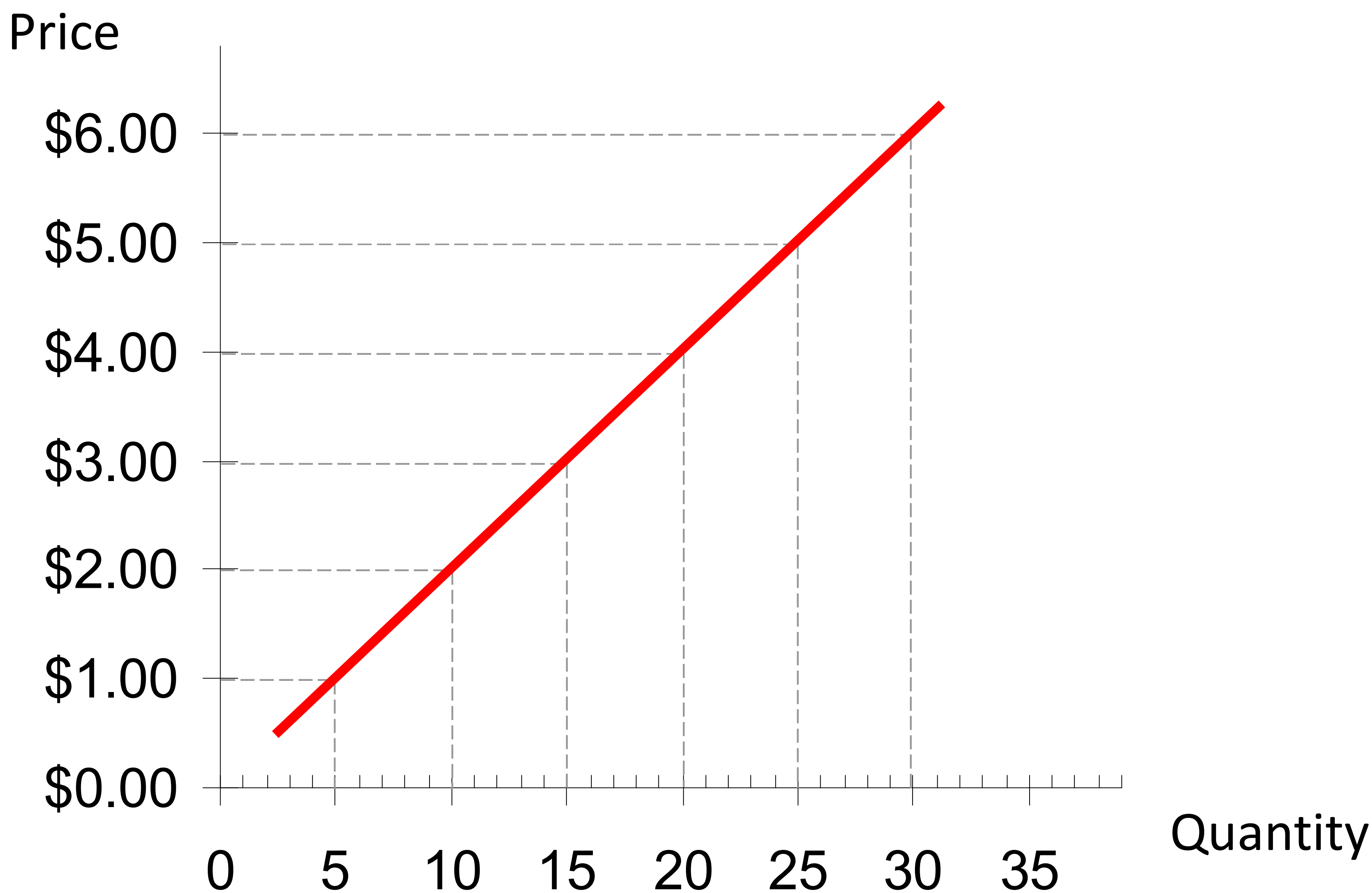
Supply

- **Supply**
  - The **quantity supplied** of any good is the amount that sellers are willing and able to sell.
- **Law of supply**
  - As the price of a good rises (falls), the quantity supplied of the good rises (falls), holding other factors affecting supply constant.

Supply

- **Market supply curve**
  - A curve indicating the total quantity supplied of a good at each price, holding input prices, technology, and other variables affecting supply constant.

Market Supply Curve



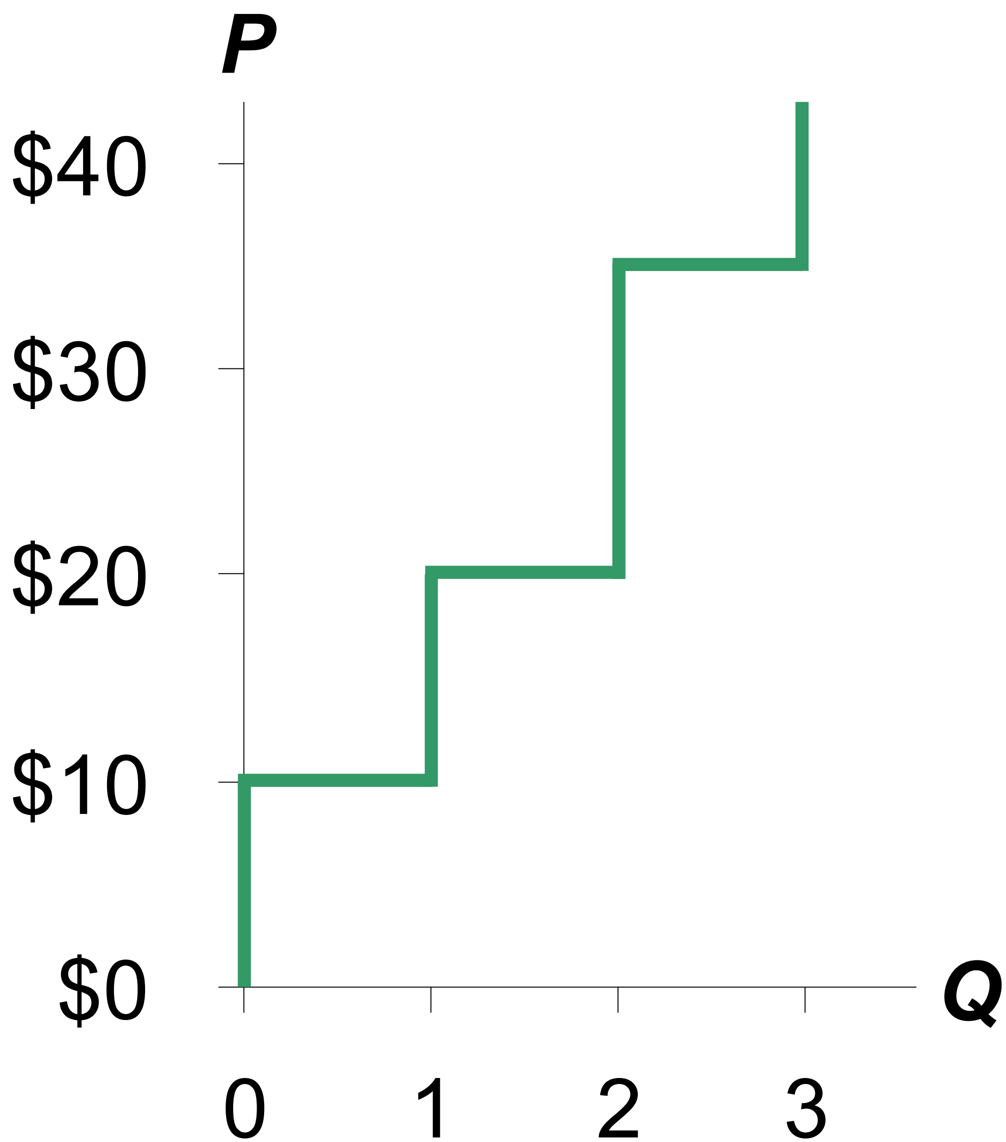
Willingness to Sell and the Supply Curve

Derive the supply schedule from the willingness to sell (cost) data:

Name	*WTS (cost)*
Jack	$10
Janet	20
Chrissy	35

P	Q^s
$0 – 9	0
10 – 19	1
20 – 34	2
35 & up	3

Willingness to Sell and the Supply Curve



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If there were a huge # of sellers, as in a competitive market, there would be a huge # of very tiny steps, and it would look more like a smooth curve.

Changes in Supply

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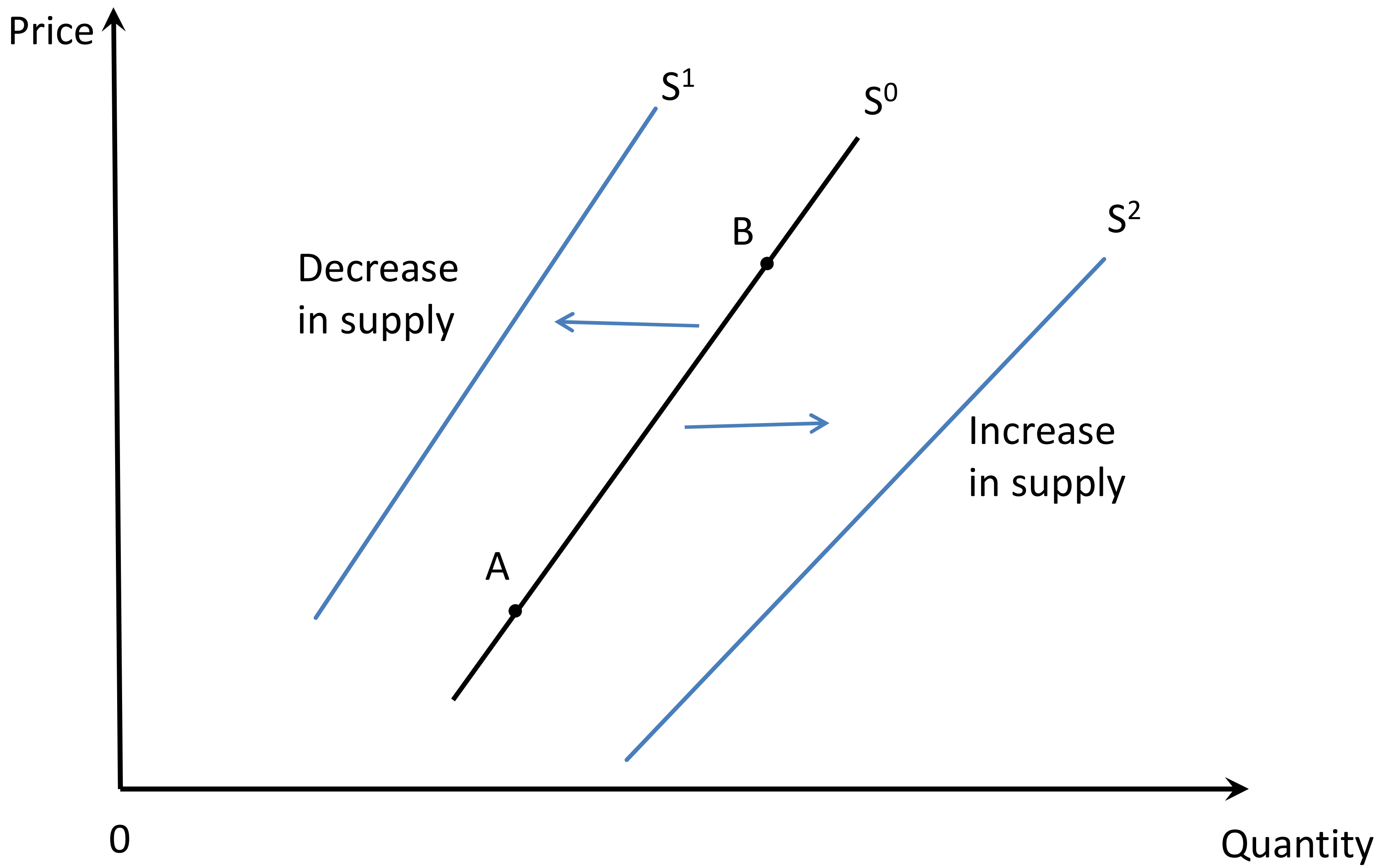
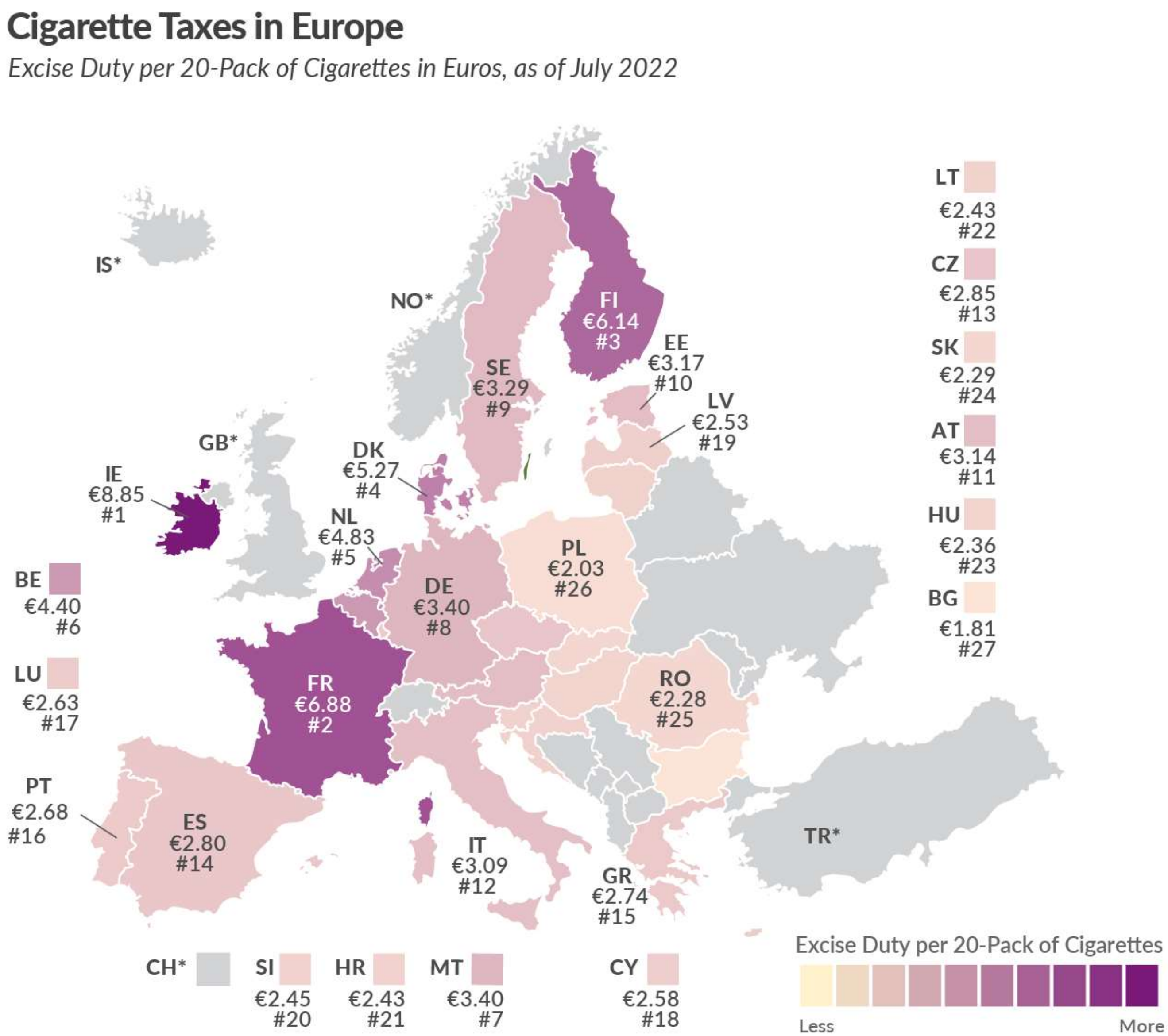
Changes in Supply



Supply Shifters

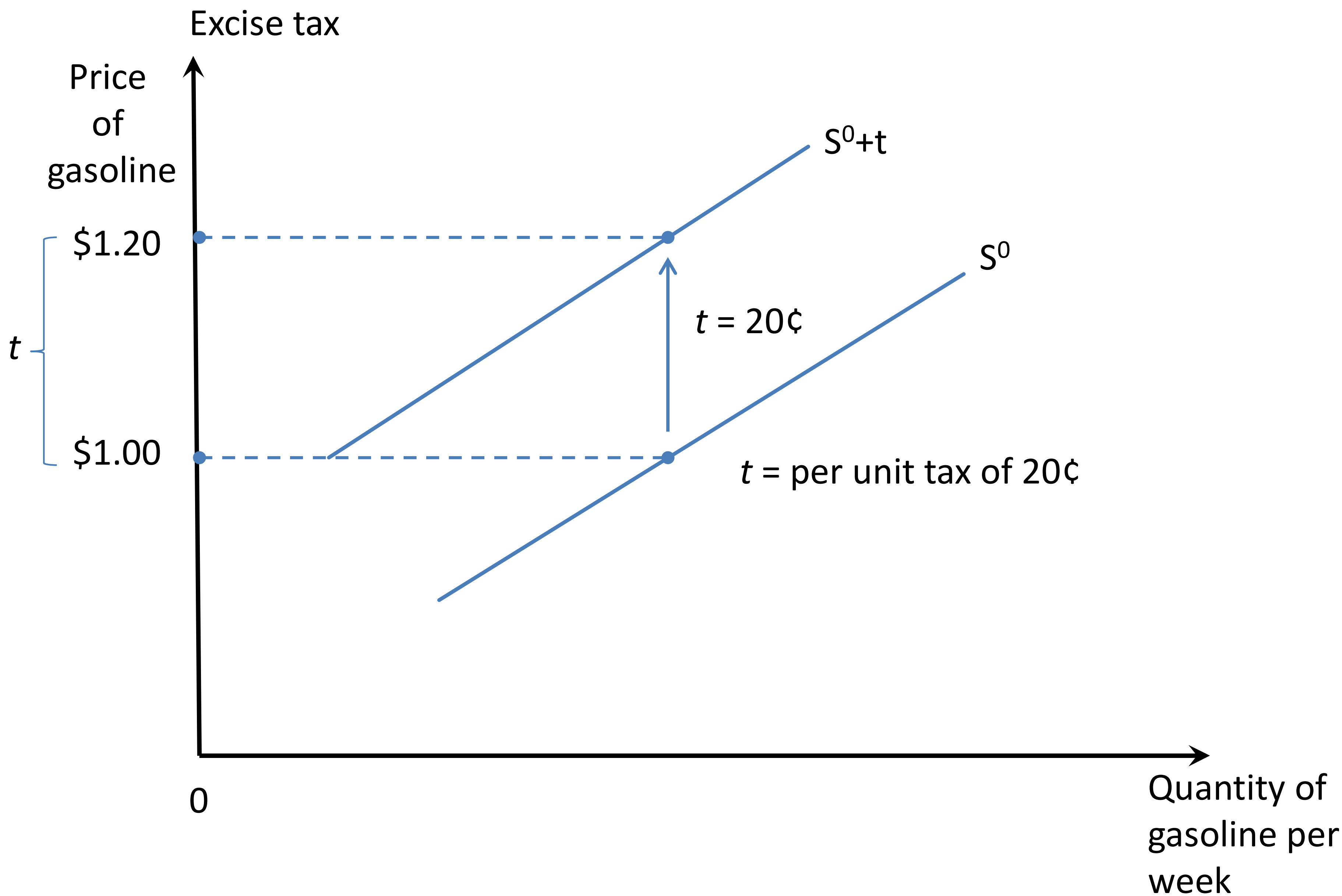
- Input prices
- Technology or government regulation
- Number of firms
  - Entry
  - Exit
- Taxes
  - ***Excise tax***: a tax on each unit of output sold, where tax revenue is collected from the supplier
  - ***Ad valorem tax***: percentage tax
- Producer expectations

A Per Unit (Excise) Tax

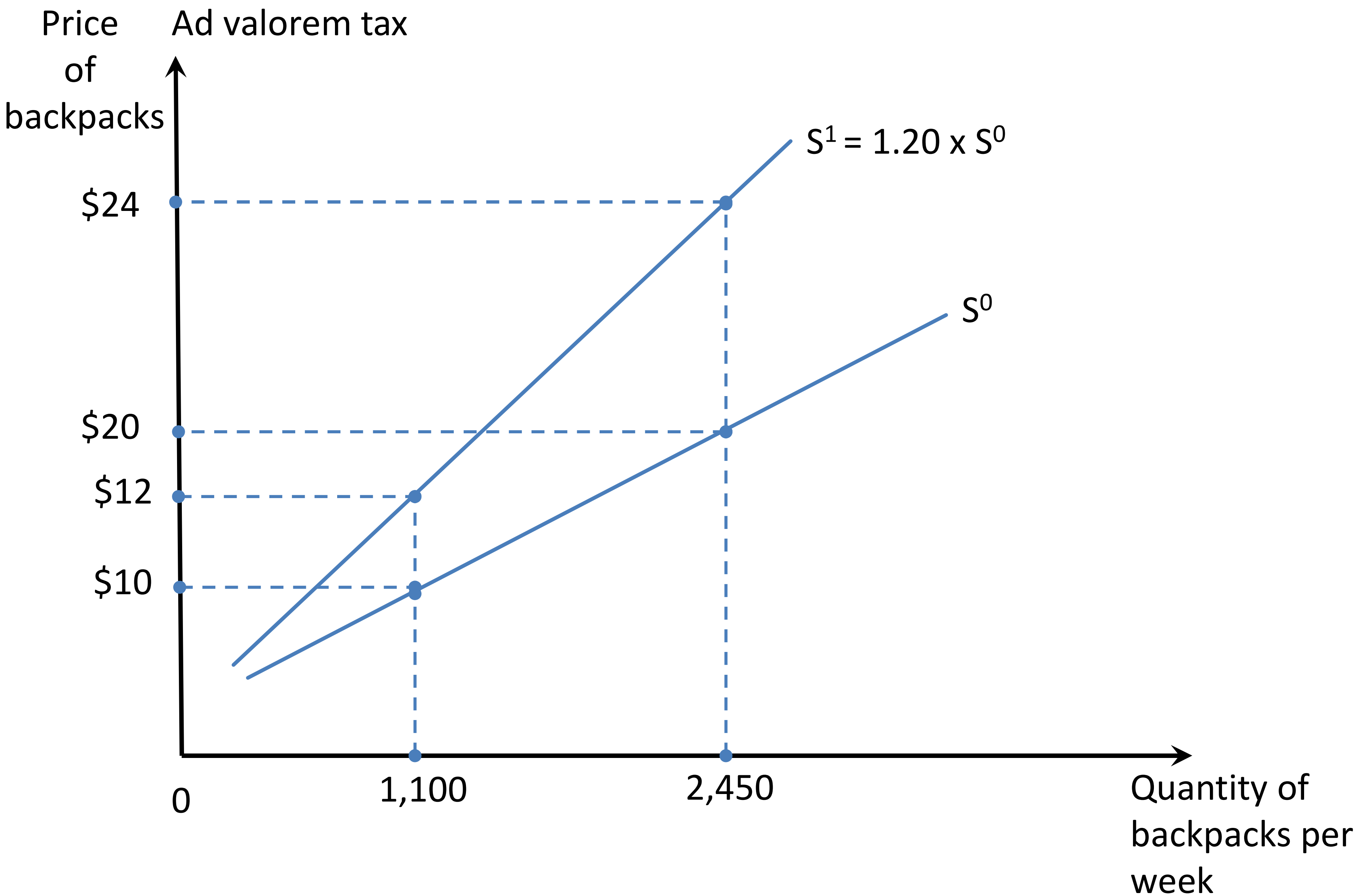


Note *Iceland, Norway, Switzerland, Turkey, and the United Kingdom are not part of the European Union (EU).
Source: European Commission, "Taxes in Europe Database."

A Per Unit (Excise) Tax



An Ad Valorem Tax

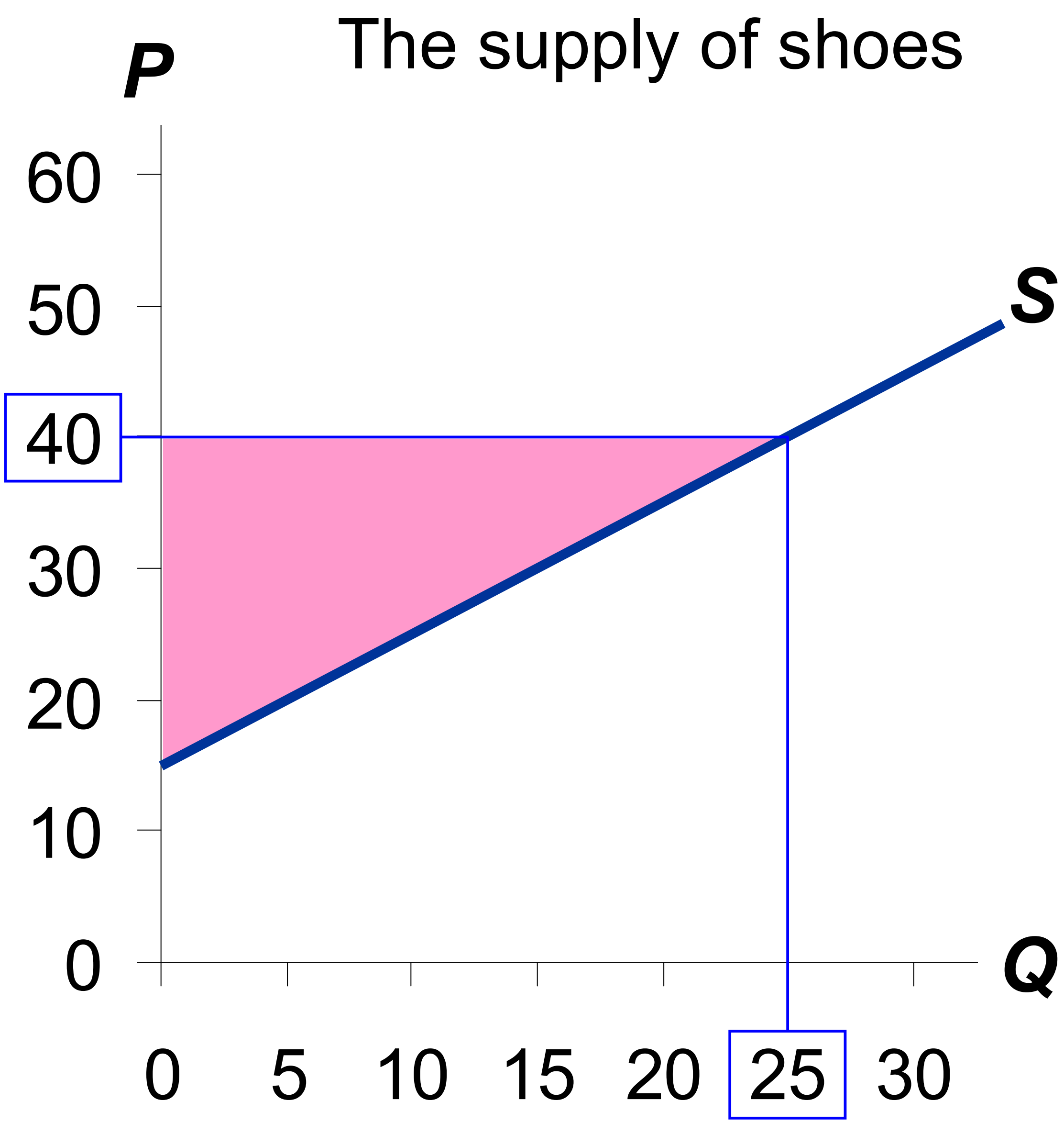


Producer Surplus (PS)

- **Producer surplus**: the amount producers receive in excess of the amount necessary to induce them to produce the good.
- Producer surplus equals the area above the supply curve under the price, from 0 to **Q**.

PS and Supply Curve

- PS is the area between **_P_** and the **_S_** curve, from 0 to **_Q_**.
- The height of this triangle is $40 – 15 = $25.
- So,
  PS = ½ x *b* x *h*
  = ½ x 25 x $25
  = <u>$312.50</u>

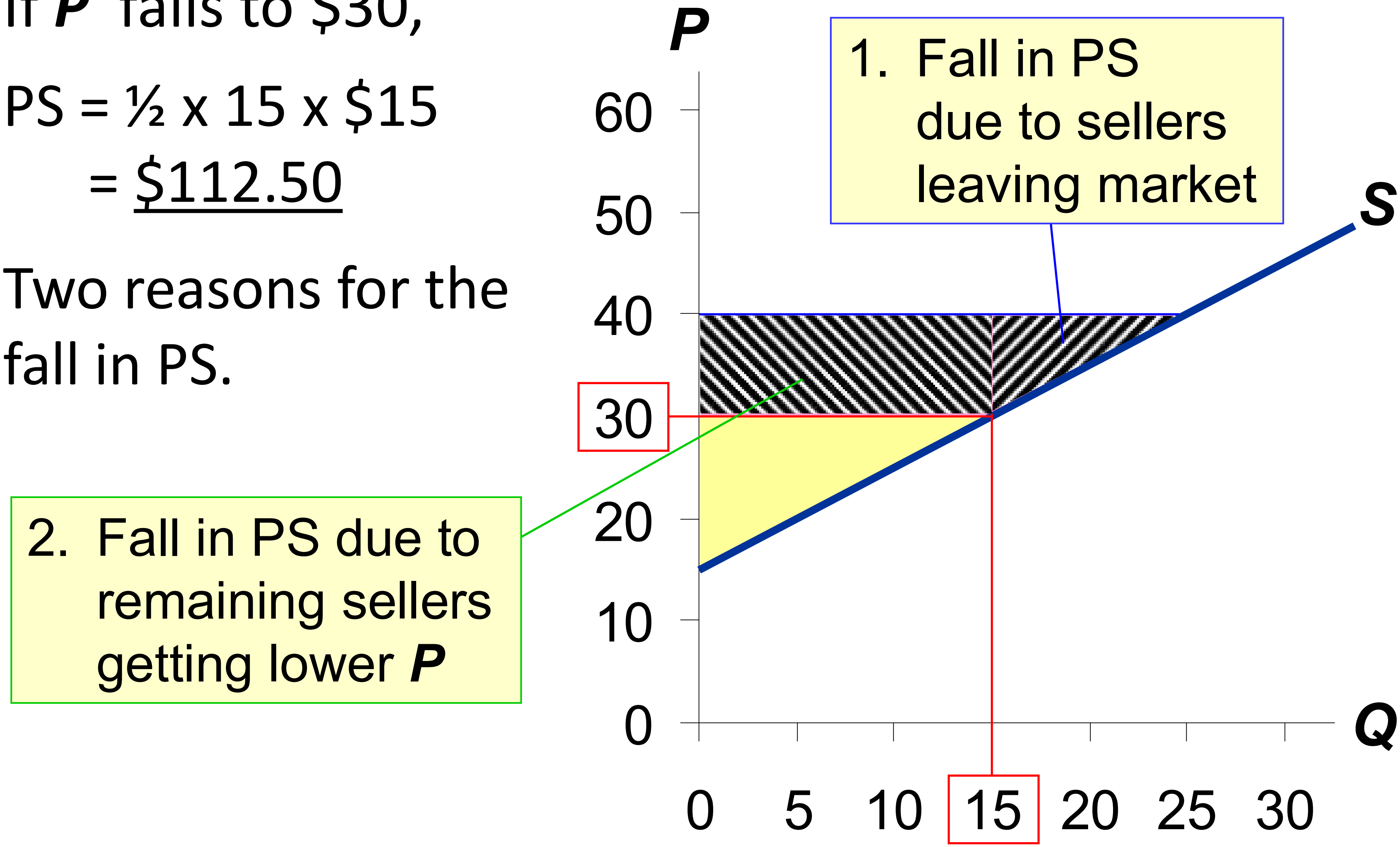


How a Lower Price Reduces PS

If ***P*** falls to \$30,

PS = ½ x 15 x \$15
= <u>\$112.50</u>

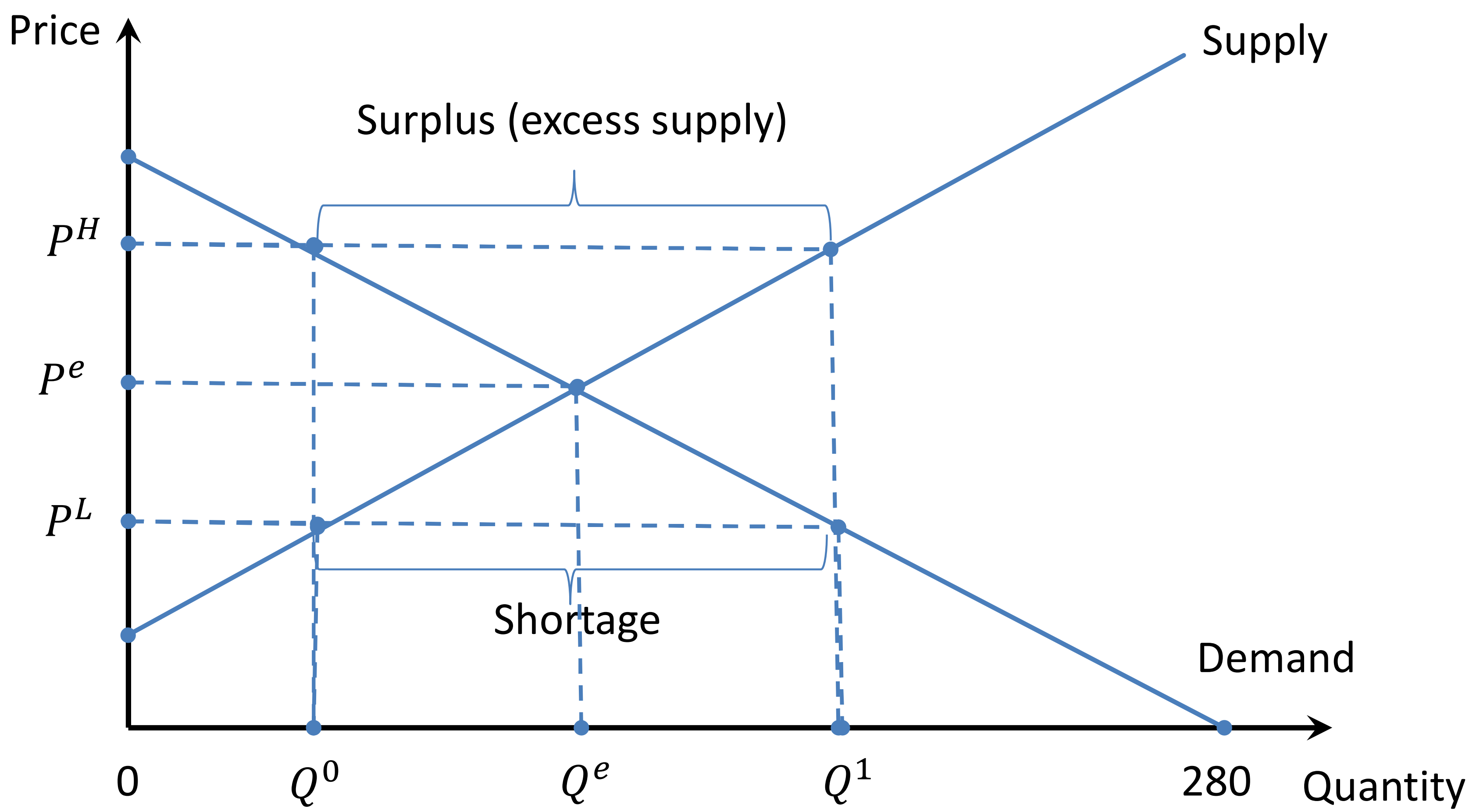
Two reasons for the fall in PS.



Market Equilibrium

- **Competitive Market Equilibrium**
  – Determined by the intersection of the market demand and market supply curves.
  – A price and quantity such that there is no shortage or surplus (excess supply) in the market.
  – Forces that drive market demand and market supply are balanced, and there is no pressure on prices or quantities to change.
  – The equilibrium price is the price that equates quantity demanded with quantity supplied

Market Equilibrium



Market Equilibrium in Action

- Consider a market with demand and supply functions, respectively, as

$$Q^d = 10 - 2P \text{ and } Q^s = 2 + 2P$$

- A competitive market equilibrium exists at a price, P^e, such that $Q^d(P^e) = Q^s(P^e)$. That is,

$$10 - 2P = 2 + 2P$$

$$8 = 4P$$

$$P^e = \$2$$

$$Q^e = 10 - 2(\$2) = 6 \text{ and } Q^e = 2 + 2(\$2) = 6$$

$$Q^e = 6 \text{ units}$$

Total Surplus

Recall:

CS = (value to buyers) – (amount paid by buyers)

= buyers' gains from participating in the market

PS = (amount received by sellers) – (cost to sellers)

= sellers' gains from participating in the market

Total surplus = CS + PS

= total gains from trade in a market

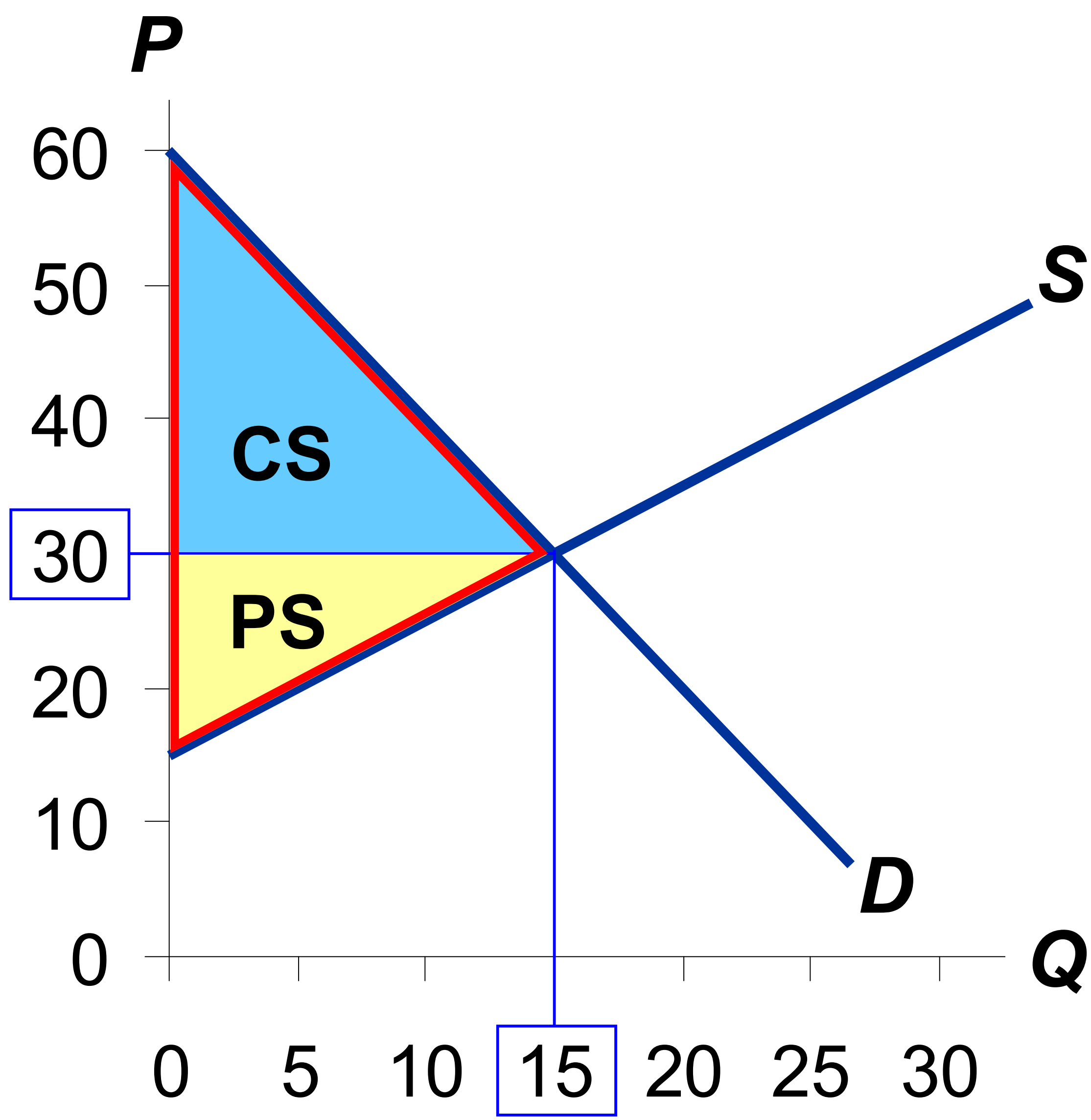
= (value to buyers) – (cost to sellers)

Efficient Allocation of Resources

- We use total surplus as a measure of society's well-being (social welfare), and we consider whether the market's allocation is *efficient* (maximizes total surplus).
- Policymakers also care about *equality*, though the focus here is on efficiency.

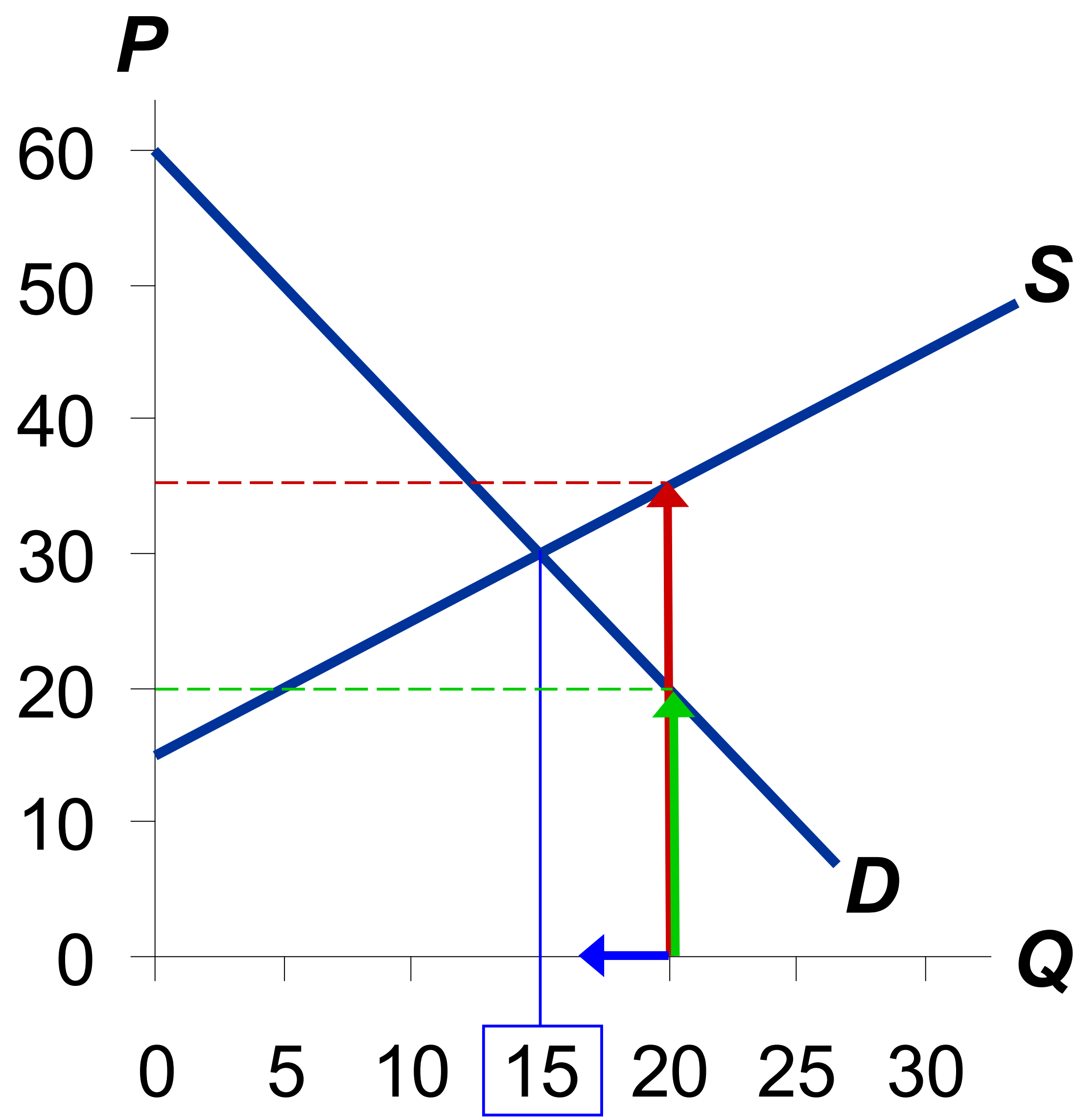
Evaluating the Market Equilibrium

- Market equilibrium:
  P = \$30
  Q = 15
- Total surplus
  = CS + PS
- Is the market equilibrium efficient?



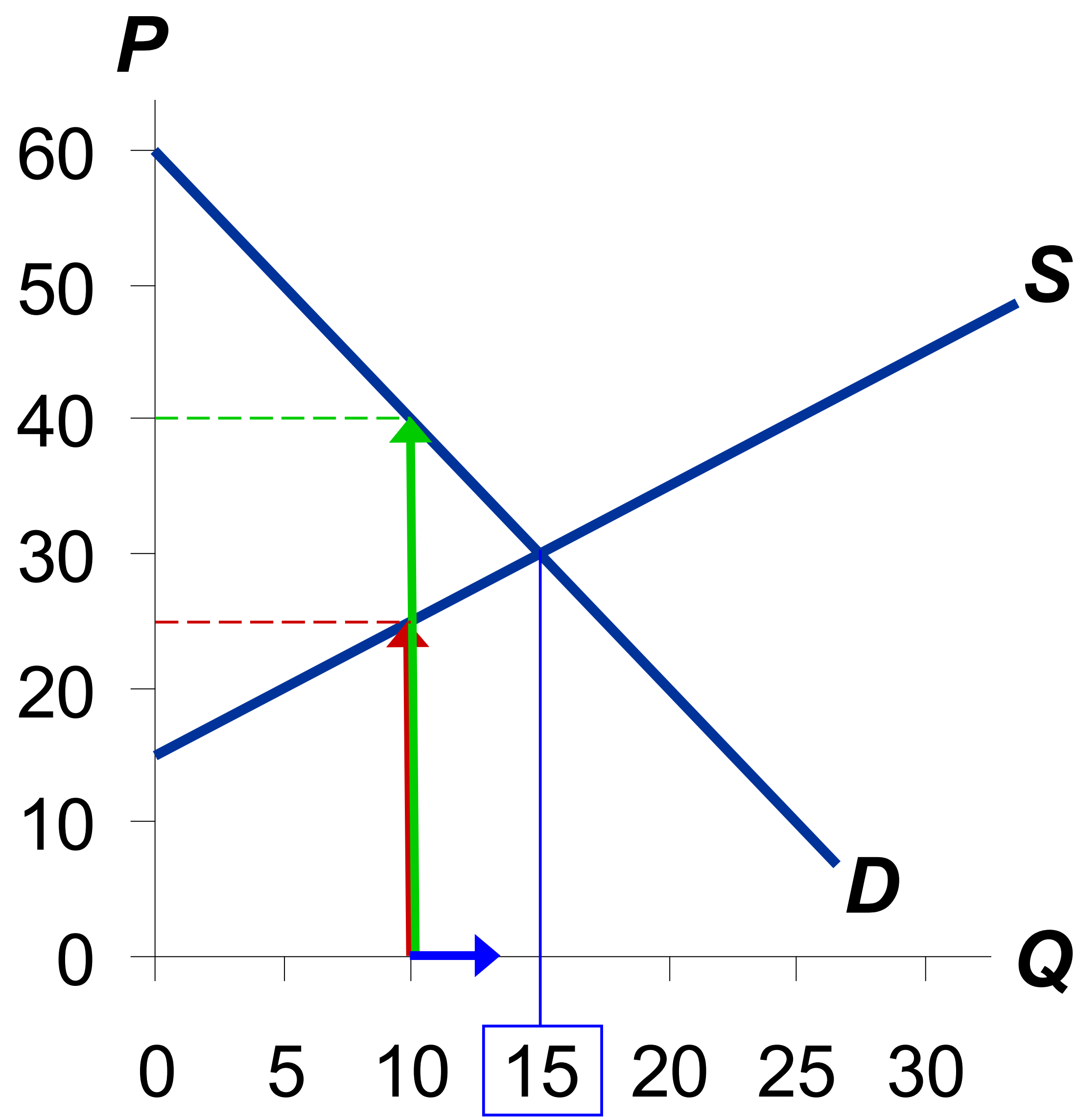
Does Equilibrium Maximize Total Surplus?

- At ***Q*** = 20, cost of producing the marginal unit is \$35
- value to consumers of the marginal unit is only \$20
- Hence, can increase total surplus by reducing ***Q***.
- *This is true at any **Q** greater than 15.*



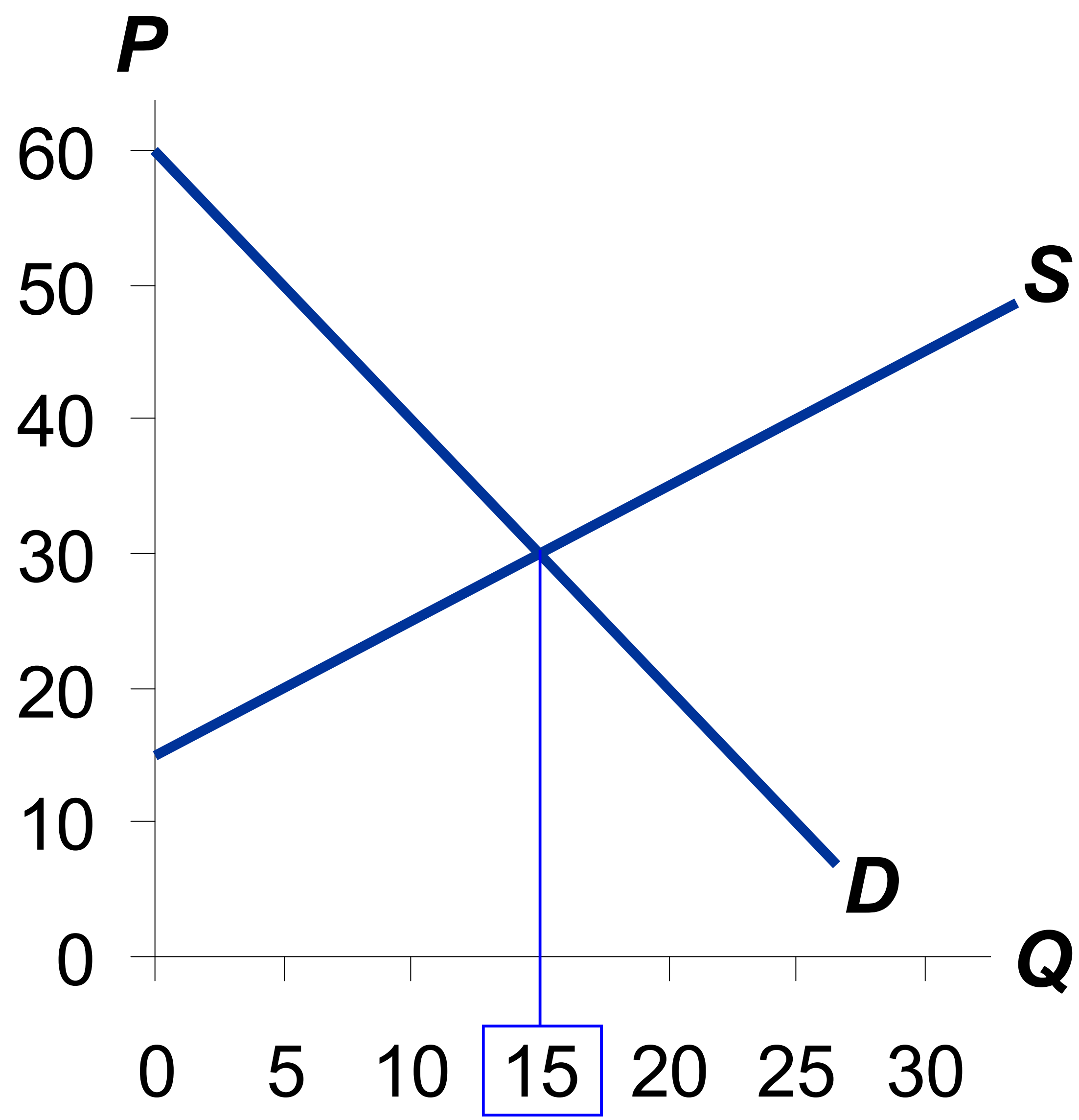
Does Equilibrium Maximize Total Surplus?

- At ***Q*** = 10,
  cost of producing the marginal unit is $25
- value to consumers of the marginal unit is $40
- Hence, can increase total surplus by increasing ***Q***.
- *This is true at any **Q** less than 15.*



Does Equilibrium Maximize Total Surplus?

- **The market equilibrium quantity maximizes total surplus.**
- At any other quantity, can increase total surplus by moving toward the market equilibrium quantity.



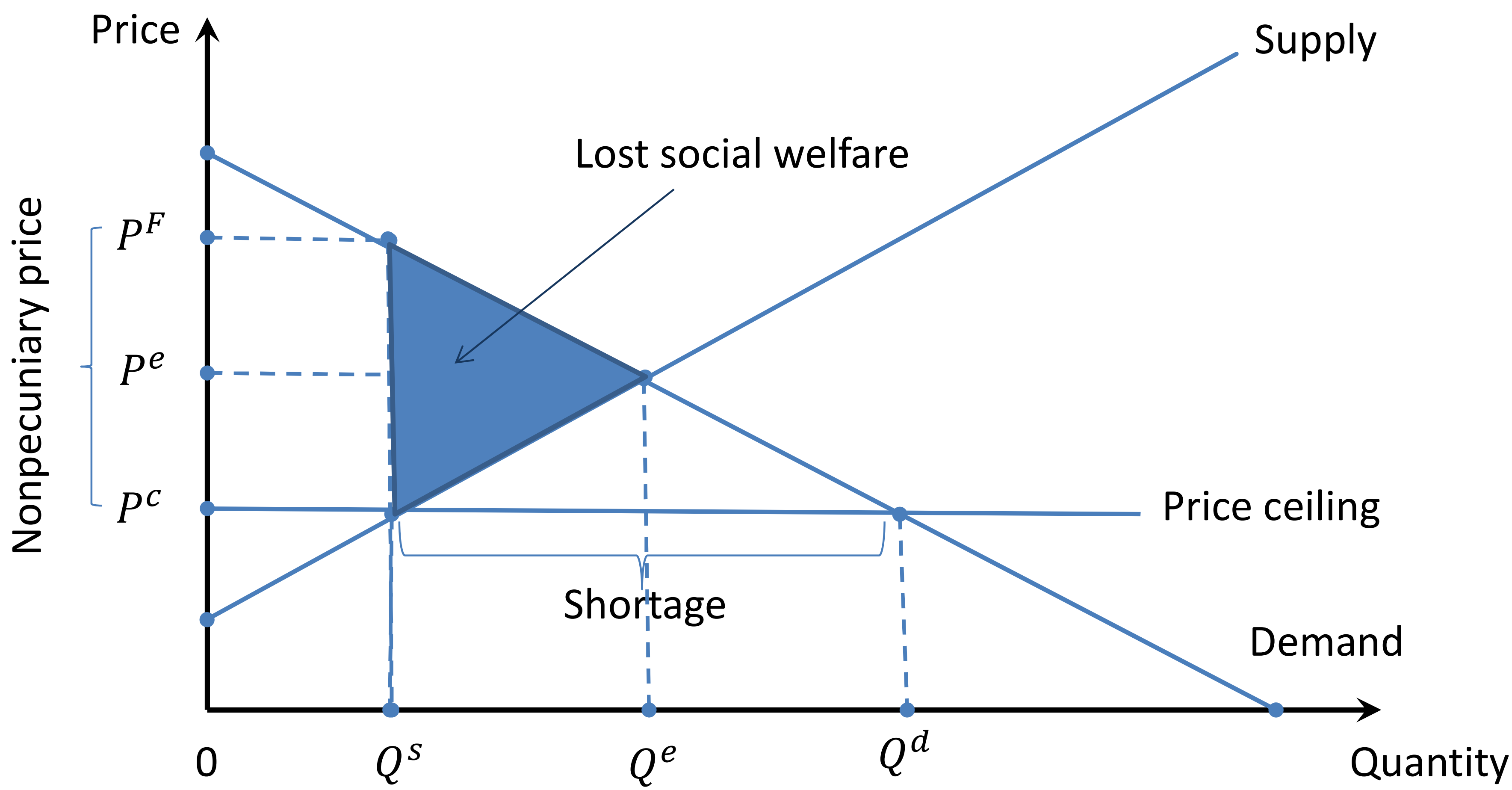
The Free Market vs. Central Planning

- The market equilibrium is efficient. No other outcome achieves higher total surplus.
  - Adam Smith and the Invisible Hand (The Wealth of Nations, 1776)
- Suppose resources were allocated not by the market, but by a central planner who cares about society's well-being.
- To allocate resources efficiently and maximize total surplus, the planner would need to know every seller's cost and every buyer's WTP for every good in the entire economy.
- This is impossible, and why centrally-planned economies are never very efficient.

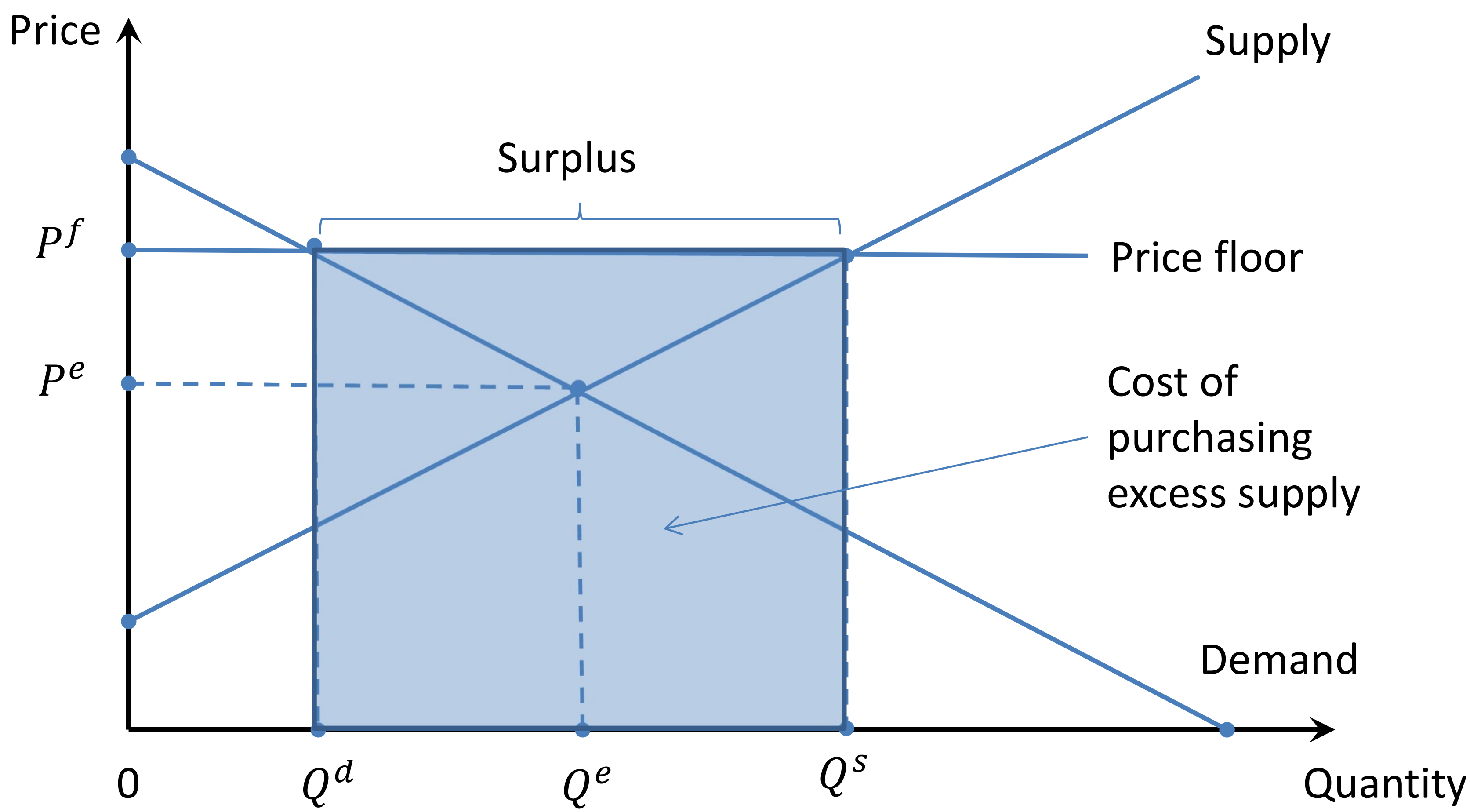
Price Restrictions and Market Equilibrium

- In a competitive market equilibrium, price and quantity freely adjust to the forces of demand and supply.
- Sometime government restricts how much prices are permitted to rise or fall.
  - Price ceiling
  - Price floor

A Price Ceiling



A Price Floor



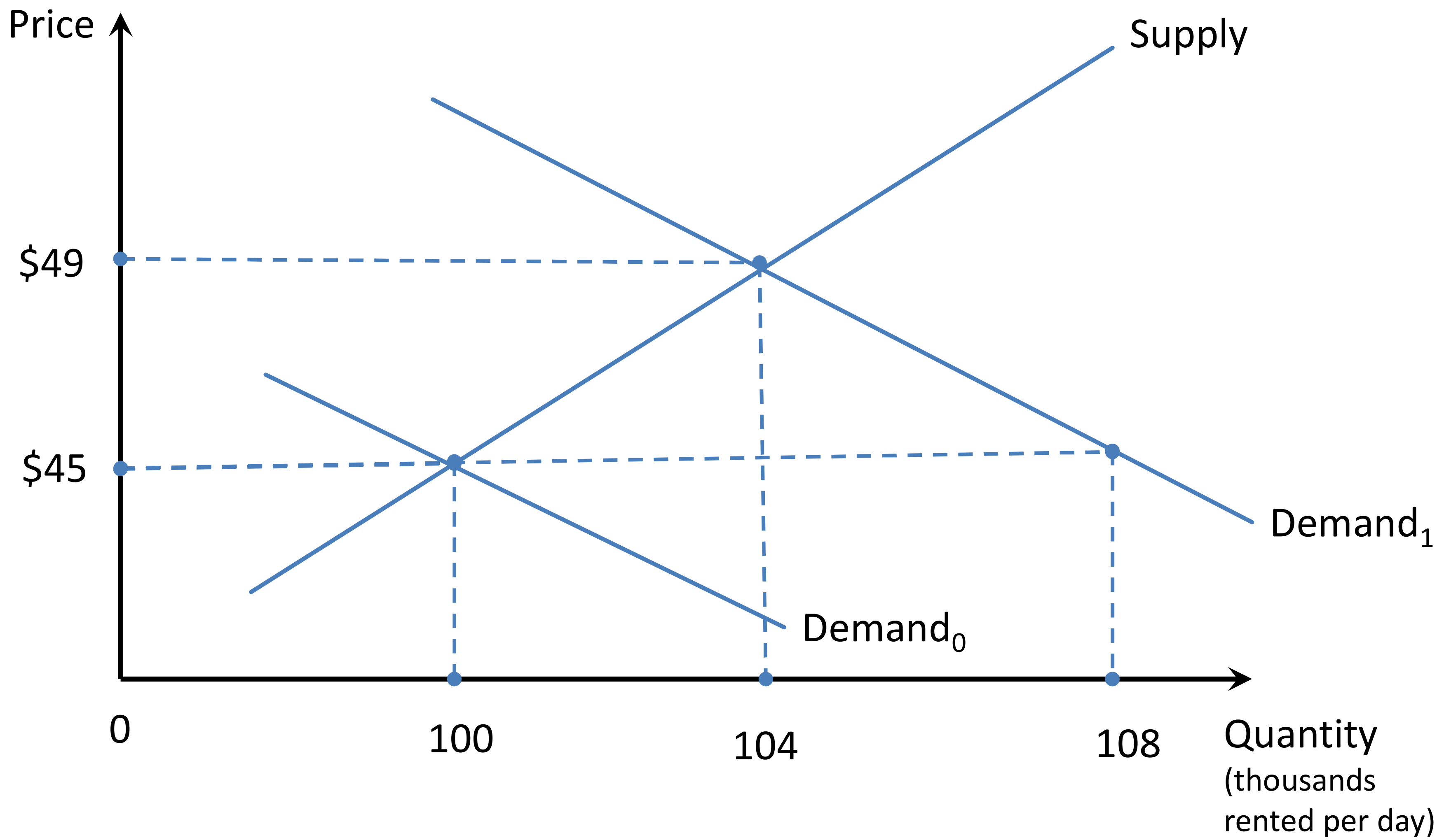
Comparative Statics

- ***Comparative static analysis***
  - The study of the movement from one equilibrium to another.
- Competitive markets, operating free of price restraints, will be analyzed when:
  - Demand changes
  - Supply changes
  - Demand and supply simultaneously change

Changes in Demand

- Increase in demand only
  - Increase equilibrium price
  - Increase equilibrium quantity
- Decrease in demand only
  - Decrease equilibrium price
  - Decrease equilibrium quantity
- Example of change in demand
  - Suppose that consumer incomes are projected to increase 2.5% and the number of individuals over 25 years of age will reach an all time high by the end of next year. What is the impact on the rental car market?

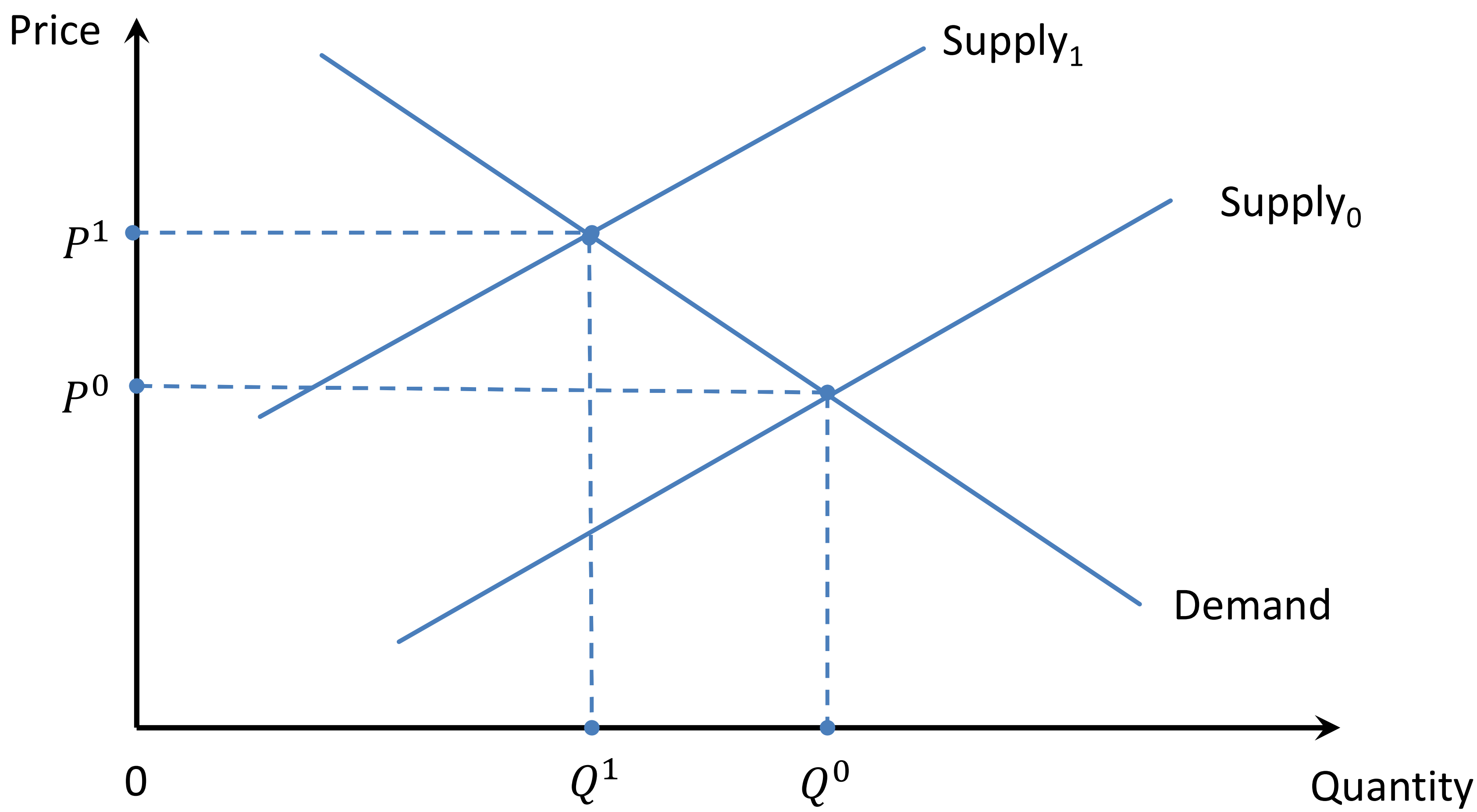
Effect of a Change in Demand for Rental Cars



Changes in Supply

- Increase in supply only
  - Decrease equilibrium price
  - Increase equilibrium quantity
- Decrease in supply only
  - Increase equilibrium price
  - Decrease equilibrium quantity
- Example of change in supply
  - Suppose that a bill before Congress would require all employers to provide health care to their workers. What is the impact on retail markets?

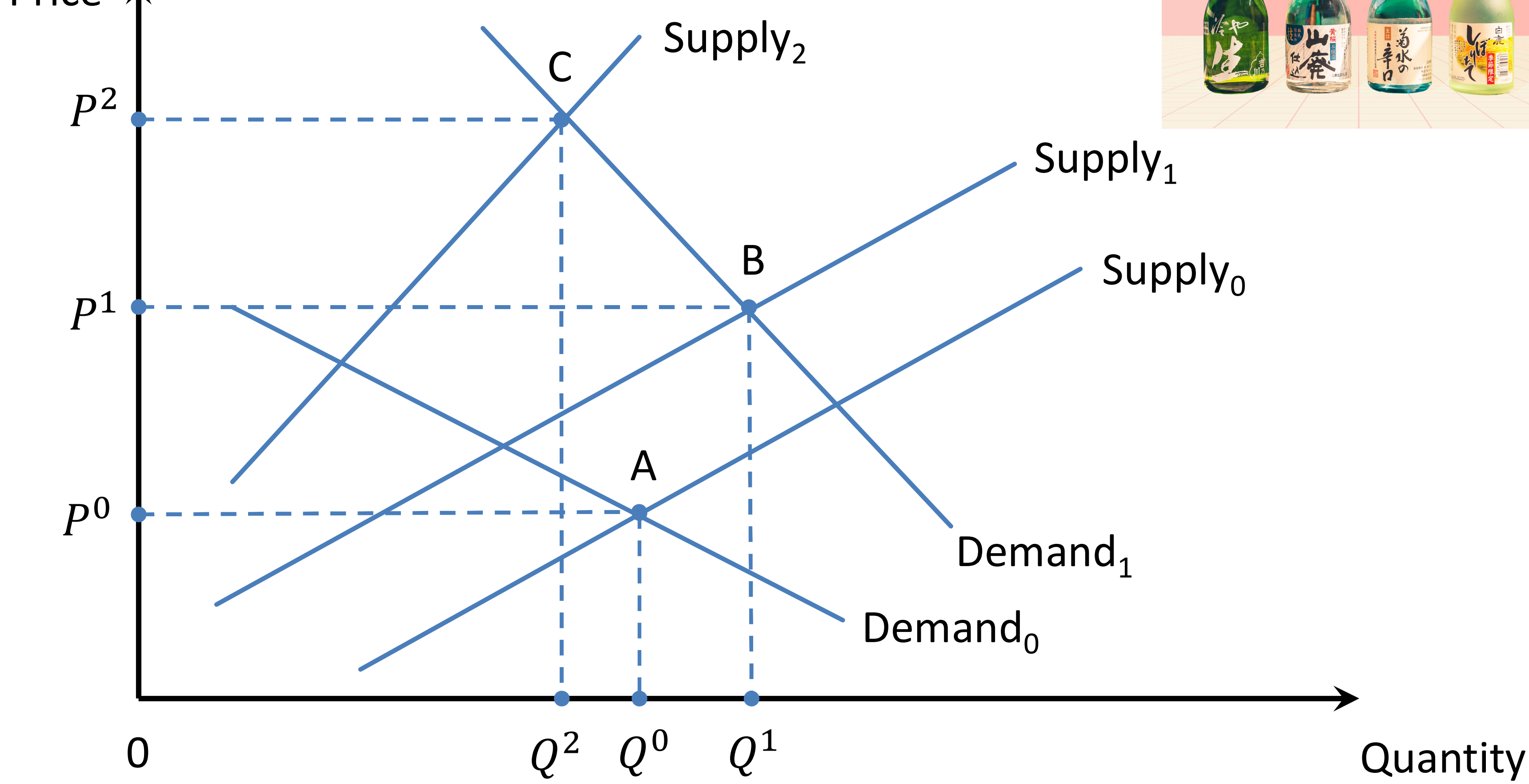
Effect of a Change in Supply



Simultaneous Shifts in Supply and Demand

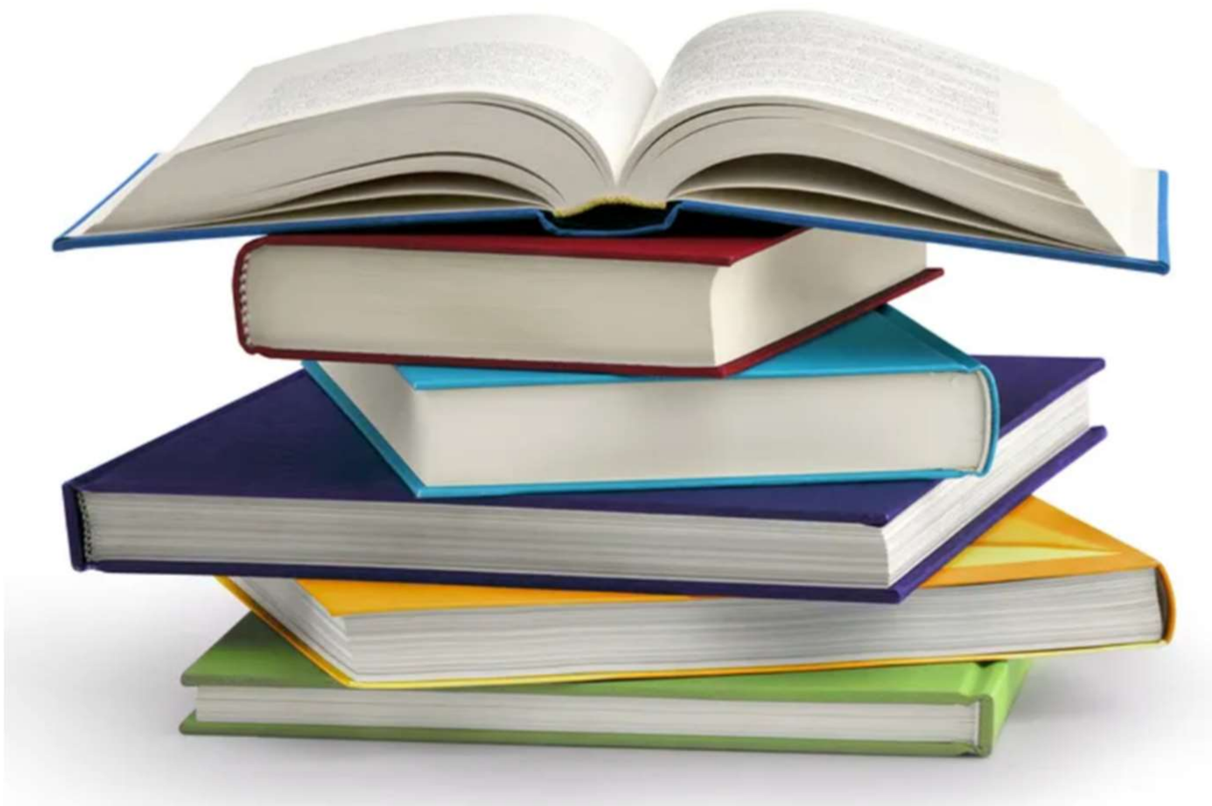
- Suppose that simultaneously the following events occur:
  - An earthquake hit Kobe, Japan and decreased the supply of fermented rice used to make sake wine.
  - The stress caused by the earthquake led many to increase their demand for sake, and other alcoholic beverages.
- What is the combined impact on Japan's sake market?

Simultaneous Shifts in Supply and Demand in Action



Class Experiment

- The demand and supply of an old math textbook



Take-home messages

- **A competitive market** has many buyers and sellers, each of whom has little or no influence on the market price.
- Economists use the **supply and demand model** to analyze competitive markets.
- The downward-sloping demand curve reflects the **Law of Demand**.
- The upward-sloping supply curve reflects the **Law of Supply**.

Take-home messages

- **Consumer surplus** is the difference between what buyers are willing to pay for a good and what they actually pay.
- **Producer surplus** is the difference between what sellers receive for a good and their cost of producing it.
- The intersection of demand and supply curves determines the **market equilibrium**.
- For a competitive market, the **market equilibrium is efficient and maximizes total surplus.**

INTRODUCTORY ECONOMICS: LECTURE 3
Quantitative Demand Analysis

Highlights

- *Price elasticity of demand*
- *Factors affecting price elasticity*
- *Price elasticity and total revenue*
- *Cross-price elasticity of demand*
- *Substitutes/complements*
- *Income elasticity of demand*
- *Normal/inferior good*
- *A taste of econometrics*

One Observation in Demand

- One observation: Some demand curves are steeper; some are flatter.
- What does it mean to have the demand curve be steeper or flatter?
- We need a **unit-free** measure for responsiveness of demand to price.

The Elasticity Concept

- **Elasticity**
  - A measure of the responsiveness of one variable to changes in another variable; the percentage change in one variable that arises due to a given percentage change in another variable.

The Elasticity Concept

- The elasticity between two variables, G and S, is mathematically expressed as:

$$E_{G,S} = \frac{\%\Delta G}{\%\Delta S}$$

- When a functional relationship exists, like $G = f(S)$, the elasticity is:

$$E_{G,S} = \frac{dG}{dS}\frac{S}{G}$$

Price Elasticity of Demand

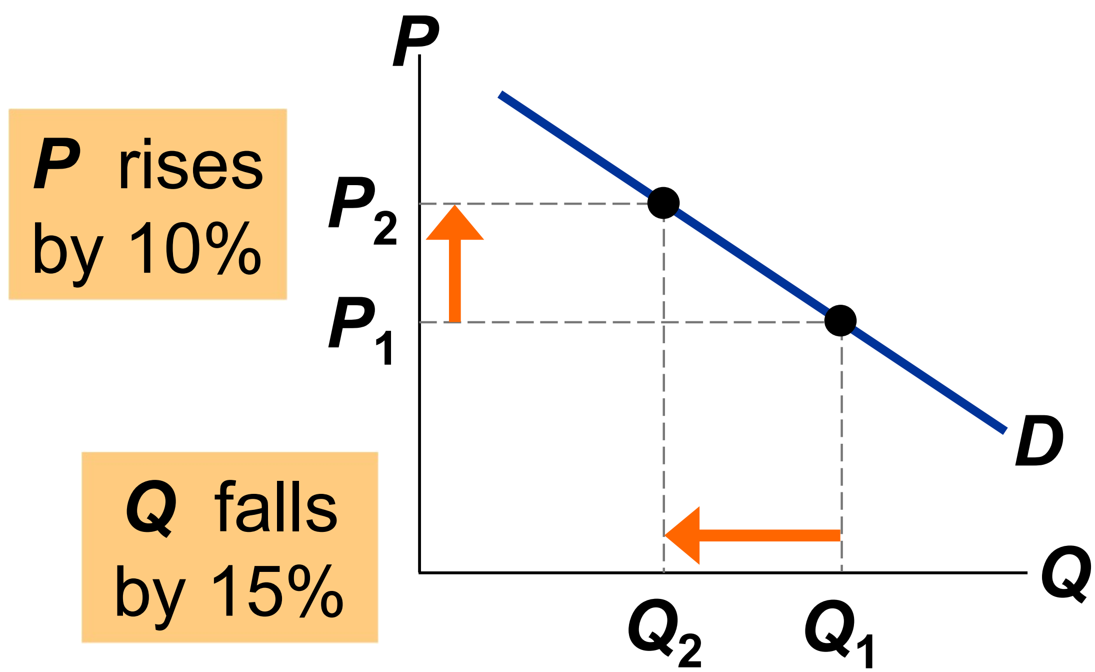
- **(Own) Price elasticity of demand**
  - Measures the responsiveness of a percentage change in the quantity demanded of good *X* to a percentage change in its price.

$$E_{Q_X{}^d, P_X} = \frac{\%\Delta Q_X{}^d}{\%\Delta P_X} = \frac{dQ_X}{dP_X}\frac{P_X}{Q_X}$$

<u>Example:</u>

Price elasticity of demand equals

$$\frac{-15\%}{10\%} = -1.5$$



Price Elasticity of Demand

- **(Own) Price elasticity of demand**
  - Measures the responsiveness of a percentage change in the quantity demanded of good *X* to a percentage change in its price.

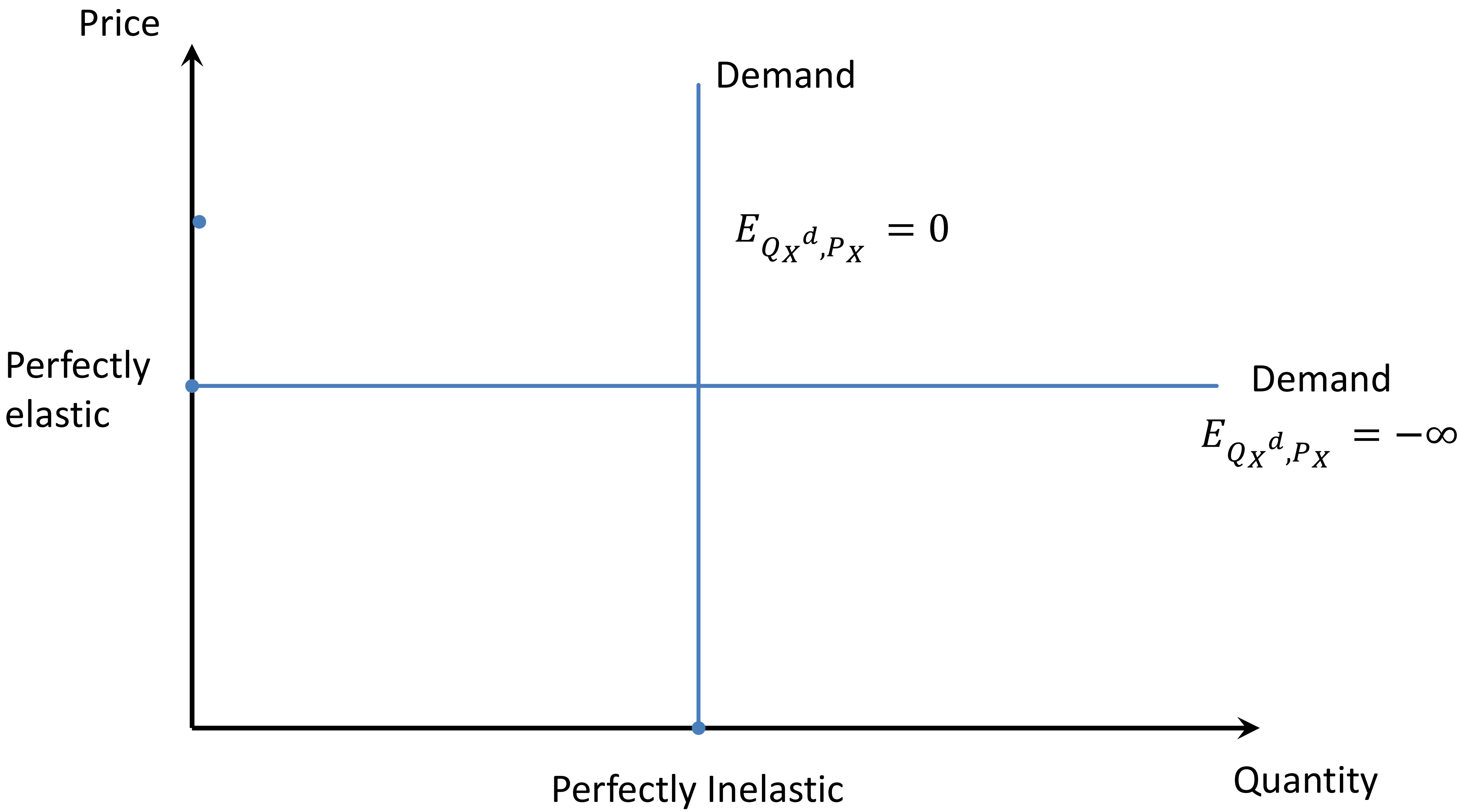
$$E_{Q_X{}^d, P_X} = \frac{\%\Delta Q_X{}^d}{\%\Delta P_X} = \frac{dQ_X}{dP_X}\frac{P_X}{Q_X}$$

  - Sign: negative by law of demand.
  - Magnitude of absolute value relative to unity:
    - $\left|E_{Q_X{}^d, P_X}\right| > 1$: Elastic.
    - $\left|E_{Q_X{}^d, P_X}\right| < 1$: Inelastic.
    - $\left|E_{Q_X{}^d, P_X}\right| = 1$: Unitary elastic.

Price Elasticity of Demand

- The price elasticity of demand is closely related to the slope of the demand curve.
- Rule of thumb:
  The flatter the curve, the bigger the elasticity. The steeper the curve, the smaller the elasticity.

Perfectly Elastic and Inelastic Demand



Discussions: Examples?

Price Elasticity of Demand in Reality

Table 3–2

Selected Own Price Elasticities

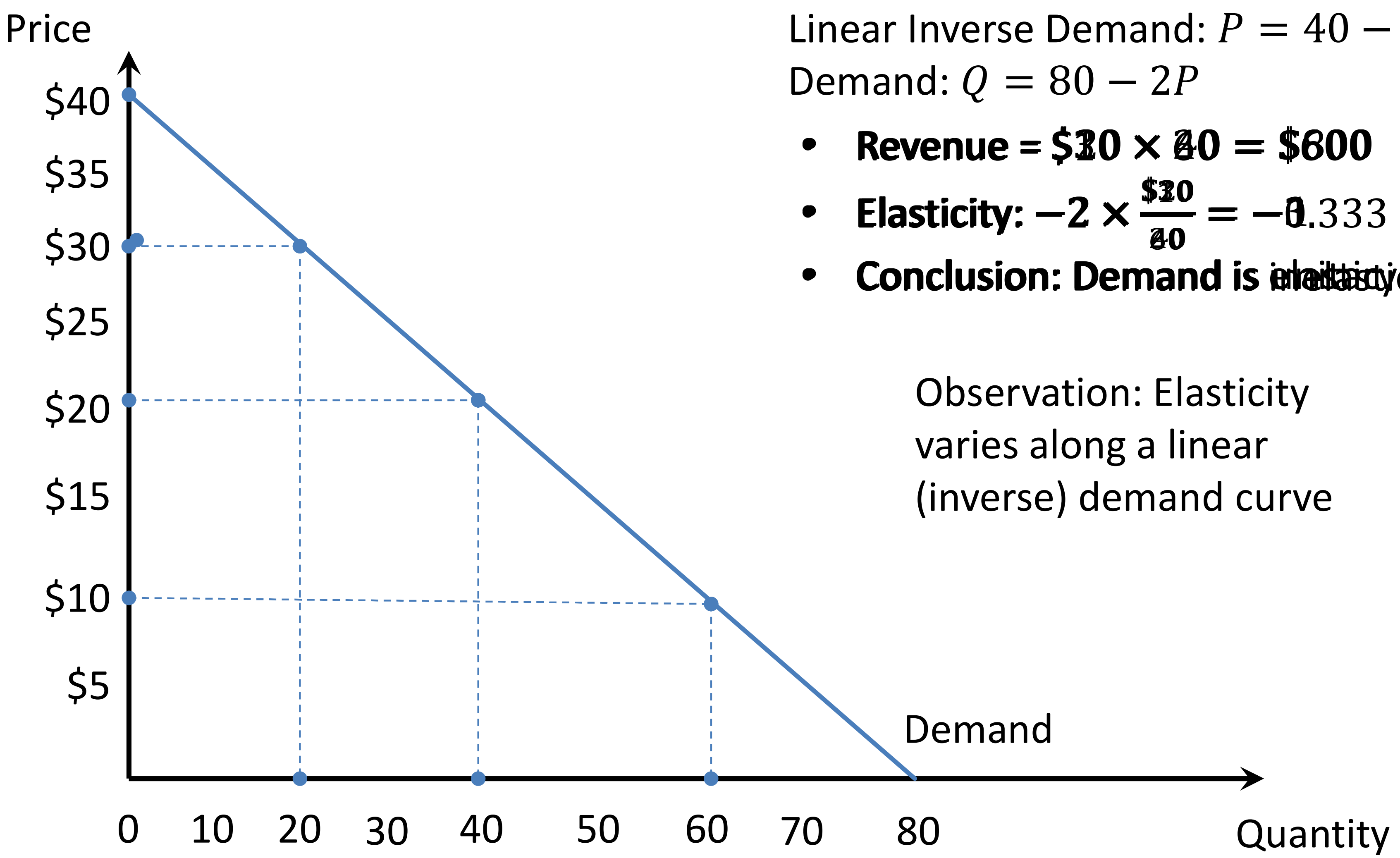
Market	Own Price Elasticity
Transportation	−0.6
Motor vehicles	−1.4
Motorcycles and bicycles	−2.3
Food	−0.7
Cereal	−1.5
Clothing	−0.9
Women's clothing	−1.2

SOURCES: M. R. Baye, D. W. Jansen, and J. W. Lee, "Advertising Effects in Complete Demand Systems," *Applied Economics* 24 (1992), pp. 1087–96; W. S. Commanor and T. A. Wilson, *Advertising and Market Power* (Cambridge, MA: Harvard University Press, 1974).

Factors Affecting Price Elasticity

- Factors can impact the own price elasticity of demand:
  - – Availability of consumption substitutes
    - How broadly or narrowly the good is defined; e.g., “Blue Jeans” vs. “Clothing”
  - – Time horizon (short-run or long-run)
    - e.g., If gasoline price increases, …
  - – Whether the good is a necessity or a luxury
    - e.g., Insulin vs. Caribbean Cruises
  - – Expenditure share of consumers’ budgets
    - e.g., food vs. transport

Linear Demand, Elasticity, and Revenue



Linear Inverse Demand: $P = 40 - 0.5Q$
Demand: $Q = 80 - 2P$

- **Revenue = $10 × 60 = $600**
- **Elasticity: $-2 \times \frac{\$10}{60} = -0.333$**
- **Conclusion: Demand is inelastic.**

Observation: Elasticity varies along a linear (inverse) demand curve

Price Elasticity and Total Revenue

- Continuing our scenario, if you raise your price, would your revenue rise or fall?

$$\text{Revenue} = \boldsymbol{P} \times \boldsymbol{Q}$$

- A price increase has two effects on revenue:
  - Higher ***P*** means more revenue on each unit you sell.
  - But you sell fewer units (lower ***Q***), due to Law of Demand.
- Which of these two effects is bigger?
  It depends on the price elasticity of demand.

Price Elasticity and Total Revenue

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } \boldsymbol{Q}}{\text{Percentage change in } \boldsymbol{P}}$$

Revenue = ***P*** x ***Q***

- If demand is elastic, then

  price elast. of demand > 1

  % change in ***Q*** > % change in ***P***

- The fall in revenue from lower ***Q*** is greater than the increase in revenue from higher ***P***, so revenue falls.

Price Elasticity and Total Revenue

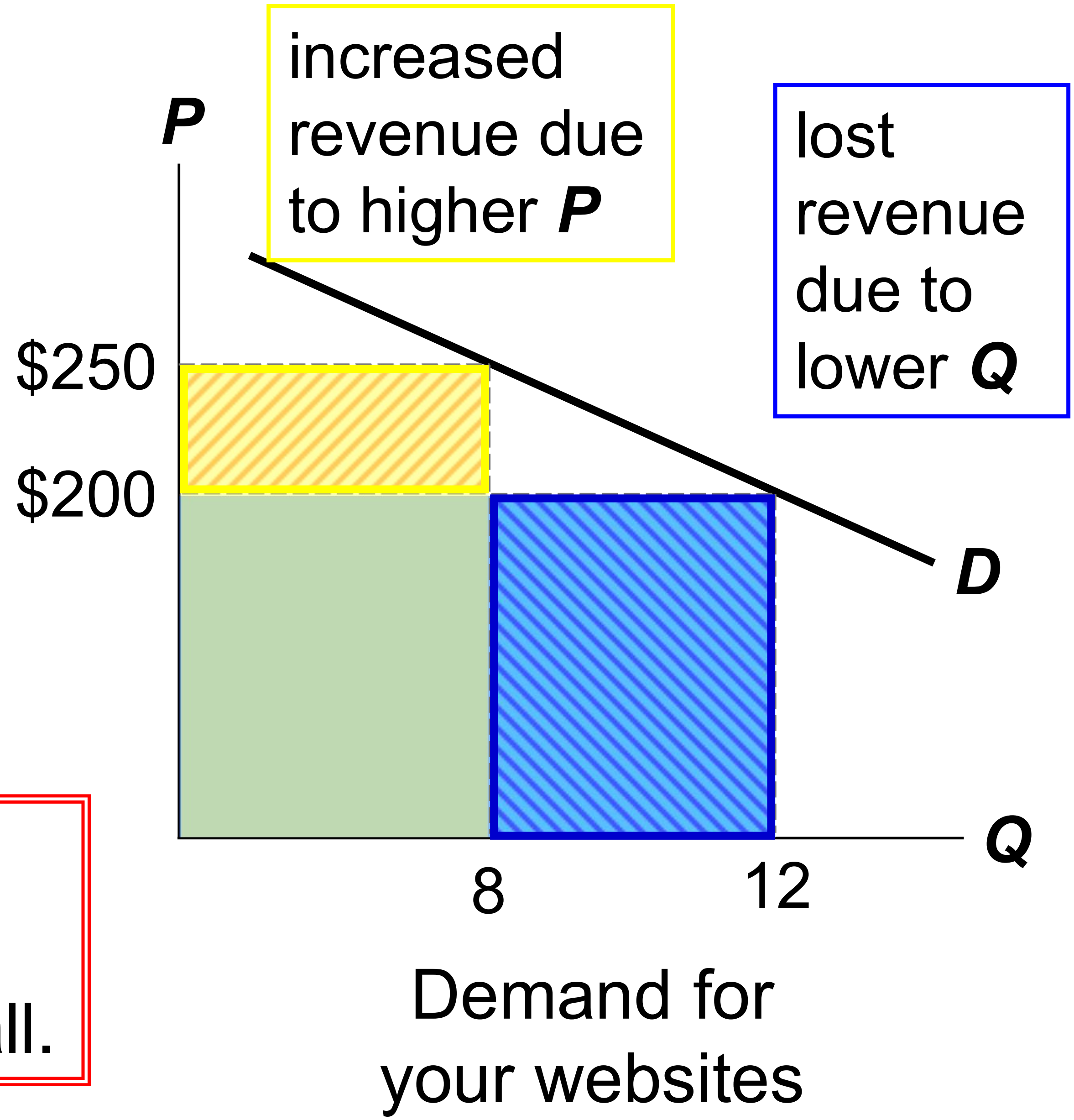
Scenario: You design websites for local businesses.

With elastic demand:

If P = \$200,
Q = 12 and
revenue = \$2400.

If P = \$250,
Q = 8 and
revenue = \$2000.

When D is elastic,
a price increase
causes revenue to fall.



Price Elasticity and Total Revenue

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } \boldsymbol{Q}}{\text{Percentage change in } \boldsymbol{P}}$$

Revenue = ***P*** x ***Q***

- If demand is inelastic, then
  price elast. of demand < 1
  % change in ***Q*** < % change in ***P***
- The fall in revenue from lower ***Q*** is smaller than the increase in revenue from higher ***P***, so revenue rises.

Price Elasticity and Total Revenue

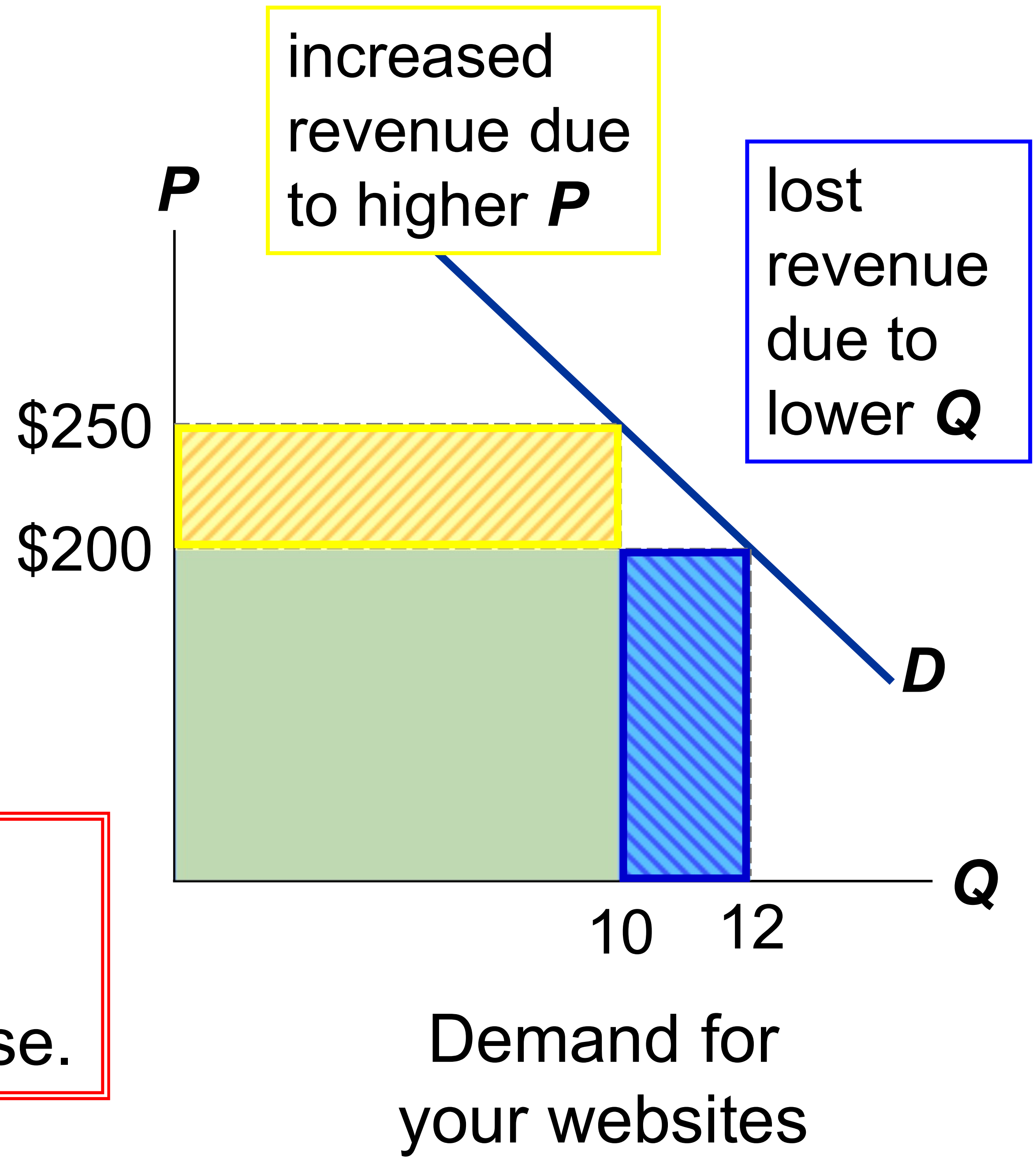
Now, demand is inelastic:

elasticity = 0.82

If ***P*** = $200,
Q = 12 and
revenue = $2400.

If ***P*** = $250,
Q = 10 and
revenue = $2500.

When ***D*** is inelastic, a price increase causes revenue to rise.



Total Revenue

- When demand is elastic:
  - A price increase (decrease) leads to a decrease (increase) in total revenue.
- When demand is inelastic:
  - A price increase (decrease) leads to an increase (decrease) in total revenue.
- When demand is unitary elastic:
  - Total revenue is maximized.

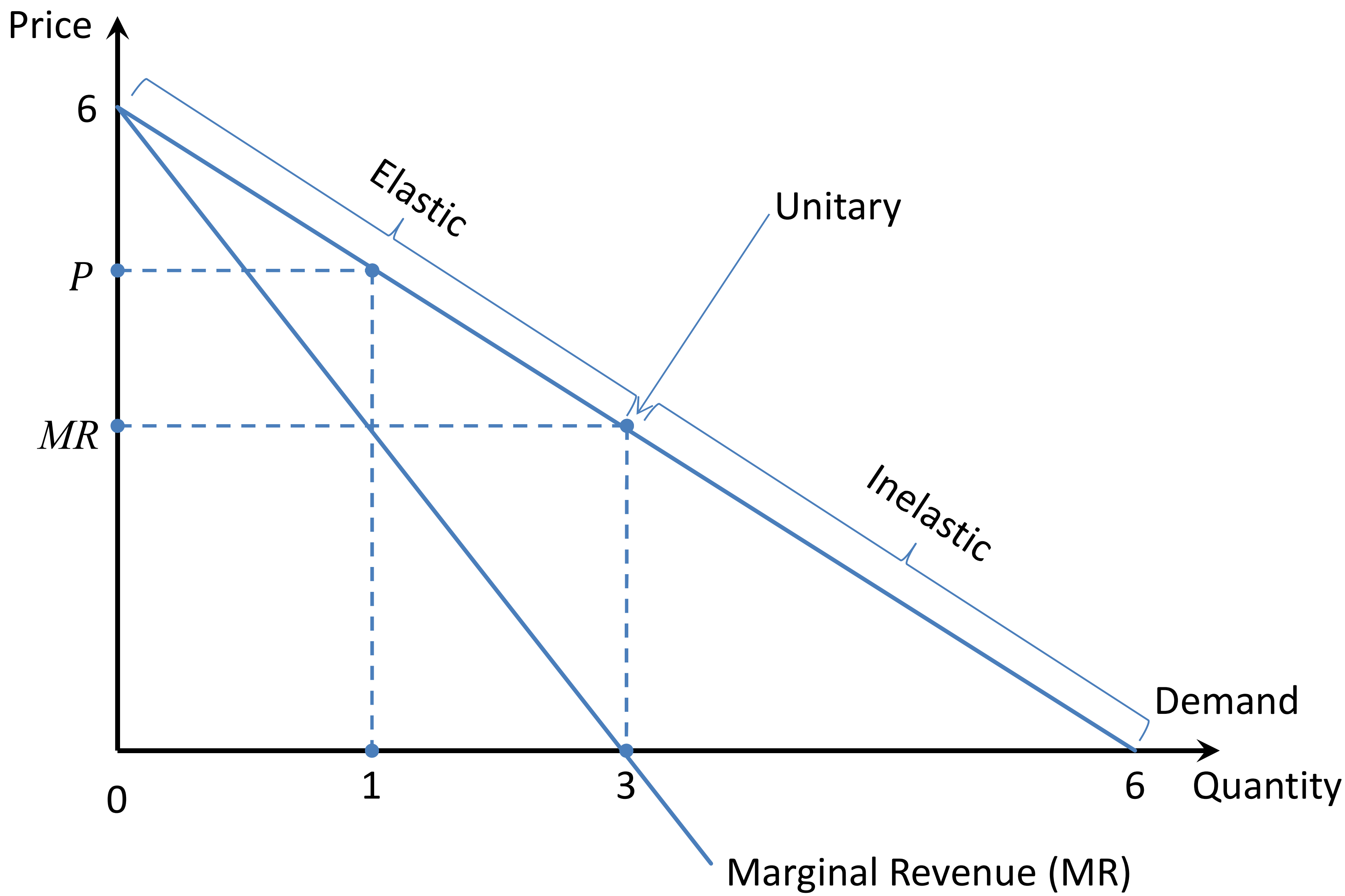
Marginal Revenue and the Own Price Elasticity of Demand

- The *marginal revenue* can be derived from a market demand curve.
  - Marginal revenue measures the additional revenue due to a change in output.
- This link relates *marginal revenue* to the own price elasticity of demand as follows:

$$MR = P\left(\frac{1+E}{E}\right)$$

  - When $-\infty < E < -1$ then, $MR > 0$.
  - When $E = -1$ then, $MR = 0$.
  - When $-1 < E < 0$ then, $MR < 0$.

Demand and Marginal Revenue



Cross-Price Elasticity

- Cross-price elasticity
  - Measures responsiveness of a percent change in demand for good X due to a percent change in the price of good Y.

$$E_{{Q_X}^d, P_Y} = \frac{\%\Delta {Q_X}^d}{\%\Delta P_Y}$$

  - If $E_{{Q_X}^d, P_Y} > 0$, then X and Y are substitutes.
  - If $E_{{Q_X}^d, P_Y} < 0$, then X and Y are complements.

Cross-Price Elasticity in the News

"As Gas Costs Soar, Buyers Flock to Small Cars"
-*New York Times*, 5/2/2008

"Gas Prices Drive Students to Online Courses"
-*Chronicle of Higher Education*, 7/8/2008

"Gas prices knock bicycle sales, repairs into higher gear"
-*Associated Press*, 5/11/2008

"Camel demand soars in India"
(as a substitute for "gas-guzzling tractors")
-*Financial Times*, 5/2/2008

"High gas prices drive farmer to switch to mules"
-*Associated Press*, 5/21/2008

Cross-Price Elasticity in Action

- Suppose it is estimated that the cross-price elasticity of demand between clothing and food is -0.18. If the price of food is projected to increase by 10 percent, by how much will demand for clothing change?

$$-0.18 = \frac{\%\Delta Q_{Clothing}{}^{d}}{10} \Rightarrow \%\Delta Q_{Clothing}{}^{d} = -1.8$$

  – That is, demand for clothing is expected to decline by 1.8 percent when the price of food increases 10 percent.

Cross-Price Elasticity in Action

- Suppose a restaurant earns \$4,000 per week in revenues from hamburger sales (*X*) and \$2,000 per week from soda sales (*Y*).
- If the own price elasticity for burgers is $E_{Q_X,P_X} = -1.5$ and the cross-price elasticity of demand between sodas and hamburgers is $E_{Q_Y,P_X} = -4.0$, what would happen to the firm's total revenues if it reduced the price of hamburgers by 1 percent?

$$\Delta R = [\$4{,}000(1 - 1.5) + \$2{,}000(-4.0)](-1\%)$$
$$= \$100$$

  – That is, lowering the price of hamburgers 1 percent increases total revenue by \$100.

Income Elasticity

- **Income elasticity**
  - Measures responsiveness of a percent change in demand for good *X* due to a percent change in income.

$$E_{Q_X{}^d,M} = \frac{\%\Delta Q_X{}^d}{\%\Delta M}$$

  - If $E_{Q_X{}^d,M} > 0$, then X is a ***normal good***.
  - If $E_{Q_X{}^d,M} < 0$, then X is an ***inferior good***.

Income Elasticity in Action

- Suppose that the income elasticity of demand for transportation is estimated to be 1.80. If income is projected to decrease by 15 percent,
- what is the impact on the demand for transportation?

$$1.8 = \frac{\%\Delta Q_X{}^d}{-15}$$

  – Demand for transportation will decline by 27 percent.
- is transportation a normal or inferior good?
  – Since demand decreases as income declines, transportation is a normal good.

Other Elasticities

- ***(Own) advertising elasticity*** of demand for good *X* is the ratio of the percentage change in the consumption of *X* to the percentage change in advertising spent on *X*.
- ***Cross-advertising elasticity*** between goods *X* and *Y* would measure the percentage change in the consumption of *X* that results from a 1 percent change in advertising toward *Y*.

Elasticities for Linear Demand Functions

- From a linear demand function, we can easily compute various elasticities.
- Given a linear demand function:

$$Q_X{}^d = \alpha_0 + \alpha_X P_X + \alpha_Y P_Y + \alpha_M M + \alpha_H P_H$$

  – Own price elasticity: $\alpha_X \frac{P_X}{Q_X{}^d}$.

  – Cross price elasticity: $\alpha_Y \frac{P_Y}{Q_X{}^d}$.

  – Income elasticity: $\alpha_M \frac{M}{Q_X{}^d}$.

Elasticities for Linear Demand Functions In Action

The daily demand for Invigorated PED shoes is estimated to be:

$$Q_X{}^d = 100 - 3P_X + 4P_Y - 0.01M + 2P_{A_X}$$

Suppose good *X* sells at $25 a pair, good *Y* sells at $35, the company utilizes 50 units of advertising, and average consumer income is $20,000. Calculate the own price, cross-price and income elasticities of demand.

- $Q_X{}^d = 100 - 3(\$25) + 4(\$35) - 0.01(\$20{,}000) + 2(50) = 65$ units.
- Own price elasticity: $-3(\frac{25}{65}) = -1.15.$
- Cross-price elasticity: $4(\frac{35}{65}) = 2.15.$
- Income elasticity: $-0.01(\frac{20{,}000}{65}) = -3.08.$

Elasticities for Nonlinear Demand Functions

- One non-linear demand function is the log-linear demand function:

$$\ln {Q_X}^d \\ = \beta_0 + \beta_X \ln P_X + \beta_Y \ln P_Y + \beta_M \ln M + \beta_H \ln H$$

  - Own price elasticity: β_X.
  - Cross price elasticity: β_Y.
  - Income elasticity: β_M.

Elasticities for Nonlinear Demand Functions In Action

An analyst for a major apparel company estimates that the demand for its raincoats is given by

$$ln\ {Q_X}^d = 10 - 1.2 \ln P_X + 3 \ln R\ - 2 \ln A_Y$$

where R denotes the daily amount of rainfall and A_Y the level of advertising on good Y. What would be the impact on demand of a 10 percent increase in the daily amount of rainfall?

$E_{{Q_X}^d,R} = \beta_R = 3$. So, $E_{{Q_X}^d,R} = \frac{\%\Delta {Q_X}^d}{\%\Delta R} \Rightarrow 3 = \frac{\%\Delta {Q_X}^d}{10}$.

A 10 percent increase in rainfall will lead to a 30 percent increase in the demand for raincoats.

Econometric/Regression Analysis

- How does one obtain information on the demand function?
  - Published studies
  - Hire consultant
  - Statistical technique called regression analysis using data on quantity, price, income and other important variables.

An Introduction to Econometrics

- Econometrics fills a gap between being a "student of economics" and being a "practicing economist"
  - It lets you tell your employer:
    - "I can predict the sales of your product"
    - "I can estimate the effect on your sales if your competition lowers its price by $1 per unit"
    - "I can test whether your new ad campaign is actually increasing your sales"
  - Helps you develop "intuition" about how things work and is invaluable if you go to graduate school

An Introduction to Econometrics

Econometrics is about how we can use theory and data from economics, business, and the social sciences, along with tools from statistics, to answer ‘‘how much’’ questions.

- Every day, decision-makers face ‘‘how much’’:
  - The owner of a local Pizza Hut must decide how much advertising space to purchase in the local newspaper, and thus must estimate the relationship between advertising and sales
  - A public transportation council in Melbourne, Australia, must decide how an increase in fares for public transportation (trams, trains, and buses) will affect the number of travelers who switch to car or bike, and the effect of this switch on revenue going to public transportation

An Introduction to Econometrics

- In economics we express our ideas about relationships between economic variables using the mathematical concept of a function

$$Consumption = f(Income)$$

$$Q^d = f(P, P^s, P^C, INC)$$

- An econometric model consists of a systematic part and a random and unpredictable component *e* that we will call a **random error**

$$Q^d = f(P, P^s, P^c, INC) + e$$

$$f(P, P^s, P^c, INC) = \beta_1 + \beta_2 P + \beta_3 P^s + \beta_4 P^c + \beta_5 INC$$

$$Q^d = \beta_1 + \beta_2 P + \beta_3 P^s + \beta_4 P^c + \beta_5 INC + e$$

An Introduction to Econometrics

- **Econometric model of criminal activity**
  - The functional form has to be specified
  - Variables may have to be approximated by other quantities

Measure of criminal activity

Wage for legal employment

Other income

Frequency of prior arrests

Unobserved determinants of criminal activity

$$crime = \beta_0 + \beta_1 wage_m + \beta_2 othinc + \beta_3 freqarr$$
$$+ \beta_4 freqconv + \beta_5 avgsen + \beta_6 age + u$$

Frequency of conviction

Average sentence length after conviction

Age

e.g. moral character, <u>wage in criminal activity</u>, family background …

An Introduction to Econometrics

- **Econometric model of job training and worker productivity**

$$wage = \beta_0 + \beta_1 educ + \beta_2 exper + \beta_3 training + u$$

Unobserved determinants of the wage

Hourly wage

Years of formal education

Years of work-force experience

Weeks spent in job training

e.g. innate ability, quality of education, family background …

- **Econometric models may be used for hypothesis testing**
  - For example, the parameter β_3 represents effect of training on wage
  - How large is this effect? Is it different from zero?

A Simple Regression Model

- **Definition of the simple linear regression model**

"Explains variable y in terms of variable x"

Intercept

Slope parameter

$$y = \beta_0 + \beta_1 x + u$$

Dependent variable, explained variable, response variable,…

Independent variable, explanatory variable, regressor,…

Error term, disturbance, unobservables,…

A Simple Regression Model

- **Interpretation of the simple linear regression model**

"Studies how y varies with changes in x:"

$$\frac{\partial y}{\partial x} = \beta_1 \quad \text{as long as} \quad \frac{\partial u}{\partial x} = 0$$

By how much does the dependent variable change if the independent variable is increased by one unit?

Interpretation only correct if all other things remain equal when the indepen-dent variable is increased by one unit

- **The simple linear regression model is rarely applicable in prac-tice but its discussion is useful for pedagogical reasons**

A Simple Regression Model

- **Example: A simple wage equation**

$$wage = \beta_0 + \beta_1 educ + u$$

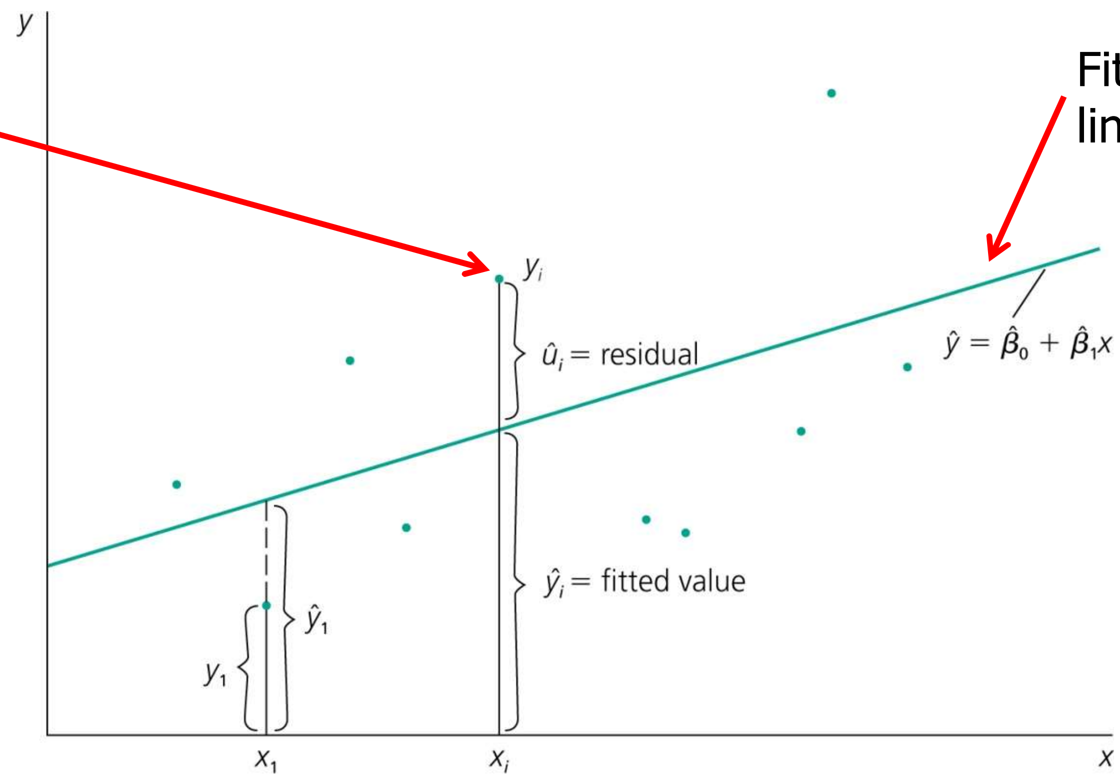
Measures the change in hourly wage given another year of education, holding all other factors fixed

Labor force experience, tenure with current employer, work ethic, intelligence …

A Simple Regression Model

- **Fit as good as possible a regression line through the data points:**

For example, the i-th data point (x_i, y_i)



Fitted regression line

A Simple Regression Model

- **<u>What does „as good as possible“ mean?</u>**
- **Regression residuals**

$$\widehat{u}_i = y_i - \widehat{y}_i = y_i - \widehat{\beta}_0 - \widehat{\beta}_1 x_i$$

- **Minimize sum of squared regression residuals**

$$\min \sum_{i=1}^{n} \widehat{u}_i^2 \quad \rightarrow \quad \widehat{\beta}_0, \widehat{\beta}_1$$

- **<u>Ordinary Least Squares (OLS) estimates</u>**

$$\widehat{\beta}_1 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}, \qquad \widehat{\beta}_0 = \bar{y} - \widehat{\beta}_1 \bar{x}$$

Fit of the Regression

- **Goodness-of-Fit**

„How well does the explanatory variable explain the dependent variable?"

- **Measures of Variation**

$$SST = \sum_{i=1}^{n} (y_i - \bar{y})^2 \qquad SSE = \sum_{i=1}^{n} (\hat{y}_i - \bar{y})^2 \qquad SSR = \sum_{i=1}^{n} \hat{u}_i^2$$

Total sum of squares, represents total variation in dependent variable

Explained sum of squares, represents variation explained by regression

Residual sum of squares, represents variation not explained by regression

Fit of the Regression

- **Decomposition of total variation**

$$SST = SSE + SSR$$

Total variation

Explained part

Unexplained part

- **Goodness-of-fit measure (R-squared)**

$$R^2 = \frac{SSE}{SST} = 1 - \frac{SSR}{SST}$$

R-squared measures the fraction of the total variation that is explained by the regression

Evaluating Statistical Significance

- ***Standard error***
  - The estimated standard deviations of the regression coefficients are called „standard errors". They measure how precisely the regression coefficients are estimated.

$$se(\hat{\beta}_1) = \sqrt{\widehat{Var}(\hat{\beta}_1)} = \sqrt{\hat{\sigma}^2 / SST_x}$$

$$se(\hat{\beta}_0) = \sqrt{\widehat{Var}(\hat{\beta}_0)} = \sqrt{\hat{\sigma}^2 n^{-1} \sum_{i=1}^{n} x_i^2 / SST_x}$$

- **t-statistic (or t-ratio)**

$$t_{\hat{\beta}_j} = \frac{\hat{\beta}_j}{se(\hat{\beta}_j)}$$

  - When $|t| > 1.96$, we are 95 percent confident the true parameter is in the regression is not zero.

Excel and Least Squares Estimates

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.87
R Square	0.75
Adjusted R Square	0.72
Standard Error	112.22
Observations	10.00

$se\,(\widehat{a}) = 243.97$

$se(\widehat{b}) = 0.53$

$t_{\hat{a}} = |6.69| > 1.96$, the intercept is different from zero.

$t_{\hat{b}} = |-4.89| > 1.96$, the intercept is different from zero.

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	301470.89	301470.89	23.94	0.0012
Residual	8	100751.61	12593.95		
Total	9	402222.50			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1631.47	243.97	6.69	0.0002	1068.87	2194.07
Price	-2.60	0.53	-4.89	0.0012	-3.82	-1.37

Take-home messages

- **Price elasticity of demand** equals percentage change in Q^d divided by percentage change in P. When it's less than one, demand is "inelastic." When greater than one, demand is "elastic."
- **Demand is less elastic** in the short run, for broadly defined goods, or for goods with few close substitutes, for goods with small share in expenditure..
- When **demand** is inelastic, **total revenue** rises when price rises. When demand is elastic, total revenue falls when price rises.

Take-home messages

- The **cross-price elasticity of demand** measures how much demand for one good responds to changes in the price of another good.
- The **income elasticity of demand** measures how much quantity demanded responds to changes in buyers' incomes.

INTRODUCTORY ECONOMICS: LECTURE 4

The Production Process and Costs

Highlights

- *Production function and marginal product*
- *Marginal rate of technical substitutions*
- *Cost-minimizing input rule*
- *Cost function: Marginal cost vs Avg. cost*
- *Fixed costs vs sunk costs*
- *Long-run cost curve*
- *Economies of scale*
- *Economies of scope*

The Production Function

- Mathematical function that defines the maximum amount of output that can be produced with a given set of inputs.

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

  - Q is the level of output.
  - K is the quantity of capital input.
  - L is the quantity of labor input.

Short-Run versus Long-Run Decisions: Fixed and Variable Inputs

- Short-run
  - Period of time where some factors of production (inputs) are ***fixed***, and constrain a manager's decisions.
- Long-run
  - Period of time over which all factors of production (inputs) are ***variable***, and can be adjusted by a manager.

Measures of 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: $MP_K = \frac{\Delta Q}{\Delta K}$

Measures of Productivity in Action

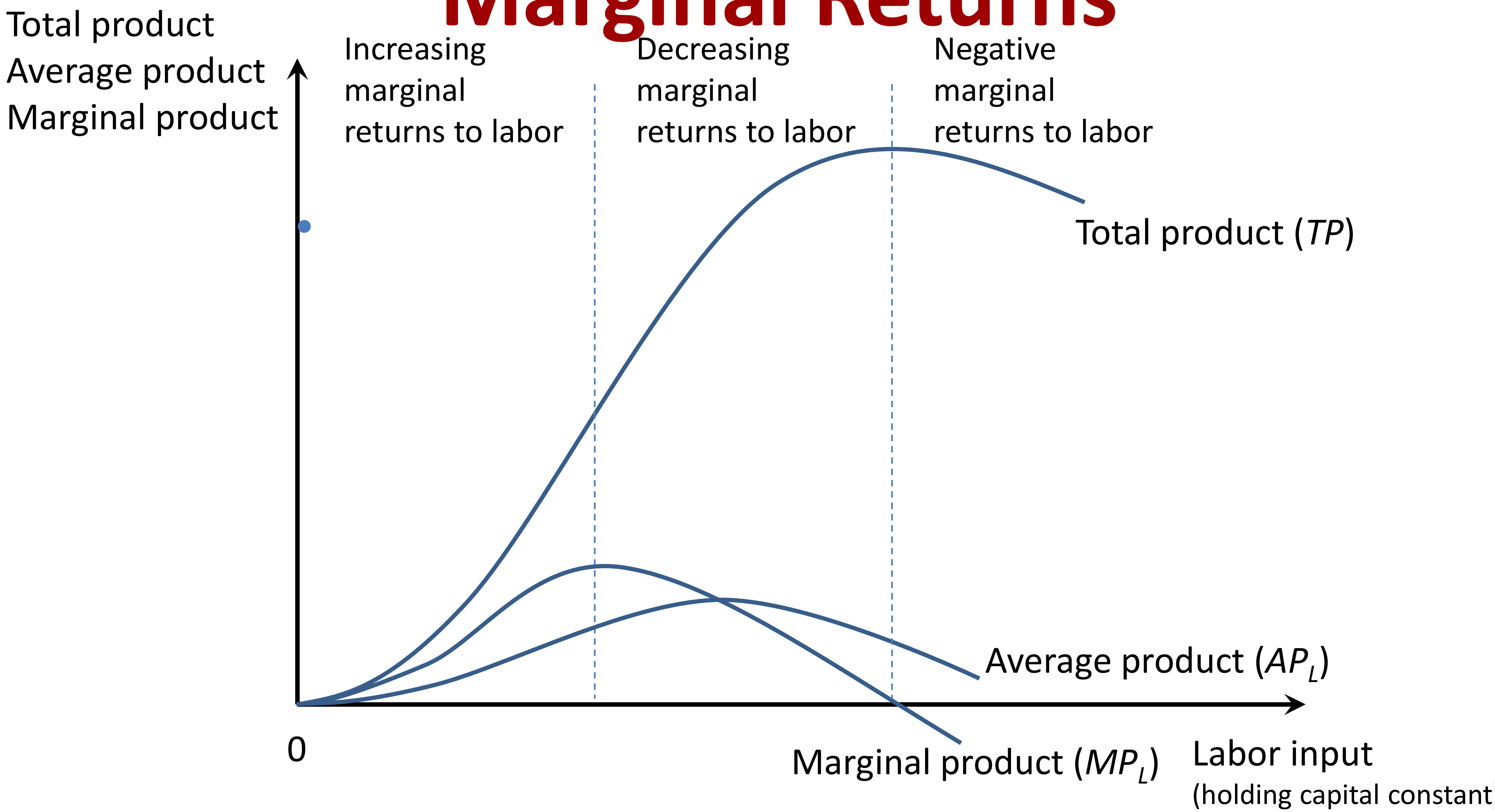
- Consider the following production function when 5 units of labor and 10 units of capital are combined produce: $Q = F(10,5) = 150$.
- Compute the average product of labor.

$$AP_L = \frac{150}{5} = 30 \text{ units per worker}$$

- Compute the average product of capital.

$$AP_L = \frac{150}{10} = 15 \text{ units capital unit}$$

Increasing, Decreasing, and Negative Marginal Returns



Algebraic Forms of Production Functions

- Commonly used algebraic production function forms:
  - ***Linear***: Assumes a perfect linear relationship between all inputs and total output

    $Q = F(K, L) = aK + bL$, where a and b are constants.
  - ***Leontief***: Assumes that inputs are used in fixed proportions

    $Q = F(K, L) = \min\{aK, bL\}$, where a and b are constants.
  - ***Cobb-Douglas***: Assumes some degree of substitutability among inputs

    $Q = F(K, L) = K^a L^b$, where a and b are constants.

Algebraic Forms of Production Functions in Action

- Suppose that a firm's estimated production function is:

$$Q = 3K + 6L$$

- How much output is produced when 3 units of capital and 7 units of labor are employed?

$$Q = F(3,7) = 3(3) + 6(7) = 51 \text{ units}$$

Algebraic Measures of Productivity

- Given the commonly used algebraic production function forms, we can compute the measures of productivity as follows:
  - *Linear*:
    - Marginal products: $MP_K = a$ and $MP_L = b$
    - Average products: $AP_K = \frac{aK+bL}{K}$ and $AP_L = \frac{aK+bL}{L}$
  - *Cobb-Douglas*:
    - Marginal products: $MP_K = aK^{a-1}L^b$ and $MP_L = bK^aL^{b-1}$
    - Average products: $AP_K = \frac{K^aL^b}{K}$ and $AP_L = \frac{K^aL^b}{L}$

Algebraic Measures of Productivity in Action

- 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?

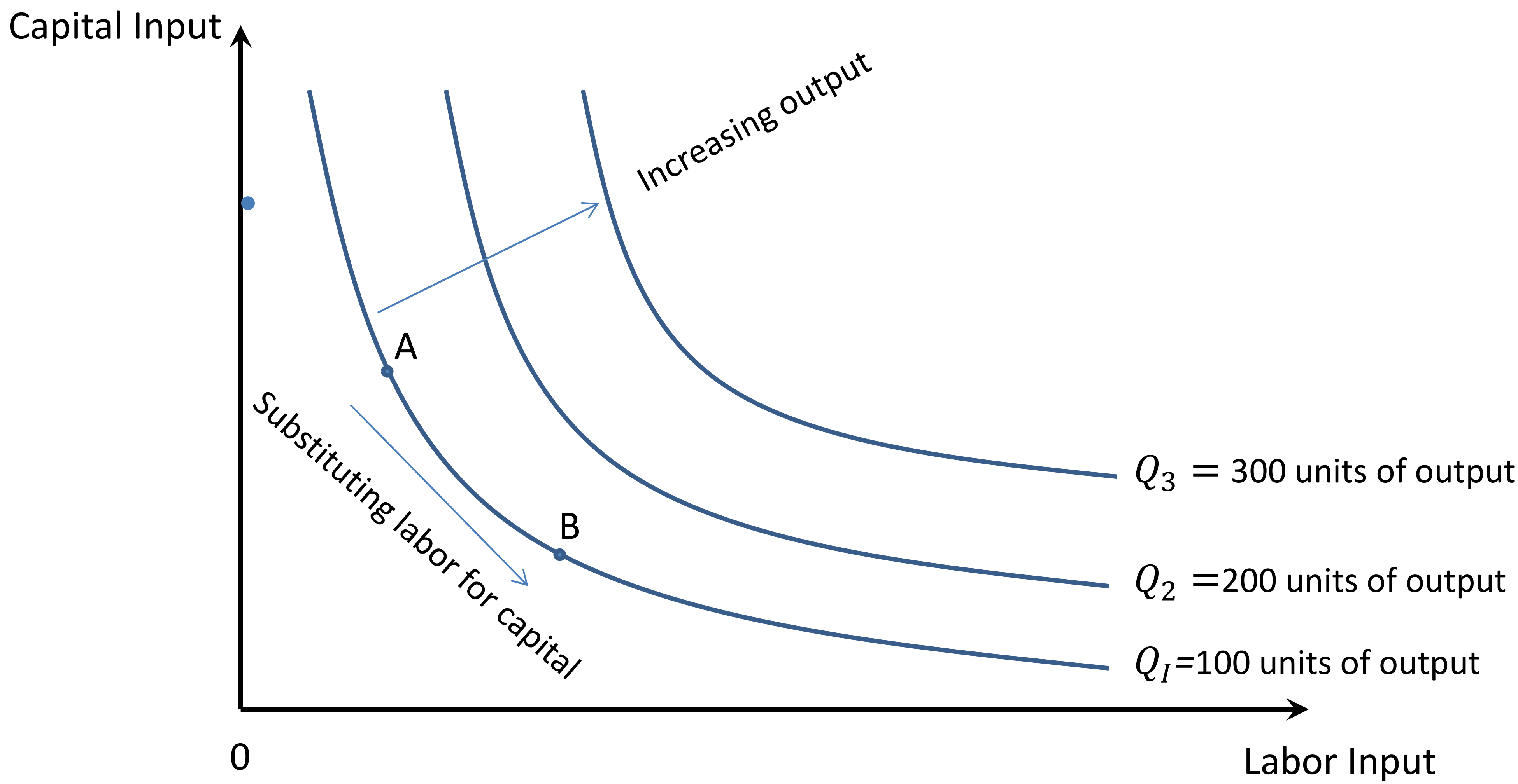
$$MP_L = 1 \times \frac{3}{4} L^{-\frac{1}{4}} = 1 \times \frac{3}{4} (16)^{-\frac{1}{4}} = \frac{3}{8}$$

Isoquants and Marginal Rate of Technical Substitution

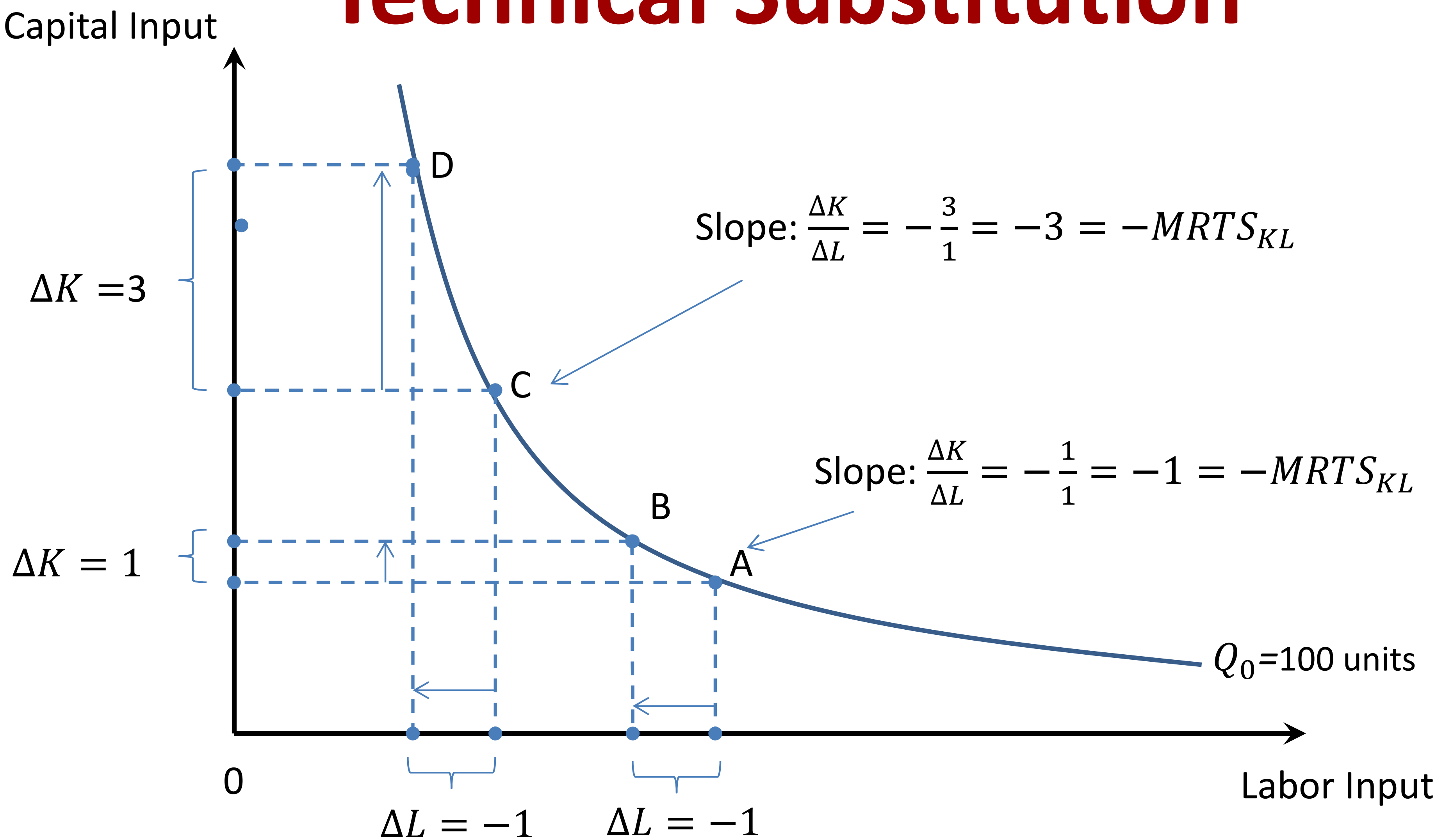
- ***Isoquants*** capture the tradeoff between combinations of inputs that yield the same output in the long run, when all inputs are variable.
- **Marginal rate of technical substitutions (MRTS)**
  - The rate at which a producer can substitute between two inputs and maintain the same level of output.
  - Absolute value of the slope of the isoquant.

$$MRTS_{KS} = \frac{MP_L}{MP_K}$$

Isoquants and Marginal Rate of Technical Substitution in Action



Diminishing Marginal Rate of Technical Substitution



Isocost and Changes in Isocost Lines

- **Isocost**
  - Combination of inputs that yield cost the same cost.

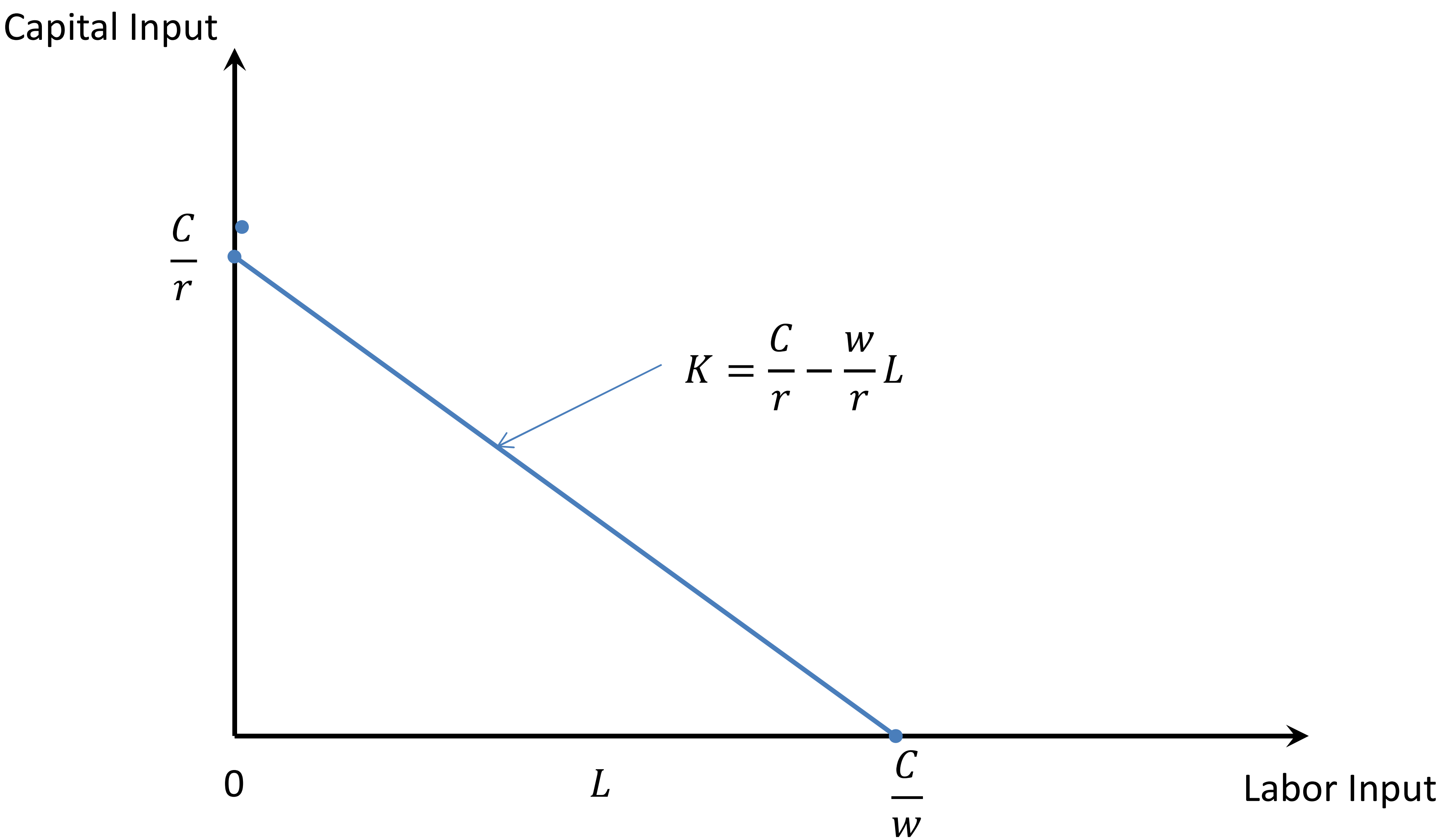
$$wL + rK = C$$

or, re-arranging to the intercept-slope formulation:

$$K = \frac{C}{r} - \frac{w}{r}L$$

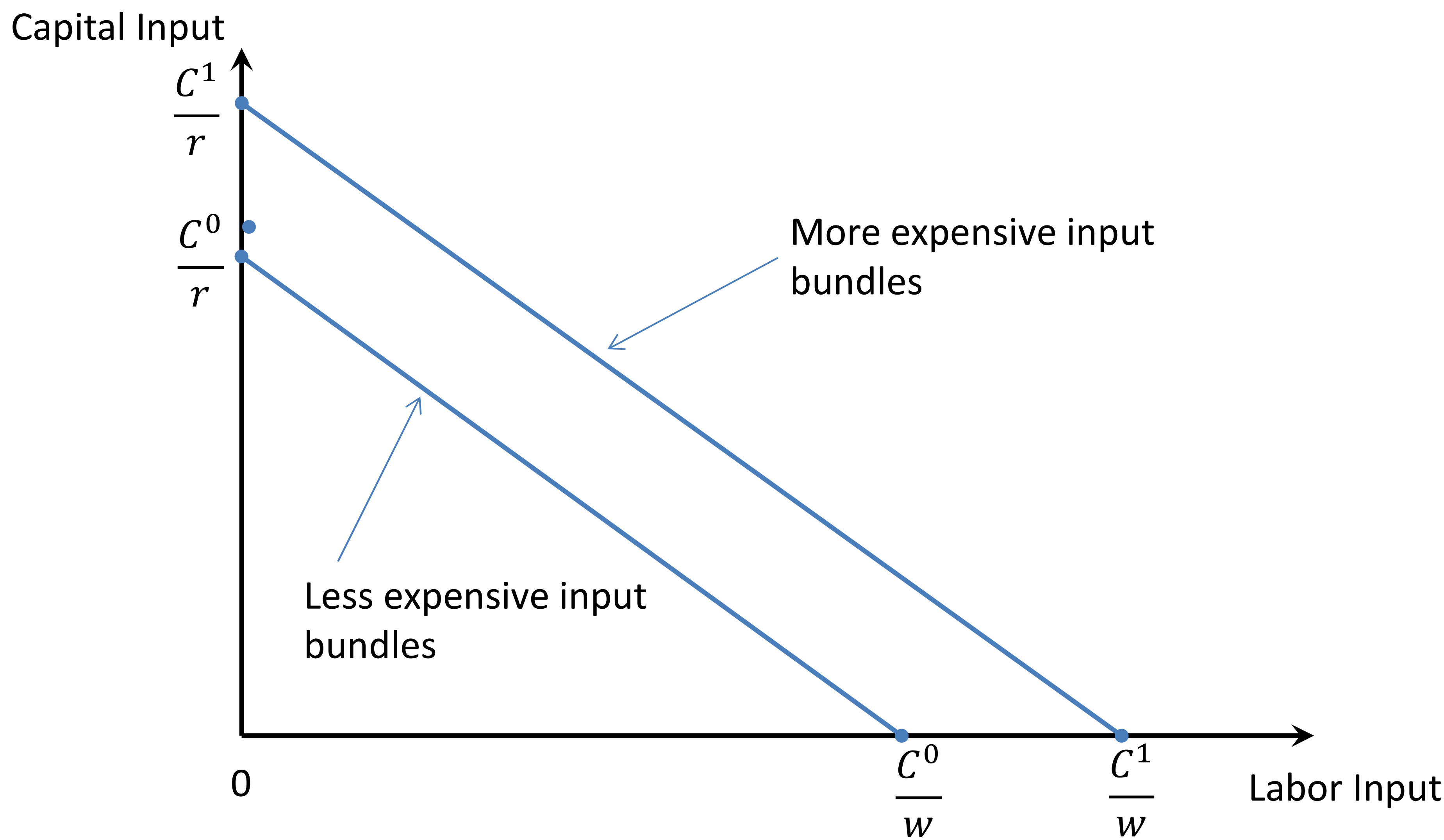
- **Changes in isocosts**
  - For given input prices, isocosts farther from the origin are associated with higher costs.
  - Changes in input prices change the slopes of isocost lines.

Isocosts

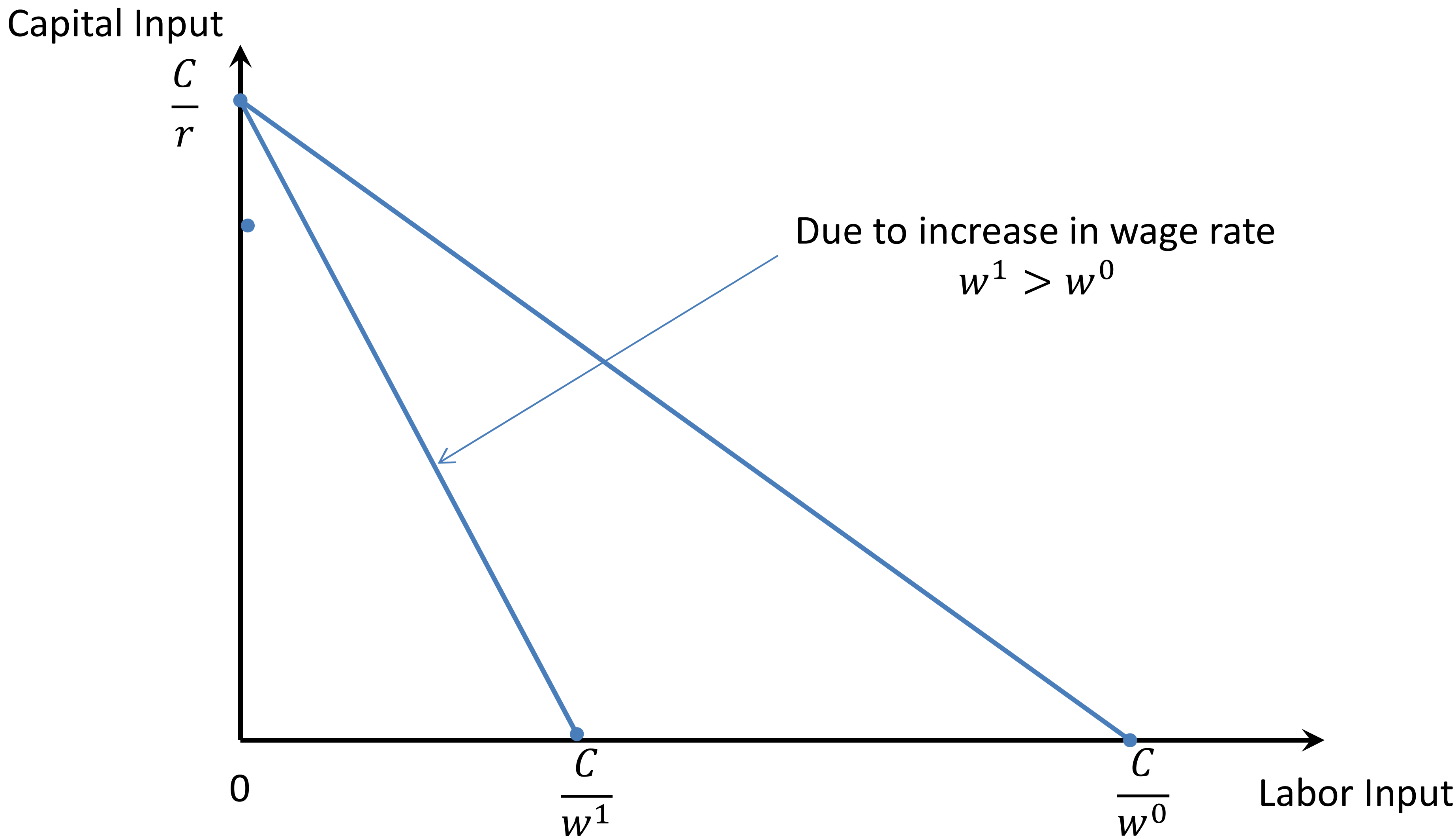


Capital Input
$\frac{C}{r}$
$K = \frac{C}{r} - \frac{w}{r}L$
0
L
$\frac{C}{w}$
Labor Input

Changes in the Isocosts



Changes in the Isocost Line



Cost Minimization and the Cost-Minimizing Input Rule

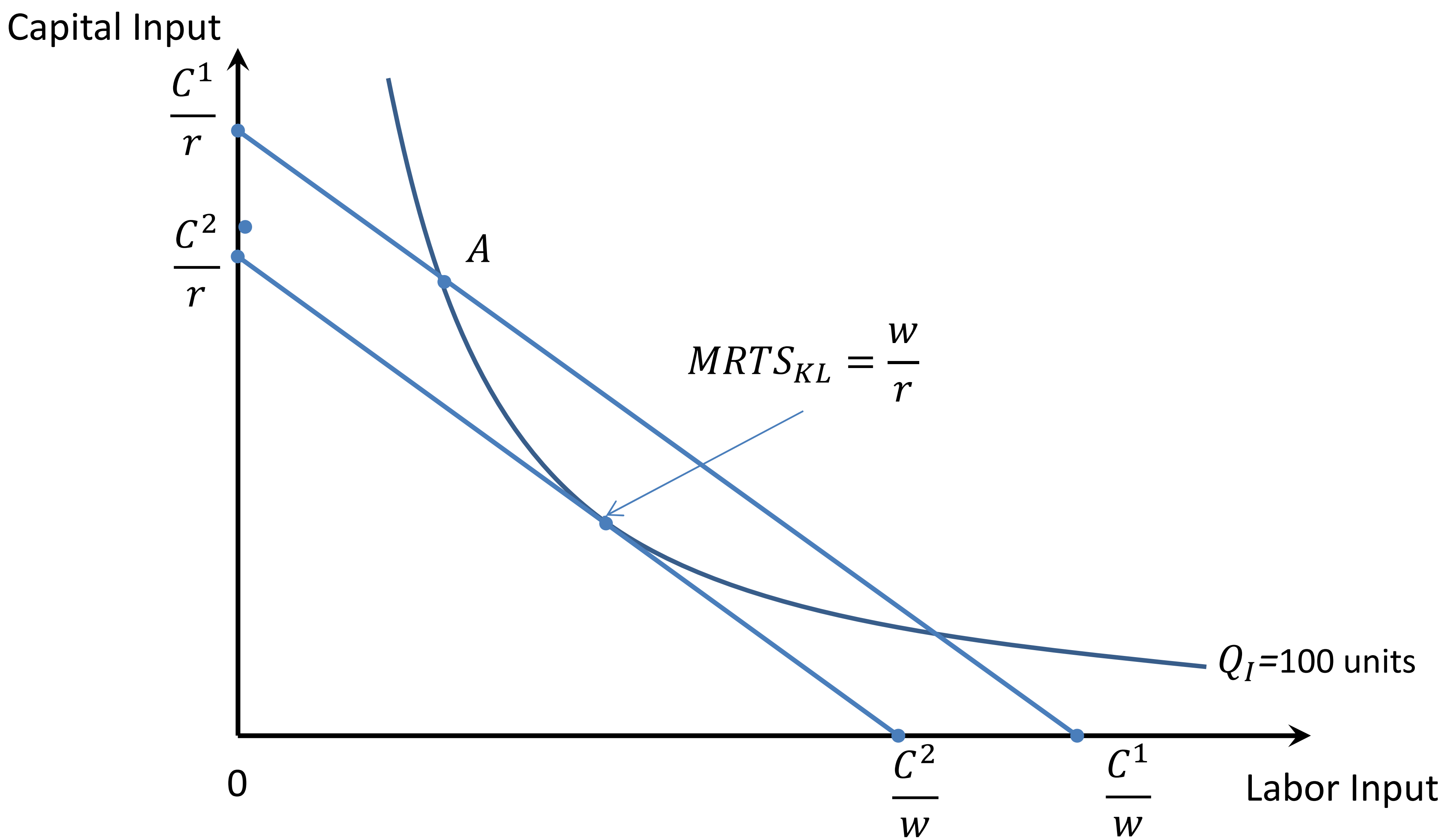
- **Cost minimization**
  - Producing at the lowest possible cost.
- **Cost-minimizing input rule**
  - Produce at a given level of output where the marginal product per dollar spent is equal for all input:

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

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

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

Cost-Minimization Input Rule in Action



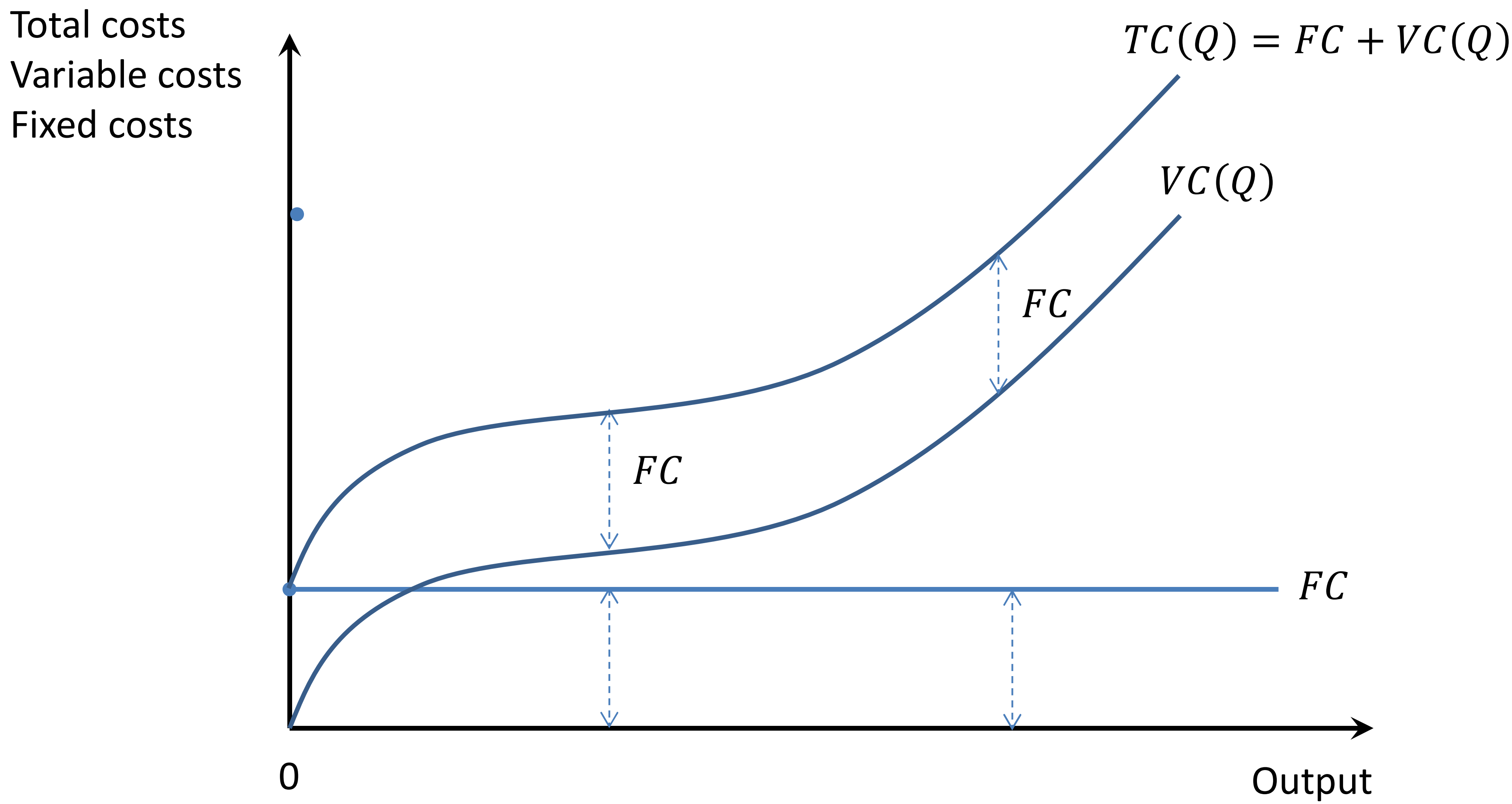
Optimal Input Substitution

- To minimize the cost of producing a given level of output, the firm should use less of an input and more of other inputs when that input's price rises.

The Cost Function

- Mathematical relationship that relates cost to the cost-minimizing output associated with an isoquant.
- Short-run costs
  - **Fixed costs ($\boldsymbol{FC}$)**: do not change with changes in output; include the costs of fixed inputs used in production
  - **Variable costs [$\boldsymbol{VC(Q)}$]**: costs that change with changes in outputs; include the costs of inputs that vary with output
  - **Total costs:** $TC(Q) = FC + VC(Q)$
- Long-run costs
  - All costs are variable
  - No fixed costs

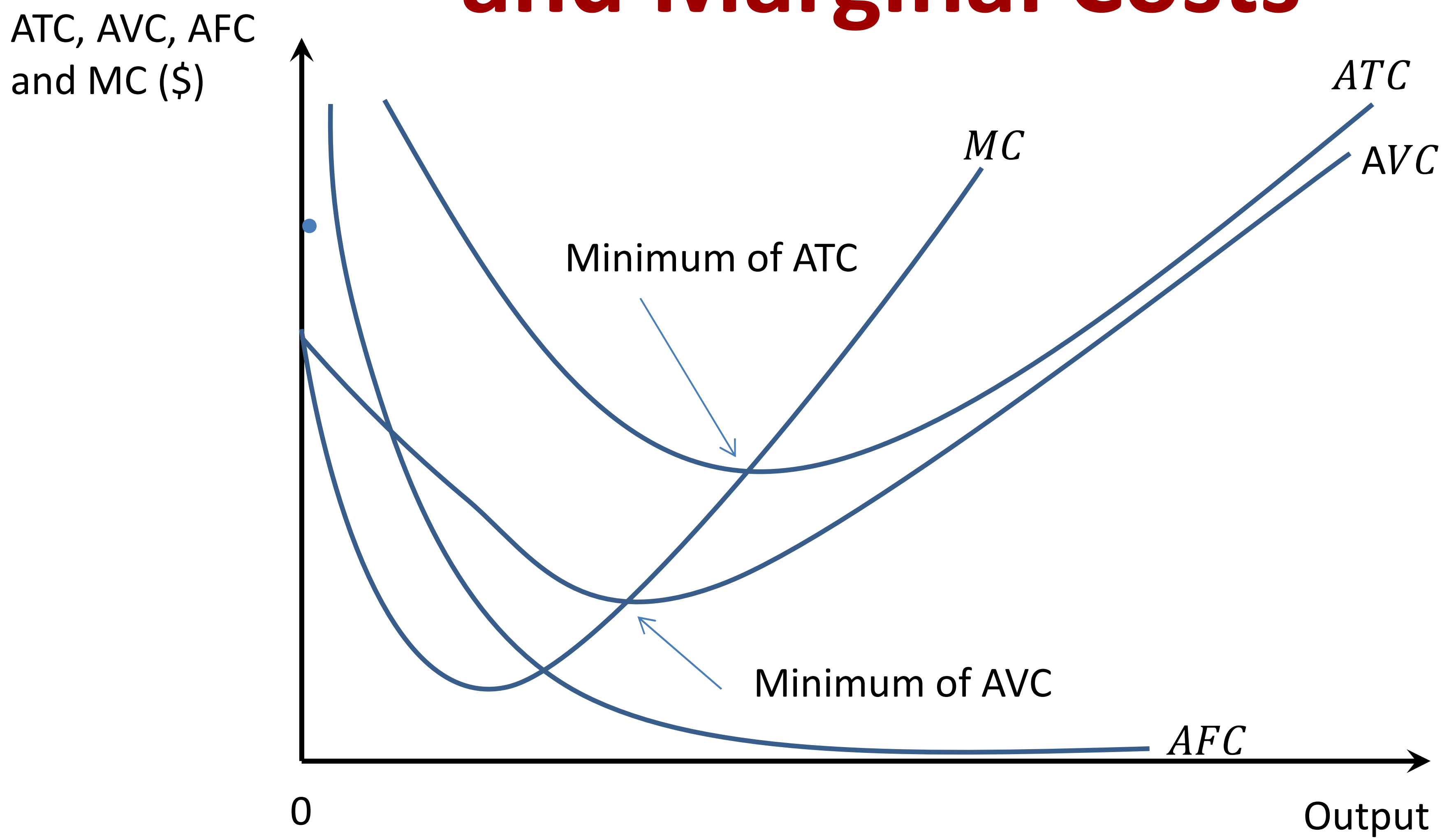
Short-Run Costs



Average and Marginal Costs

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

The Relationship between 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.

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

Algebraic Forms of Cost Functions

- The cubic cost function: costs are a cubic function of output; provides a reasonable approximation to virtually any cost function.

  $$C(Q) - F + aQ + bQ^2 + cQ^3$$

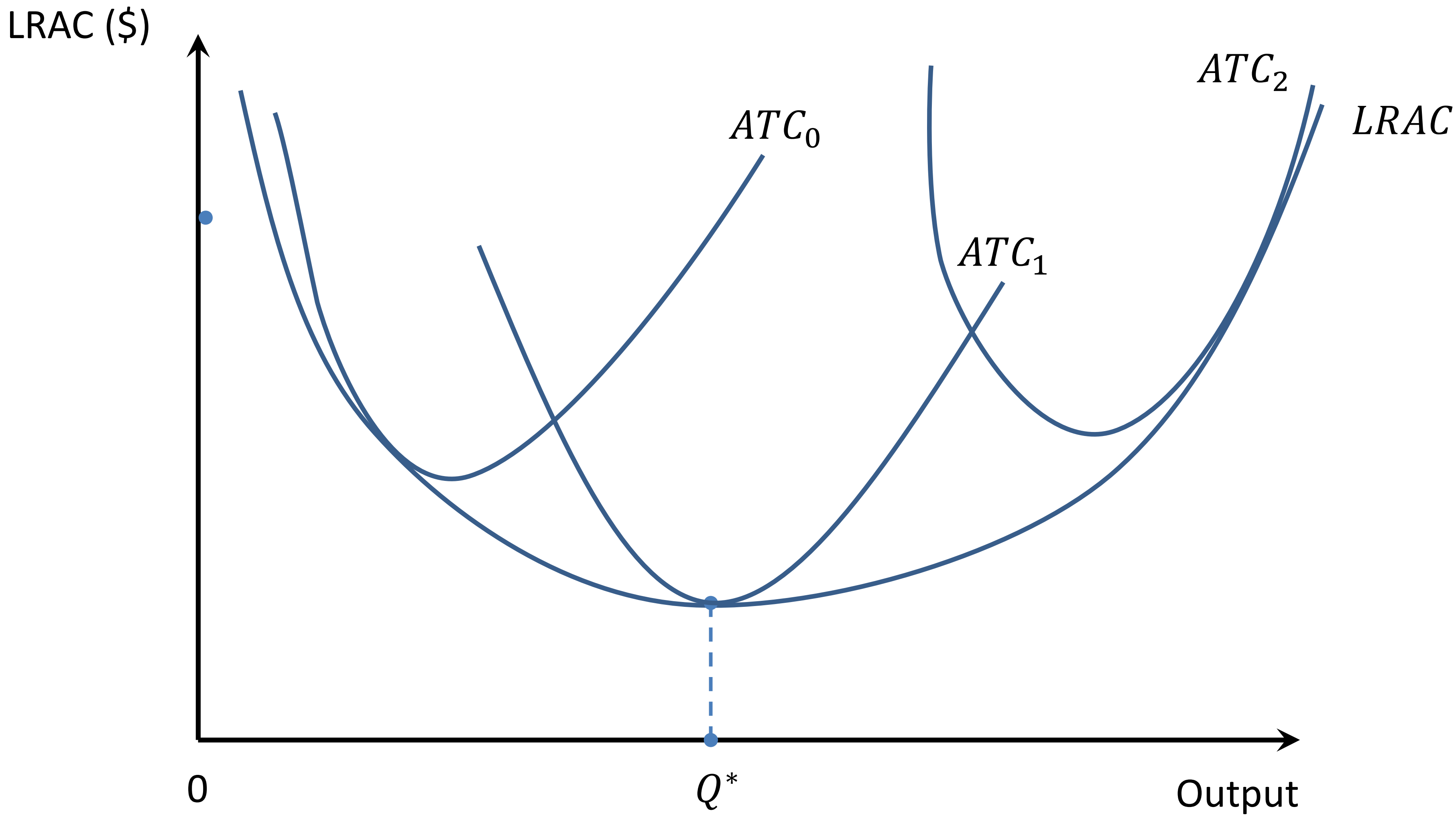
  where *a*, *b*, *c*, and *f* are constants and *f* represents fixed costs
- Marginal cost function is:

  $$MC(Q) = a + 2bQ + 3cQ^2$$

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.

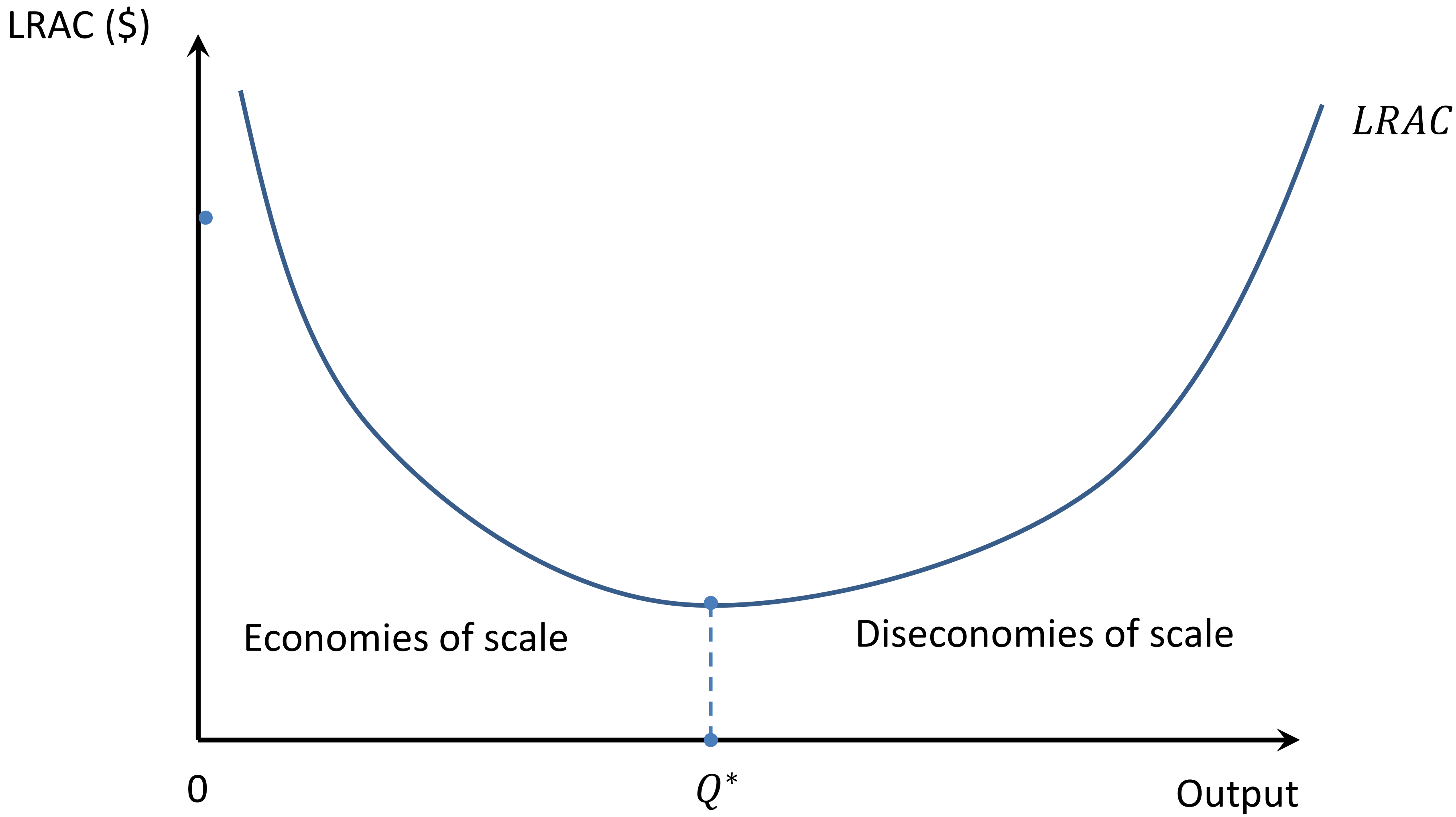
Long-Run Average Cost



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.

Economies and Diseconomies of Scale



Multiple-Output Cost Function

- **Economies of scope**
  - Exist when the total cost of producing Q_1 and Q_2 together is less than the total cost of producing each of the type of output separately.

$$C(Q_1, 0) + C(0, Q_2) > C(Q_1, Q_2)$$

- **Cost complementarity**
  - Exist when the marginal cost of producing one type of output decreases when the output of another good is increased.

$$\frac{\Delta MC_1(Q_1, Q_2)}{\Delta Q_2} < 0$$

Algebraic Form for a Multiproduct Cost Function

$$C(Q_1, Q_2) = f + aQ_1Q_2 + (Q_1)^2 + (Q_2)^2$$

- For this cost function:

  $MC_1 = aQ_2 + 2Q_1$

  - When a < 0, an increase in Q_2 reduces the marginal cost of producing product 1.
  - If a < 0, this cost function exhibits cost complementarity
  - If a > 0, there are no cost complementarities
  - Exhibits economies of scope whenever $f - aQ_1Q_2 > 0$

Take-home Message

- The **production function** shows the relationship between output and inputs.
- **Marginal product usually diminishes** as the input increases.
- A firm should employ inputs such that the **marginal rate of technical substitution equals the ratio of input prices**.
- Variable costs vary with output; fixed costs do not.
- The **marginal cost curve** intersects the **average cost curve** at minimum average cost.
- Economies of scale: LR average cost falls as $\boldsymbol{Q}$ rises.

INTRODUCTORY ECONOMICS: LECTURE 5

From Firms to Industry

Highlights

- *Methods of procuring*
- *Transaction cost*
- *The principle-agent problem*
- *S-C-P Paradigm*
- *Externality*
- *Coase Theorem*

Methods of Procuring Inputs

- **Spot exchange**
  - An informal relationship between a buyer and seller in which neither party is obligated to adhere to specific terms for exchange.
- **Contract**
  - A formal relationship between a buyer and seller that obligates the buyer and seller to exchange at terms specified in a legal document.
- **Produce inputs internally (vertical integration)**
  - A situation where a firm produces the inputs required to make its final product.

Methods of Procuring Inputs In Action

- Determine whether the following transactions involve spot exchange, a contract, or vertical integration:
  - Clone 1 PC is legally obligated to purchase 300 computer chips each year for the next 3 years from AML. The price paid in the first year is $200 per chip, and the price rises during the second and third years by the same percentage by which the wholesale price index rises during those years.
  - Clone 2 PC purchased 300 computer chips from a firm that ran an advertisement in the back of a computer magazine.
  - Clone 3 PC manufactures its own motherboards and computer chips for its personal computers.
- Answers:
  - Clone 1 PC is using a contract.
  - Clone 2 PC used the spot exchange.
  - Clone 3 PC uses vertical integration.

Transaction Costs

- The cost that parties incur in the process of agreeing to and following through on a bargain.
- In our context, transaction costs are cost associated with acquiring an input that is in excess of the amount paid to the input supplier.
- Types of "obvious" transaction costs
  - Cost of searching for a supplier.
  - Cost of negotiating a price.
  - Investments and expenditures required to facilitate exchange.
- Discussions: Transaction costs in reality?

The Principal-Agent Problem

- The separation of ownership and control creates the **Principle-Agent (P-A) problem**.
  - **Principal-agent problem in our context:** if the owner is not present to monitor the manager, how can she get the manager to do what is in her best interest?
  - Owners have to incent managers since they are not present to monitor.
- Other examples of P-A problem in reality:
  - Patient and doctors?
  - Supervisor and PhD students?
  - Landlord and tenant?

Managers' Compensation Mechanisms

- Manager's economic trade-off
  - Leisure.
  - Labor
- Fixed salary
  - Receives wage independent of labor hours and effort.
    - No strong incentive to monitor other employees labor hours and effort.
    - Adversely impacts firm performance.
- Incentive contract (e.g., Stock option, bonus)
  - Tie manager wage to firm performance (like profits).
  - Manager makes labor-leisure choice and is accordingly compensated.

The Manager-Worker Principal-Agent Problem

- The owner-manager, principal-agent problem is not unique.
  - A similar problem exists between the firm's managers and the employees he or she supervises.

Solutions to the Principal-Agent Problem

- Manager-worker principal-agent problem solutions:
  - Profit sharing
  - Revenue sharing
  - Piece rates
  - Time clocks and spot checks
- Discussions: solutions to supervisor-student P-A problem?

From Firms to Industry

- Market structure factors that impact managerial decisions:
  - Number of firms competing in an industry
  - Relative size of firms (concentration)
  - Technological and cost conditions
  - Demand conditions
  - Ease of firm exit or entry

Industry Concentration

- Measures the size distribution of firms within an industry.
  - Are there many small firms?
  - Are there only a few large firms?

Measuring Industry Concentration

- Measures of industry concentration
  - Four-firm concentration ratio:

$$C_4 = \frac{S_1 + S_2 + S_3 + S_4}{S_T}$$

  - Herfindahl-Hirschman index (*HHI*):

$$HHI = 10{,}000 \sum_{i=1}^{N} \left(\frac{S_i}{S_T}\right)^2$$

Measuring Industry Concentration in Action

- Suppose an industry is composed of six firms. Four firms have sales of $10 each, and two firms haves sales of $5 each. What is the four-firm concentration ratio for this industry?
- Answer:
  - Total industry sales are $S_T = \$50$.
  - Sales of the four largest firms are $40.
  - The four-firm concentration ratio is: $C_4 = \frac{\$10+\$10+\$10+\$10}{\$50} = 0.80$
  - The four largest firms in the industry account for 80 percent of total industry output.

Table 7–2

Four-Firm Concentration Ratios and Herfindahl-Hirschman Indexes for Selected U.S. Manufacturing Industries

Industry	C_4 (percentage)	HHI
Breweries	90	NA
Distilleries	70	1,519
Electronic computers	87	NA
Fluid milk	46	1,075
Furniture and related products	11	62
Jewelry (excluding costume)	29	347
Men's and boys' cut and sew apparel	27	324
Motor vehicles	68	1,744
Ready-mix concrete	23	313
Semiconductor and other electronic components	34	476
Snack foods	53	1,984
Soap and cleaning compound	47	848
Soft drinks	52	891
Women's and girls' cut and sew apparel	20	174

Source: *Concentrations Ratios: 2007*, U.S. Bureau of the Census, 2012.

Note: The U.S. Bureau of the Census approximates the HHI by using only data on the top 50 firms in the industry

Potential for Entry

- Optimal decisions by firms in an industry will depend on the ease with which new firms can enter the market.
- Several factors can create ***barriers to entry*** (or make entry difficult).
  - Capital requirements
  - Patents
  - Economies of scale

Conduct

- Behavior of firms:
  - Price markup over costs
  - Integration and merger
  - Advertising expenditures
  - Research and development expenditures

Pricing Behavior

- **Lerner index**
  - A measure of the difference between price and marginal cost as a fraction of the product's price.

$$L = \frac{P - MC}{P}$$

rearranging this equation yields

$$P = \left(\frac{1}{1 - L}\right) MC$$

where $\left(\frac{1}{1-L}\right)$ is the *markup factor* over marginal costs.

Pricing Behavior in Action

- A firm in the airline industry has a marginal cost of \$200 and charges a price of \$300. What are the Lerner index and markup factor?
  - The Lerner index is

$$L = \frac{P - MC}{P} = \frac{\$300 - \$200}{\$300} = \frac{1}{3}$$

- The markup factor is

$$\frac{1}{1 - L} = \frac{1}{1 - \frac{1}{3}} = 1.5$$

Table 7–5

Lerner Indexes and Markup Factors for Selected U.S. Industries

Industry	Lerner Index	Markup Factor
Food	0.26	1.35
Tobacco	0.76	4.17
Textiles	0.21	1.27
Apparel	0.24	1.32
Paper	0.58	2.38
Printing and publishing	0.31	1.45
Chemicals	0.67	3.03
Petroleum	0.59	2.44
Rubber	0.43	1.75
Leather	0.43	1.75

Sources: Michael R. Baye and Jae-Woo Lee, "Ranking Industries by Performance: A Synthesis," Texas A&M University, Working Paper No. 90-20, March 1990; Matthew D. Shapiro, "Measuring Market Power in U.S. Industry," National Bureau of Economic Research, Working Paper No. 2212, 1987.

Integration and Merger Activity

- Integration
  - Uniting productive resources of firms.
  - Can occur during the formation of a firm.
- Merger
  - Two or more existing firms "unite," or merge, into a single firm
- Type: Vertical, Horizontal, Conglomerate
- Reasons firms merge:
  - Reduce transaction costs.
  - Reap benefits of economies of scale and scope.
  - Increase market power.
  - Gain better access to capital markets.

Other Firm Behaviors

- Research and development
  - Expenditures made by firms to gain a technological advantage, with the aim of acquiring a patent.
- Advertisement
  - Expenditures made by firms to inform or persuade consumers to purchase their products.

Performance

- Refers to the profits and social welfare that result in a given industry.

The Structure-Conduct-Performance (S-C-P) Paradigm

- ***Structure***:
  - Factors like technology, concentration and market conditions.
- ***Conduct***:
  - Individual firm behavior in the market. Behavior includes pricing decisions, advertising decisions and R&D decisions, among other factors.
- ***Performance***:
  - Resulting profit and social welfare that arise in the market.
- ***Structure-conduct-performance paradigm***
  - Model that views these three aspects of industry as being integrally related.

The Ideas of S-C-P Paradigm

- Market structure "causes" firms to behave in a certain way.
- … this behavior, or conduct, "causes" resources to be allocated in certain ways.
- … this resource allocation leads to "good" or "bad" performance.

The Critique on S-C-P Paradigm

- There is no one-way causal link among structure, conduct and performance.
  - Firm conduct can affect market structure;
  - Market performance can affect conduct and market structure.

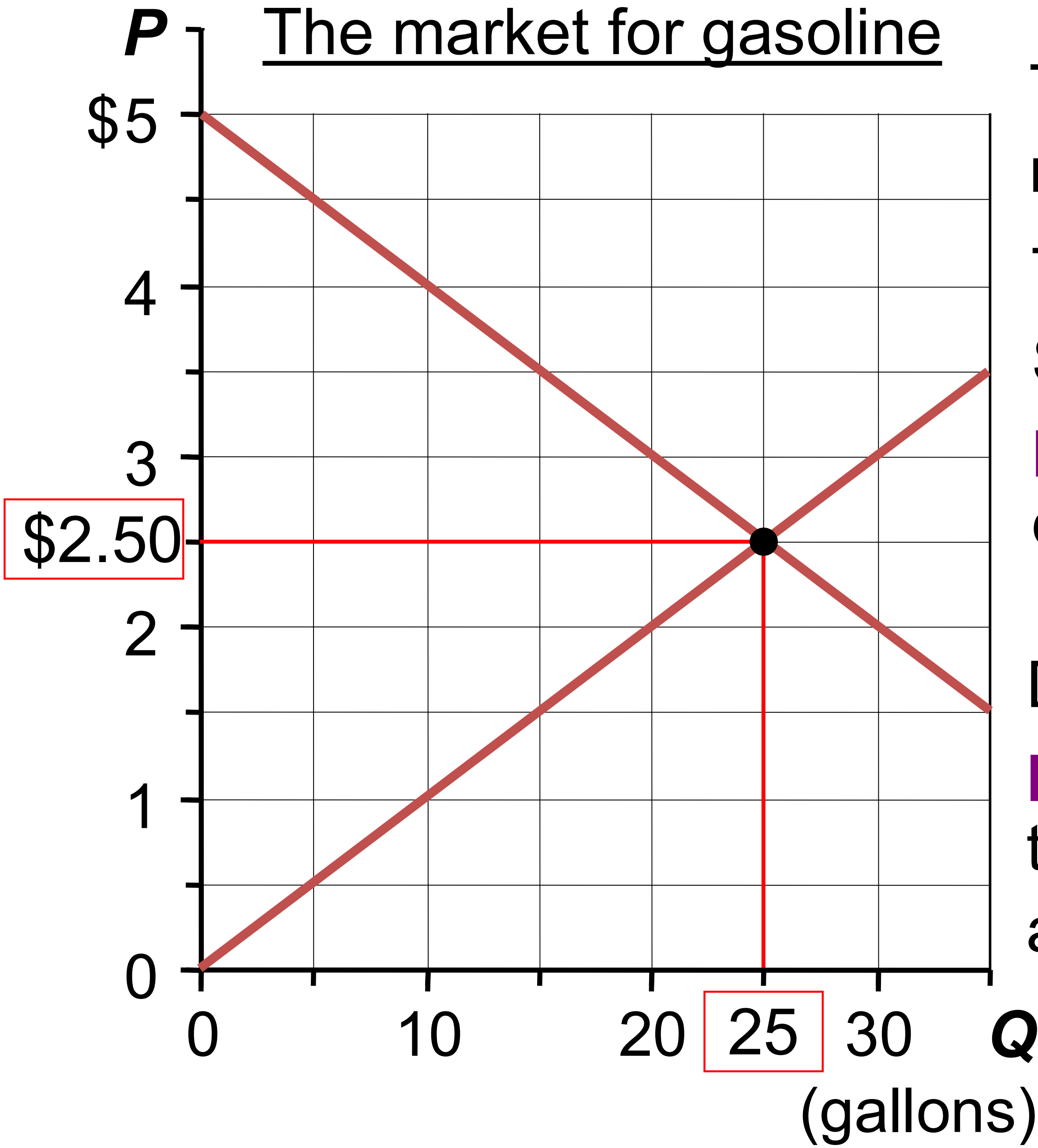
Frims and Society: Externality

- In absence of market failures, **the competitive market outcome is efficient, maximizes total surplus**.
- One type of market failure: **externality**, the uncompensated impact of one person's actions on the well-being of a bystander.
- Externalities can be **negative** or **positive**, depending on whether impact on bystander is adverse or beneficial.

Examples of Negative Externalities

- Air pollution from a factory
- The neighbor's barking dog
- Late-night stereo blasting from the dorm room next to yours
- Noise pollution from construction projects
- Health risk to others from second-hand smoke
- Talking on cell phone while driving makes the roads less safe for others

Recap of Welfare Economics

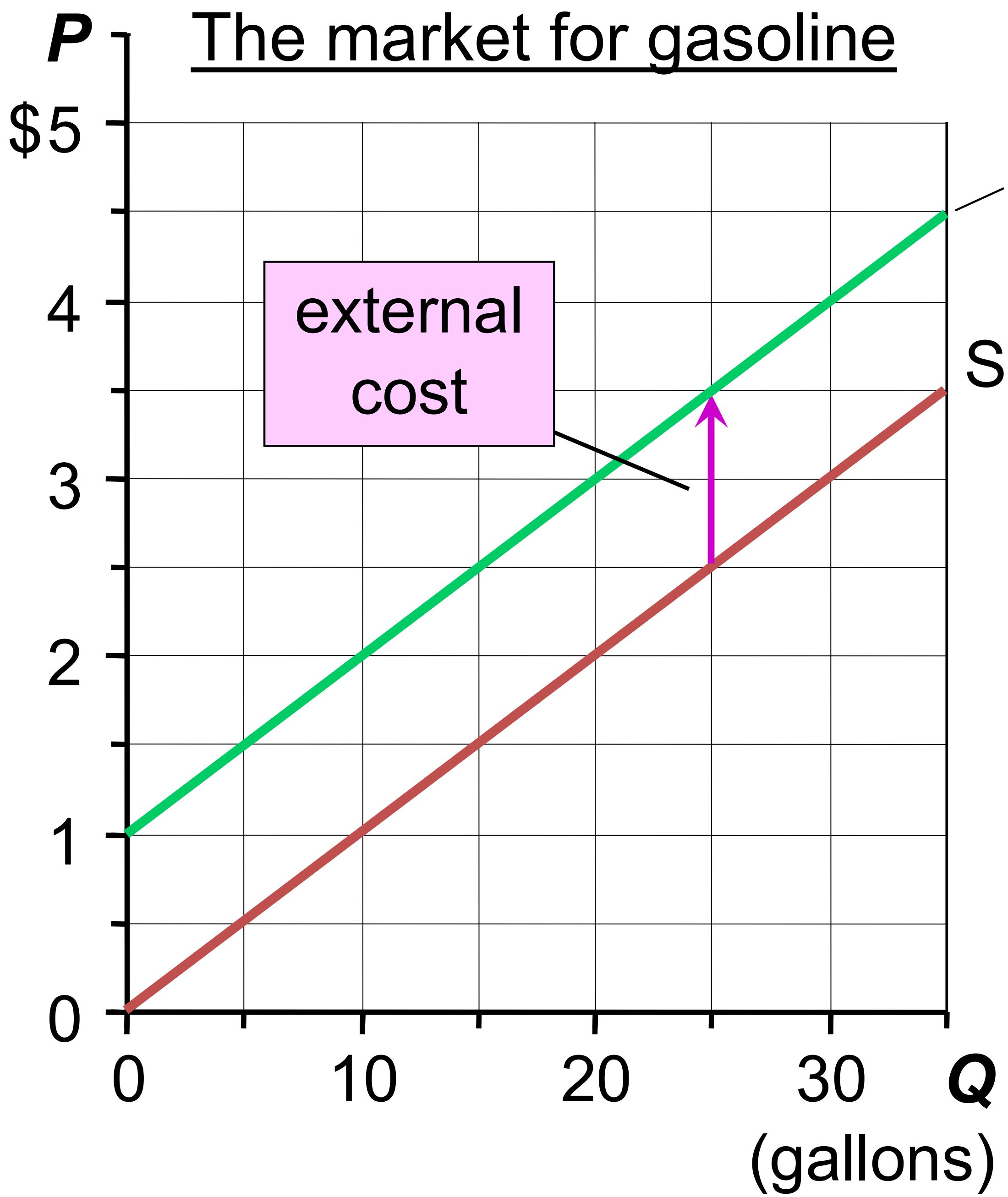


The market eq'm maximizes consumer + producer surplus.

Supply curve shows **private cost**, the costs directly incurred by sellers.

Demand curve shows **private value**, the value to buyers (the prices they are willing to pay).

Analysis of a Negative Externality



Social cost

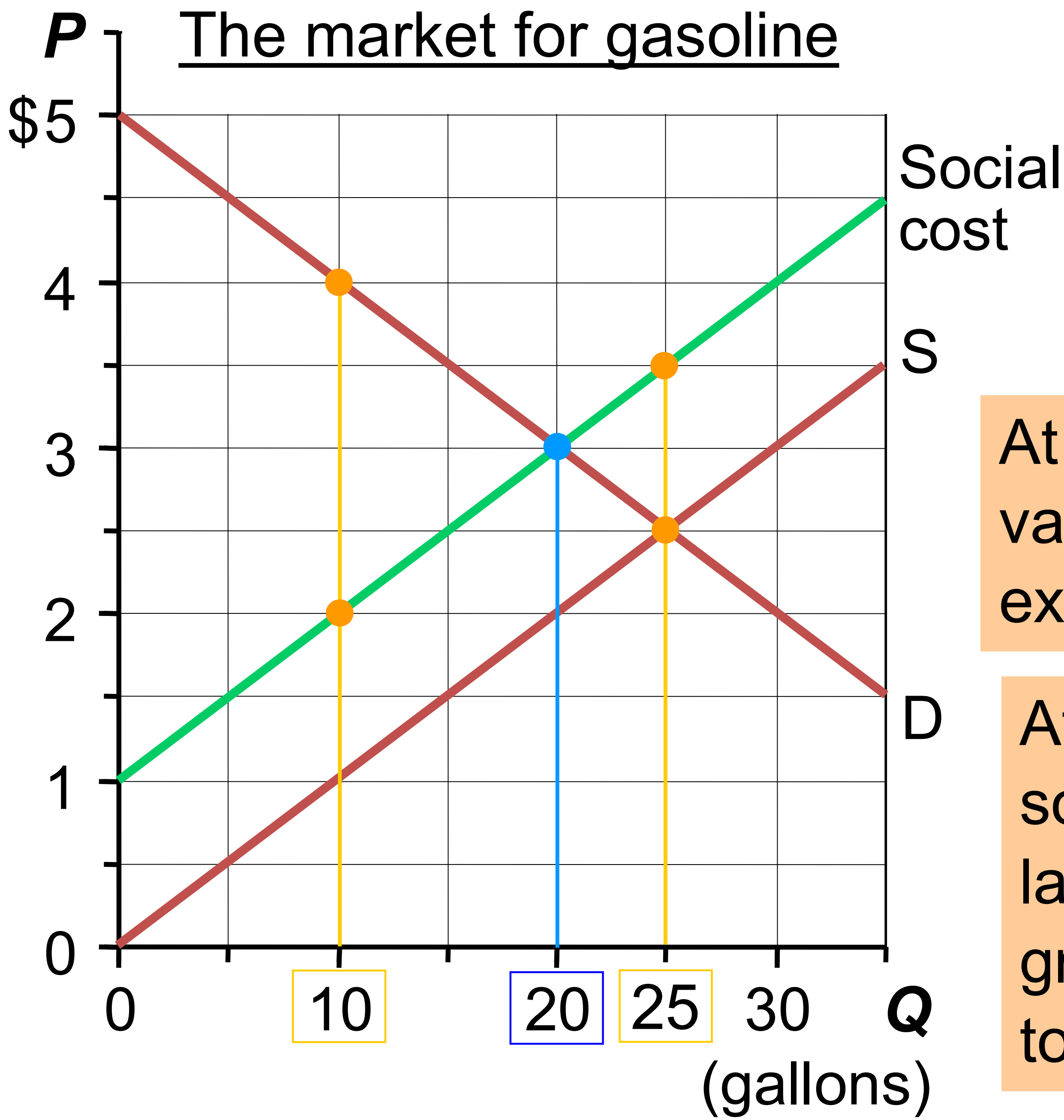
= private + external cost

External cost

= value of the negative impact on bystanders

= $1 per gallon (value of harm from smog, greenhouse gases)

Analysis of a Negative Externality

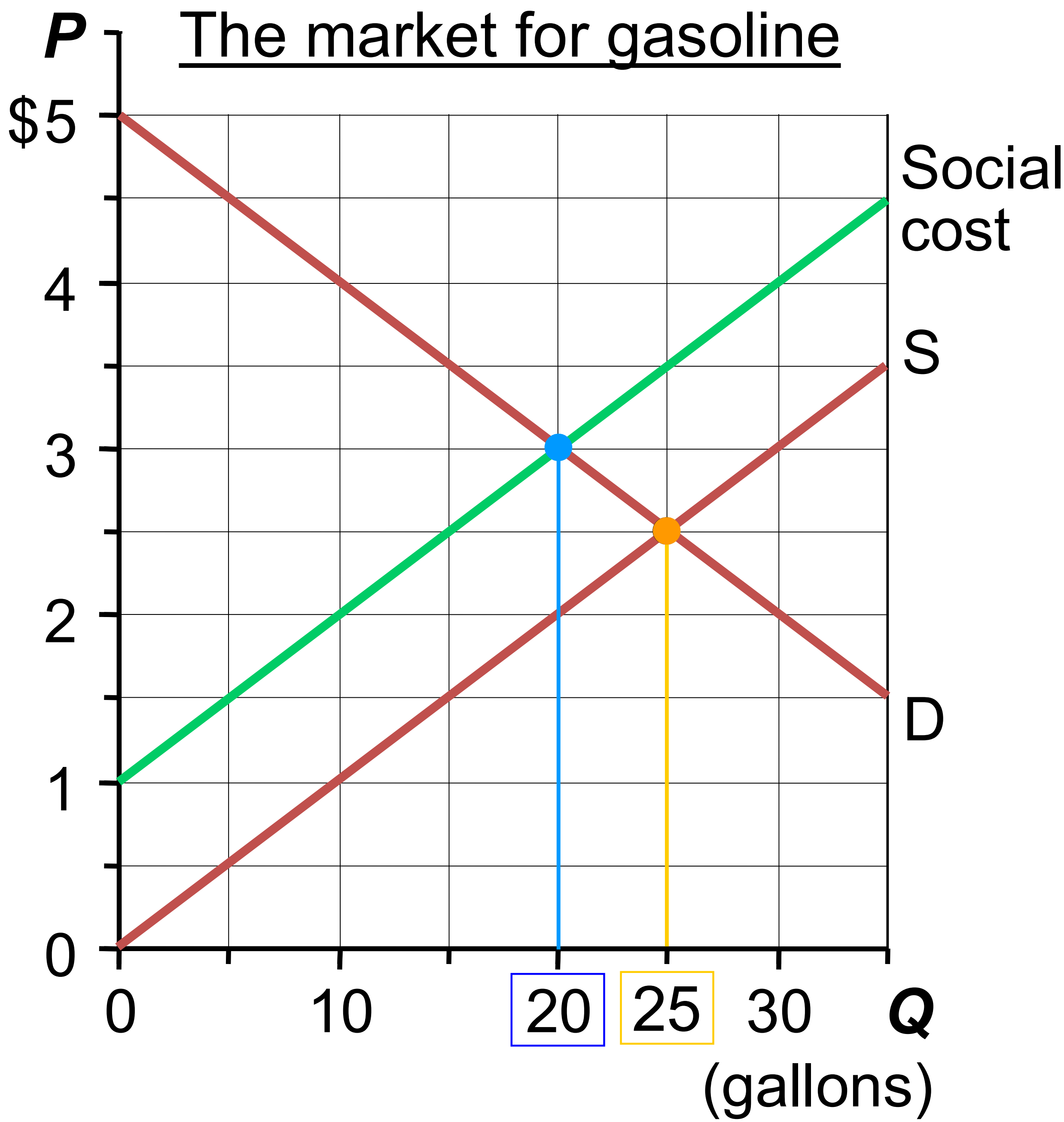


The socially optimal quantity is 20 gallons.

At any ***Q*** < 20, value of additional gas exceeds social cost.

At any ***Q*** > 20, social cost of the last gallon is greater than its value to society.

Analysis of a Negative Externality



Market eq'm
(***Q*** = 25)
is greater than
social optimum
(***Q*** = 20).

One solution:
tax sellers
$1/gallon,
would shift
S curve up $1.

"Internalizing the Externality"

- **Internalizing the externality**: altering incentives so that people take account of the external effects of their actions
- In our example, the $1/gallon tax on sellers makes sellers' costs = social costs.
- When market participants must pay social costs, market equilibrium = social optimum.

Examples of Positive Externalities

- Being vaccinated against contagious diseases protects not only you, but people who visit the salad bar or produce section after you.
- R&D creates knowledge others can use.
- People going to college raise the population's education level, which reduces crime and improves government.
- **Discussion: How to internalize the positive externalities of vaccination?**

Thank you for not contaminating the fruit supply!

Private Solutions to Externalities

- **The Coase theorem**:
  If private parties can costlessly bargain over the allocation of resources, they can solve the externalities problem on their own.

The Coase Theorem: An Example

- Dick owns a dog named Spot.
- Negative externality:
  Spot's barking disturbs Jane,
  Dick's neighbor.
- The socially efficient outcome maximizes Dick's + Jane's well-being.
  – If Dick values having Spot more than Jane values peace & quiet, the dog should stay.

See Spot bark.

Coase theorem: The private market will reach the efficient outcome on its own…

The Coase Theorem: An Example

- CASE 1:
  Dick has the right to keep Spot.
  Benefit to Dick of having Spot = $500
  Cost to Jane of Spot's barking = $800
- Socially efficient outcome:
  Spot goes bye-bye.
- Private outcome:
  Jane pays Dick $600 to get rid of Spot,
  both Jane and Dick are better off.
- Private outcome = efficient outcome.

The Coase Theorem: An Example

- CASE 2:
  Dick has the right to keep Spot.
  Benefit to Dick of having Spot = $1000
  Cost to Jane of Spot's barking = $800
- Socially efficient outcome:
  See Spot stay.
- Private outcome:
  Jane not willing to pay more than $800,
  Dick not willing to accept less than $1000,
  so Spot stays.
- Private outcome = efficient outcome.

The Coase Theorem: An Example

- CASE 3:
  Jane has the legal right to peace & quiet.
  Benefit to Dick of having Spot = $800
  Cost to Jane of Spot's barking = $500
- Socially efficient outcome: Dick keeps Spot.
- Private outcome: Dick pays Jane $600 to put up with Spot's barking.
- Private outcome = efficient outcome.

The private market achieves the efficient outcome regardless of the initial distribution of rights.

Why Private Solutions Do Not Always Work

1. **Transaction costs**:
   The costs parties incur in the process of agreeing to and following through on a bargain.
   These costs may make it impossible to reach a mutually beneficial agreement.
2. **Stubbornness**:
   Even if a beneficial agreement is possible, each party may hold out for a better deal.
3. **Coordination problems**:
   If # of parties is very large, coordinating them may be costly, difficult, or impossible.

Take-home Message

- **Transaction costs** are the costs parties incur in the process of agreeing to and following through on a bargain.
- To overcome **principal-agent problems**, principals must align the agents' interests with the principals' interests.
- An externality occurs when a market transaction affects a third party. **If the transaction yields negative externalities (*e.g.*, pollution), the market quantity exceeds the socially optimal quantity.**

Take-home Message

- The **Coase theorem** states that the private market can solve externalities and reach the socially optimal allocation of resources as long as people can bargain without cost. In practice, bargaining is often costly or difficult, and the Coase theorem does not apply.
- The government can attempt to remedy the problem, e.g., it can **internalize the externality** using corrective taxes.

INTRODUCTORY ECONOMICS: LECTURE 6

Competitive, Monopolistic, and Monopolistically Competitive Markets

Highlights

- *Perfect competition*
- *Output decision of competitive firm*
- *Shut-down decision*
- *Supply curve of a competitive firm*
- *Long-run equilibrium*
- *Monopoly output and pricing rule*
- *Deadweight loss of monopoly*

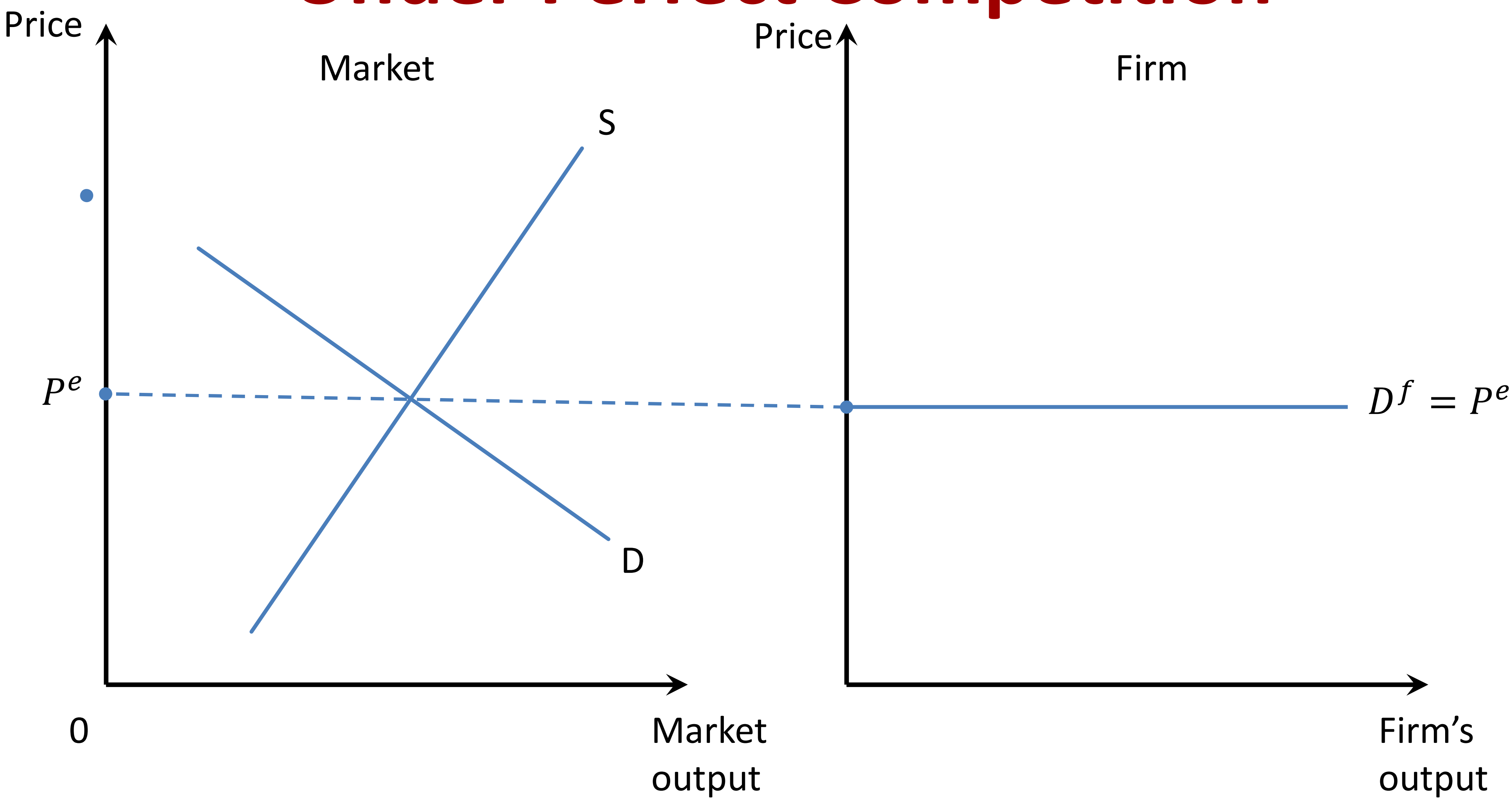
Introduction: A Scenario

- Three years after graduating, you run your own business.
- You must decide how much to produce, what price to charge, how many workers to hire, *etc*.
- What factors should affect these decisions?
  - Your costs (studied in preceding chapter)
  - How much competition you face
- We begin by studying the behavior of firms in perfectly competitive markets.

Perfect Competition

- **Perfectly competitive markets** are characterized by:
  - The interaction between many buyers and sellers that are “small” relative to the market.
  - Each firm in the market produces a homogeneous (identical) product.
  - Buyers and sellers have perfect information.
  - No transaction costs.
  - Free entry into and exit from the market.
- The implications of these conditions are:
  - a single market price is determined by the interaction of demand and supply
  - firms earn zero economic profits in the long run.

Demand at the Market and Firm Levels Under Perfect Competition



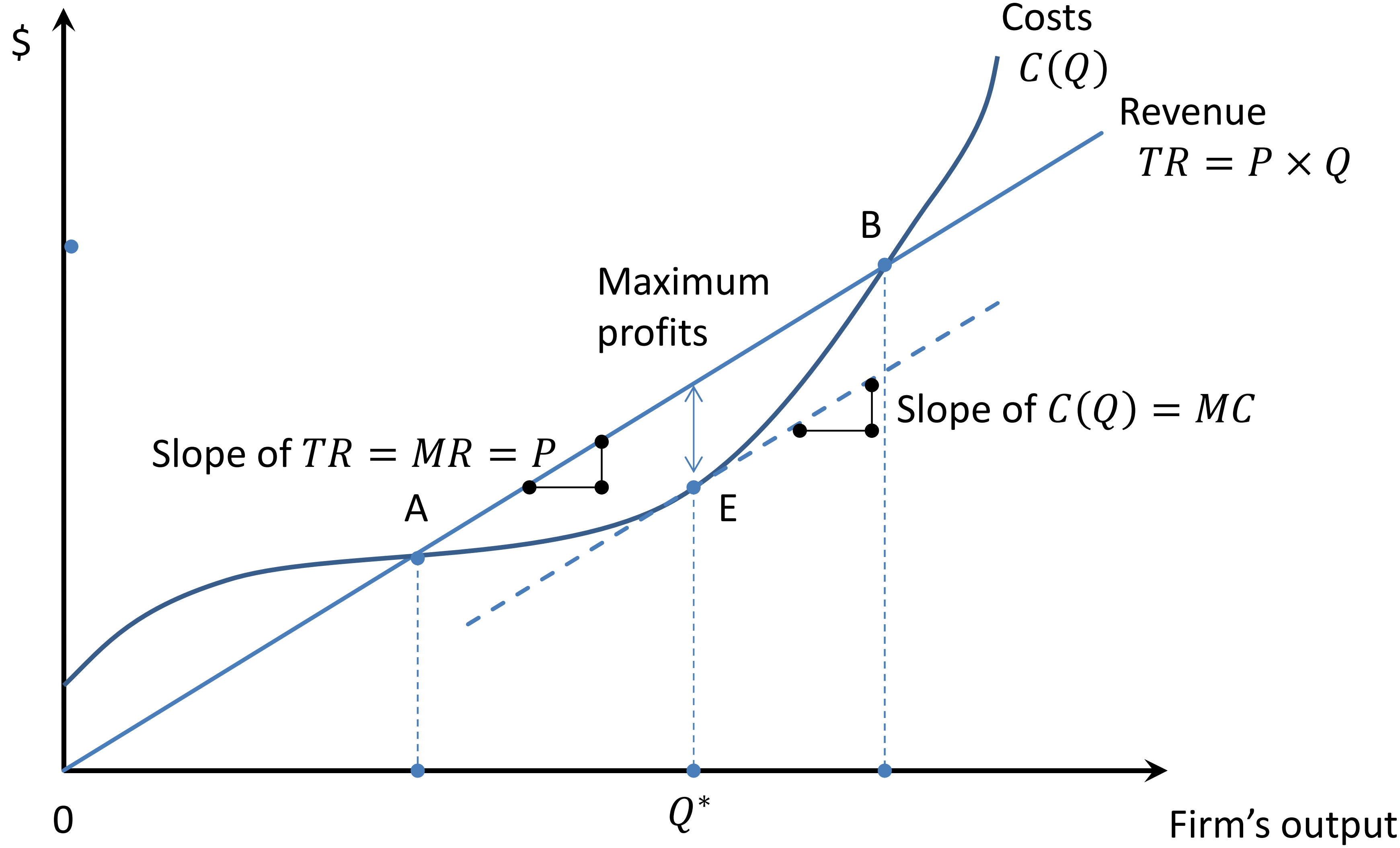
Short-Run Output Decisions

- The short run is a period of time over which some factors of production are fixed.
- To maximize short-run profits, managers must take as given the fixed inputs (and fixed costs), and determine how much output to produce by changing the variable inputs.

Revenue of a Competitive Firm

- Total revenue (*TR*) $$TR = \boldsymbol{P} \times \boldsymbol{Q}$$
- **Average revenue (*AR*)** $$AR = \frac{TR}{\boldsymbol{Q}} = \boldsymbol{P}$$
- **Marginal revenue (*MR*)**: The change in *TR* from selling one more unit. $$MR = \frac{\Delta TR}{\Delta \boldsymbol{Q}} = \boldsymbol{P}$$

Revenue, Costs, and Profits for a Perfectly Competitive Firm



Competitive Firm's Demand

- The demand curve for a competitive firm's product is a horizontal line at the market price. This price is the competitive firm's marginal revenue.

$$D^f = P = MR$$

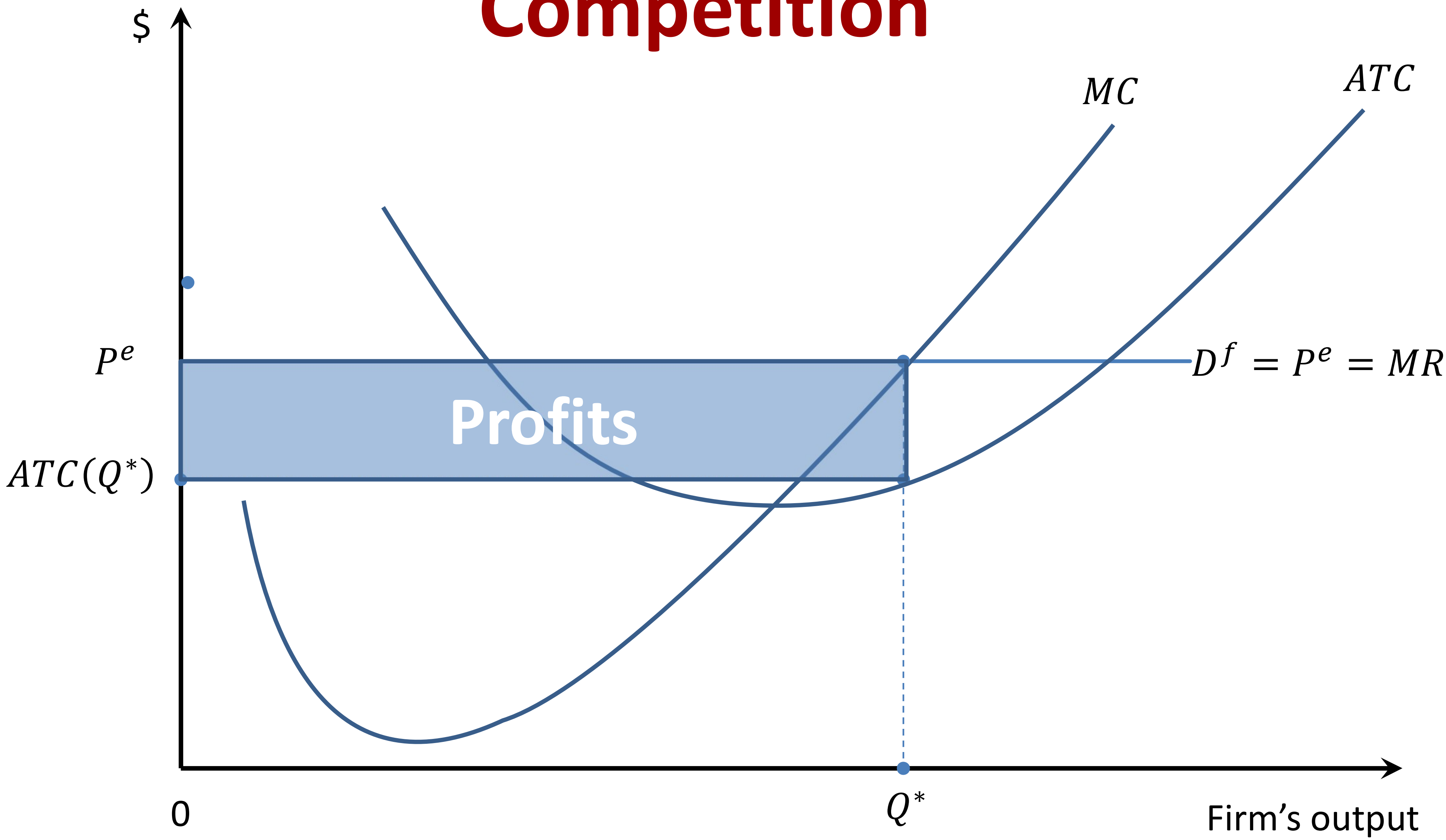
Profit Maximization

- What ***Q*** maximizes the firm's profit?
- To find the answer, "***think at the margin***."

  If increase ***Q*** by one unit,
  revenue rises by *MR*,
  cost rises by *MC*.

- If $MR > MC$, then increase ***Q*** to raise profit.
- If $MR < MC$, then reduce ***Q*** to raise profit.

Profit Maximization under Perfect Competition



Competitive Output Rule

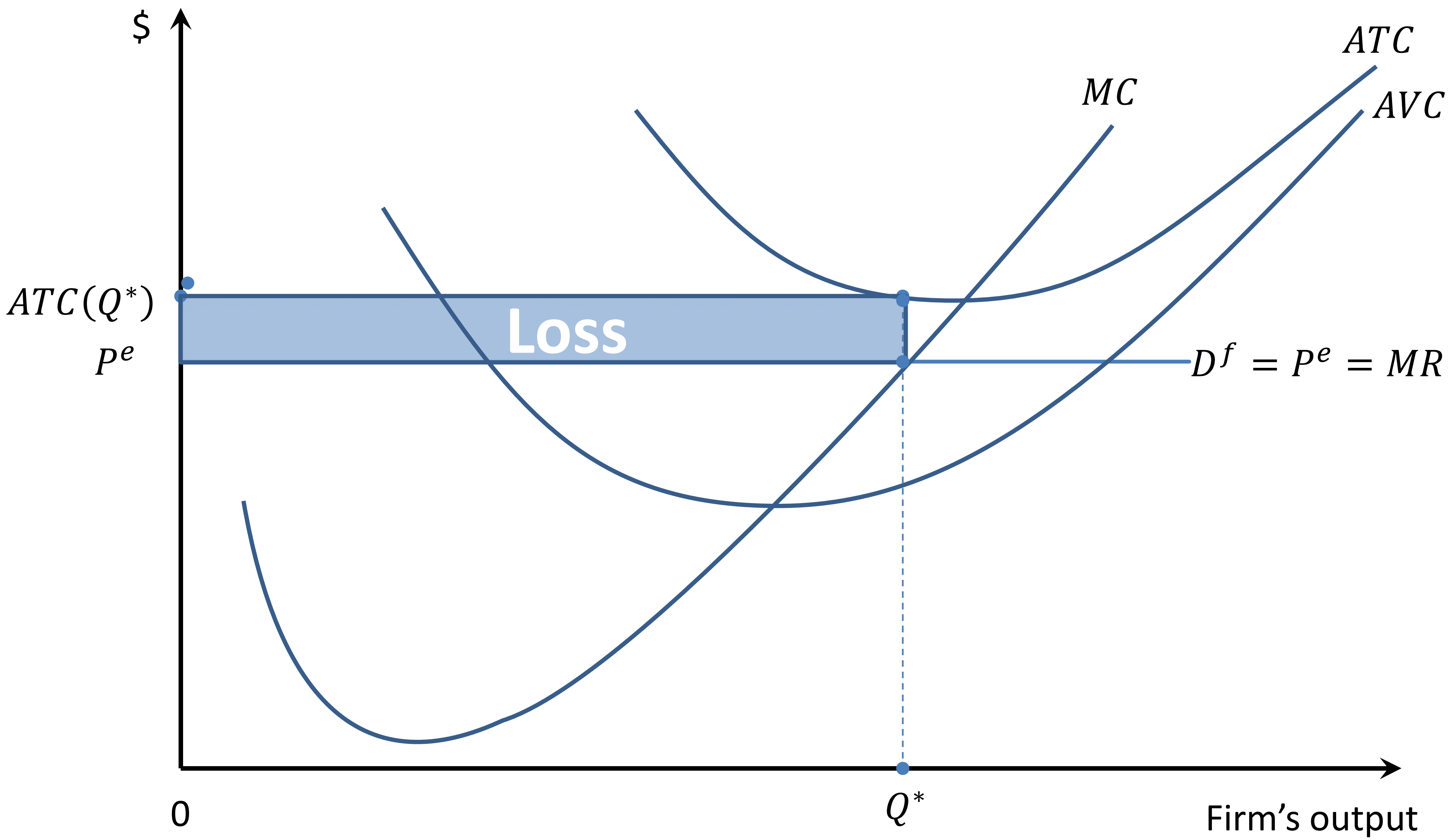
- To maximize profits, a perfectly competitive firm produces the output at which price equals marginal cost in the range over which marginal cost is increasing.

$$P = MC(Q)$$

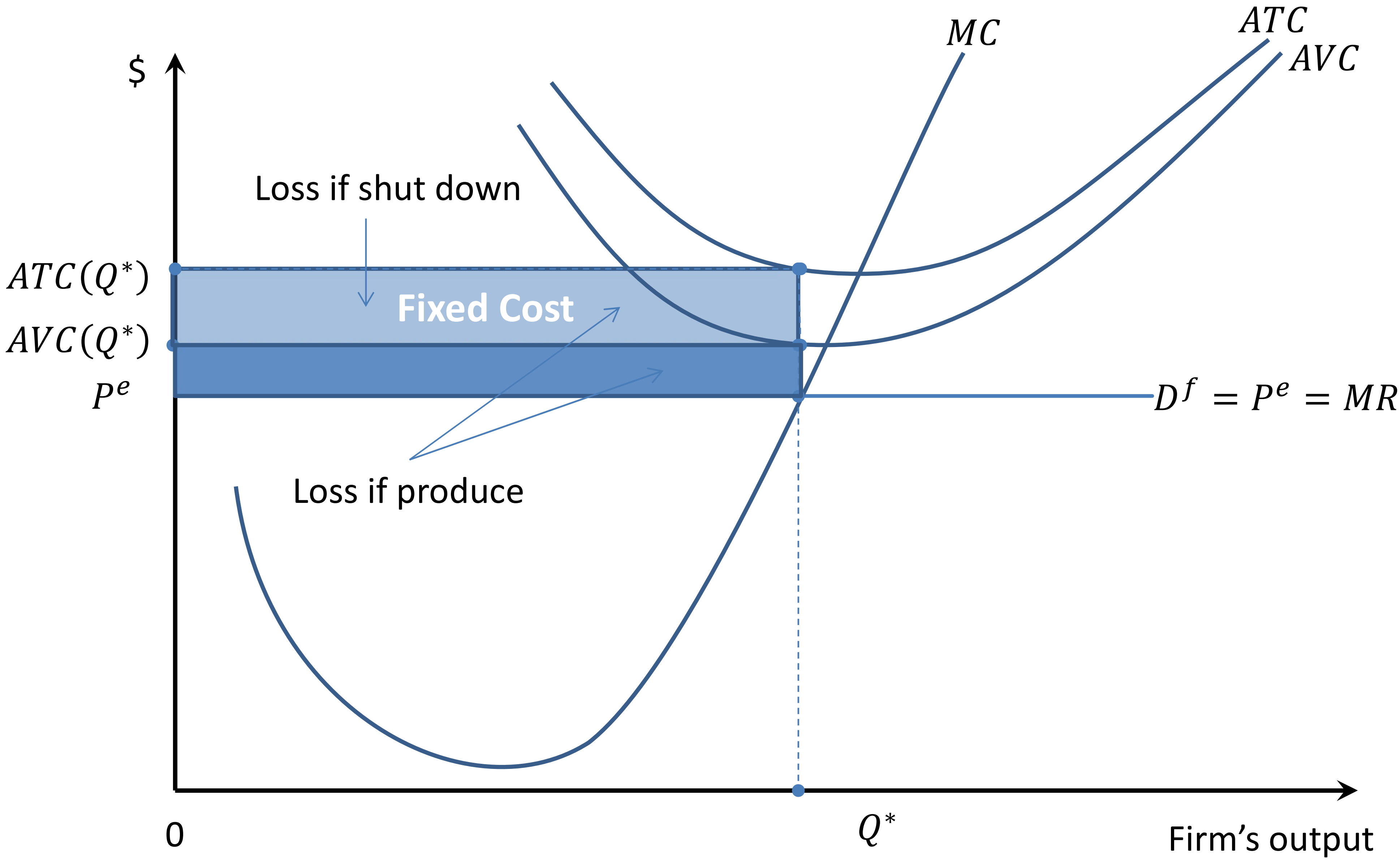
Competitive Output Rule In Action

- The cost function for a firm is $C(Q) = 5 + Q^2$.
- If the firm sells output in a perfectly competitive market and other firms in the industry sell output at a price of $20, what price should the manager of this firm charge? What level of output should be produced to maximize profits? How much profit will be earned?
- Answer:
  – Charge $20.
  – Since marginal cost is $2Q$, equating price and marginal cost yields: $\$20 = 2Q \Longrightarrow Q = 10$ units.
  – Maximum profits are: $\pi = 20 \times 10 - (5 + 10^2) = \$95$.

Short-Run Operating Losses



The Shut-Down Case



Short-run Decision to Shut Down

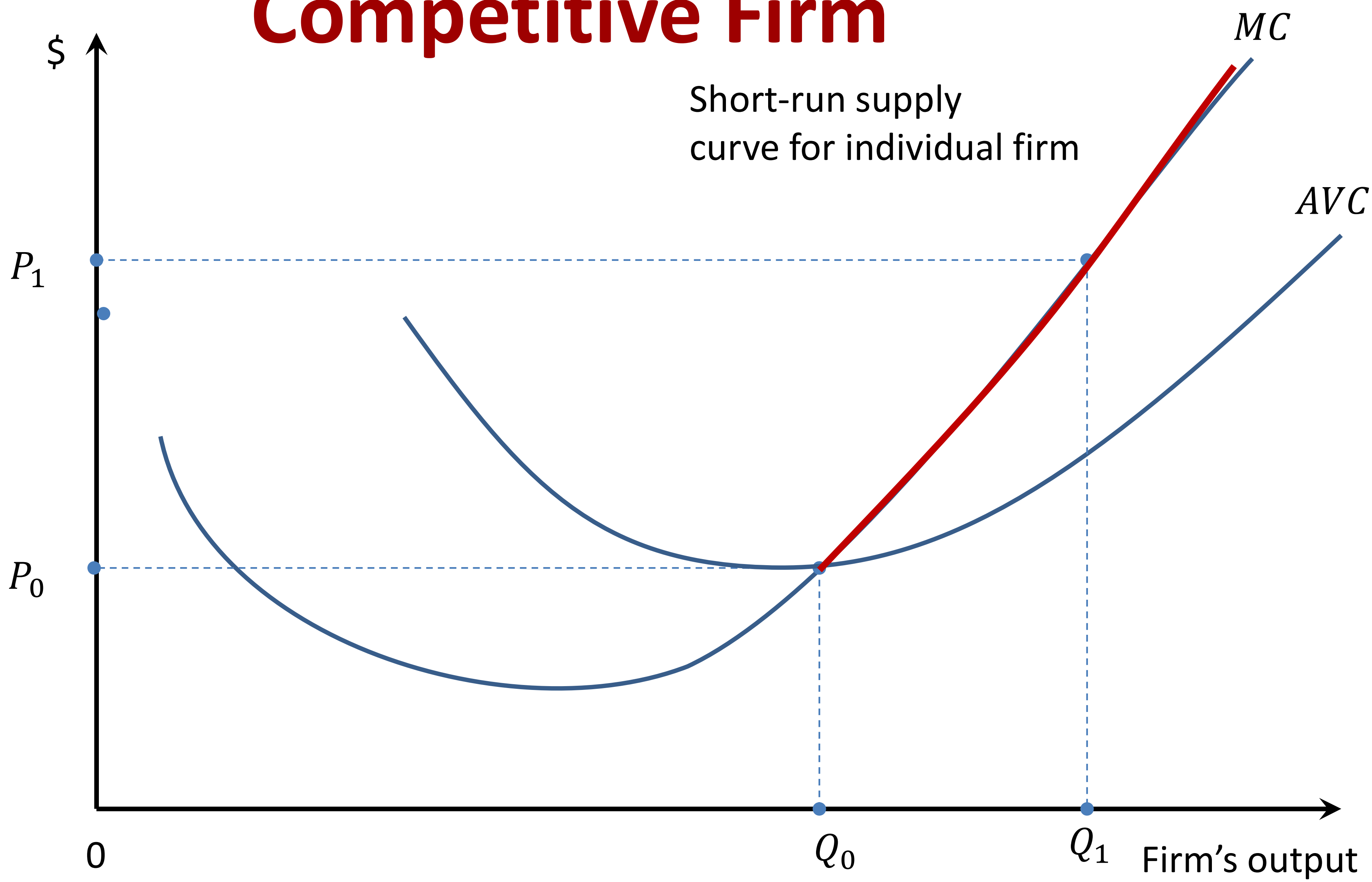
- Loss if shut down: Fixed cost
- Lost if produce: Fixed cost + variable cost - TR
- So, shut down if $\boxed{TR < VC}$
- Divide both sides by $\boldsymbol{Q}$: $TR/\boldsymbol{Q} < VC/\boldsymbol{Q}$
- So, firm's decision rule is:

Shut down if $P < AVC$

Short-Run Output Decision Under Perfect Competition

- To maximize short-run profits, a perfectly competitive firm should produce in the range of increasing marginal cost where $P = MC$, provided that $P \geq AVC$. If $P < AVC$, the firm should shut down its plant to minimize it losses.

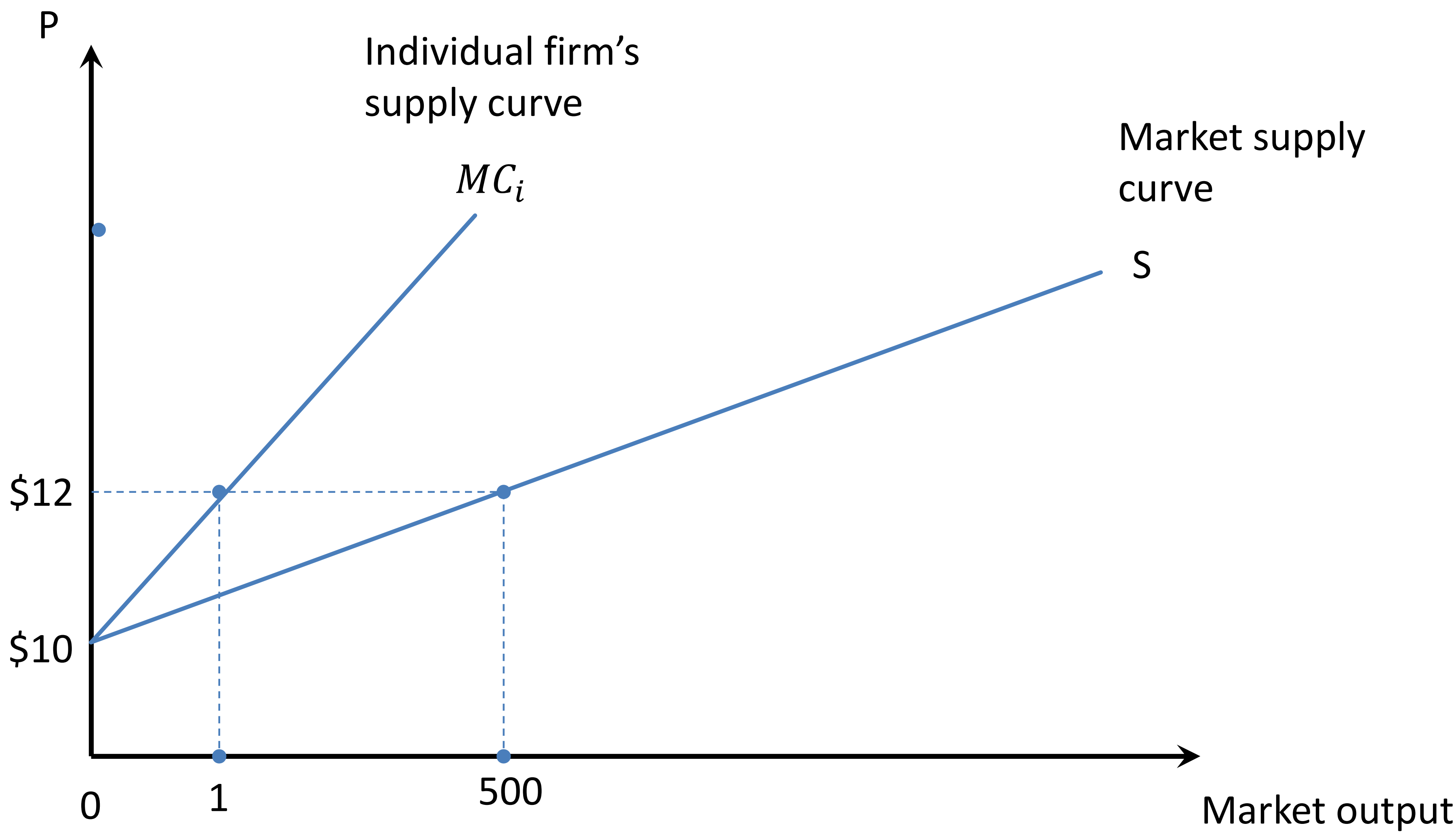
Short-Run Firm Supply Curve for a Competitive Firm



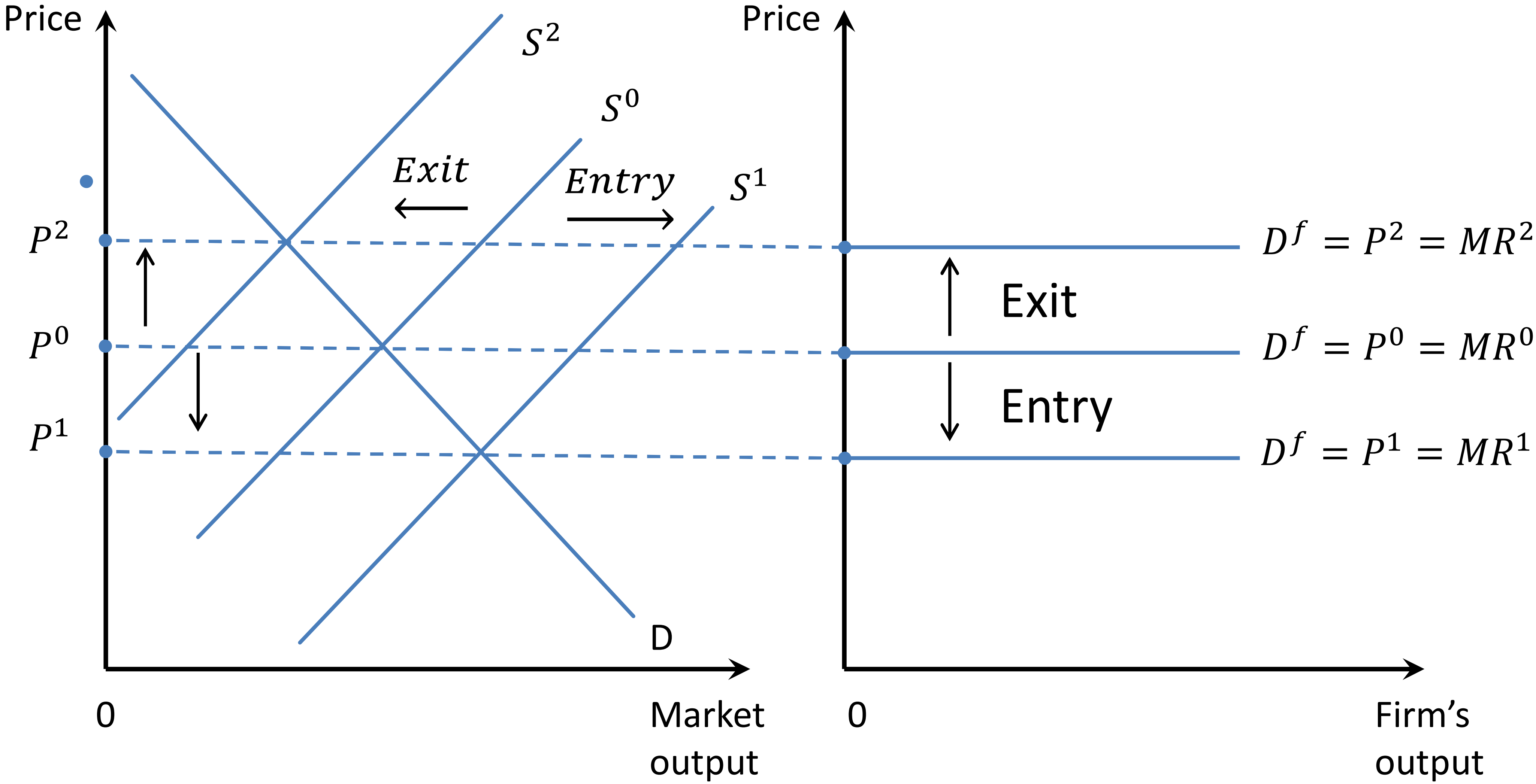
The Short-Run Firm and Industry Supply Curves

- The short-run supply curve for a perfectly competitive firm is its marginal cost curve above the minimum point on the AVC curve.

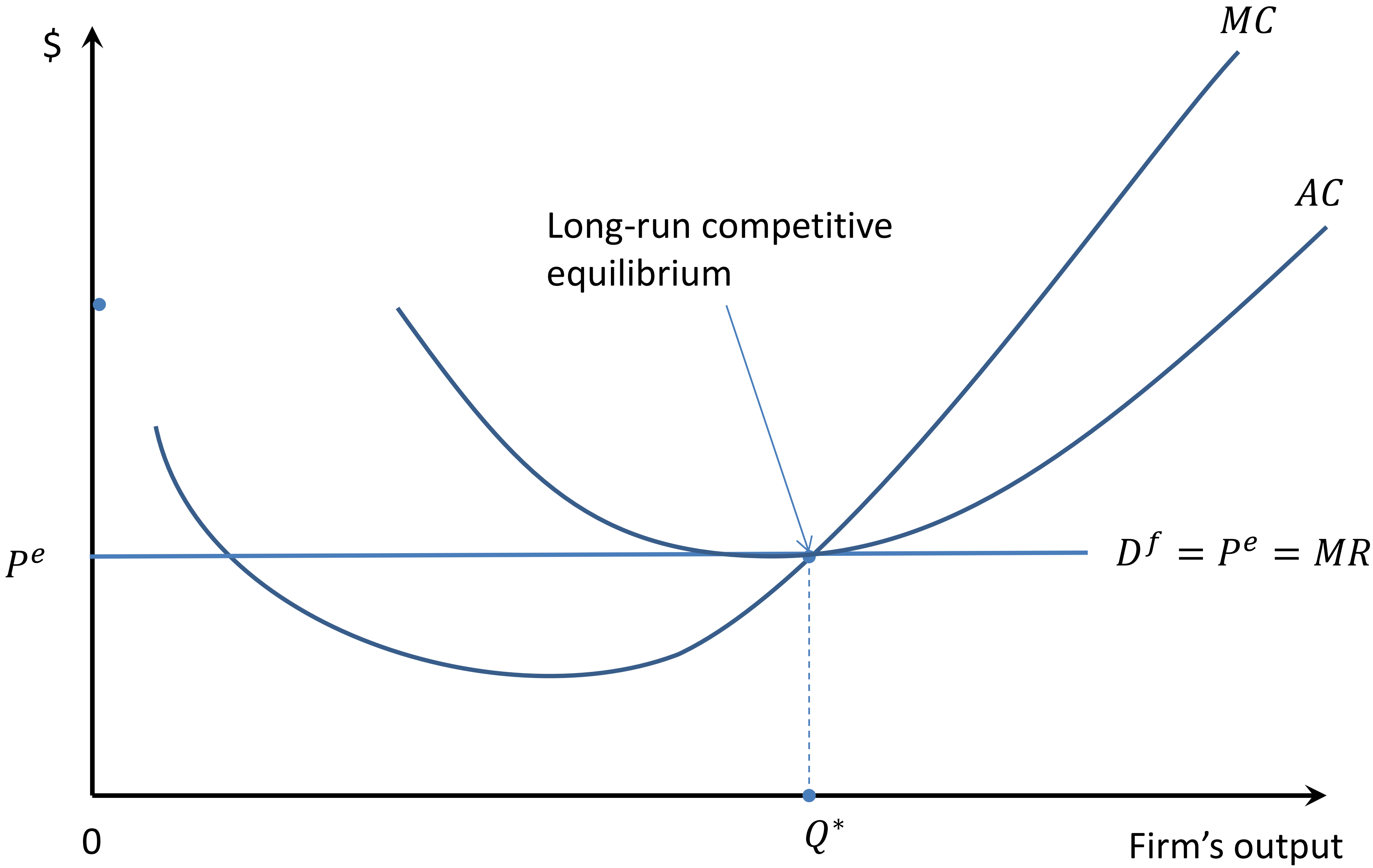
The Market Supply Curve



Long-Run Decisions: Entry and Exit The Market and Firm's Demand



Long-Run Competitive Equilibrium



Long-Run Competitive Equilibrium

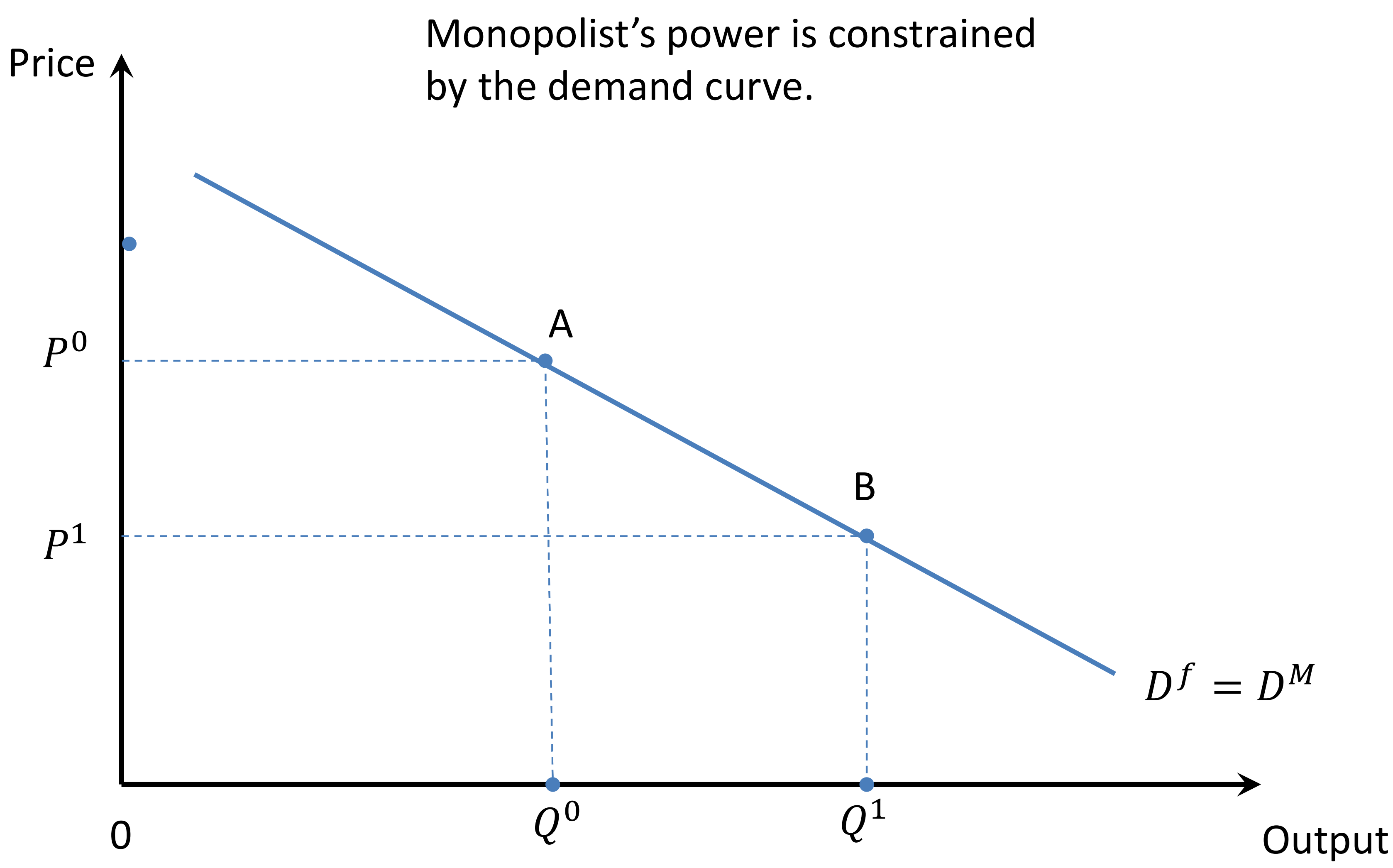
- In the long run, perfectly competitive firms produce a level of output such that

1. $P = MC$
2. $P = minimum\ of\ AC$ (zero economic profits)

Monopoly and Monopoly Power

- **Monopoly:** A market structure in which a single firm serves an entire market for a good that has no close substitutes.
- Sole seller of a good in a market gives that firm greater market power than if it competed against other firms.
  - Implication:
    - market demand curve is the monopolist's demand curve.
  - However, a monopolist does not have unlimited market power.

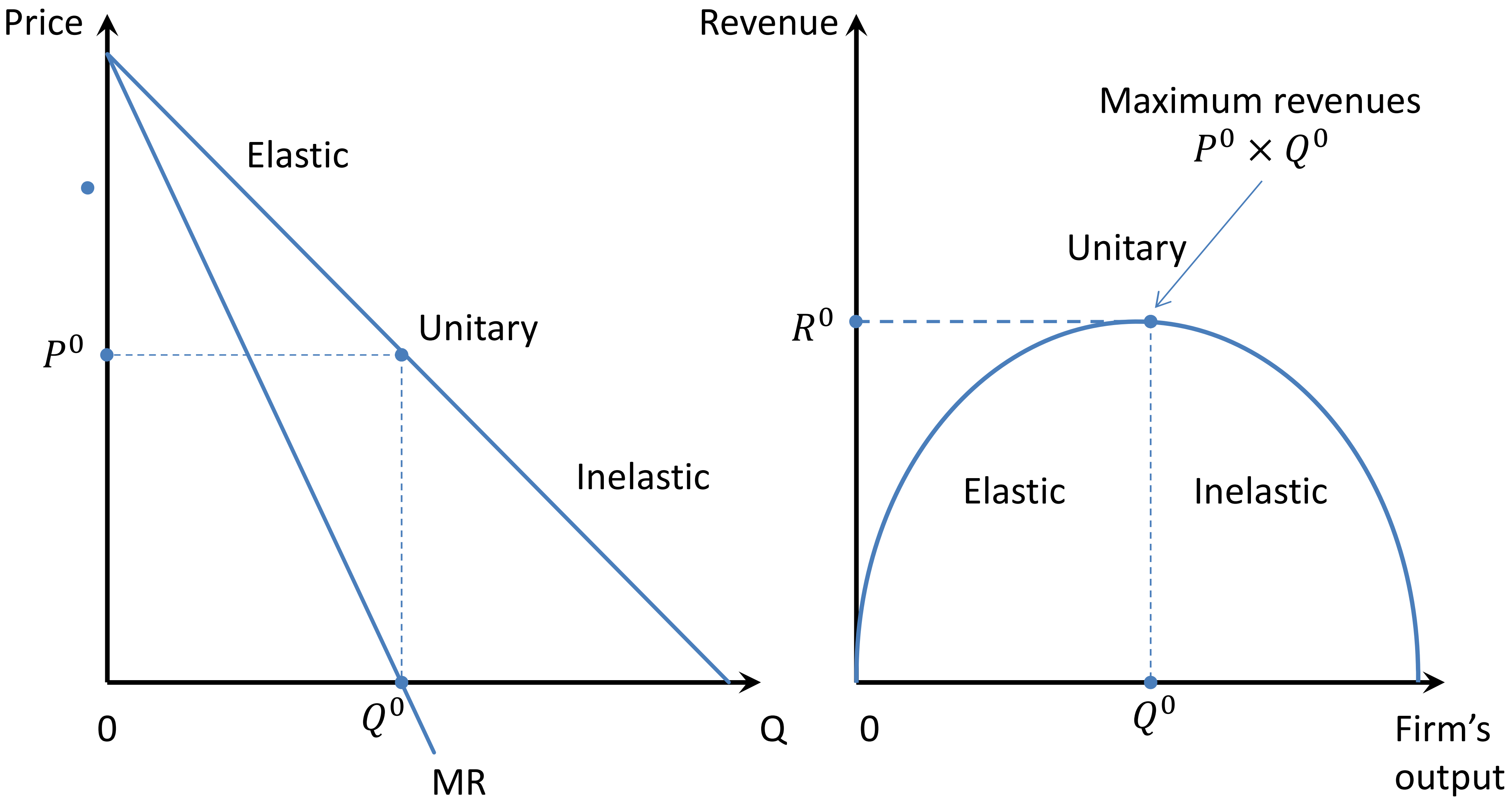
The Monopolist's Demand



Sources of Monopoly Power

- **Economies of scale**: exist whenever long-run average costs decline as output increases.
  - **Diseconomies of scale:** exist whenever long-run average costs increase as output increases.
- **Economies of scope:** exist when the total cost of producing two products within the same firm is lower than when the products are produced by separate firms.
- **Cost complementarity:** exist when the marginal cost of producing one output is reduced when the output of another product is increased.
- **Patents and other legal barriers**

Elasticity of Demand and Total Revenues



Marginal Revenue and Elasticity

- The monopolist's marginal revenue function is

$$MR = P\left[\frac{1+E}{E}\right]$$

, where E is the elasticity of demand for the monopolist's product and P is the price charged.

– For $P > 0$
  - $MR > 0$ when $E < -1$.
  - $MR = 0$ when $E = -1$.
  - $MR < 0$ when $-1 < E < 0$.

Marginal Revenue and Linear Demand

- Given an linear inverse demand function

$$P(Q) = a + bQ$$

, where $a > 0 \; and \; b < 0$, the associated marginal revenue is

$$MR(Q) = a + 2bQ$$

Marginal Revenue In Action

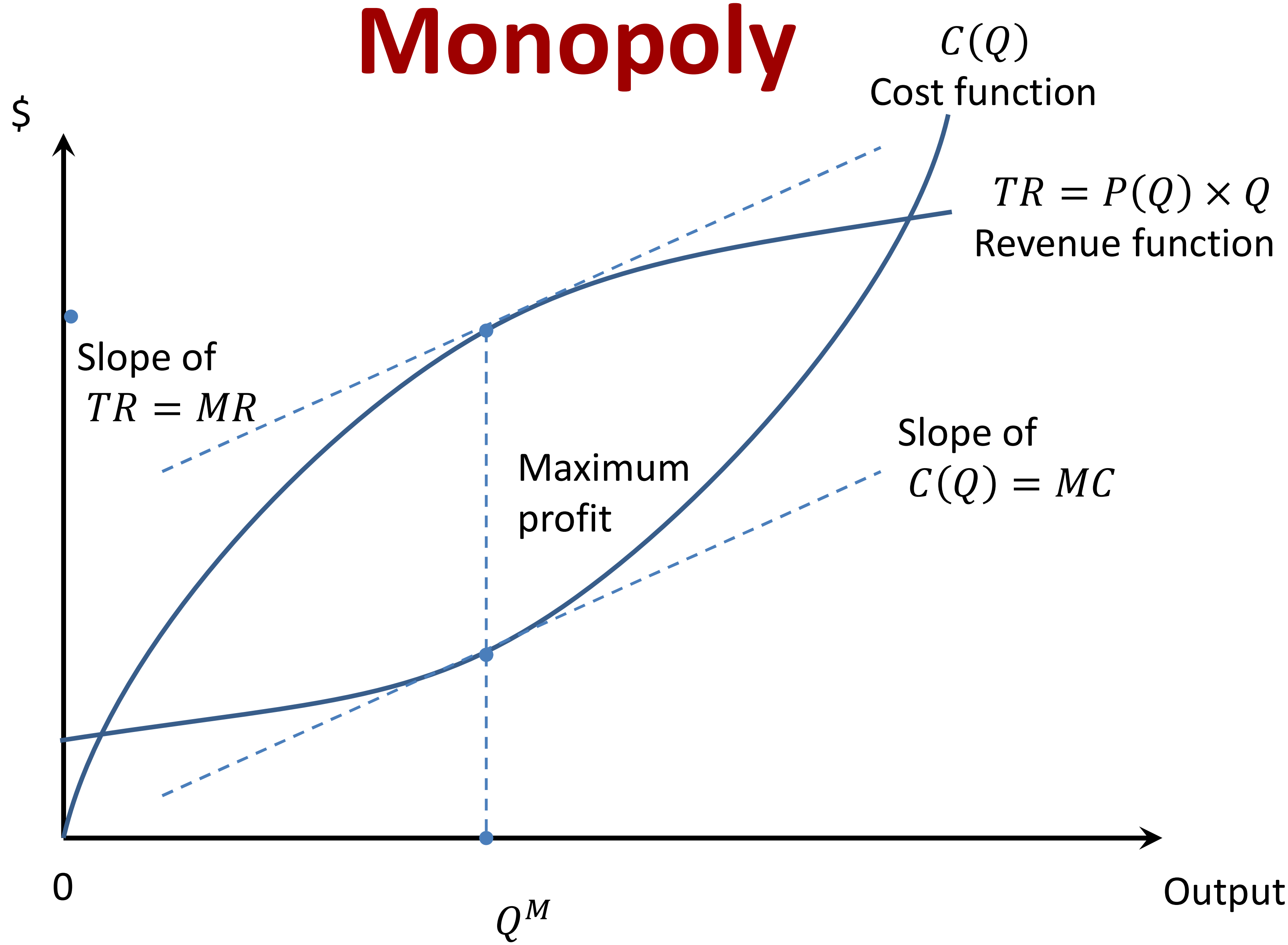
- Suppose the inverse demand function for a monopolist's product is given by $P = 10 - 2Q$. What is the maximum price per unit a monopolist can charge to be able to sell 3 units? What is marginal revenue when $Q = 3$?
- Answer:
  - The maximum price the monopolist can charge for 3 units is: $P = 10 - 2(3) = \$4$.
  - The marginal revenue at 3 units for this inverse linear demand is: $MR = 10 - 2(2)(3) = -\$2$.

Monopoly Output Rule

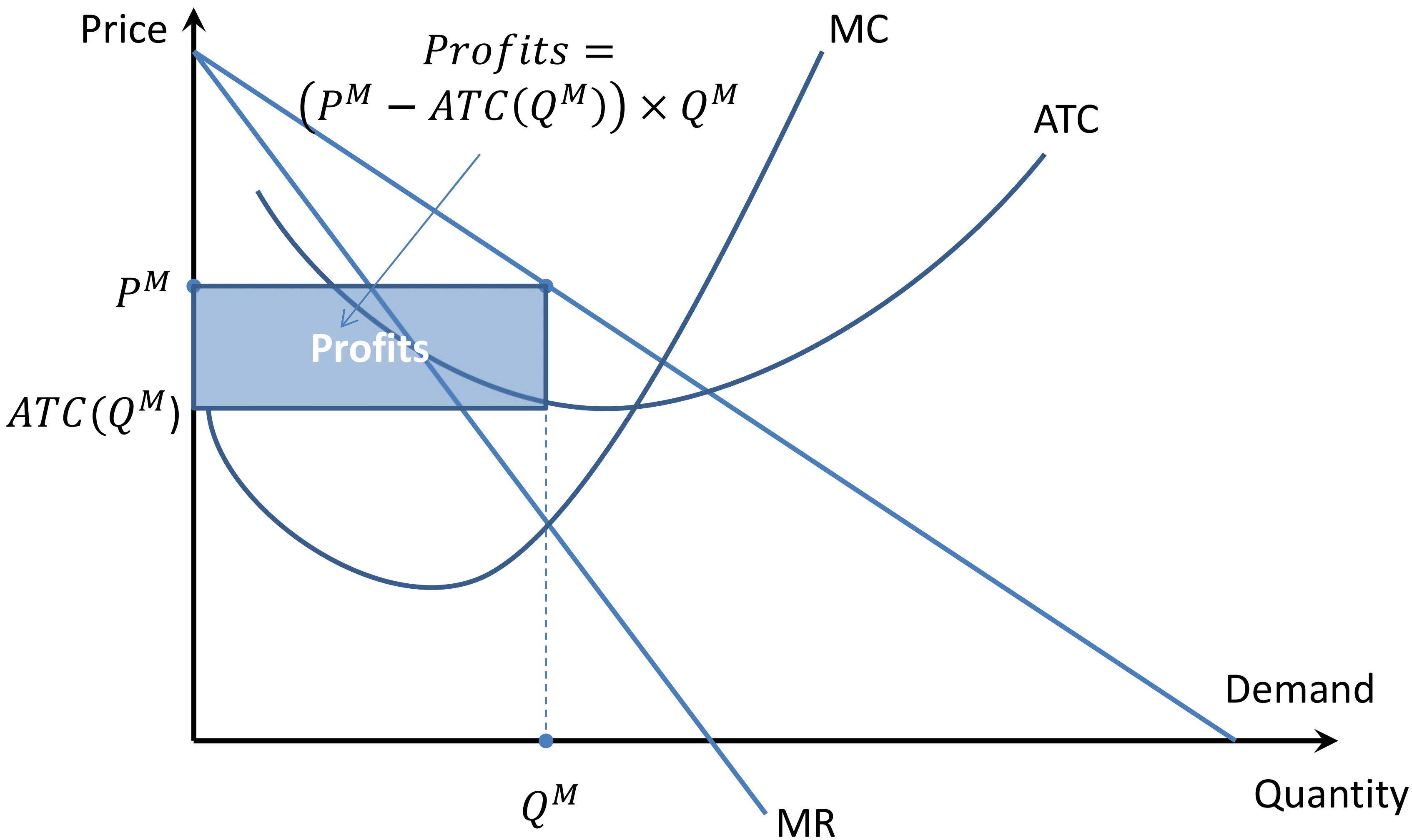
- A profit-maximizing monopolist should produce the output, Q^M, such that marginal revenue equals marginal cost:

$$MR(Q^M) = MC(Q^M)$$

Costs, Revenues, and Profits Under Monopoly



Profit Maximization Under Monopoly



Monopoly Pricing Rule

- Given the level of output, Q^M, that maximizes profits, the monopoly price is the price on the demand curve corresponding to the Q^M units produced:

$$P^M = P(Q^M)$$

Monopoly In Action

- Suppose the inverse demand function for a monopolist's product is given by $P = 100 - 2Q$ and the cost function is $C(Q) = 10 + 2Q$. Determine the profit-maximizing price, quantity and maximum profits.
- Answer:
  - Profit-maximizing output is found by solving: $100 - 4Q = 2 \Longrightarrow Q^M = 24.5$.
  - The profit-maximizing price is: $P^M = 100 - 2(24.5) = \$51$.
  - Maximum profits are: $\pi = \$51 \times 24.5 - (10 + 2 \times 24.5) = \$1{,}190.50$.

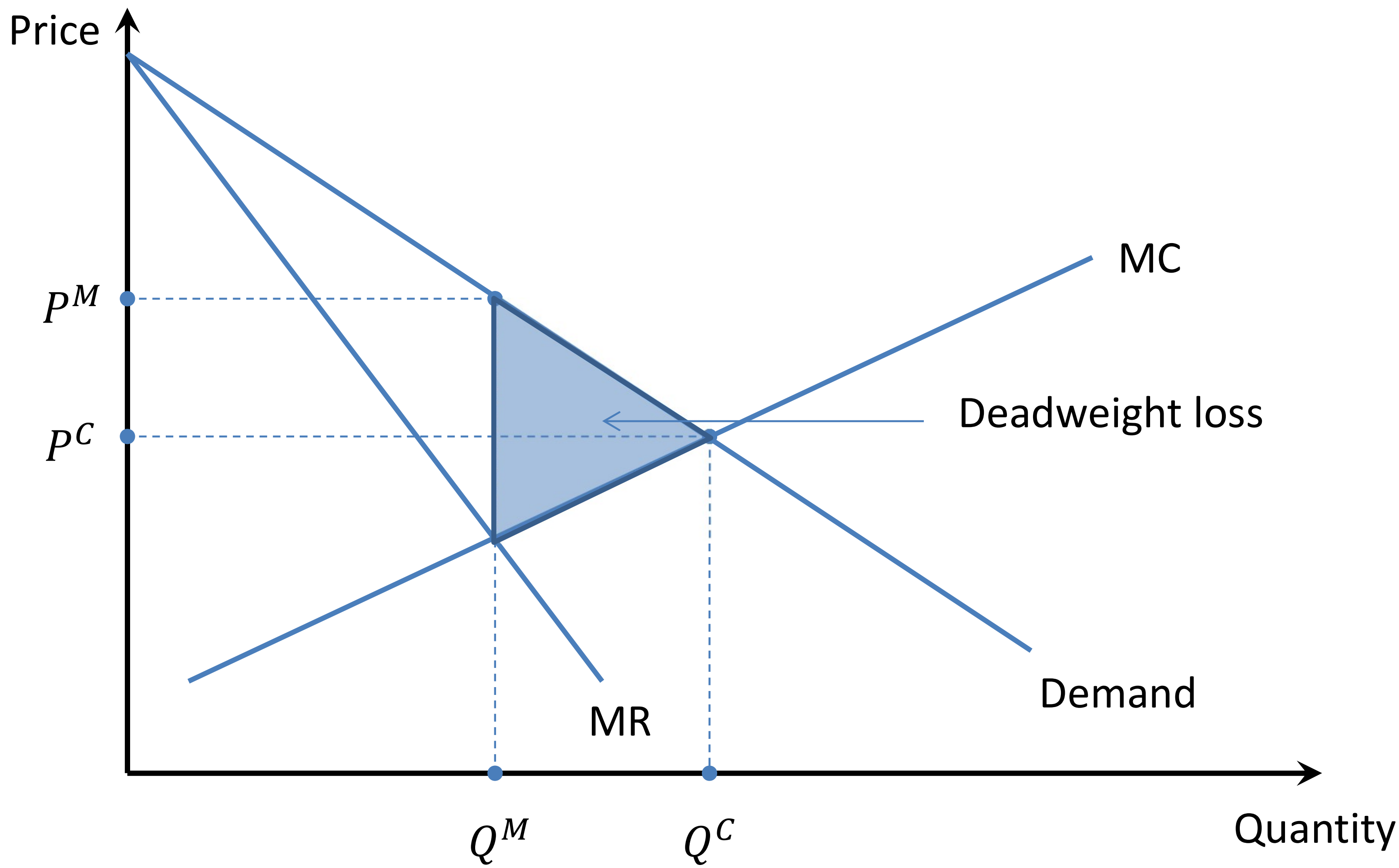
The Absence of a Supply Curve

- Recall, firms operating in perfectly competitive markets determine how much output to produce based on price ($P = MC$).
  - Thus, a supply curve exists in perfectly competitive markets.
- A monopolist's market power implies $P > MR = MC$.
  - Thus, there is no supply curve for a monopolist, or in markets served by firms with market power.

Deadweight Loss of Monopoly

- The consumer and producer surplus that is lost due to the monopolist charging a price in excess of marginal cost.

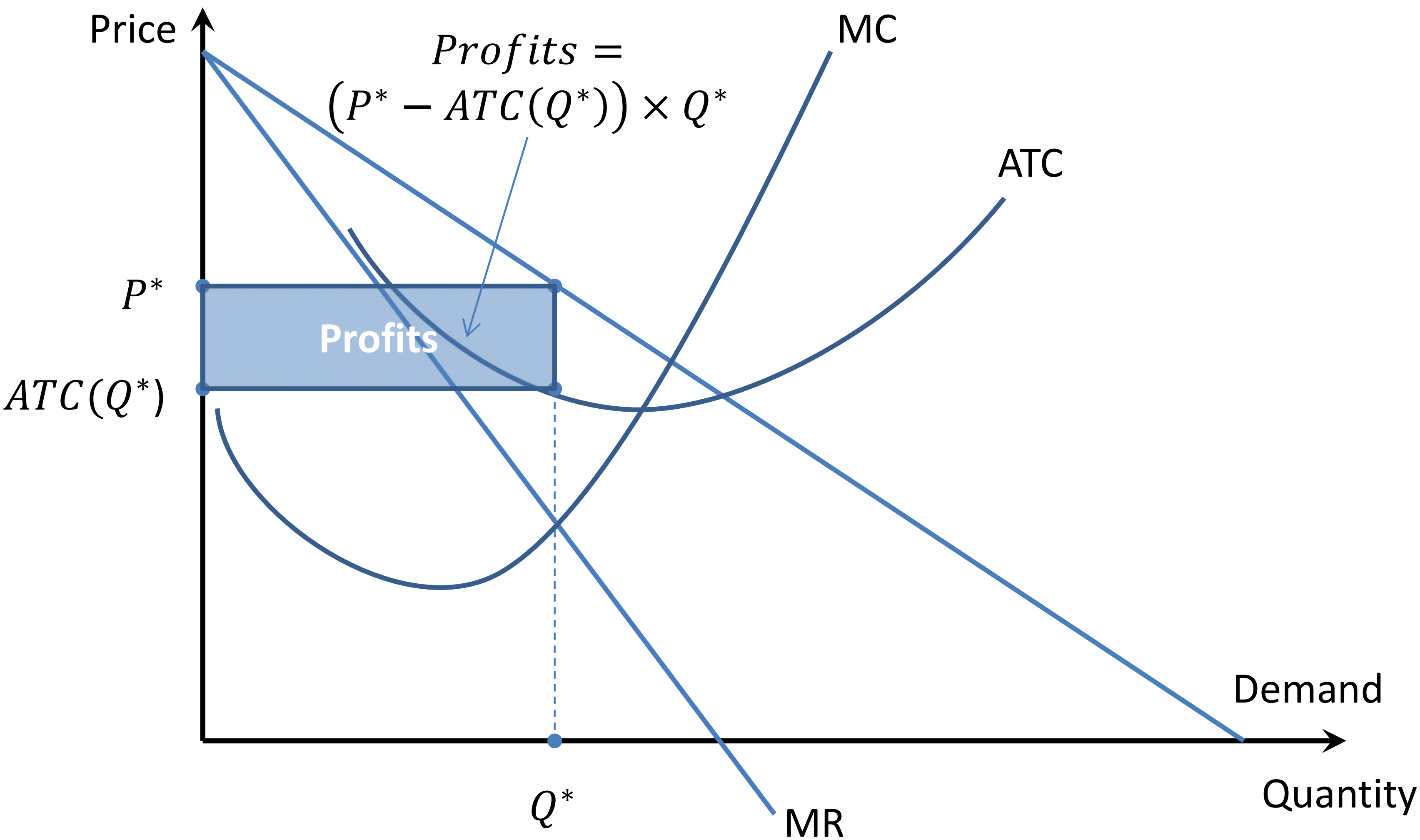
Deadweight Loss of Monopoly



Monopolistic Competition

- An industry is **monopolistically competitive** if:
  - There are many buyers and sellers.
  - Each firm in the industry produces a differentiated product.
  - There is free entry into and exit from the industry.
- A key difference between monopolistically competitive and perfectly competitive markets is that each firm produces a slightly differentiated product.
  - Implication: products are close, but not perfect, substitutes; therefore, firm's demand curve is downward sloping under monopolistic competition.

Profit-Maximization under Monopolistic Competition



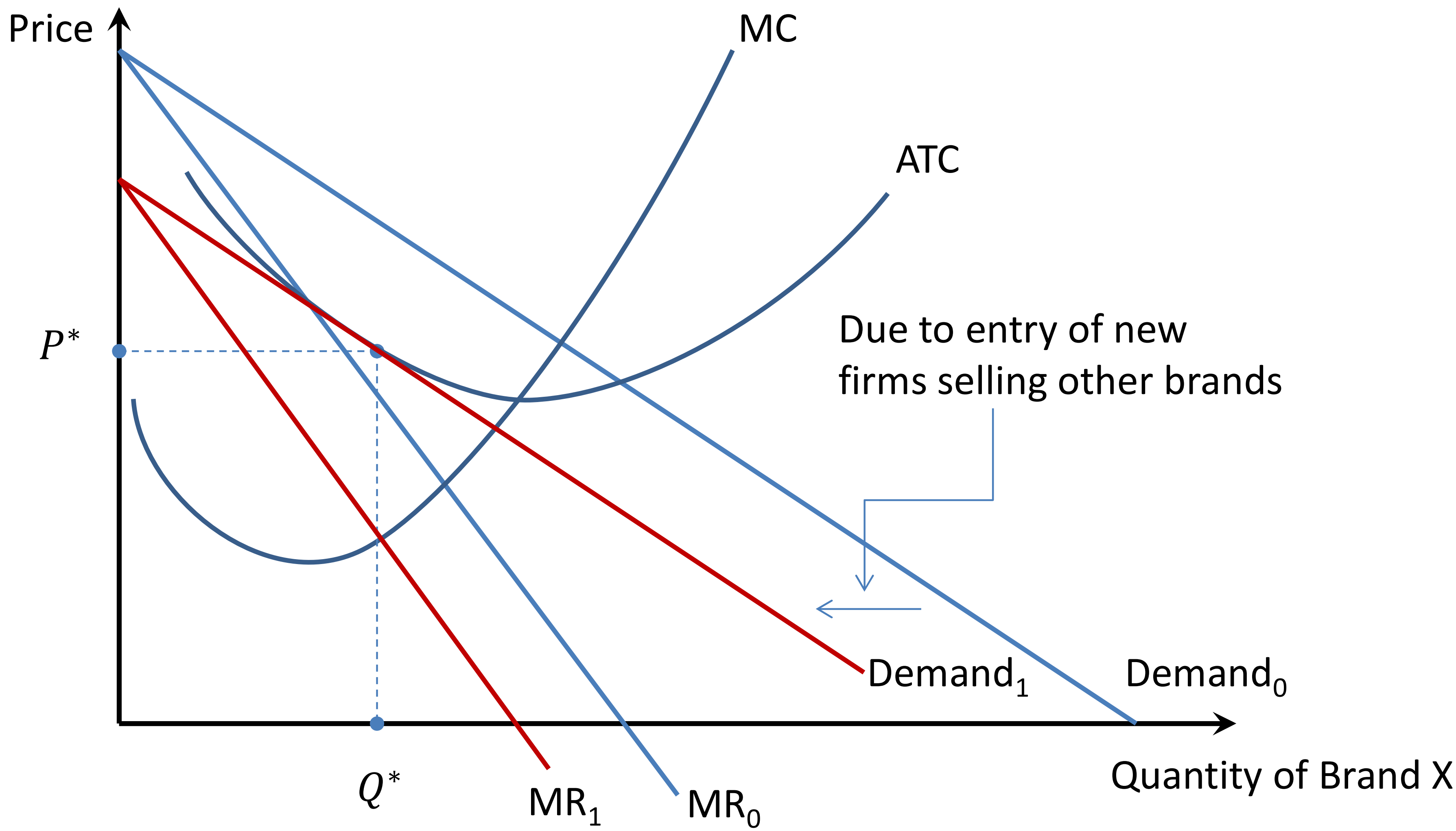
Profit-Maximization Rule for Monopolistic Competition

- To maximize profits, a monopolistically competitive firm produces where its marginal revenue equals marginal cost.
- The profit-maximizing price is the maximum price per unit that consumers are willing to pay for the profit-maximizing level of output.
- The profit-maximizing output, Q^*, is such that $MR(Q^*) = MC(Q^*)$ and the profit-maximizing price is $P^* = P(Q^*)$.

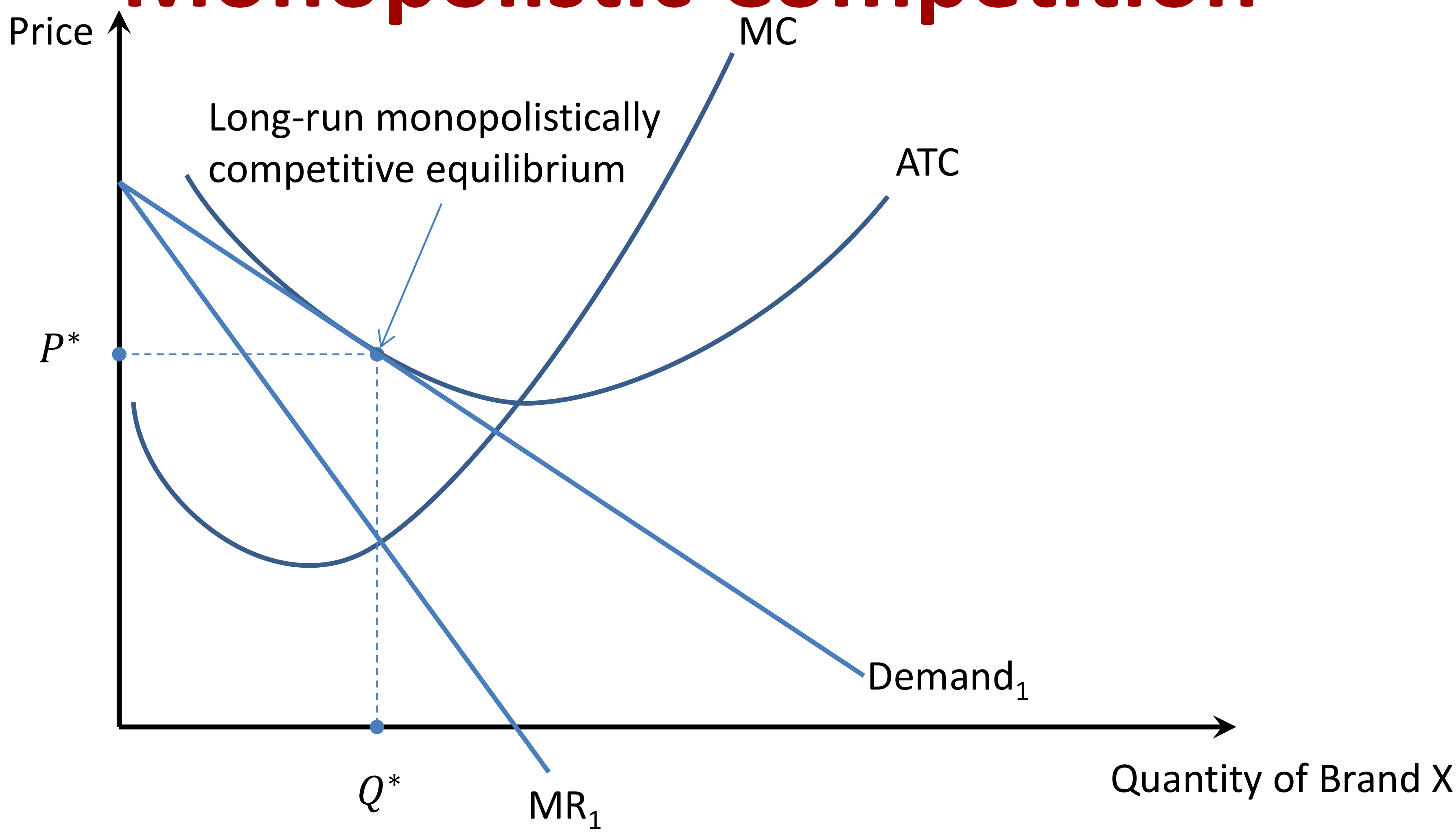
Long-Run Equilibrium

- If firms in monopolistically competitive markets earn short-run
  - profits, additional firms will enter in the long run to capture some of those profits.
  - losses, some firms will exit the industry in the long run.

Effect of Entry on a Monopolistically Competitive Firm's Demand



Long-Run Equilibrium under Monopolistic Competition



The Long-Run and Monopolistic Competition

- In the long run, monopolistically competitive firms produce a level of output such that:

1. $P > MC$
2. $P = ATC > minimum\ of\ average\ costs$

Take-home Message

- For a firm in a **perfectly competitive market**, price = marginal revenue = average revenue.
- If ***P*** > *AVC*, a firm maximizes profit by producing the quantity where *P* = *MC*. If ***P*** < *AVC*, a firm will shut down in the short run.
- With free entry and exit, profits = 0 in the long run, and ***P*** = minimum *ATC*.
- **Monopoly** firms maximize profits by producing the quantity where marginal revenue equals marginal cost. The monopoly price will be greater than marginal cost, leading to a deadweight loss.

Present value of a firm:

Assumptions:

- A firm's current profits () have not yet been paid out as dividends to stockholders
- The firm's profits are expected to grow at a constant rate of g percent each year
- The profit growth is less than the interest rate (g < i)

$$PV_{Firm} = \pi_0 + \frac{\pi_0(1+g)}{(1+i)} + \frac{\pi_0(1+g)^2}{(1+i)^2} + \frac{\pi_0(1+g)^3}{(1+i)^3} + \cdots$$

$$= \pi_0 \frac{(1+i)}{(i-g)}$$

PV of a firm after paying out dividends

- The value of the firm immediately after its current profit have been paid out as dividends:

$$PV_{Firm}^{Ex-Dividend} = PV_{Firm} - \pi_0$$

$$= \pi_0 \frac{(1+g)}{(i-g)}$$

Present value of indefinitely lived assets:

Assumption:

- An asset generates a cash flow of CF_0 today, CF_1 one year from today, CF_2 two years from today, and so on for an indefinite time period.

$$PV_{Asset} = CF_0 + \frac{CF_1}{(1+i)} + \frac{CF_2}{(1+i)^2} + \frac{CF_3}{(1+i)^3} + \frac{CF_4}{(1+i)^4} + \cdots$$

Present Value of a perpetuity:

Assumption:

- Current cash flow is zero ($CF_0 = 0$) and all future cash flows are identical ($CF_1 = CF_2 = \cdots$)

$$PV_{Perpetuity} = \frac{CF}{(1+i)} + \frac{CF}{(1+i)^2} + \frac{CF}{(1+i)^3} + \frac{CF}{(1+i)^4} + \cdots$$

$$= \frac{CF}{i}$$

Source: Baye, M.R., 2009. Managerial economics and business strategy, 6th ed. ed. McGraw-Hill Irwin, Boston (pp. 14-16).

Derivation of Formulas

1) PV of a firm

$$PV_{Firm} = \pi_0 + \frac{\pi_0(1+g)}{(1+i)} + \frac{\pi_0(1+g)^2}{(1+i)^2} + \frac{\pi_0(1+g)^3}{(1+i)^3} + \cdots \qquad (1)$$

a) Multiply both sides with $\frac{(1+i)}{(1+g)}$:

$$\frac{PV_{Firm}(1+i)}{(1+g)} = \pi_0 * \frac{(1+i)}{(1+g)} + \pi_0 + \frac{\pi_0(1+g)}{(1+i)} + \frac{\pi_0(1+g)^2}{(1+i)^2} + \cdots \qquad (2)$$

b) Subtract first equation from second equation (2)-(1):

$$\frac{PV_{Firm}(1+i)}{(1+g)} - PV_{Firm} = \left[\pi_0 \frac{(1+i)}{(1+g)} + \pi_0 + \frac{\pi_0(1+g)}{(1+i)} + \frac{\pi_0(1+g)^2}{(1+i)^2} + \cdots\right] - \left[\pi_0 + \frac{\pi_0(1+g)}{(1+i)} + \frac{\pi_0(1+g)^2}{(1+i)^2} + \frac{\pi_0(1+g)^3}{(1+i)^3} + \cdots\right]$$

$$\frac{PV_{Firm}(1+i)}{(1+g)} - PV_{Firm} = \pi_0 \frac{(1+i)}{(1+g)}$$

c) Solve for PV_{Firm}:

$$PV_{Firm} * \left[\frac{(1+i)}{(1+g)} - 1\right] = \pi_0 \frac{(1+i)}{(1+g)}$$

$$PV_{Firm} * \left[\frac{(1+i)}{(1+g)} - \frac{(1+g)}{(1+g)}\right] = \pi_0 \frac{(1+i)}{(1+g)}$$

$$PV_{Firm} * \left[\frac{(1+i-1-g)}{(1+g)}\right] = \pi_0 \frac{(1+i)}{(1+g)}$$

$$PV_{Firm} * \left[\frac{(i-g)}{(1+g)}\right] = \pi_0 \frac{(1+i)}{(1+g)}$$

$$PV_{Firm} * (i-g) = \pi_0(1+i)$$

$$\boldsymbol{PV_{Firm} = \pi_0 \frac{(1+i)}{(i-g)}}$$

Source: Baye, M.R., 2009. Managerial economics and business strategy, 6th ed. ed. McGraw-Hill Irwin, Boston (pp. 14-16).

2) PV of a firm after paying out dividends

$$PV_{Firm}^{Ex-Dividend} = PV_{Firm} - \pi_0$$

$$= \pi_0 \frac{(1+i)}{(i-g)} - \pi_0$$

$$= \pi_0 \left(\frac{(1+i)}{(i-g)} - 1\right)$$

$$= \pi_0 \left(\frac{(1+i)}{(i-g)} - \frac{(i-g)}{(i-g)}\right)$$

$$= \pi_0 \left(\frac{(1+i-i+g)}{(i-g)}\right)$$

$$= \boldsymbol{\pi_0 \frac{(1+g)}{(i-g)}}$$

Source: Baye, M.R., 2009. Managerial economics and business strategy, 6th ed. ed. McGraw-Hill Irwin, Boston (pp. 14-16).

3) Present Value of a perpetuity:

$$PV_{Perpetuity} = \frac{CF}{(1+i)} + \frac{CF}{(1+i)^2} + \frac{CF}{(1+i)^3} + \frac{CF}{(1+i)^4} + \cdots \qquad (1)$$

a) Divide both sides by $(1+i)$:

$$\frac{PV_{Perpetuity}}{(1+i)} = \frac{CF}{(1+i)^2} + \frac{CF}{(1+i)^3} + \frac{CF}{(1+i)^4} + \cdots \qquad (2)$$

b) Subtract second equation from first equation (1)-(2):

$$PV_{Perpetuity} - \frac{PV_{Perpetuity}}{(1+i)} = \left[\frac{CF}{(1+i)} + \frac{CF}{(1+i)^2} + \frac{CF}{(1+i)^3} + \frac{CF}{(1+i)^4} + \cdots\right] - \left[\frac{CF}{(1+i)^2} + \frac{CF}{(1+i)^3} + \frac{CF}{(1+i)^4} + \cdots\right]$$

$$PV_{Perpetuity} - \frac{PV_{Perpetuity}}{(1+i)} = \frac{CF}{(1+i)}$$

c) Solve for $PV_{Perpetuity}$:

$$PV_{Perpetuity} = \frac{CF}{(1+i)} + \frac{PV_{Perpetuity}}{(1+i)}$$

$$PV_{Perpetuity} * (1+i) = CF + PV_{Perpetuity}$$

$$PV_{Perpetuity} + PV_{Perpetuity} * i = CF + PV_{Perpetuity}$$

$$PV_{Perpetuity} * i = CF$$

$$\boldsymbol{PV_{Perpetuity} = \frac{CF}{i}}$$

Source: Baye, M.R., 2009. Managerial economics and business strategy, 6th ed. ed. McGraw-Hill Irwin, Boston (pp. 14-16).

Problem Set 1

Exercise 1:

What is the maximum amount you would pay for an asset that generated an income of $200,000 at the end of each of four years if the opportunity cost of using funds is 5%?

Solution 1):

Present Value of Future Cash Flows:

Formula:

$$PV = \sum_{n=1}^{N} \frac{CF}{(1+r)^n}$$

Apply formula:

$$PV = \sum_{n=1}^{4} \frac{200{,}000}{(1+0.05)^n}$$

$$PV = \frac{200{,}000}{(1+0.05)} + \frac{200{,}000}{(1+0.05)^2} + \frac{200{,}000}{(1+0.05)^3} + \frac{200{,}000}{(1+0.05)^4}$$

$$PV = 709{,}190.1$$

Exercise 2:

A firm's current profits are \$200,000. These profits are expected to grow indefinitely at a constant annual rate of 5%.

If the firm's opportunity cost of funds Is 7¤%, determine the present value of the firm at…

a) … the instant before it pays out the current profits as dividends.

Solution 2a):

Present Value of a Firm:

Assumptions:

- A firm's current profits (π_0) have not yet been paid out as dividends to stockholders.
- The firm's profits are expected to grow at a constant rate of g percent each year.
- The profit growth (g) is less than the opportunity costs/interest rate (r), i.e., $g < r$

Formula:

$$PV_{Firm} = \sum_{n=0}^{N} \frac{\pi_0(1+g)^n}{(1+r)^n}$$

$$PV_{Firm} = \frac{\pi_0(1+g)^0}{(1+r)^0} + \frac{\pi_0(1+g)^1}{(1+r)^1} + \frac{\pi_0(1+g)^2}{(1+r)^2} + \frac{\pi_0(1+g)^3}{(1+r)^3} + \cdots$$

$$PV_{Firm} = \pi_0 + \frac{\pi_0(1+g)^1}{(1+r)^1} + \frac{\pi_0(1+g)^2}{(1+r)^2} + \frac{\pi_0(1+g)^3}{(1+r)^3} + \cdots$$

$$PV_{Firm} = \pi_0 \frac{(1+r)}{(r-g)}$$

Apply formula:

$PV_{Firm} = \pi_0 \frac{(1+r)}{(r-g)}$

$PV_{Firm} = 200{,}000 * \frac{(1+0.07)}{(0.07-0.05)}$

$PV_{Firm} = 200{,}000 * \frac{1.07}{0.02}$

$PV_{Firm} = 200{,}000 * 53.5$

$PV_{Firm} = 10{,}700{,}000$

b) … the instant after it pays out current profits as dividends.

Solution 2b):

PV of a firm after paying out dividends

- The value of the firm immediately after its current profit have been paid out as dividends:

Formula:

$$PV_{Firm}^{Ex-Dividend} = PV_{Firm} - \pi_0$$

$$PV_{Firm}^{Ex-Dividend} = \sum_{n=0}^{N} \frac{\pi_0(1+g)^n}{(1+r)^n} - \pi_0$$

$$PV_{Firm}^{Ex-Dividend} = \pi_0 \frac{(1+r)}{(r-g)} - \pi_0$$

$$PV_{Firm}^{Ex-Dividend} = \pi_0 \frac{(1+g)}{(r-g)}$$

Apply formula:

$$PV_{Firm}^{Ex-Dividend} = 200{,}000 * \frac{(1+0.05)}{(0.07-0.05)}$$

$$PV_{Firm}^{Ex-Dividend} = 200{,}000 * \frac{1.05}{0.02}$$

$$PV_{Firm}^{Ex-Dividend} = 200{,}000 * 52.5$$

$$PV_{Firm}^{Ex-Dividend} = 10{,}500{,}000$$

Exercise 3:

What is the value of a preferred stock that pays a perpetual dividend of $150 at the end of each year when the interest rate is 8%?

Solution 3):

Present Value of Perpetuity:

Formula:

$$PV_{Perpetuity} = \sum_{n=1}^{\infty} \frac{CF_n}{(1+r)^n}$$

$$PV_{Perpetuity} = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \frac{CF_4}{(1+r)^4} + \cdots$$

$$PV_{Perpetuity} = \frac{CF}{r}$$

Apply formula:

$$PV_{Perpetuity} = \frac{perpetual\ divident}{interest\ rate}$$

$$PV_{Perpetuity} = \frac{150}{0.08}$$

$$PV_{Perpetuity} = 1{,}875$$

Exercise 4:

Suppose the total benefit $B(Q)$ derived from a continuous decision (Q) and the corresponding total cost $C(Q)$, is given by:

$$B(Q) = 10Q - Q^2 \qquad ; \qquad C(Q) = 2 + Q^2$$

The corresponding marginal benefits $[MB(Q)]$ and marginal costs $[MC(Q)]$ are:

$$MB(Q) = \frac{\partial B(Q)}{\partial Q} = 10 - 2Q \qquad ; \qquad MC(Q) = \frac{\partial C(Q)}{\partial Q} = 2Q$$

a) What is the net benefit when $Q = 2$ and $Q = 5$?

Solution 4a):

Net Benefit (NB):

$$NB(Q) = B(Q) - C(Q)$$

$$NB(Q) = (10Q - Q^2) - (2 + Q^2)$$

For $\boldsymbol{Q} = \mathbf{2}$	For $\boldsymbol{Q} = \mathbf{5}$
$NB(2) = B(2) - C(2)$ $NB(2) = (10 * 2 - 2^2) - (2 + 2^2)$ $NB(2) = (20 - 4) - (2 + 4)$ $NB(2) = 16 - 6$ $NB(2) = 10$	$NB(5) = B(5) - C(5)$ $NB(5) = (10 * 5 - 5^2) - (2 + 5^2)$ $NB(5) = (50 - 25) - (2 + 25)$ $NB(5) = 25 - 27$ $NB(5) = -2$

b) What is the marginal benefit (MB) when $Q = 2$ and $Q = 5$?

Solution 4b):

Marginal Benefit (MB):

$$MB(Q) = \frac{\partial B(Q)}{\partial Q} = 10 - 2Q$$

For $Q = 2$	**For $Q = 5$**
$MB(2) = 10 - 2 * 2$ $MB(2) = 10 - 4$ $MB(2) = 6$	$MB(5) = 10 - 2 * 5$ $MB(5) = 10 - 10$ $MB(5) = 0$

c) What level of Q maximizes total benefit?

Solution 4c):

Total benefit is maximized when the marginal benefits are equal to zero:

$$MB(Q) = 0 = 10 - 2Q$$

Solve for Q:

$$2Q = 10$$

$$Q^* = 5$$

d) What are the total costs when $Q = 2$ and $Q = 5$?

Solution 4d):

Total Costs:

$$C(Q) = 2 + Q^2$$

For $Q = 2$	**For $Q = 5$**
$C(2) = 2 + 2^2$ $C(2) = 2 + 4$ $C(2) = 6$	$C(5) = 2 + 5^2$ $C(5) = 2 + 25$ $C(5) = 27$

e) What is the marginal cost when $Q = 2$ and $Q = 5$?

Solution 4e):

Marginal Cost (MC):

$$MC(Q) = \frac{\partial C(Q)}{\partial Q} = 2Q$$

For $Q = 2$	**For $Q = 5$**
$MC(2) = 2 * 2$ $MC(2) = 4$	$MC(5) = 2 * 5$ $MC(5) = 10$

f) What level of Q maximizes total cost?

Solution 4f):

Total costs are maximized when marginal costs are equal to zero:

$$MC(Q) = 0 = 2Q$$

$$2Q = 0$$

$$Q^* = 0$$

g) What level of Q maximizes net benefits?

Solution 4g):

Net benefits are maximized when marginal benefits equal marginal costs:

$$MC(Q) = MB(Q)$$

$$2Q = 10 - 2Q$$

$$4Q = 10$$

$$Q^* = 2.5$$

Exercise 5:

In a coffee shop, suppose that the total benefit of selling Q cups of coffee is given by:

$$B(Q) = 5 + 30Q - 0.05Q^2$$

The costs for making Q cups of coffee is:

$$C(Q) = 10 + 0.1Q$$

Consequently, the marginal benefit and marginal costs per cup of coffee are:

$$MB(Q) = \frac{\partial B(Q)}{\partial Q} = 30 - 0.1Q \quad ; \qquad MC(Q) = \frac{\partial C(Q)}{\partial Q} = 0.1$$

a) Write out the equation for the net benefits (NB):

<u>Solution 5a):</u>

<u>Net Benefit (NB):</u>

$NB(Q) = B(Q) - C(Q)$

$NB(Q) = (5 + 30Q - 0.05Q^2) - (10 + 0.1Q)$

$NB(Q) = -5 + 29.9Q - 0.05Q^2$

b) What are the net benefits when the shop sells 100 cups of coffee?

Solution 5b):

Net Benefit (NB) if $Q = 100$:

$NB(100) = -5 + 29.9 * 100 - 0.05 * 100^2$

$NB(100) = -5 + 2{,}990 - 0.05 * 10{,}000$

$NB(100) = -5 + 2{,}990 - 500$

$NB(100) = 2{,}485$

c) Write out the marginal net benefits (MNB)

Solution 5c):

Marginal Net Benefits (MNB):

$MNB(Q) = \frac{\partial NB(Q)}{\partial Q} = 29.9 - 0.1Q$ m

Alternatively:

$MNB(Q) = MB(Q) - MC(Q)$

$MNB(Q) = 30 - 0.1Q - 0{,}1$

$MNB(Q) = 29.9 - 0.1Q$

d) What are the marginal net benefits (MNB) when the shop sells 100 cups of coffee?

Solution 5d):

Marginal Net Benefits (MNB) if $Q = 100$:

$MNB(100) = 29.9 - 0.1 * 100$

$MNB(100) = 29.9 - 10$

$MNB(100) = 19.9$

e) How many cups of coffee should the shop sell to maximize net benefits?

Solution 5e):

The shop maximizes net benefits where the marginal net benefits are qual to zero:

$MNB(Q) = MB(Q) - MC(Q) = 0$

$MC(Q) = MB(Q)$

$0.1 = 30 - 0.1Q$

$0.1Q = 29.9$

$Q^* = 299$

f) When they sold a certain amount of coffee that maximize the net benefit, what is the value of marginal net benefits (MNB)

Solution 5f):

Marginal Net Benefits (MNB) with maximized net benefits, i.e. Q^*

$MNB(Q^*) = MB(Q^*) - MC(Q^*)$

$MNB(299) = 30 - 0.1 * 299 - 0.1$

$MNB(299) = 0.1 - 0.1$

$MNB(299) = 0$

Problem Set 2

Exercise 1:

Suppose the supply function for product X is given by: $Q_X^S = -30 + 2P_X - 4P_Z$

a) How much of product X is produced when $P_X = \$600$ and $P_Z = \$60$?

Solution 1a):

Insert $P_X = \$600$ and $P_Z = \$60$ into the supply function:

$Q_X^S = -30 + 2 * 600 - 4 * 60$

$Q_X^S = -30 + 1{,}200 - 240$

$Q_X^S = 930$

b) How much of product X is produced when $P_X = \$80$ and $P_Z = \$60$?

Solution 1b):

Insert $P_X = \$80$ and $P_Z = \$60$ into the supply function:

$Q_X^S = -30 + 2 * 80 - 4 * 60$

$Q_X^S = -30 + 160 - 240$

$Q_X^S = -110$

Notably, having a negative output in supply is impossible. Thus, the quantity supplied is zero, i.e., $Q_X^S = 0\ \ if\ P_X = \$80\ and\ P_Z = \$60$.

c) Suppose that $P_Z = \$60$. Determine the supply function and inverse supply function for good X. Graph the inverse supply function.

Solution 1c):

Insert $P_Z = \$60$ into the supply function:

$$Q_X^S = -30 + 2P_X - 4 * 60$$

$$Q_X^S = -30 + 2P_X - 240$$

$$Q_X^S = 2P_X - 270$$

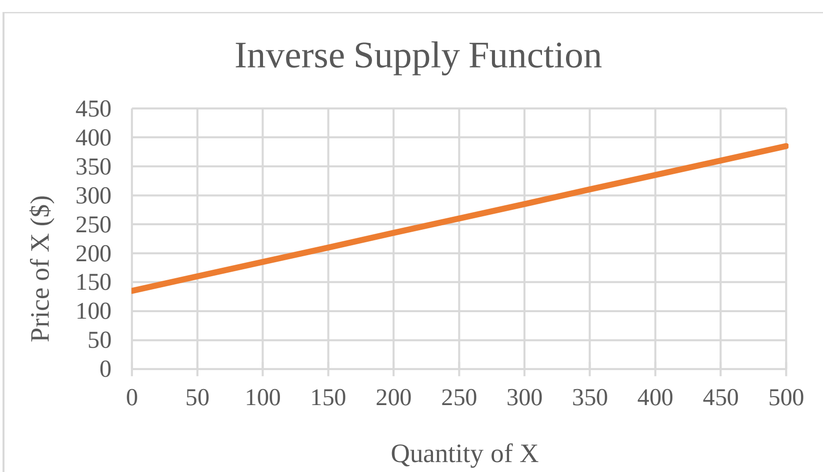
To obtain the inverse supply equation, simply solve for P_X:

$$Q_X^S = 2P_X - 270$$

$$2P_X = Q_X^S + 270$$

$$P_X = \frac{1}{2}Q_X^S + 135$$

The inverse supply function is graphed below:



Exercise 2:

Suppose the demand function for good X is given by:

$$Q_X^D = 6000 - \frac{1}{2}P_X - P_Y + 9P_Z + \frac{1}{10}M$$

Research shows that the prices of related goods are given by: $P_Y = \$6{,}500$ and $P_Z = \$100$. The average income of individuals consuming this product is: $M = \$70{,}000$.

a) Indicate whether goods Y and Z are substitutes or complements for good X.

Solution 2a):

Cross price elasticity of demand:

$$E_{Q_X,P_Y} = \alpha_Y \frac{P_Y}{Q_X}$$

$$E_{Q_X,P_Y} = -1 * \frac{P_Y}{Q_X^D} \quad < \quad \mathbf{0}$$

Good Y is a complement good for good X since the cross-price elasticity is negative, i.e., $E_{Q_X,P_Y} < 0$¨

This means that the demand for good X decreases as the price for good Y increases and vice versa (e.g., toner and printer)

$$E_{Q_X,P_Z} = \alpha_Y \frac{P_Z}{Q_X}$$

$$E_{Q_X,P_Z} = (+)\,9 * \frac{P_Z}{Q_X^D} \quad > \quad \mathbf{0}$$

Good Z is a substitute good for good X since the cross-price elasticity is positive, i.e., $E_{Q_X,P_Y} > 0$

This means that the demand for good X will increase as the price for good Z increases and vice versa (e.g., butter and margarine)

b) Is X an inferior or a normal good?

Solution 2b):

Income elasticity:

$$E_{Q_X,M} = \alpha_M \frac{M}{Q_X^D}$$

$$E_{Q_X,M} = (+)\frac{1}{10}\,\frac{M}{Q_X^D} \quad > \quad \mathbf{0}$$

Good X is considered a normal good, as the income elasticity is positive, i.e., $E_{Q_X,M} > 0$

The demand for good X increases as the income (M) increases and vice versa (e.g., high tech products, cars, home services…)

For inferior foods, the demand for a good X would deacrese as income (M) increases and vice versa, (e.g., secondhand clothing, used cars…)

c) How many units of good X will be purchased when $P_X = \$5{,}230$?

Solution 2c):

Insert in all known variables in demand function:

$Q_X^D = 6000 - \frac{1}{2}P_X - P_Y + 9P_Z + \frac{1}{10}M$

$Q_X^D = 6000 - \frac{1}{2} * 5{,}230 - 6{,}500 + 9 * 100 + \frac{1}{10} * 70{,}000$

$Q_X^D = 6000 - 2{,}615 - 6{,}500 + 900 + 7{,}000$

$Q_X^D = 4{,}785$

d) Determine the demand function and inverse demand function for good X.

Solution 2d):

For the given income and prices of other goods, the demand function for good X is:

$Q_X^D = 6000 - \frac{1}{2}P_X - P_Y + 9P_Z + \frac{1}{10}M$

$Q_X^D = 6000 - \frac{1}{2} * P_X - 6{,}500 + 9 * 100 + \frac{1}{10} * 70{,}000$

$Q_X^D = 6000 - \frac{1}{2}P_X - 6{,}500 + 900 + 7{,}000$

$Q_X^D = 7{,}400 - \frac{1}{2}P_X$

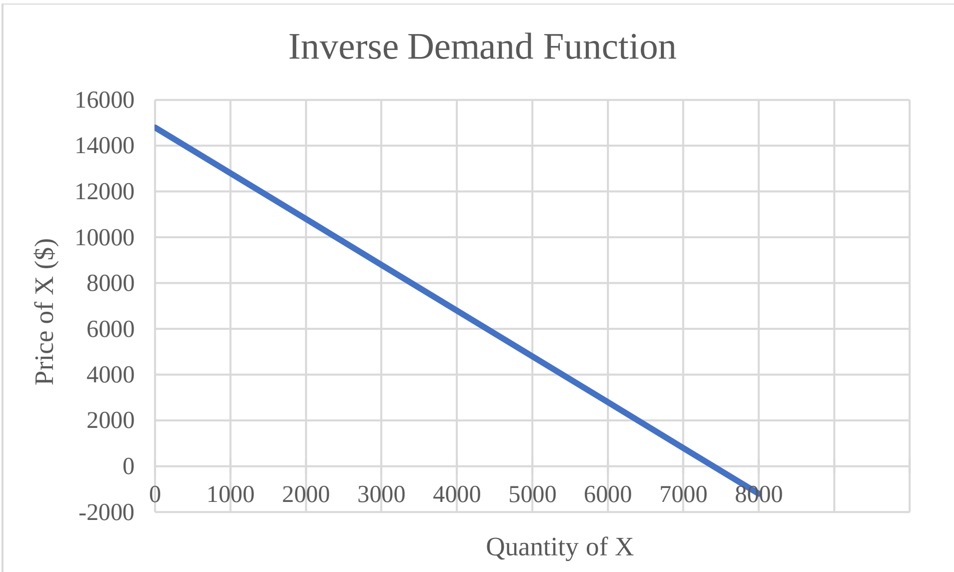
To find the inverse demand function, solve for the price P_X:

$Q_X^D = 7{,}400 - \frac{1}{2}P_X$

$\frac{1}{2}P_X = 7{,}400 - Q_X^D$

$P_X = 14{,}800 - 2Q_X^D$

The inverse demand function is graphed in the figure below:



Exercise 3:

The demand curve for product X us given by the following function:

$$Q_X^D = 300 - 2P_X$$

a) Find the inverse demand curve.

Solution 3a):

To find the inverse demand function, solve for the price P_X:

$Q_X^D = 300 - 2P_X$

$2P_X = 300 - Q_X^D$

$P_X = 150 - \frac{1}{2}Q_X^D$

b) How much consumer surplus (CS) of consumers receive when $P_X = \$45$?

Solution 3b):

Find quantity demand if $P_X = \$45$:

$Q_X^D = 300 - 2P_X$

$Q_X^D = 300 - 2 * 45$

$Q_X^D = 300 - 90$

$Q_X^D = 210$

<u>From 3a) we know that the vertical intercept of the inverse demand curve is 150.</u>

<u>The consumer surplus is calculated by:</u>

$CS = \frac{1}{2}\left[P_X^{\max} \quad - P_X\right] * Q_X^D$

$CS = \frac{1}{2}[150 - 45] * 210$

$CS = \frac{1}{2} * 105 * 210$

$CS = 52.5 * 210$

$CS = 11{,}025$

c) How much consumer surplus (CS) do consumers receive when $P_X = \$30$?

<u>Solution 3c):</u>

<u>Find quantity demand if $P_X = \$30$:</u>

$Q_X^D = 300 - 2P_X$

$Q_X^D = 300 - 2 * 30$

$Q_X^D = 300 - 60$

$Q_X^D = 240$

From 3a) we know that the vertical intercept of the inverse demand curve is 150.

The consumer surplus is calculated by:

$CS = \frac{1}{2}\left[P_X^{\max} \quad - P_X\right] * Q_X^D$

$CS = \frac{1}{2}[150 - 30] * 240$

$CS = \frac{1}{2} * 120 * 240$

$CS = 60 * 240$

$CS = 14{,}400$

d) In general, what happens to the level of consumer surplus (CS) as the price of a good falls?

Solution 3d):

So long as the law of demand holds, a decrease in price leads to an increase in consumer surplus, and vice versa.

In general, there is an inverse relationship between the price of a product and consumer surplus.

$$CS = \frac{1}{2}\left[P_X^{\max} \quad - P_X\right] * Q_X^D$$

If $P_X \uparrow \; \rightarrow \; Q_X^D \downarrow \; \rightarrow \; CS \downarrow$ If $P_X \downarrow \; \rightarrow \; Q_X^D \uparrow \; \rightarrow \; CS \uparrow$

Exercise 4:

Suppose the demand and supply are given by the following equations:

$$Q_X^D = 14 - \tfrac{1}{2}P_X \qquad \text{and} \qquad Q_X^S = \tfrac{1}{4}P_X - 1$$

a) Determine the equilibrium price (P_X^*) and quantity (Q_X^*)

<u>Solution 4a):</u>

<u>To find the equilibrium price set $Q_X^D = Q_X^S$ and solve for P_X</u>

$$Q_X^D = Q_X^S$$

$$14 - \frac{1}{2}P_X = \frac{1}{4}P_X - 1$$

$$\frac{1}{4}P_X + \frac{1}{2}P_X = 14 + 1$$

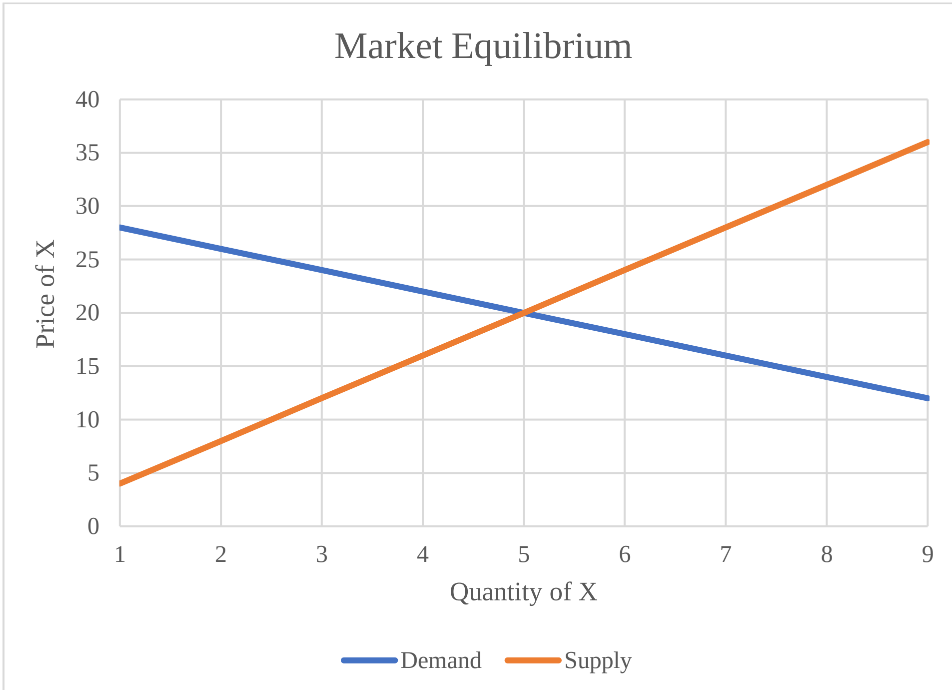
$$\frac{3}{4}P_X = 15$$

$$P_X^* = 20$$

<u>To find the equilibrium quantity, put P_X^* into the demand or supply function and solve for Q_X^*:</u>

Demand Function	Supply Function
$Q_X^D = 14 - \frac{1}{2}P_X^*$ $Q_X^D = 14 - \frac{1}{2}20$ $Q_X^D = 14 - 10$ $Q_X^* = 4$	$Q_X^S = \frac{1}{4}P_X^* - 1$ $Q_X^S = \frac{1}{4}20 - 1$ $Q_X^S = 5 - 1$ $Q_X^* = 4$

<u>The equilibrium is shown in the figure below:</u>



b) Suppose a $12 excise tax is imposed on the good. Determine the new equilibrium price and quantity

<u>Solution 4b):</u>

A $12 excise tax shifts the supply curve up by the amount of the tax.

Mathematically that means that the intercept of the inverse supply function increases by $12.

<u>Inverse supply function before tax:</u>

$Q_X^S = \frac{1}{4} P_X - 1$

$\frac{1}{4} P_X = 1 + Q_X^S$

$P_X = 4 + 4Q_X^S$

Inverse demand function after tax:

$P_X^{tax} = 4 + tax + 4Q_X^S$

$P_X^{tax} = 4 + 12 + 4Q_X^S$

$P_X^{tax} = 16 + 4Q_X^S$

After Tax quantity supplied:

$P_X^{tax} = 16 + 4Q_X^S$

$4Q_X^S = P_X - 16$

$Q_X^{S,tax} = \frac{1}{4}P_X - 4$

To find the new equilibrium price, we equate quantity demand to after-tax quantity supplied:

$$Q_X^D = Q_X^{S,tax}$$

$$14 - \frac{1}{2}P_X = \frac{1}{4}P_X - 4$$

$$\frac{1}{4}P_X + \frac{1}{2}P_X = 14 + 4$$

$$\frac{3}{4}P_X = 18$$

$$P_X^* = 24$$

To find the equilibrium quantity, put P_X^* into the demand or supply function and solve for Q_X^*:

Demand Function	Supply Function
$Q_X^D = 14 - \frac{1}{2}P_X^*$ $Q_X^D = 14 - \frac{1}{2}24$ $Q_X^D = 14 - 12$ $Q_X^{tax\,*} = 2$	$Q_X^{S,tax} = \frac{1}{4}P_X^* - 4$ $Q_X^{S,tax} = \frac{1}{4}24 - 4$ $Q_X^{S,tax} = 6 - 4$ $Q_X^{tax\,*} = 2$

c) How much tax revenue does the government earn with the $12 tax?

Solution 4c):

After imposing the tax, a total of $Q_X^{tax\,*} = 2$ units are sold.

With a tax rate of $12 per unit, total tax revenues (TR) are:

$TR = tax * Q_X^{tax\,*}$

$TR = 12 * 2$

$TR = 24$

Exercise 5:

Suppose the supply curve for product X is given by:

$$Q_X^S = -520 + 20P_X$$

a) Find the inverse supply curve.

Solution 5a):

Inverse supply curve:

$Q_X^S = -520 + 20P_X$

$20P_X = Q_X^S + 520$

$P_X = 26 + \frac{1}{20}Q_X^S$

b) How much surplus do producers receive when $Q_X^S = 400$ and $Q_X^S = 1{,}200$?

Solution 5b):

Producer Surplus (PS):

$$PS = \frac{1}{2}\left[P_X - P_X^{\min}\right] * Q_X^S$$

For $Q_X^S = 400$:	For $Q_X^S = 1{,}200$:
$PS = \frac{1}{2}\left[26 + \frac{1}{20} Q_X^S - P_X^{\min}\right] * Q_X^S$	$PS = \frac{1}{2}\left[26 + \frac{1}{20} Q_X^S - P_X^{\min}\right] * Q_X^S$
$PS = \frac{1}{2}\left[26 + \frac{1}{20} 400 - 26\right] * 400$	$PS = \frac{1}{2}\left[26 + \frac{1}{20} 1{,}200 - 26\right] * 1{,}200$
$PS = \frac{1}{2}[26 + 20 - 26] * 400$	$PS = \frac{1}{2}[26 + 60 - 26] * 1{,}200$
$PS = \frac{1}{2}[46 - 26] * 400$	$PS = \frac{1}{2}[86 - 26] * 1{,}200$
$PS = \frac{1}{2} 20 * 400$	$PS = \frac{1}{2} 60 * 1{,}200$
$PS = 4{,}000$	$PS = 36{,}000$

Problem Set 3

Exercise 1:

The demand curve for a product is given by the following:

$$Q_x^d = 1{,}200 - 3P_x - 0.1P_z \quad , where\ P_z = \$300$$

a) What is the own price elasticity of demand when $P_x = \$140$? Is the demand elastic or inelastic at this price? What would happen to the firm's revenue if it decided to charge a price below \$140?

Solution 1a):

Calculate quantity demand (Q_x^d) at the given prices:

$Q_x^d = 1{,}200 - 3P_x - 0.1P_z$

$Q_x^d = 1{,}200 - 3 * 140 - 0.1 * 300$

$Q_x^d = 1{,}200 - 420 - 30$

$Q_x^d = 750$

Own price elasticity of demand:

$$E_{Q_x,P_x} = \frac{\%\Delta Q_x}{\%\Delta P_x} = \frac{\partial Q_x^d}{\partial \Delta P_x} * \frac{P_x}{Q_x^d}$$

$$E_{Q_x,P_x} = -3 * \frac{P_x}{Q_x^d} = -3 * \frac{140}{750} = -0.56$$

Since the own-price elasticity is less than one in absolute terms, i.e., $|E_{Q_x,P_x}| = |-0.56| < 1$, demand is inelastic at this price.

If the firm charged a lower price, total revenue would decrease.

b) What is the own price elasticity of demand when $P_x = \$240$? Is demand elastic or inelastic at this price? What would happen to the firm's revenue if it decided to charge a price above $240?

Solution 1b):

Calculate quantity demand (Q_x^d) at the given prices:

$Q_x^d = 1{,}200 - 3P_x - 0.1P_z$

$Q_x^d = 1{,}200 - 3 * 240 - 0.1 * 300$

$Q_x^d = 1{,}200 - 720 - 30$

$Q_x^d = 450$

Own price elasticity of demand:

$$E_{Q_x,P_x} = \frac{\%\Delta Q_x}{\%\Delta P_x} = \frac{\partial Q_x^d}{\partial P_x} * \frac{P_x}{Q_x^d}$$

$$E_{Q_x,P_x} = -3 * \frac{P_x}{Q_x^d} = -3 * \frac{240}{450} = -1.6$$

Since the own-price elasticity is greater than one in absolute terms, i.e., $|E_{Q_x,P_x}| = |-1.6| < 1$, demand is elastic at this price.

If the firm charged a higher price, total revenue would decrease.

c) What is the cross-price elasticity of demand between good X and good Z when $P_x =$ $\$140$? Are goods X and Z substitutes or complements?

Solution 1c):

Calculate quantity demand (Q_x^d) at the given prices:

$Q_x^d = 1{,}200 - 3P_x - 0.1P_z$

$Q_x^d = 1{,}200 - 3 * 140 - 0.1 * 300$

$Q_x^d = 1{,}200 - 420 - 30$

$Q_x^d = 750$

Cross-price elasticity of demand:

$$E_{Q_x,P_z} = \frac{\%\Delta Q_x}{\%\Delta P_z} = \frac{\partial Q_x^d}{\partial P_z} * \frac{P_z}{Q_x^d}$$

$$E_{Q_x,P_z} = -0.1 * \frac{P_z}{Q_x^d} = -0.1 * \frac{300}{750} = -0.04$$

Since the cross-price elasticity is negative, i.e., $E_{Q_x,P_z} = -0.04 < 1$, goods X and Z are complements. This implies that if the price of good Z increases, the demand for good X decreases and vice versa.

Exercise 2:

Suppose the demand function for a firm's product is given by the following:

$$\ln Q_x^d = 7 - 1.5 \ln P_x + 2 \ln P_y - 0.5 \ln M + \ln A$$

, where $P_x = \$15$, $P_y = \$6$, $M = \$40{,}000$ (income) , and $A = \$350$ (advertising)

a) Determine the own price elasticity of demand, and state whether demand is elastic, inelastic, or unitary elastic.

Solution 2a):

Own price elasticity of demand:

The own price elasticity of demand is simply the coefficient of $\ln P_x$, which is:

$$E_{Q_x,P_x} = -1.5$$

Since the own price elasticity is greater than one in absolute terms, i.e., $|E_{Q_x,P_x}| = |-1.5| > 1$, demand is elastic.

b) Determine the cross-price elasticity of demand between good X and good Y, and state whether these two goods are substitutes or complements.

Solution 2b):

Cross-price elasticity of demand:

The cross-price elasticity of demand is simply the coefficient of $\ln P_y$, which is:

$$E_{Q_x,P_y} = 2$$

Since the cross-price elasticity is positive, goods X and Y are subtitutes. This implies that the demand for good Xwill increase as the price of good Yincreases, and vice versa.

c) Determine the income elasticity of demand, and state whether good X is a normal or inferior good.

Solution 2c):

Income elasticity of demand:

The income elasticity of demand is simply the coefficient of M, which is:

$$E_{Q_x,M} = -0.5$$

Since the income elasticity of demand is negative, good X is an inferior good. This implies that the demand for good X increases as income decreases, and vice versa.

d) Determine the own advertising elasticity of demand.

Solution 2d):

Advertising elasticity of demand:

The advertising elasticity of demand is simply the coefficient of A, which is:

$$E_{Q_x,A} = 1$$

The advertising elasticity of demand is positive, implying that an increase in advertising increases the demand for good X,

Exercise 3:

Suppose you are the manager of a firm that receives revenues of \$40,000 per year from product X and \$90,000 per year from product Y.

The own price elasticity of demand for product X is – 1.5 and the cross-price elasticity of demand between product Y and X is –1.8., i.e., $E_{Q_x,P_x} = -1.5$ and $E_{Q_x,P_y} = -1.8$

How much will your firm's revenues (i.e., revenues from both products) change if you increase the price of product X by 2%?

<u>Solution 3):</u>

<u>Firm's Total Revenues:</u>

$$\underline{TR = R_x + R_y}$$

$$\underline{TR = Q_x P_x + Q_y P_y}$$

<u>Change in Revenue Formula elasticity of demand:</u>

$$\Delta TR = [R_x * \left(1 + E_{Q_x,P_x}\right) + R_y * E_{Q_y,P_x}] * \frac{\Delta P_x}{P_x}$$

<u>Substitute given values:</u>

$$\Delta TR = \left[40{,}000 * \left(1 + (-1.5)\right) + \$90{,}000 * (-1.8)\right] * 0.02$$

$$\Delta TR = [40{,}000 - 60{,}000 - 162{,}000] * 0.02$$

$$\Delta TR = -3{,}640$$

A 2% increase in the price of good X would cause total revenues from both products to decrease by \$3,540.

Exercise 4:

A quant jock from your firm used a linear demand specification to estimate the demand for its product and sent you a hard copy of the results. Use the information presented below to answer the accompanying questions.

a) Based on these estimates, write an equation that summarizes the demand for the firm's product.

Solution 4a):

$$Q^d = \beta_0 + \beta_1\, x_1 + \beta_2\, x_2 + \cdots$$

$$Q^d = \beta_{intercept} + \beta_{price}\ Price_x + \beta_{income}\ Income$$

$$Q^d = 58.87 - 1.64P_x + 1.11M$$

b) Which regression coefficients are statistically significant at the 5 percent level?

Solution 4b):

Only the coefficients for the intercept and Income are statistically significant at the 5 percent level (or better), as the corresponding p-values are $0.00 < 0.05$

The coefficient for the price is statistically significant at the 10% level, as $p = 0.6 < 0.1$

c) Comment on how well the regression line fits the data

Solution 4c):

The R-Square (R^2) is quite low, indicating that the model explains only 14% of the total variation in demand for X. The adjusted R-Square is only marginally lower (13 percent), suggesting that the R-Square is not the result of an excessive number of estimated coefficients relative to the sample size.

The F-statistic, however, suggests that the overall regression is statistically significant at beterr that the 5 percent level.

Exercise 5:

The demand function for good X is given by the following:

$$\ln Q_x^d = a + b \ln P_x + c \ln M + e$$

, where P_x is the price of good X and M is income.

Least square regression reveals coefficient estimates of: $\hat{a} = 7.42$, $\hat{b} = -2.18$, and $\hat{c} = 0.34$.

a) If $M = 55{,}000$ and $P_x = 4.39$, compute the own price elasticity of demand based on these estimates. Determine whether demand is elastic or inelastic.

Solution 5a):

Own price elasticity of demand:

As in 2a), the own price elasticity of demand is simply the coefficient (estimate) of $\ln P_x$, which is:

$$E_{Q_x,P_x} = \hat{b} = -2.18$$

Since the own price elasticity is greater than one in absolute terms, i.e., $|E_{Q_x,P_x}| = |-2.18| > 1$, demand is elastic.

b) If $M = 55{,}000$ and $P_x = 4.39$, compute the income elasticity of demand based on these estimates. Determine whether good X is a normal or inferior good.

Solution 5b):

Income elasticity of demand:

As in 2c), the income elasticity of demand is simply the coefficient (estimate) of M, which is:

$$E_{Q_x,M} = \hat{c} = 0.34$$

Since the income elasticity of demand is positive, good X is a normal good. This implies that the demand for good X increases as income increases.

Exercise 6:

Suppose you are a division manager at Toyota. If your marketing department estimates that the semiannual demand for the Highlander is $Q_H^d = 150{,}000 - 1.5P_H$, what price should you charge in order to maximize revenues from sales of the Highlander?

<u>Solution 6):</u>

To maximize revenues, Toyota should charge the price that makes demand unit elastic.

Using the own price elasticity of demand, this implies that:

$$E_{Q_H,P_H} = \frac{\partial Q_H^d}{\partial P_H} * \frac{P_H}{Q_H^d} = -1$$

$$E_{Q_H,P_H} = -1.5 * \frac{P_H}{(150{,}000 - 1.5P_H)} = -1$$

Now, solving for P_H:

$$-1.5 * \frac{P_H}{(150{,}000 - 1.5P_H)} = -1$$

$$-1.5\ P_H = -1\ (150{,}000 - 1.5P_H)$$

$$-1.5\ P_H = -150{,}000 + 1.5\ P_H$$

$$-3\ P_H = -150{,}000$$

$$P_H^* = 50{,}000$$

Thus, in order to maximize revenues from the sales of the Highlander, Toyota should charge a price of $50,000

Problem Set 4

Exercise 1:

A firm can manufacture a product according to the following production function:

$$Q = F(K, L) = K^{\frac{3}{4}} * L^{\frac{1}{4}}$$

a) Calculate the average product of labor (AP_L), when the level of capital (K) is fixed at $K = 81$ units and the firm uses 16 units of labor ($L = 16$). How does the average product of labor change when the firm uses 256 units of labor?

Solution 1a):

Average product of Labor:

$$AP_L = \frac{Q}{L} = \frac{F(K, L)}{L}$$

a.1) For $K = 81 \quad and \quad L = 16$

$$AP_L = \frac{K^{\frac{3}{4}} * L^{\frac{1}{4}}}{L} = \frac{81^{\frac{3}{4}} * 16^{\frac{1}{4}}}{16}$$

$$AP_L = \frac{27 * 2}{16} = \frac{54}{16}$$

$$AP_L = 3.375$$

Thus, on average, one worker produces 3.375 units of output.

a.2) For $K = 81 \quad and \quad L = 256$

$$AP_L = \frac{K^{\frac{3}{4}} * L^{\frac{1}{4}}}{L} = \frac{81^{\frac{3}{4}} * 256^{\frac{1}{4}}}{256}$$

$$AP_L = \frac{27 * 2}{256} = \frac{54}{256}$$

$$AP_L = 0.422$$

If the firm uses 256 units of labor, on average, one worker produces 0.422 units of output.

b) Find an expression for the marginal product of labor (MP_L), when the amount of capital is fixed at 81 units. Then, illustrate that the marginal product of labor depends on the amount of labor hired by calculating the marginal product of labor for $L = 16$ and $L = 81$ units of labor.

Solution 1b):

Marginal product of Labor:

$$MP_L = \frac{\partial Q}{\partial L} = \frac{\partial F(K,L)}{\partial L}$$

$$MP_L = \frac{\partial \, [K^{\frac{3}{4}} * L^{\frac{1}{4}}]}{\partial L}$$

$$MP_L = \frac{1}{4} * K^{\frac{3}{4}} * L^{-\frac{3}{4}}$$

a.1) For $K = 81 \quad and \quad L = 16$

$$MP_L = \frac{1}{4} * K^{\frac{3}{4}} * L^{-\frac{3}{4}}$$

$$MP_L = \frac{1}{4} * 81^{\frac{3}{4}} * 16^{-\frac{3}{4}}$$

$$MP_L = \frac{1}{4} * 27 * 0.125$$

$$MP_L = 0.844$$

Thus, with $K = 81 \quad and \quad L = 16$, adding one more unit labor increases output by 0.844.

a.2) For $K = 81 \quad and \quad L = 81$

$$MP_L = \frac{1}{4} * K^{\frac{3}{4}} * L^{-\frac{3}{4}}$$

$$MP_L = \frac{1}{4} * 81^{\frac{3}{4}} * 81^{-\frac{3}{4}}$$

$$MP_L = \frac{1}{4} * 27 * 0.04$$

$$MP_L = 0.25$$

Thus, with $K = 81 \quad and \quad L = 81$, adding one more unit labor increases output by 0.25.

c) Suppose capital is fixed at 81 units. If the firm can sell its output at a price of $200 per unit of output and can hire labor at $50 per unit of labor, how many units of labor should the firm hire in order to maximize profits?

Solution 1c):

Value Marginal Product:

Labor: $VMP_L = P * MP_L$ → *benefit to the firm from each unit of labor*

Capital: $VMP_K = P * MP_K$ → *benefit to the firm from each unit of capital*

Equate VMP_L with wage ($w = 50$):

$$VMP_L = P * MP_L = w$$

$$P * \frac{1}{4} * K^{\frac{3}{4}} * L^{-\frac{3}{4}} = w$$

$$200 * \frac{1}{4} * 81^{\frac{3}{4}} * L^{-\frac{3}{4}} = 50$$

$$200 * \frac{1}{4} * 27 * L^{-\frac{3}{4}} = 50$$

$$200 * 6.75 * L^{-\frac{3}{4}} = 50$$

$$1{,}350 * L^{-\frac{3}{4}} = 50$$

$$L^{-\frac{3}{4}} = \frac{50}{1{,}350}$$

$$\frac{1}{\sqrt[4]{L^3}} = \frac{50}{1{,}350}$$

$$\frac{1}{\frac{50}{1{,}350}} = \sqrt[4]{L^3}$$

$$L^3 = \left[\frac{1}{\frac{50}{1{,}350}}\right]^4$$

$$L = \sqrt[3]{\left[\frac{1}{\frac{50}{1{,}350}}\right]^4}$$

$$L = 81$$

Thus, hiring 81 units of labor maximizes the firm's profits.

Exercise 2:

Explain the difference between the law of diminishing marginal returns and the law of diminishing marginal rate of substitution.

Solution 2):

Law of Diminishing Marginal Returns:

➔ Marginal productivity declines due to increased input usage, holding all inputs constant.

Marginal Rate of Technical Substitution (MRTS):

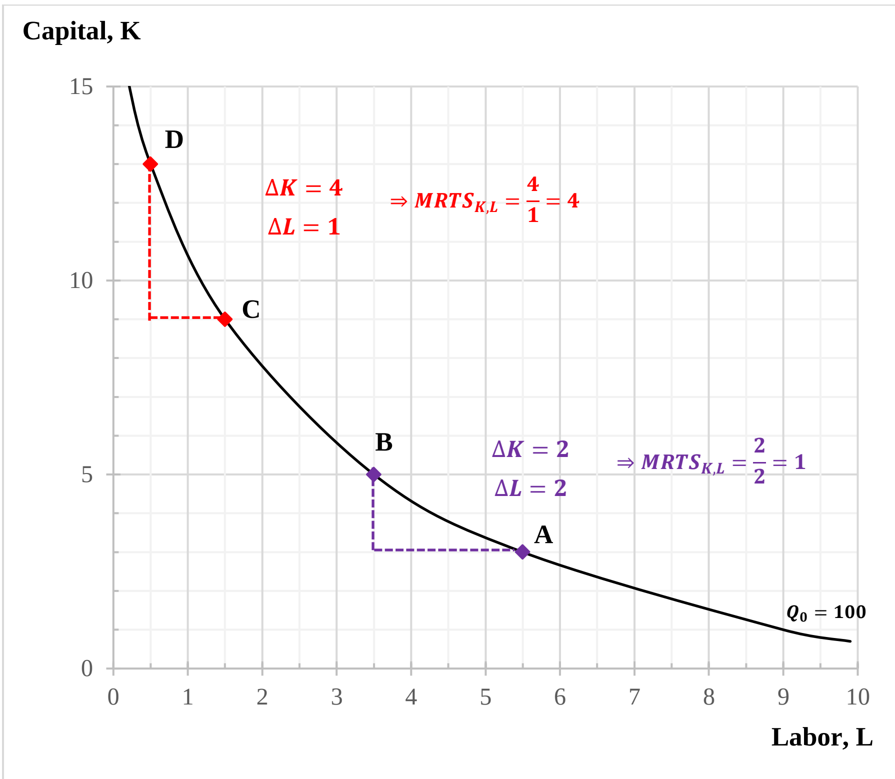
➔ The rate at which a producer can substitute between two inputs and maintain the same level of output

$$MRTS_{K,L} = \frac{MP_L}{MP_K}$$

Law of diminishing Marginal Rate of Technical Substitution (MRTS):

➔ When a producer uses less of an input, increasingly more of the other input must be employed to produce the same level of output

Marginal Rate of Technical Substitution (MRTS):



- ***A → B*:**
  - ➢ The producer substitutes 2 units of capital (K) for 2 units of labor (L) and still produces a total quantity of $Q_0 = 100$

- ***C → D*:**
  - ➢ The producer has to substitute 4 units of capital (K) for one unit of labor (L) to maintain $Q_0 = 100$

Exercise 3:

An economist estimated that the cost function of a single-product firm is:

$$C(Q) = 100 + 20Q + 15Q^2 + 10Q^3$$

Based on this information, determine:

a) The fixed cost of producing 10 units of output.

Solution 3a):

Fixed Cost:

$$FC(Q) = 100$$

$$FC(10) = 100$$

b) The variable cost of producing 10 units of output.

Solution 3b):

Variable Cost:

$$VC(Q) = 20Q + 15Q^2 + 10Q^3$$

$$VC(10) = 20 * 10 + 15 * 10^2 + 10 * 10^3$$

$$VC(10) = 200 + 1{,}500 + 10{,}000$$

$$VC(10) = 11{,}700$$

c) The total cost of producing 10 units of output.

Solution 3c):

Total Cost:

$$TC(Q) = FC(Q) + VC(Q)$$

$$TC(Q) = 100 + 20Q + 15Q^2 + 10Q^3$$

$$TC(10) = 100 + 11{,}700$$

$$TC(10) = 11{,}800$$

d) The average fixed cost of producing 10 units of output.

Solution 3d):

Average Fixed Cost:

$$AFC(Q) = \frac{FC(Q)}{Q}$$

$$AFC(10) = \frac{100}{10}$$

$$AFC(10) = 10$$

e) The average variable costr5 of producing 10 units of output.

Solution 3e):

Average Variable Cost:

$$AVC(Q) = \frac{VC(Q)}{Q}$$

$$AVC(Q) = \frac{20Q + 15Q^2 + 10Q^3}{Q}$$

$$AVC(10) = \frac{11{,}700}{10}$$

$$AVC(10) = 1{,}170$$

f) The average total cost of producing 10 units of output.

Solution 3f):

Average Total Cost:

$$ATC(Q) = \frac{TC(Q)}{Q}$$

$$ATC(Q) = \frac{100 + 20Q + 15Q^2 + 10Q^3}{Q}$$

$$ATC(10) = \frac{11{,}800}{10}$$

$$ATC(10) = 1{,}180$$

g) The marginal cost when $Q = 10$.

<u>Solution 3g):</u>

<u>Marginal Cost:</u>

$$MC(Q) = \frac{\partial\, TC(Q)}{\partial\, Q}$$

$$MC(Q) = 20 + 30Q + 30Q^2$$

$$MC(10) = 20 + 30 * 10 + 30 * 10^2$$

$$MC(10) = 20 + 300 + 3{,}000$$

$$MC(10) = 3{,}320$$

Exercise 4:

A multi-product firm's cost function was recently estimates as the following:

$$C(q_1, q_2) = 90 - 0.5q_1q_2 + 0.4q_1^2 + 0.3q_2^2$$

a) Are there economies of scope in producing 10 units of product 1 and 10 units of product 2 ($q_1 = q_2 = 10$)?

Solution 4a):

Economies of Scope:

- A firm's unit cost to produce a product will decline as the variety of its products increases.
- Economies of scope exist when the total cost of producing q_1 and q_2 together is less than producing q_1 and q_2 separately.

$$C(q_1, 0) + C(0, q_2) > C(q_1, q_2)$$

$$C(q_1, 0) + C(0, q_2) - C(q_1, q_2) > 0$$

$$f + (q_1)^2 + f + (q_2)^2 - [f + \alpha\, q_1q_2 + (q_1)^2 + (q_2)^2] > 0$$

$$f + \alpha\, q_1q_2 > 0$$

For $q_1 = q_2 = 10$

$$f + \alpha\, q_1 q_2 > 0$$

$$90 - 0.5\, q_1 q_2 > 0$$

$$90 - 0.5 * 10 * 10 > 0$$

$$90 - 50 > 0$$

$$40 > 0$$

Yes, economies of scope exist when producing 10 units of both products, as total cost of producing both products together is less than producing them separately.

b) Are there cost complementarities in producing products 1 and 2?

Solution 4b):

Cost Complementarity:

➔ Exists when the marginal cost of producing one unit of output is reduced when the output of another product is increased.

$$\frac{\partial\, MC_1(q_1, q_2)}{\partial\, q_2} < 0$$

Marginal Cost of product1:

$$MC_1(q_1, q_2) = \frac{\partial\, C(q_1, q_2)}{\partial\, q_1} = -0.5q_2 + 0.8q_1$$

$$\frac{\partial\, MC_1(q_1, q_2)}{\partial\, q_2} = -0.5 < 0$$

Yes, there are cost complementarities. An increase in q_2 reduces the marginal cost of producing product 1.

c) Suppose the division selling product 2 is floundering and another company has made an offer to buy the exclusive rights to produce product 2. How would the sale of the rights to produce product 2 change the firm's marginal cost of producing product 1?

<u>Solution 4c):</u>

<u>Marginal Cost of product1 with $q_2 = 0$:</u>

$$MC_1(q_1, 0) = \frac{\partial\, C(q_1, 0)}{\partial\, q_1} = 0.8q_1$$

<u>Compare marginal cost of product 1 before and after.</u>

$$MC_1(q_1, q_2) < MC_1(q_1, 0)$$

If the division sales the rights of producing product 2, then the marginal cost of producing product 1increases.

Exercise 5:

Explain the difference between fixed costs, sunk costs, and variable costs. Provide an example that illustrates that these costs are, in general, different.

Solution 5):

- **Fixed costs** are associated with fixed inputs and do not change when output changes.
- **Variable costs** are costs associated with variable inputs and do change when output changes.
- **Sunk costs** are costs that are forever lost once they have been paid.

Problem Set 5

Exercise 1:

Explain the difference between transaction costs and opportunity costs.

Solution 1):

Transaction Cost:

Transaction costs are the cost in excess of the actual amount paid to the supplier, including the costs of locating a seller, negotiating a price and putting the product to use.

Opportunity Cost:

Opportunity costs are the potential benefits an individual has forgone when making a choice over alternatives.

Exercise 2:

If you are a PhD supervisor, how are you going to design a solution to make your PhD student work hard? (Hint: Consider it as a principle-agent problem)

Solution 2):

One possible way is to link the PhD student's salary/bonus with the outputs of journal publications, conference papers, etc.

Exercise 3:

Consider an industry that has eight firms with the following market share percentages: 20%, 20%, 16%, 16%, 9%, 8%, 6%, and 5%.

a) Calculate the four-firm concentration ratio for this industry.

<u>Solution 3a):</u>

<u>Four-Firm Concentration Ratio:</u>

$$CR_4 = \frac{S_1 + S_2 + S_3 + S_4}{S_T}$$

, where $S_1, S_2, S_3, and\ S_4$ are the sales of the largest 4 firms and S_T are the total sales in the market

$$CR_4 = w_1 + w_2 + w_3 + w_4$$

, where $w_1, w_2, w_3, and\ w_4$ are the market shares of the largest 4 firms

<u>Identify market shares of largest firms and apply formula:</u>

$CR_4 = w_1 + w_2 + w_3 + w_4$

$CR_4 = 0.2 + 0.2 + 0.16 + 0.16$

$CR_4 = 0.72$

➔ The 4 largest firms account for 72% of total industry output

b) Calculate the Herfindahl-Hirschman index for this industry.

<u>Solution 3b):</u>

<u>Herfindahl-Hirschman Index (HHI):</u>

$$\mathrm{HHI} = 10{,}000 * \sum_{i}^{n} w_i^2$$

, where w_i is the market share of firm i.

- ➔ *Multiply by 10,000 to eliminate the need of decimals*
- ➔ *By squaring the market shares before adding them up, the index weights firms with high market shares more heavily*

<u>Identify market shares of largest firms and apply formula:</u>

$$\mathrm{HHI} = 10{,}000 * \left[\left(\frac{20}{100}\right)^2 + \left(\frac{20}{100}\right)^2 + \left(\frac{16}{100}\right)^2 + \left(\frac{16}{100}\right)^2 + \left(\frac{9}{100}\right)^2 + \left(\frac{8}{100}\right)^2 + \left(\frac{6}{100}\right)^2 + \left(\frac{5}{100}\right)^2\right]$$

$$\mathrm{HHI} = 10{,}000 * [0.04 + 0.04 + 0.0256 + 0.0256 + 0.0081 + 0.0064 + 0.0036 + 0.0025]$$

$$\mathrm{HHI} = 10{,}000 * 0.1518$$

$$\mathrm{HHI} = 1{,}518$$

c) Discuss the Pros and Cons for each of the two measures for market structure.

Solution 3a):

Four-Firm Concentration Ratio:

Pros: Does not need the information of all firms

Cons: Might not capture the overall picture of the industry

Herfindahl-Hirschman Index (HHI):

Pros: Covers all firms and the weights for larger firms are higher to capture the market structure better

Cons: It might not be easy to get the information of all firms in the industry

Exercise 4:

Let a firm's total cost function be: $TC(Q) = 800 + 8Q + 8Q^2$

The firm's marginal cost is given by: $MC(Q) = 8 + 16Q$

a) Derive an expression for the firm's average cost function.

Solution 4a):

Average Cost Function:

$$AC(Q) = \frac{TC(Q)}{Q}$$

$$AC(Q) = \frac{800 + 8Q + 8Q^2}{Q}$$

$$AC(Q) = \frac{1}{Q}800 + 8 + 8Q$$

b) Find the range of production characterized by economies of scale.

Solution 4b):

Economies of Scale:

- ➔ Economies of scale is the phenomenon where the cost per unit of production decreases as the scale (output) of production increases.
- ➔ Therefore, economies of scale exist if the marginal cost is lower than the average cost, i.e., $MC(Q) < AC(Q)$. That is, if $MC(Q) < AC(Q)$, then the average cost of the firm are decreasing.

Set marginal cost equal to average cost and solve for Q:

$$MC(Q) = AC(Q)$$

$$8 + 16Q = \frac{1}{Q}800 + 8 + 8Q$$

$$16Q = \frac{1}{Q}800 + 8Q$$

$$16Q^2 = 800 + 8Q^2$$

$$16Q^2 - 8Q^2 = 800$$

$$8Q^2 = 800$$

$$Q^2 = 100$$

$$Q = 10$$

- ➔ Thus, for $0 < Q < 10$ the condition of $MC(Q) < AC(Q)$ holds and there exists economies of scale.

c) Do you think the economies of scale constitute a serious barrier to entry into the industry? Explain your reasoning.

<u>Solution 4c):</u>

This will depend on the demand of the industry.

If the demand is much larger (relative to 10), the economies of scale do not constitute a serious barrier to entry.

Otherwise, there will be an entry barrier due to the economies of scale.

Exercise 5:

Use the externality concept you learned from class to explain why everyone gets the Covid-19 vaccine for free.

<u>Solution 5):</u>

The Covid-19 vaccine is considered a positive externality. That is, its widespread adoption not only benefits individuals (by reducing their risk of infection) but also benefits society as a whole by lowering the overall transmission of the virus.

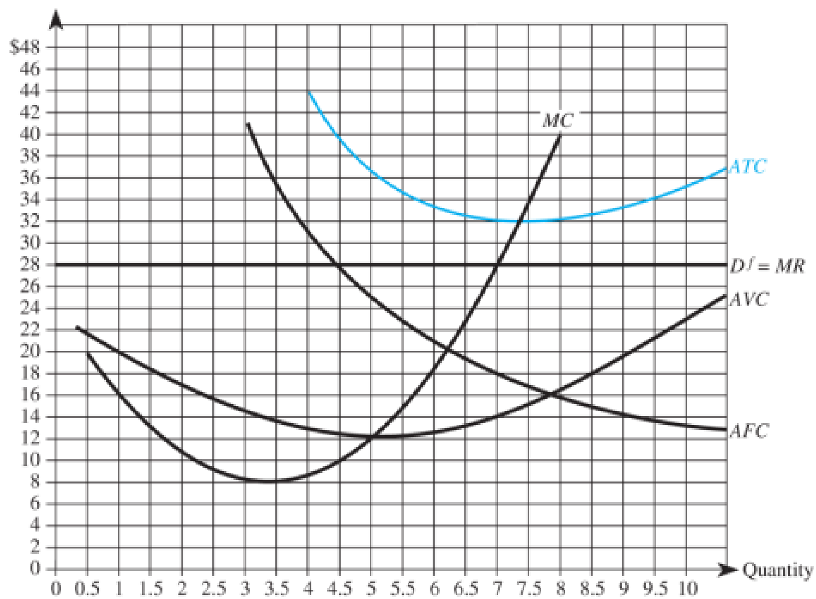
With a positive externality, the market equilibrium quantity would be less than the social optimum.

Therefore, to internalize the externality, the government will need to provide a subsidy to increase vaccination.

Problem Set 6

Exercise 1:

The following graph summarizes the demand and costs for a firm that operates in a perfectly competitive market:



a) What level of output should this firm produce in the short run?

Solution 1a):

In the short run, the firm produces (maximizes profits) at the point where the marginal cost are equal to the marginal revenue, i.e., $MC = MR$

This occurs at a quantity of $Q = 7$ units.

b) What price should this firm charge in the short run?

Solution 1b):

In the short run the firm produces where $MC = MR$. Hence, the firm should charge a price of $P = \$28 = D^f = MR$.

c) What is the firm's total cost at this level of output?

Solution 1c):

Total Costs:

The total cost is the sum of fixed costs and variable cost.

At a quantity of $Q = 7$ (short term equilibrium) the average fixed cost are $AFC(7) = 14$ and average variable cost are: $AVC(7) = 18$.

Thus, the total cost are:

$$TC(Q) = FC(Q) + VC(Q)$$

$$TC(Q) = Q * AFC(Q) + Q * AVC(Q)$$

$$TC(7) = 7 * 14 + 7 * 18$$

$$TC(7) = 98 + 126$$

$$TC(7) = 224$$

d) What is the firm's total variable cost at this level of output?

Solution 1d):

Variable Cost:

$$VC(Q) = Q * AVC(Q)$$

In the short term, the firm produces $Q = 7$ units of output:

$$VC(7) = 7 * 14$$

$$VC(7) = 98$$

e) What is the firm's fixed cost at this level of output?

Solution 1e):

Fixed Cost:

The fixed cost are given by the difference between total cost and variable cost:

$$FC = TC(Q) - VC(Q)$$

The optimal output level is $\mathrm{Q}^* = 7$ (solution 1a):

$$\mathrm{FC} = \mathrm{TC}(7) - \mathrm{VC}(7)$$

$$\mathrm{FC} = 224 - 98$$

$$\mathrm{FC} = 126$$

f) What is the firm's profit if it produces this level of output?

Solution 1f):

Profits:

$$\pi(Q^*) = R(Q^*) - TC(Q^*)$$

$$\pi(Q^*) = p * Q^* - [FC + VC(Q^*)]$$

$$\pi(7) = 28 * 7 - 224$$

$$\pi(7) = 196 - 224$$

$$\pi(7) = -28$$

The firm is earning a loss of $28, i.e., it incurs negative profits.

g) What is the firm's profit if it shuts down?

Solution 1g):

If the firm shuts down it will not produce any output. Hence, the firm's revenues and variable cost will be equal to zero. However, the firm still faces fixed costs of $\mathrm{FC} = 126$

$$\pi(0) = R(0) - TC(0)$$

$$\pi(0) = R(0) - [FC + VC(0)]$$

$$\pi(0) = 0 - 126 - 0$$

$$\pi(0) = -126$$

Thus, when shutting down, the firm will incur losses equal to its fixed costs.

h) In the long run, should this firm continue to operate or shut down?

<u>Solution 1h):</u>

In the long term the firm should shut down, as it incurs negative profits.

Exercise 2:

A firm sells its product in a perfectly competitive market where other firms charge a price of \$90 per unit. The firm's total costs are given by:

$$C(Q) = 50 + 10Q + 2Q^2$$

a) How much output should the firm produce in the short run?

<u>Solution 2a):</u>

<u>Marginal Revenue:</u>

$$MR(Q) = \frac{\partial R(Q)}{\partial Q} = \frac{\partial (Q * p)}{\partial Q} = p = 90$$

<u>Marginal Cost</u>

$$MC = \frac{\partial C(Q)}{\partial Q} = 10 + 4Q$$

Optimal Output:

Optimal output occurs where the marginal cost are equal to the marginal revenue, i.e., $MC = MR$

$$MC = MR$$

$$10 + 4Q = 90$$

$$4Q = 80$$

$$Q^{*} = 20$$

b) What price should the firm charge in the short run?

Solution 2b):

In the short run, the firm should charge the market price of \$90 per unit. This is equal to the form's marginal revenue.

c) What are the firm's short-run profits?

Solution 2c):

Profits:

$$\pi(Q^*) = R(Q^*) - C(Q^*)$$

$$\pi(Q^*) = Q^* * p - [50 + 10Q^* + 2Q^{*2}]$$

$$\pi(20) = 20 * 90 - [50 + 10 * 20 + 2 * 20^2]$$

$$\pi(20) = 1800 - [50 + 200 + 800]$$

$$\pi(20) = 1800 - 1050$$

$$\pi^*(20) = 750$$

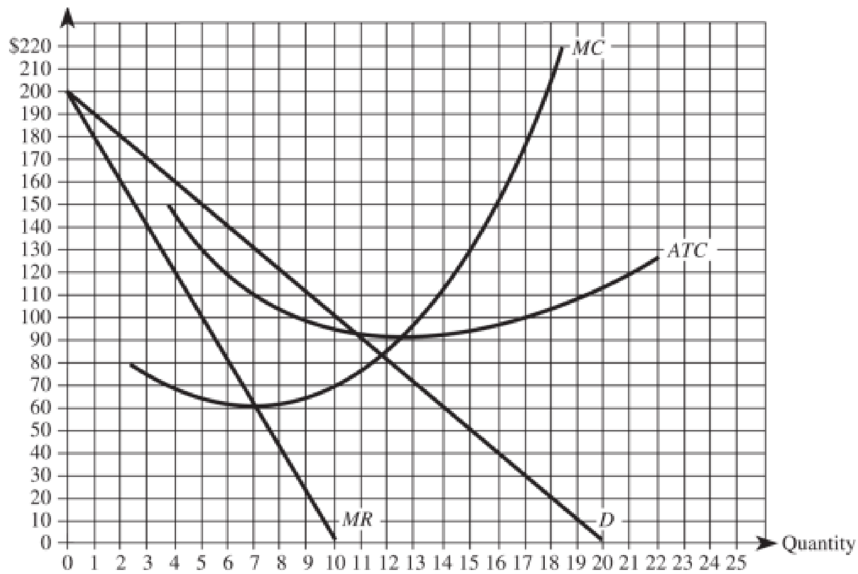
d) What adjustments should be anticipated in the long run?

Solution 2d):

The firm needs to anticipate that in the long-run, new firms will enter the market, i.e., entry will occur. Consequently, the market market price will fall and the firm should plan to reduce its output. In the long-run, the firm's economic profits will shrink to zero.

Exercise 3:

The following graph summarizes the demand and costs for a firm that operates in a monopolistically competitive market:



a) What is the firm's optimal output?

Solution 3a):

The monopolistic firm will produce at the point where the marginal cost are equal to the marginal revenue, i.e., $MC = MR$

This occurs at a quantity of $Q^M = 7$ units.

b) What is the firm's optimal price?

Solution 3b):

At a quantity of $Q^M = 7$ the monopolistic firm will charge a price of $p^M = \$130$. Executing its market power, the firm will charge a price equal to the demand function at the firm's optimal quantity, i.e., $p^M = D(Q^M)$.

c) What are the firm's maximum profits?

Solution 3c):

Profits:

$$\pi^M(Q^M) = R(Q^M) - C(Q^M)$$

$$\pi^M(Q^M) = p^M * Q^M - ATC(Q^M) * Q^M$$

$$\pi^M(7) = 130 * 7 - 110 * 7$$

$$\pi^M(7) = 910 - 770$$

$$\pi^M(7) = 140$$

d) What adjustments should the manager be anticipating?

Solution 3d):

In the long-term, new firms will enter the market, i.e., monopolistically competitive market. Thus, the firm's demand will decrease over time and it's economic profits will shrink to zero.

Exercise 4:

Suppose you are the manager of a monopoly, and your demand and cost functions are given by the following:

Demand: $P(Q) = 300 - 3Q$

Cost: $C(Q) = 1{,}500 + 2Q^2$

a) What price-quantity combination maximizes your firm's profits?

<u>Solution 4a):</u>

<u>Revenues:</u>

$$R(Q) = P(Q) * Q$$

$$R(Q) = (300 - 3Q) * Q$$

$$R(Q) = 300Q - 3Q^2$$

<u>Marginal Revenue:</u>

$$MR(Q) = \frac{\partial R(Q)}{\partial Q} = 300 - 6Q$$

<u>Marginal Cost</u>

$$MC = \frac{\partial C(Q)}{\partial Q} = 4Q$$

Optimal Output:

Optimal output occurs where $MC = MR$

$$MC = MR$$

$$4Q = 300 - 6Q$$

$$10Q = 300$$

$$Q^* = 30$$

Optimal Price:

$$P^*(Q^*) = 300 - 3Q^*$$

$$P^*(30) = 300 - 3 * 30$$

$$P^*(30) = 210$$

b) Calculate the maximum profits.

Solution 4b):

Profits:

$$\pi(Q^*) = R(Q^*) - C(Q^*)$$

$$\pi(Q^*) = P^* * Q^* - C(Q^*)$$

$$\pi(30) = 210 * 30 - [1{,}500 + 2 * 30^2]$$

$$\pi(30) = 6{,}300 - 3{,}300$$

$$\pi(30) = 3{,}000$$

c) Is demand elastic, inelastic, or unit elastic at the profit-maximizing price-quantity combination?

Solution 4c):

Demand:

$$P(Q) = 300 - 3Q \;\Leftrightarrow\; Q(P) = 100 - \tfrac{1}{3}P$$

Price elasticity of demand:

$$E_{Q,P} = \frac{\partial Q(P)}{\partial P} * \frac{P}{Q}$$

$$E_{Q,P} = -\frac{1}{3} * \frac{P^*}{Q^*}$$

$$E_{Q,P} = -\frac{1}{3} * \frac{210}{30}$$

$$E_{Q,P} = -\frac{70}{3}$$

Since the price elasticity is greater than one in absolute terms, i.e. $|E_{Q,P}| = \left|-\frac{70}{3}\right| > 1$, demand is elastic.

d) What price-quantity combination maximizes revenue?

Solution 4d):

Revenues are maximized when the firm's marginal revenues are equal to zero:

Revenue maximizing output:

$$MR(Q) = 300 - 6Q = 0$$

$$6Q = 300$$

$$Q^{**} = 50$$

Revenue maximizing price:

$$P(Q^{**}) = 300 - 3 * Q^{**}$$

$$P(50) = 300 - 3 * 50$$

$$P^{**} = 150$$

e) Calculate the maximum revenues.

Solution 4e):

Maximum Revenues:

$$R(Q^{**}) = P^{**} * Q^{**}$$

$$R(50) = 150 * 50$$

$$R(50) = 7{,}500$$

f) Is demand elastic, inelastic, or unit elastic at the revenue-maximizing price-quantity combination?

Solution 4f):

Demand:

$$P(Q) = 300 - 3Q \;\Leftrightarrow\; Q(P) = 100 - \tfrac{1}{3}P$$

Price elasticity of demand:

$$E_{Q,P} = \frac{\partial Q(P^{**})}{\partial P} * \frac{P^{**}}{Q^{**}}$$

$$E_{Q,P} = -\frac{1}{3} * \frac{150}{50}$$

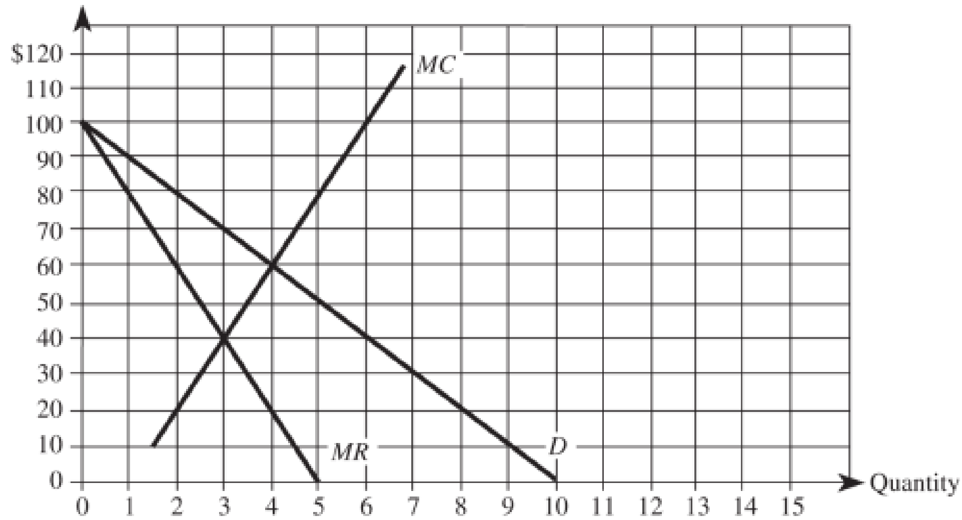
$$E_{Q,P} = -\frac{1}{3} * 3$$

$$E_{Q,P} = -1$$

Since the price elasticity is equal to one in absolute terms, i.e. $|E_{Q,P}| = |-1| = 1$, demand is unit elastic.

Exercise 5:

The accompanying diagram shows the demand, marginal revenue, and marginal cost of a monopolist:



a) Determine the profit-maximizing output and price.

Solution 5a):

The monopolistic firm will produce at the point where the marginal cost are equal to the marginal revenue, i.e., $MC = MR$

This occurs at a quantity of $Q^M = 3$ units.

At a quantity of $Q^M = 3$ the monopolistic firm will charge a price of $p^M = \$70$. Executing its market power, the firm will charge a price equal to the demand function at the firm's optimal quantity, i.e., $p^M = D(Q^M)$.

b) What price and output would prevail if this firm's product were sold by price-taking firms in a perfectly competitive market?

Solution 5b):

Under perfect competition, the market equilibrium will occur where the supply curve and demand curve intersect, i.e. where $MC = D$:

Thus, under perfect competitive market conditions, the firm would produce $Q^* = 4$ units with a market price of $P^* = 60$.

c) Calculate the deadweight loss of this monopoly.

Solution 5c):

Deadweight Loss (DWL):

$$DWL = \frac{1}{2}[(70 - 40) * (5 - 4)]$$

$$DWL = \frac{1}{2}[30 * 1]$$

$$DWL = 15$$

1.

Suppose the demand for good x is $\ln Q_x^d = 21 - 0.8 \ln P_x - 1.6 \ln P_y + 6.2 \ln M + 0.4 \ln A_x$. Then we know good x is:

- an inferior good.
- an elastic good.
- → a normal good.
- a Giffen good.

2.

Net benefits in the table:

Control variable	Total Benefits	Total Costs	Net Benefits	Marginal Benefit	Marginal Cost	Marginal Net Benefit
Q	B(Q)	C(Q)	N(Q)	MB(Q)	MC(Q)	MNB(Q)
0	0	0	0	-	-	-
1	900	100	800	900	100	800
2	1,700	300	C	800	200	600
3	2,400	600	1,800	700	E	400
4	A	1,000	2,000	600	400	200
5	3,500	1,500	2,000	500	500	F
6	3,900	2,100	1,800	D	600	-200
7	4,200	2,800	1,400	300	700	-400
8	4,400	B	800	200	800	-600
9	4,500	4,500	0	100	900	-800
10	4,500	5,500	-1,000	0	1,000	-1,000

- → initially increase, reach a maximum, and then decrease.
- initially decrease, reach a minimum, and then increase.
- remain relatively stable over different values for the control variable.
- initially remain relatively stable and then decrease.

3.

If the own price elasticity of demand is infinite in absolute value, then:

- demand is perfectly inelastic.
- → the demand curve is horizontal.
- consumers do not respond at all to changes in price.
- demand is neither perfectly inelastic nor is the demand curve horizontal.

4.

An ad valorem tax shifts the supply curve

- ○ down by the amount of the tax.
- ○ up by the amount of the tax.
- → ○ by rotating it counter-clockwise.
- ○ by rotating it clockwise.

5.

If the demand function for a particular good is $Q = 25 - 10P$, then the price elasticity of demand (in absolute value) at a price of $1 is:

- ○ 8.
- ○ 2.
- → ○ 2/3.
- ○ 1/8.

6.

Suppose total benefits and total costs are given by $B(Y) = 100Y - 8Y^2$ and $C(Y) = 10Y^2$. Then marginal benefits are:

- → ○ $100 - 16Y$.
- ○ $100Y - 8Y^2$.
- ○ $50 - 4Y$.
- ○ $200Y - 10Y$.

7.

Suppose the own price elasticity of demand for good X is −0.5, and the price of good X increases by 10 percent. We would expect the quantity demanded of good X to:

- ○ increase by 5 percent.
- ○ increase by 20 percent.
- → ○ decrease by 5 percent.
- ○ decrease by 20 percent.

8.

If the interest rate is 5 percent, $100 received at the end of seven years is worth how much today?

- ○ $100/(0.05)^7$
- → ○ $100/(1 + 0.05)^7$
- ○ $100/(1 + 5)^7$
- ○ 100

9.

Which of the following is probably not a normal good?

- ○ Designer jeans.
- ○ Diamond rings.
- → ○ Intercity passenger bus travel.
- ○ New automobiles.

10.

Suppose supply decreases and demand increases. What effect will this have on the quantity?

- ○ It will fall.
- ○ It will rise.
- → ○ It may rise or fall.
- ○ It will remain the same.

11.

If the interest rate is 5 percent, the present value of $200 received at the end of five years is:

- ○ $121.34.
- → ○ $156.71.
- ○ $176.41.
- ○ $132.62.

12.

New firms have incentive to enter an industry when there is(are):

- ○ new production technologies.
- → ○ positive economic profits.
- ○ an abundance of labor.
- ○ high capital costs.

13.

In a competitive market, the market demand is $Q^d = 70 - 3P$ and the market supply is $Q^s = 6P$. A price ceiling of $4 will result in a

- ○ shortage of 24 units.
- → ○ shortage of 34 units.
- ○ surplus of 58 units.
- ○ surplus of 34 units.

14.

At what level of output does marginal cost equal marginal revenue?

No. units produced	Total Revenue	Total costs
0	0	0
1	100	50
2	180	110
3	250	180
4	290	270
5	310	380

- ○ 1
- ○ 2
- → ○ 3
- ○ 4

15.

When the own price elasticity of good X is −3.5, then total revenue can be increased by:

- ○ increasing the price.
- ○ decreasing the quantity supplied.
- → ○ decreasing the price.
- ○ neither increasing the price, decreasing the price, nor decreasing the quantity supplied.

16.

To maximize profits, a firm should continue to increase production of a good until:

- total revenue equals total cost.
- profits are zero.
- → marginal revenue equals marginal cost.
- average cost equals average revenue.

17.

When a demand curve is linear,

- the elasticity is the same as the slope of the demand curve.
- → demand is elastic at high prices.
- demand is unitary elastic at low prices.
- the elasticity is constant at all prices.

18.

Suppose $B(Q) = 5Q - Q^2$ and $C(Q) = 1 + Q^2$. Then, net benefits are _______ when Q equals ___________ units since the second-order condition is ________________.

- → maximized; 5/4; negative
- minimized; −1; positive
- maximized; 4/5; positive
- minimized; 4/5; negative

19.

When marginal revenue is zero, total revenue:

- will increase when price increases.
- → is maximized.
- will decrease when price decreases.
- will decrease as quantity decreases.

20.

What is the level of net benefits when 20 units are produced?

No. units produced	Total Revenue	Total Costs
0	0	0
10	120	40
20	200	100
30	270	170
40	310	260
50	330	370

- -100
- 80
- → 100
- 10

21.

Graphically, an increase in the number of vegetarians will cause the demand curve for Tofu (a meat substitute) to

- → shift rightward.
- shift leftward.
- become flatter.
- become steeper.

22.

Which of the following is the incorrect statement?

- The marginal benefits curve is the slope of the total benefits curve.
- $dB(Q)/dQ = MB$.
- → The slope of the net benefit curve is vertical where MB = MC.
- The vertical difference between the total benefit curve and the total cost curve is maximized at the optimal level of Q.

23.

Which of the following is incorrect?

- Accounting profits generally overstate economic profits.
- Accounting profits do not take opportunity cost into account.
- Economic costs include not only the accounting costs but also the opportunity costs of the resources used in production.
- → Managers should only be interested in accounting profits.

24.

Suppose good X is a normal good. Then a decrease in income would lead to

- an outward shift of the demand curve.
- → an inward shift of the demand curve.
- no shift of the demand curve.
- a movement along the demand curve.

25.

Which of the following is the main goal of a continuing company?

- → To maximize the value of the firm
- To minimize costs
- To improve product quality
- To enhance service to its customers

26.

The supply function

- describes how much of good X will be produced at an alternative price of good X, given all the other variables being constant.
- → recognizes that the quantity of a good produced depends on its price and supply shifters.
- shows the relationship between the quantity supplied of X and variables other than its price.
- does not include technology.

27.

Which of the following is NOT an important factor that affects the magnitude of the own price elasticity of a good?

- Available substitutes
- → Supply of the good
- Time
- Expenditure share

28.

A firm derives revenue from two sources: goods X and Y. Annual revenues from good X and Y are $10,000 and $20,000, respectively. If the price elasticity of demand for good X is −4.0 and the cross-price elasticity of demand between Y and X is 2.0, then a 2 percent decrease in the price of X will:

- ○ increase total revenues from X and Y by $520.
- → ○ decrease total revenues from X and Y by $200.
- ○ leave total revenues from X and Y unchanged.
- ○ decrease total revenues for X and Y by $600.

29.

You are the manager of a popular shoe company. You know that the advertising elasticity of demand for your product is 0.15. How much will you have to increase advertising in order to increase demand by 10 percent?

- ○ 0.02 percent
- ○ 38.6 percent
- → ○ 66.7 percent
- ○ 4.3 percent

30.

To an economist, maximizing profit is:

- → ○ maximizing the value of the firm.
- ○ maximizing the current year's profits.
- ○ minimizing the permanent total costs.
- ○ minimizing the future risks.

31.

To maximize net benefits in the table, it is most appropriate to use:

Control variable	Total Benefits	Total Costs	Net Benefits	Marginal Benefit	Marginal Cost	Marginal Net Benefit
Q	B(Q)	C(Q)	N(Q)	MB(Q)	MC(Q)	MNB(Q)
0	0	0	0	-	-	-
1	900	100	800	900	100	800
2	1,700	300	C	800	200	600
3	2,400	600	1,800	700	E	400
4	A	1,000	2,000	600	400	200
5	3,500	1,500	2,000	500	500	F
6	3,900	2,100	1,800	D	600	-200
7	4,200	2,800	1,400	300	700	-400
8	4,400	B	800	200	800	-600
9	4,500	4,500	0	100	900	-800
10	4,500	5,500	-1,000	0	1,000	-1,000

- four units of the control variable, since the marginal benefit exceeds marginal cost.
- six units of the control variable, since the marginal cost exceeds marginal benefit.
- → five units of the control variable, since net marginal benefits are zero.
- None of the statements associated with this question are correct.

32.

The statistical analysis of economic phenomena is defined as:

- standard error.
- confidence intervals.
- the t-statistic.
- → econometrics.

33.

A price ceiling is

- the minimum legal price that can be charged in a market.
- → the maximum legal price that can be charged in a market.
- above the initial equilibrium price.
- equal to the initial equilibrium price.

34.

Which of the following is not a supply shifter?

- Level of technology.
- Prices of inputs.
- → Average income level.
- Weather.

35.

Suppose the demand for a product is $\ln Q_x^d = 10 - \ln P_x$, then product x is:

- elastic.
- inelastic.
- → unitary elastic.
- Cannot be determined without more information.

36.

The curve which summarizes the total quantity producers are willing and able to produce at differing prices is the:

- market demand curve.
- consumer surplus curve.
- average cost curve.
- → market supply curve.

37.

What is the marginal net benefit of producing the twentieth unit?

No. units produced	Total Revenue	Total Costs
0	0	0
10	120	40
20	200	100
30	270	170
40	310	260
50	330	370

- → 2
- -5
- -2
- 8

38.

The law of demand states that, holding all else constant:

- as price falls, demand will fall also.
- as price rises, demand will also rise.
- price has no effect on quantity demanded.
- → as price falls, quantity demanded rises.

39.

If the cross-price elasticity between goods X and Y is zero, we know the goods are:

- → independent.
- complements.
- inelastic.
- substitutes.

40.

The demand for good X has been estimated by $Q_x^d = 6 - 2P_x + 5P_y$. Suppose that good X sells at $3 per unit and good Y sells for $2 per unit. Calculate the own price elasticity.

- −0.3
- −0.4
- −0.5
- → −0.6

41.

Assume that the price elasticity of demand is −2 for a certain firm's product. If the firm raises price, the firm's managers can expect total revenue to:

- → decrease.
- increase.
- remain constant.
- either increase or remain constant, depending upon the size of the price increase.

42.

If A and B are complements, an increase in the price of good A would:

- have no effect on the quantity demanded of B.
- lead to an increase in demand for B.
- → lead to a decrease in demand for B.
- none of the statements associated with this question are correct.

43.

Which of the following can explain an increase in the demand for housing in retirement communities?

- A drop in real estate prices.
- → An increase in the population of the elderly.
- A drop in the average age of retirees.
- Mandatory government legislation.

44.

Consider a market characterized by the following inverse demand and supply functions: $P_X = 50 - 4Q_X$ and $P_X = 10 + 2Q_X$. Compute the surplus producers receive when a \$30 per unit price floor is imposed on the market.

- → \$75.
- \$25.
- \$35.
- \$50.

45.

Changes in the price of a good lead to:

- → changes in the quantity supplied of the good.
- changes in supply.
- changes in demand.
- no effects in quantity supplied or demanded.

1. Award: **2.00 points**

Suppose the production function is Q = min{K, 2L}. How much output is produced when 4 units of labor and 9 units of capital are employed?

- 2
- 4
- → 8
- 9

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

2. Award: **2.00 points**

Suppose the production function is given by Q = 3K + 4L. What is the average product of capital when 10 units of capital and 10 units of labor are employed?

- 3
- 4
- → 7
- 45

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

3. Award: **2.00 points**

For the cost function $C(Q) = 100 + 2Q + 3Q^2$, the marginal cost of producing 2 units of output is:

- 2.
- 3.
- 12.
- → 14.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 05-05 Calculate average and marginal costs from algebraic or tabular cost data and illustrate the relationship between average and marginal costs.

4. Award: **2.00 points**

For the cost function $C(Q) = 100 + 2Q + 3Q^2$, the average fixed cost of producing 2 units of output is:

- 100.
- → 50.
- 3.
- 2.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 05-05 Calculate average and marginal costs from algebraic or tabular cost data and illustrate the relationship between average and marginal costs.

5. Award: **2.00 points**

If a firm's production function is Leontief and the wage rate goes up, the:

- firm must use more labor in order to minimize the cost of producing a given level of output.
- firm must use more capital in order to minimize the cost of producing a given level of output.
- firm must use less labor in order to minimize the cost of producing a given level of output.
- → cost minimizing combination of capital and labor does not change.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

6. Award: **2.00 points**

Which of the following statements is incorrect?

- Fixed costs do not vary with output.
- Sunk costs are those costs that are forever lost after they have been paid.
- → Fixed costs are always greater than sunk costs.
- Fixed costs could be positive when sunk costs are zero.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 05-04 Explain the difference between and the economic relevance of fixed costs; sunk costs; variable costs; and marginal costs.

7. Award: **2.00 points**

The production function $Q = L^{.5}K^{.5}$ is called:

→ ○ Cobb Douglas.

○ Leontief.

○ linear.

○ None of the answers are correct.

References

Multiple Choice | Difficulty: 01 Easy | Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

8. Award: **2.00 points**

The production function for a competitive firm is $Q = K^{.5}L^{.5}$. The firm sells its output at a price of $10, and can hire labor at a wage of $5. Capital is fixed at one unit. The profit-maximizing quantity of labor is:

○ 2/5.

→ ○ 1.

○ 10.

○ None of the answers are correct.

References

Multiple Choice | Difficulty: 03 Hard | Learning Objective: 05-02 Calculate input demand and the cost-minimizing combination of inputs and use isoquant analysis to illustrate optimal input substitution.

9. Award: **2.00 points**

The recipe that defines the maximum amount of output that can be produced with K units of capital and L units of labor is the:

→ ○ production function.

○ technological constraint.

○ research and development schedule.

○ total product.

References

Multiple Choice | Difficulty: 01 Easy | Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

10. Award: **2.00 points**

If the last unit of input increases total product, we know that the marginal product is:

→ ◯ positive.
◯ negative.
◯ zero.
◯ indeterminate.

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

11. Award: **2.00 points**

Total product begins to fall when:

◯ marginal product is maximized.
◯ average product is below zero.
◯ average product is negative.
→ ◯ marginal product is zero.

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

12. Award: **2.00 points**

What is the value marginal product of labor if: P = $10, MP_L = $25, and AP_L = 40?

◯ $10,000
◯ $1,000
◯ $400
→ ◯ $250

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

13. Award: **2.00 points**

The production function is $Q = K^{.6} L^{.4}$. The marginal rate of technical substitution is:

- $2/3\ K^{-1} L$.
- $K^{-1} L^{-1}$.
- → $2/3\ K L^{-1}$.
- $K^{.4} L^{-.6}$.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 05-01 Explain alternative ways of measuring the productivity of inputs and the role of the manager in the production process.

14. Award: **2.00 points**

For the cost function $C(Q) = 200 + 3Q + 8Q^2 + 4Q^3$, what is the average fixed cost of producing six units of output?

- 18.31
- 212.61
- 42.12
- → 33.33

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 05-05 Calculate average and marginal costs from algebraic or tabular cost data and illustrate the relationship between average and marginal costs.

15. Award: **2.00 points**

An isoquant defines the combination of inputs that yield the producer:

- higher levels of output than the desired level of output.
- lower levels of output than the desired level of output.
- → the same level of output.
- None of the statements is correct.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 05-02 Calculate input demand and the cost-minimizing combination of inputs and use isoquant analysis to illustrate optimal input substitution.

16. Award: **2.00 points**

An isocost line:

- represents the combinations of w and K that cost the firm the same amount of money.
- → represents the combinations of K and L that cost the firm the same amount of money.
- represents the combinations of r and w that cost the firm the same amount of money.
- has a convex shape.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 05-03 Calculate a cost function from a production function and explain how economic costs differ from accounting costs.

17. Award: **2.00 points**

Economies of scope exist when:

- $C(Q_1) + C(Q_2) < C(Q_1, Q_2)$.
- $C(Q_1) - C(Q_2) < C(Q_1, Q_2)$.
- → $C(Q_1) + C(Q_2) > C(Q_1, Q_2)$.
- $C(Q_1) - C(Q_2) > C(Q_1, Q_2)$.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 05-07 Conclude whether a multiple-output production process exhibits economies of scope or cost complementarities and explain their significance for managerial decisions.

18. Award: **2.00 points**

Cost complementarity exists in a multiproduct cost function when:

- the average cost of producing one output is reduced when the output of another product is increased.
- the average cost of producing one output is increased when the output of another product is increased.
- the marginal cost of producing one output is increased when the output of another product is decreased.
- → the marginal cost of producing one output is reduced when the output of another product is increased.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 05-07 Conclude whether a multiple-output production process exhibits economies of scope or cost complementarities and explain their significance for managerial decisions.

19. Award: **2.00 points**

Suppose the cost function is $C(Q) = 50 + Q - 10Q^2 + 2Q^3$. At 3 units of output, the marginal cost curve is:

→ ◯ in the increasing stage.

◯ in the declining stage.

◯ at the minimum level.

◯ at the maximum level.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 05-05 Calculate average and marginal costs from algebraic or tabular cost data and illustrate the relationship between average and marginal costs.

20. Award: **2.00 points**

Suppose that production for good X is characterized by the following production function, $Q = 4K^{0.5}L^{0.5}$, where K is the fixed input in the short run. If the per-unit rental rate of capital, r, is $12 and the per-unit wage, w, is $20, then the average total cost of using 25 units of capital and 49 units of labor is:

◯ $6.25.

→ ◯ $9.14.

◯ $10.07.

◯ There is insufficient information to determine the average total costs.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 05-05 Calculate average and marginal costs from algebraic or tabular cost data and illustrate the relationship between average and marginal costs.

21. Award: **2.00 points**

Which of the following forms of payment is NOT an incentive plan?

◯ Commission plans for salesmen

→ ◯ Flat salary for a plant manager

◯ Bonuses for managers that increase as profits increase

◯ None of the statements is correct.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 06-05 Discuss three forces that owners can use to discipline managers.

22. Award: **2.00 points**

An example of a job that usually involves a revenue-sharing plan would be:

- waiters and waitresses.
- car salesman.
- insurance agents.
- → All of the statements associated with this question are correct.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 06-07 Discuss four tools the manager can use to mitigate incentive problems in the workplace.

23. Award: **2.00 points**

Solving the principal-agent problem ensures that the firm is operating:

- → on the production function.
- above the production function.
- below the production function.
- above the isoquant curve.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 06-04 Describe the principal-agent problem as it relates to owners and managers.

24. Award: **2.00 points**

If a manager is not the owner, the manager:

- receives the full benefit of good decisions.
- bears the full cost of bad decisions.
- → does not receive the full benefit nor the full cost of his or her decisions.
- None of the statements is correct.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 06-04 Describe the principal-agent problem as it relates to owners and managers.

25. Award: **2.00 points**

Spot markets are an INEFFICIENT way for the firm to purchase inputs if:

- opportunism is a problem.
- suppliers engage in hold-up.
- profit sharing is used to compensate managers.
- → opportunism is a problem and suppliers engage in hold-up.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 06-03 Explain the optimal manner of procuring different types of inputs.

26. Award: **2.00 points**

Which of the following is NOT a transaction cost associated with using inputs?

- Time spent negotiating labor contracts with union workers
- Opportunity costs of negotiating the price of renting machines
- → Wages paid to labor
- Costs of searching for a new supplier of machines

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 06-02 Identify four types of specialized investments; and explain how each can lead to costly bargaining; underinvestment; and/or a "hold-up problem."

27. Award: **2.00 points**

The presence of substantial specialized investment relative to contracting costs suggests that the optimal input procurement method is:

- spot exchange.
- vertical integration.
- contract.
- → vertical integration or contract.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 06-03 Explain the optimal manner of procuring different types of inputs.

28. Award: **2.00 points**

The causal view of an industry is that:

→ ○ market structure causes firms to behave in a certain way.

○ market performance causes firms to have a certain structure.

○ market performance causes firms to behave in a certain way.

○ behavior causes firms to have a certain structure.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 07-04 Describe the structure-conduct-performance paradigm; the feedback critique; and their relation to the five forces framework.

29. Award: **2.00 points**

According to the "feedback critique":

○ the conduct of firms in an industry may affect the firm's performance.

○ the conduct of firms in an industry may affect the market structure.

○ market structure may affect the firm's conduct.

→ ○ All of the statements associated with this question are correct.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 07-04 Describe the structure-conduct-performance paradigm; the feedback critique; and their relation to the five forces framework.

30. Award: **2.00 points**

The Dansby-Willig index measures the potential for a change in:

○ production cost.

○ firm's revenue.

○ firm's profit.

→ ○ social welfare.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 07-01 Calculate alternative measures of industry structure; conduct; and performance; and discuss their limitations.

31. Award: **2.00 points**

The products in a monopolistically competitive industry are:

- homogeneous.
- → heterogeneous.
- competitive.
- uncompetitive.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 07-05 Identify whether an industry is best described as perfectly competitive; a monopoly; monopolistically competitive; or an oligopoly.

32. Award: **2.00 points**

According to the U.S. Department of Justice Merger Guidelines, a Herfindahl-Hirschman index (HHI) above __________ is associated with a highly concentrated industry. Therefore, if the automobile industry had an HHI of 2,200, then a vertical merger between GM and one of its suppliers likely would be:

- 1,300 and rejected since the HHI is above the acceptable threshold
- 2,400 and approved since the HHI is below the acceptable threshold
- 1,800 and rejected since the HHI is above the acceptable threshold
- → None of the answers are correct

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 07-03 Explain the relevance of the Herfindahl-Hirschman index for antitrust policy under the horizontal merger guidelines.

33. Award: **2.00 points**

The industry elasticity of demand for good Y is −3, while the elasticity of demand for an individual manufacturer of good Y is −12. Based on the Rothschild approach to measuring market power, we conclude that:

- 1/4, indicating there is significant monopoly power in this industry.
- → 1/4, indicating there is little monopoly power in this industry.
- 4, indicating there is little monopoly power in this industry.
- None of the answers are correct.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 07-01 Calculate alternative measures of industry structure; conduct; and performance; and discuss their limitations.

34. Award: **2.00 points**

Advertising is an aspect of a firm's:

- performance.
- structure.
- environment.
- → conduct.

References

Multiple Choice | Difficulty: 01 Easy | Learning Objective: 07-01 Calculate alternative measures of industry structure; conduct; and performance; and discuss their limitations.

35. Award: **2.00 points**

There are five firms in an industry. You know sales of the four largest firms are $1,000,000, $500,000, $400,000, and $178,000. If the C_4 ratio is 95 percent, then the HHI is:

- 1,810.
- 2,755.
- → 3,038.
- 5,017.

References

Multiple Choice | Difficulty: 03 Hard | Learning Objective: 07-01 Calculate alternative measures of industry structure; conduct; and performance; and discuss their limitations.

36. Award: **2.00 points**

You are the manager of a firm that sells its product in a competitive market at a price of $50. Your firm's cost function is $C = 40 + 5Q^2$. Your firm's maximum profits are:

- 125.
- 250.
- 100.
- → 85.

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 08-03 Apply the marginal principle to determine the profit-maximizing price and output.

37. Award: 2.00 points

You are the manager of a monopoly that faces a demand curve described by P = 85 − 5Q. Your costs are C = 20 + 5Q. The profit-maximizing output for your firm is:

- 6.
- 5.
- 7.
- → 8.

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 08-03 Apply the marginal principle to determine the profit-maximizing price and output.

38. Award: 2.00 points

You are the manager of a monopoly that faces a demand curve described by P = 63 − 5Q. Your costs are C = 10 + 3Q. The profit-maximizing price is:

- 20.
- 27.
- → 33.
- 55.

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 08-03 Apply the marginal principle to determine the profit-maximizing price and output.

39. Award: 2.00 points

If a monopolistically competitive firm's marginal cost increases, then in order to maximize profits, the firm will:

- → reduce output and increase price.
- increase output and decrease price.
- increase both output and price.
- reduce both output and price.

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 08-03 Apply the marginal principle to determine the profit-maximizing price and output.

40. Award: 2.00 points

The primary difference between monopolistic competition and perfect competition is:

- the ease of entry and exit into the industry.
- the number of firms in the market.
- Both the ease of entry and exit into the industry and the number of firms in the market are correct.
- → None of the answers is correct.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 08-01 Identify the conditions under which a firm operates as perfectly competitive; monopolistically competitive; or a monopoly.

41. Award: 2.00 points

Which of the following industries is best characterized as monopolistically competitive?

- → Toothpaste
- Crude oil
- Agriculture
- Local telephone service

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 08-01 Identify the conditions under which a firm operates as perfectly competitive; monopolistically competitive; or a monopoly.

42. Award: 2.00 points

A firm has a total cost function of $C(Q) = 50 + 10Q^{1/2}$. The firm experiences:

- → economies of scale.
- constant returns to scale.
- diseconomies of scale.
- All of the statements associated with this question are correct, depending on the quantity.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 08-02 Identify sources of (and strategies for obtaining) monopoly power.

43. Award: **2.00 points**

"Monopolistic competition is literally a kind of competition. Hence, there is no deadweight loss in a monopolistically competitive market."

- The statement is by definition correct but empirically incorrect.
- The statement is correct.
- → The statement is incorrect.
- None of the answers is correct.

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 08-05 Explain how long-run adjustments impact perfectly competitive; monopoly; and monopolistically competitive firms; discuss the ramifications of each of these market structures on social welfare.

44. Award: **2.00 points**

You are the manager of a firm that produces output in two plants. The demand for your firm's product is $P = 20 - Q$, where $Q = Q_1 + Q_2$. The marginal costs associated with producing in the two plants are $MC_1 = 2$ and $MC_2 = 2Q_2$. How much output should be produced in plant 1 in order to maximize profits?

- 1
- 4
- → 8
- 11

References

Multiple Choice	Difficulty: 02 Medium	Learning Objective: 08-08 Calculate the optimal output of a firm that operates two plants and the optimal level of advertising for a firm that enjoys market power.

45. Award: **2.00 points**

Consider a monopoly where the inverse demand for its product is given by $P = 50 - 2Q$. Total costs for this monopolist are estimated to be $C(Q) = 100 + 2Q + Q^2$. At the profit-maximizing combination of output and price, deadweight loss is:

- → \$32.
- \$64.
- \$128.
- cannot be determined with the given information.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 08-05 Explain how long-run adjustments impact perfectly competitive; monopoly; and monopolistically competitive firms; discuss the ramifications of each of these market structures on social welfare.

46. Award: 2.00 points

Consider firms operating in an industry where the own price elasticity of demand is infinite; that is, $E_{Q,P} = -\infty.$ Use this information to determine the type of industry in which these firms operate and the optimal advertising-to-sales ratio.

→ ○ Perfectly competitive industry and 0

○ Monopolistically competitive industry and ∞

○ Perfectly competitive industry and ∞

○ Monopolistic industry and 0

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 08-08 Calculate the optimal output of a firm that operates two plants and the optimal level of advertising for a firm that enjoys market power.

47. Award: 2.00 points

The second-order condition for a firm maximizing its profit operating in a monopolistically competitive market is:

○ $-(d^2C(Q)/dQ^2) < 0.$

→ ○ $(d^2R\ (Q)/dQ^2) - (d^2C(Q)/dQ^2) < 0.$

○ $(d^2R\ (Q)/dQ^2) = (d^2C(Q)/dQ^2).$

○ $(dMR/dQ) > (dMC/dQ).$

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 08-03 Apply the marginal principle to determine the profit-maximizing price and output.

48. Award: 2.00 points

The first-order conditions for profit maximization in a perfectly competitive market are:

→ ○ $P - (dC(Q)/dQ) = 0.$

○ $(dR(Q)/dQ) - (d^2C(Q)/dQ^2) < 0.$

○ $P - (d^2C(Q)/dQ^2) = 0.$

○ $P > (dC(Q)/dQ).$

References

Multiple Choice | Difficulty: 02 Medium | Learning Objective: 08-03 Apply the marginal principle to determine the profit-maximizing price and output.

49. Award: **2.00 points**

In a competitive industry with identical firms, long-run equilibrium is characterized by:

- P > min ATC.
- P < AVC.
- → MR = MC = min ATC.
- MR < P.

References

Multiple Choice	Difficulty: 01 Easy	Learning Objective: 08-05 Explain how long-run adjustments impact perfectly competitive; monopoly; and monopolistically competitive firms; discuss the ramifications of each of these market structures on social welfare.

50. Award: **2.00 points**

Clark Industries currently spends 5 percent of its sales on advertising. Suppose that the elasticity of advertising for Clark is 0.25. Determine the optimal profit margin over price (P − MC)/P.

- 15 percent.
- → 20 percent.
- 25 percent.
- None of the answers is correct.

References

Multiple Choice	Difficulty: 03 Hard	Learning Objective: 08-08 Calculate the optimal output of a firm that operates two plants and the optimal level of advertising for a firm that enjoys market power.

View Statistics - Mid-term Exam 42009 Introductory Economics

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12/10...
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(Number of First Attempts: 210)

What do the statistics on this page mean?

Question 1 Difficulty: 1

Which of the following activities have zero opportunity cost?

To see a concert with a free ticket obtained from a lucky draw	12	(5.71 %)
To attend college fully on scholarships	1	(0.48 %)
To participate in the demonstration for equality in Nyhavn, Copenhagen	8	(3.81 %)
⇨ None of the above. All of the events above have opportunity costs.	189	(90 %)

Average Grade: 0.9 / 1 (90 %)
Standard Deviation: 30.07 %
Point Biserial: 0.36
Discrimination Index: 23.21 %

Question 2 Difficulty: 1

Changes in the price of a good lead to:

⇨ change in the quantity supplied of the good.	155	(73.81 %)
changes in supply.	4	(1.9 %)
changes in demand.	51	(24.29 %)
no effects in quantity supplied or demanded.	0	(0 %)

Average Grade: 0.74 / 1 (73.81 %)
Standard Deviation: 44.07 %
Point Biserial: 0.28
Discrimination Index: 44.64 %

Question 3 Difficulty: 1

To solve the traffic congestion problem in Copenhagen, the government is considering policies to reduce private cars on the road. Which of the following policy will NOT be helpful in achieving this goal?

To provide subsidy to the people who ride a bike.	5	(2.38 %)
To implement a higher tax on car	3	(1.43 %)

Average Grade: 0.96 / 1 (96.19 %)

purchase.		
To implement a higher tax on gasoline.	0	(0 %)
⇨ To charge a higher price on public transport.	202	(96.19 %)

Standard Deviation: 19.19 %
Point Biserial: 0.21
Discrimination Index: 12.50 %

Question 4 Difficulty: 1

The quantity demanded of a good decreases by 20% when its price increase by 2%. Which of the followings best fit this good?

This good has no close substitutes.	17	(8.1 %)
This is a necessity good.	9	(4.29 %)
⇨ This is more likely to happen in a short-run.	105	(50 %)
This is an inferior good.	79	(37.62 %)

Average Grade: 0.5 / 1 (50 %)
Standard Deviation: 50.12 %
Point Biserial: 0.43
Discrimination Index: 73.21 %

Question 5 Difficulty: 1

Suppose we observe a decrease of the equilibrium price of potato and an increase of the equilibrium quantity. Which of the following best fit the observed data?

An increase in demand with supply unchanged	10	(4.76 %)
A decrease in supply with demand unchanged	17	(8.1 %)
⇨ An increase in supply with demand unchanged	156	(74.29 %)
An increase in demand coupled with an decrease in supply	27	(12.86 %)

Average Grade: 0.74 / 1 (74.29 %)
Standard Deviation: 43.81 %
Point Biserial: 0.26
Discrimination Index: 37.50 %

Question 6 Difficulty: 1

The cross price elasticity between good x and good y is found to be positive. We conclude that good x and good y are:

normal goods	4	(1.9 %)
inferior goods	0	(0 %)
⇨ substitutes	204	(97.14 %)
complements	2	(0.95 %)

Average Grade: 0.97 / 1 (97.14 %)
Standard Deviation: 16.70 %
Point Biserial: 0.31
Discrimination Index: 10.71 %

Question 7 Difficulty: 1

The CEO of a large restaurant chain said, "For each 1 percent price increase, we lose 5 percent of our diners." We can conclude that:

demand is price inelastic.	21	(10 %)
⇨ a price increase will decrease total revenue.	177	(84.29 %)
the price elasticity is -0.5.	10	(4.76 %)
the demand curve is		

Average Grade: 0.84 / 1 (84.29 %)
Standard Deviation: 36.48 %
Point Biserial: 0.38
Discrimination Index: 37.50 %

the demand curve is horizontal. | 2 (0.95 %)

Question 8 Difficulty: 1

Suppose the (inverse) demand for a product is P = 40 - Q and (inverse) supply of the product is P = 4 + 2Q. The equilibrium quantity, price, and consumer surplus (CS) would be:

- ⇨ Q=12, P=28, CS=72 — 176 (83.81 %)
- Q=8, P=14, CS=36 — 3 (1.43 %)
- Q=12, P=28, CS=36 — 28 (13.33 %)
- Q=8, P=14, CS=72 — 3 (1.43 %)

Average Grade: 0.84 / 1 (83.81 %)
Standard Deviation: 36.92 %
Point Biserial: 0.52
Discrimination Index: 42.86 %

Question 9 Difficulty: 1

A price ceiling is

- the minimum legal price that can be charged in a market. — 6 (2.86 %)
- ⇨ the maximum legal price that can be charged in a market. — 203 (96.67 %)
- higher than the initial equilibrium price. — 1 (0.48 %)
- equal to the initial equilibrium price. — 0 (0 %)

Average Grade: 0.97 / 1 (96.67 %)
Standard Deviation: 17.99 %
Point Biserial: 0.13
Discrimination Index: 7.14 %

Question 10 Difficulty: 1

Suppose the supply curve of a product is $Q = -10 + 10P$. The producer surplus will increase by the amount of _ if the price rises from 2 DKK to 3 DKK per unit.

- 5 DKK — 31 (14.76 %)
- 10 DKK — 85 (40.48 %)
- ⇨ 15 DKK — 79 (37.62 %)
- 20 DKK — 15 (7.14 %)

Average Grade: 0.38 / 1 (37.62 %)
Standard Deviation: 48.56 %
Point Biserial: 0.40
Discrimination Index: 58.93 %

Question 11 Difficulty: 1

Suppose the production function is given by Q= min{3K, 4L}. What is name of this production function form and what is the average product of labor (AP_L) when 15 units of capital and 10 units of labor are employed?

- Cobb-Douglas, AP_L=4 — 4 (1.9 %)
- ⇨ Leontief, AP_L=4 — 191 (90.95 %)
- Cobb-Douglas, AP_L=3 — 3 (1.43 %)
- Leontief, AP_L=3 — 12 (5.71 %)

Average Grade: 0.91 / 1 (90.95 %)
Standard Deviation: 28.75 %
Point Biserial: 0.33
Discrimination Index: 25.00 %

Question 12 Difficulty: 1

Suppose that a firm produces output according to the production function $Q = K^{1/4}L^{3/4}$, what is the marginal product of labor when 1 unit of capital and 16 units of labor are employed?

- ⇨ 3/8 — 199 (94.76 %)
- 5/8 — 1 (0.48 %)

Average Grade: 0.95 / 1 (94.76 %)
Standard Deviation: 22.33 %

3/4	8	(3.81 %)
5/4	2	(0.95 %)

Point Biserial: 0.35
Discrimination Index: 14.29 %

Question 13 Difficulty: 1

Suppose the production function is Q=3K + 4L. The marginal rate of technical substitution is:

⇨	4/3	208	(99.05 %)
	2/3	0	(0 %)
	8/3	0	(0 %)
	5/6	2	(0.95 %)

Average Grade: 0.99 / 1 (99.05 %)
Standard Deviation: 9.74 %
Point Biserial: 0.22
Discrimination Index: 3.57 %

Question 14 Difficulty: 1

A firm uses labor (L) and capital (K) as inputs to produce. If the price of inputs are w = 60 DKK, r = 200 DKK, and marginal products are MP_L = 30, MP_K = 100, the firm:

⇨	is cost minimizing.	178	(84.76 %)
	should use less L and more K to cost minimize.	15	(7.14 %)
	should use less K and more L to cost minimize.	9	(4.29 %)
	is profit maximizing but not cost minimizing.	8	(3.81 %)

Average Grade: 0.85 / 1 (84.76 %)
Standard Deviation: 36.02 %
Point Biserial: 0.32
Discrimination Index: 23.21 %

Question 15 Difficulty: 1

Regarding isoquants and isocosts, which of the followings is NOT correct?

	An isoquant defines the combinations of inputs that yield the producer the same level of output.	7	(3.33 %)
	An isocost line defines the combinations of inputs that yield the producer the same cost.	10	(4.76 %)
⇨	An isoquant should never intersect with an isocost line.	177	(84.29 %)
	The producer is cost minimizing at the point of tangency between an isoquant and an isocost line.	16	(7.62 %)

Average Grade: 0.84 / 1 (84.29 %)
Standard Deviation: 36.48 %
Point Biserial: 0.30
Discrimination Index: 32.14 %

Question 16 Difficulty: 1

Regarding the average and marginal costs, which of the following is NOT correct?

Average total cost increases when marginal cost curve is above the average	6	(2.86 %)

total cost curve.		
The marginal cost curve intersects the average total cost curve at the minimum point of average total cost curve.	11	(5.24 %)
The marginal cost curve intersects the average variable cost curve at the minimum point of average variable cost curve.	6	(2.86 %)
→ Marginal cost decreases when average fixed cost decreases.	187	(89.05 %)

Average Grade: 0.89 / 1 (89.05 %)
Standard Deviation: 31.30 %
Point Biserial: 0.43
Discrimination Index: 26.79 %

Question 17 Difficulty: 1

Economies of scale exist when

→ average total costs decline as output increases.	197	(93.81 %)
average total costs increase as output increases.	1	(0.48 %)
average total costs remains constant as output increases.	1	(0.48 %)
average fixed costs decline as output increases.	11	(5.24 %)

Average Grade: 0.94 / 1 (93.81 %)
Standard Deviation: 24.16 %
Point Biserial: 0.27
Discrimination Index: 12.50 %

Question 18 Difficulty: 1

Generally, an increase in the number of vegetarians will cause the demand curve for meat to

shift rightward.	14	(6.67 %)
→ shift leftward.	194	(92.38 %)
become flatter.	1	(0.48 %)
become steeper.	1	(0.48 %)

Average Grade: 0.92 / 1 (92.38 %)
Standard Deviation: 26.59 %
Point Biserial: 0.27
Discrimination Index: 16.07 %

Question 19 Difficulty: 1

Which of the following would cause the current supply curve of iPhone to shift rightward?

an economic boom, which increases the amount that people are willing to spend on personal electronics	102	(48.57 %)
a decrease in the price of songs on Apple music	6	(2.86 %)
→ the producer's		

Average Grade: 0.41 / 1 (41.43 %)
Standard Deviation: 49.38 %
Point Biserial: 0.23

expectation that the future price of iPhone will decrease	87	(41.43 %)	Discrimination Index: 37.50 %
an increase in the wages of labor in iPhone manufacturers	15	(7.14 %)	

Question 20 Difficulty: 1

Regarding accounting and economic profits/costs, which of the following is NOT correct?

	Accounting profits generally overstate economic profits.	7	(3.35 %)	Average Grade: 0.86 / 1 (85.71 %)
	Accounting profits do not take opportunity cost into account.	15	(7.18 %)	Standard Deviation: 35.08 %
	Economic costs include not only the accounting costs but also the opportunity costs of the resources used in production.	7	(3.35 %)	Point Biserial: 0.34
⇨	Managers should only care about accounting profits.	180	(86.12 %)	Discrimination Index: 30.36 %

Question 21 Difficulty: 1

A firm in a competitive market sells its product at a price of 60 DKK and its cost function is $C(Q) = 20 + 5Q^2$. The maximum profits for the firm would be:

⇨	160 DKK	159	(75.71 %)	Average Grade: 0.76 / 1 (75.71 %)
	100 DKK	9	(4.29 %)	Standard Deviation: 42.98 %
	360 DKK	27	(12.86 %)	Point Biserial: 0.24
	200 DKK	15	(7.14 %)	Discrimination Index: 33.93 %

Question 22 Difficulty: 1

Suppose you are a supervisor of PhD student, which of the following is NOT a solution to the principle-agent problem of supervisor-student?

	To give bonus for publication in journals/conferences	2	(0.95 %)	Average Grade: 0.91 / 1 (90.95 %)
	To give bonus for project reports	3	(1.43 %)	Standard Deviation: 28.75 %
	Spot checks at the office of PhD student	14	(6.67 %)	Point Biserial: 0.34
⇨	Fixed salary regardless of performance	191	(90.95 %)	Discrimination Index: 26.79 %

Question 23 Difficulty: 1

Regarding fixed costs and sunk costs, which of the following is NOT correct?

Sunk costs are those

Sunk costs are those costs that are forever lost after they have been paid.	5	(2.38 %)
Fixed costs do not vary with output.	3	(1.43 %)
A lost ticket before a movie starts is an example of sunk cost.	4	(1.9 %)
⇨ Sunk costs could be part of the marginal costs.	198	(94.29 %)

Average Grade: 0.94 / 1 (94.29 %)
Standard Deviation: 23.27 %
Point Biserial: 0.27
Discrimination Index: 14.29 %

Question 24 Difficulty: 1

The sources of monopoly power for a monopoly could be:

economies of scale.	5	(2.38 %)
economies of scope.	1	(0.48 %)
patents.	3	(1.43 %)
⇨ all of the above.	201	(95.71 %)

Average Grade: 0.96 / 1 (95.71 %)
Standard Deviation: 20.30 %
Point Biserial: 0.19
Discrimination Index: 3.57 %

Question 25 Difficulty: 1

The long-run equilibrium of a perfectly competitive market is characterized by:

P > minimum of ATC (average total cost)	17	(8.1 %)
P < AVC (average variable cost)	0	(0 %)
⇨ P = MC = minimum of ATC (average total cost)	187	(89.05 %)
P > MR (marginal revenue)	6	(2.86 %)

Average Grade: 0.89 / 1 (89.05 %)
Standard Deviation: 31.30 %
Point Biserial: 0.24
Discrimination Index: 21.43 %

Question 26 Difficulty: 1

A perfectly competitive firm will shut down (stop producing) when:

market price is lower than the average total cost (ATC).	3	(1.43 %)
total revenue is less than the total cost.	14	(6.67 %)
⇨ market price is lower than the average variable cost (AVC).	190	(90.48 %)
fixed cost is too high.	3	(1.43 %)

Average Grade: 0.9 / 1 (90.48 %)
Standard Deviation: 29.42 %
Point Biserial: 0.19
Discrimination Index: 17.86 %

Question 27 Difficulty: 1

Which of the following statements about a monopoly is NOT correct?

A monopoly does not have a supply curve.	22	(10.48 %)
The demand curve of a monopoly is the market demand curve.	7	(3.33 %)

Average Grade: 0.81 / 1 (80.95 %)
Standard Deviation: 39.36 %

curve.

⇨	A monopoly has no market power.	170 (80.95 %)
	A monopoly produces at MR = MC.	11 (5.24 %)

Point Biserial: 0.22

Discrimination Index: 32.14 %

Question 28 Difficulty: 1

A monopoly faces a demand curve described by P = 90 - 3Q and has a total cost of C(Q) = 5 + 10Q + Q^2. The profit-maximizing price for the monopoly is:

⇨	60	152 (72.73 %)
	10	38 (18.18 %)
	30	12 (5.74 %)
	20	7 (3.35 %)

Average Grade: 0.72 / 1 (72.38 %)

Standard Deviation: 44.82 %

Point Biserial: 0.46

Discrimination Index: 58.93 %

Question 29 Difficulty: 1

Which of the following is NOT an example of negative externalities?

	Air pollution from a factory	0 (0 %)
	The neighbor's barking dog	2 (0.95 %)
	Health risk to others from second-hand smoke	1 (0.48 %)
⇨	Being vaccinated against Covid-19 protects not only you, but also the people around you.	207 (98.57 %)

Average Grade: 0.99 / 1 (98.57 %)

Standard Deviation: 11.89 %

Point Biserial: 0.23

Discrimination Index: 5.36 %

Question 30 Difficulty: 1

Consider a monopoly where the inverse demand for its product is given by P = 50 - 2Q. Total costs for this monopolist is C(Q) = 100 + 2Q + Q^2. At the profit-maximizing combination of output and price, deadweight loss is:

⇨	32	175 (83.73 %)
	64	11 (5.26 %)
	128	2 (0.96 %)
	cannot be determined with the given information.	21 (10.05 %)

Average Grade: 0.83 / 1 (83.33 %)

Standard Deviation: 37.36 %

Point Biserial: 0.44

Discrimination Index: 39.29 %

Question 31 Difficulty: 1

Which of the following is NOT a transaction cost associated with using inputs?

	Time spent negotiating labor contracts with union workers	11 (5.24 %)
	Opportunity costs of negotiating the price of renting machines	8 (3.81 %)
⇨	Wages paid to labor	188 (89.52 %)
	Costs of searching for a new supplier of	3 (1.43 %)

Average Grade: 0.9 / 1 (89.52 %)

Standard Deviation: 30.70 %

Point Biserial: 0.28

Discrimination Index: 21.43 %

a new supplier of machines

Question 32 Difficulty: 1

In a free market in which an equilibrium price and quantity prevails:

	consumer surplus is less than producer surplus.	2 (0.95 %)
	consumer surplus is greater than producer surplus.	1 (0.48 %)
	consumer surplus is the same as producer surplus.	26 (12.38 %)
⇨	the sum of consumer surplus and producer surplus are maximized.	181 (86.19 %)

Average Grade: 0.86 / 1 (86.19 %)
Standard Deviation: 34.58 %
Point Biserial: 0.30
Discrimination Index: 23.21 %

Question 33 Difficulty: 1

You are a division manager at Toyota. If your marketing department estimates that the semiannual demand for the Highlander is Q = 150,000 – 1.5P, what price should you charge in order to maximize revenues from sales of the Highlander?

⇨	50,000	181 (86.6 %)
	30,000	8 (3.83 %)
	100,000	15 (7.18 %)
	60,000	5 (2.39 %)

Average Grade: 0.86 / 1 (86.19 %)
Standard Deviation: 34.58 %
Point Biserial: 0.49
Discrimination Index: 39.29 %

Question 34 Difficulty: 1

In a competitive market, the market demand is $Q^d = 70 - 3P$ and the market supply is $Q^s = 6P$. A price ceiling of 4 will result in a

	shortage of 24 units.	3 (1.44 %)
⇨	shortage of 34 units.	189 (90.43 %)
	surplus of 24 units.	2 (0.96 %)
	surplus of 34 units.	15 (7.18 %)

Average Grade: 0.9 / 1 (90 %)
Standard Deviation: 30.07 %
Point Biserial: 0.36
Discrimination Index: 23.21 %

Question 35 Difficulty: 1

Andy, a college student, loves eating burger. As a college student with no income, he is used to eating at McDonald. After graduation, Andy gets a job. As such, his income is now 200,000 DKK a year. He ends up eating burger at Sporvejen. In economic terms, the burger at McDonald is a(n) _, while the burger at Sporvejen is a(n) _.

	normal good; normal good.	2 (0.95 %)
	inferior good; inferior good.	0 (0 %)
	normal good; inferior good.	11 (5.24 %)
⇨	inferior good; normal good.	197 (93.81 %)

Average Grade: 0.94 / 1 (93.81 %)
Standard Deviation: 24.16 %
Point Biserial: 0.14
Discrimination Index: 10.71 %

Question 36 Difficulty: 1

Consider a monopoly where the inverse demand for its product is given by P = 100 - 3Q. Base on this information, the marginal revenue function is:

	MR(Q) = 200 - 1.5Q	2	(0.96 %)
⇨	MR(Q) = 100 - 6Q	199	(95.22 %)
	MR(Q) = 100 - 1.5Q	2	(0.96 %)
	MR(Q) = 200 - 6Q	6	(2.87 %)

Average Grade: 0.95 / 1 (94.76 %)
Standard Deviation: 22.33 %
Point Biserial: 0.23
Discrimination Index: 12.50 %

Question 37 Difficulty: 1

The recipe that defines the maximum amount of output that can be produced with K units of capital and L units of labor is the

⇨	production function.	209	(99.52 %)
	cost function.	0	(0 %)
	marginal product.	1	(0.48 %)
	average product.	0	(0 %)

Average Grade: 1 / 1 (99.52 %)
Standard Deviation: 6.90 %
Point Biserial: 0.17
Discrimination Index: 1.79 %

Question 38 Difficulty: 1

Suppose the demand for a product is $\ln Q^d = 20 - 2\ln P$, then this product is

⇨	elastic	164	(78.1 %)
	inelastic	21	(10 %)
	unitary elastic	19	(9.05 %)
	cannot be determined.	6	(2.86 %)

Average Grade: 0.78 / 1 (78.1 %)
Standard Deviation: 41.46 %
Point Biserial: 0.43
Discrimination Index: 50.00 %

Question 39 Difficulty: 1

When a demand curve is linear,

	the elasticity is the same as the slope of the demand curve.	10	(4.76 %)
⇨	demand is elastic at high prices.	187	(89.05 %)
	demand is unitary elastic at low prices.	2	(0.95 %)
	the elasticity is constant at all prices.	11	(5.24 %)

Average Grade: 0.89 / 1 (89.05 %)
Standard Deviation: 31.30 %
Point Biserial: 0.40
Discrimination Index: 26.79 %

Question 40 Difficulty: 1

If a firm's production function is Leontief and the wage rates goes up, the

⇨	cost minimizing combination of capital and labor does not change.	193	(92.34 %)
	firm would use more labor to minimize the cost for a given output	3	(1.44 %)
	firm would use more capital to minimize the cost for a given output	2	(0.96 %)
	firm would use less labor to minimize the cost for a given output	11	(5.26 %)

Average Grade: 0.92 / 1 (91.9 %)
Standard Deviation: 27.34 %
Point Biserial: 0.24
Discrimination Index: 17.86 %