MARKETS AND THE ENVIRONMENT

Review of Market System

Lecture Agenda

- Markets
- Review of Supply and Demand
  - Efficiency criteria
  - Welfare measures
- Market Failures
  - Externalities
  - Public goods
  - Common property
  - Hidden information

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Markets: Fundamentals

- Defining the Relevant Market
  - A market refers to the interaction between consumers and producers to exchange a well-defined commodity
  - Defining the market context is one of the more critical steps in economic analysis
- What markets do
  - Create wealth
  - Send signals
  - Fail

Key to successful market

- Property rights!
  - Comprehensive
  - Exclusive
  - Transferable
  - Secure

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Supply and Demand

An Overview

- Primary objective of the supply and demand model is to facilitate an analysis of market conditions and any observed change in price
- Sellers' decisions are modeled through a supply function and buyers' decisions are modeled through a demand function

Competitive Market for Private Goods

- Private goods are commodities that have two characteristics: rivalry in consumption and excludability
- A competitive market is characterized by:
  - A large number of buyers and sellers with no control over price
  - The product is homogenous or standardized
  - The absence of entry barriers
  - Perfect information

Demand

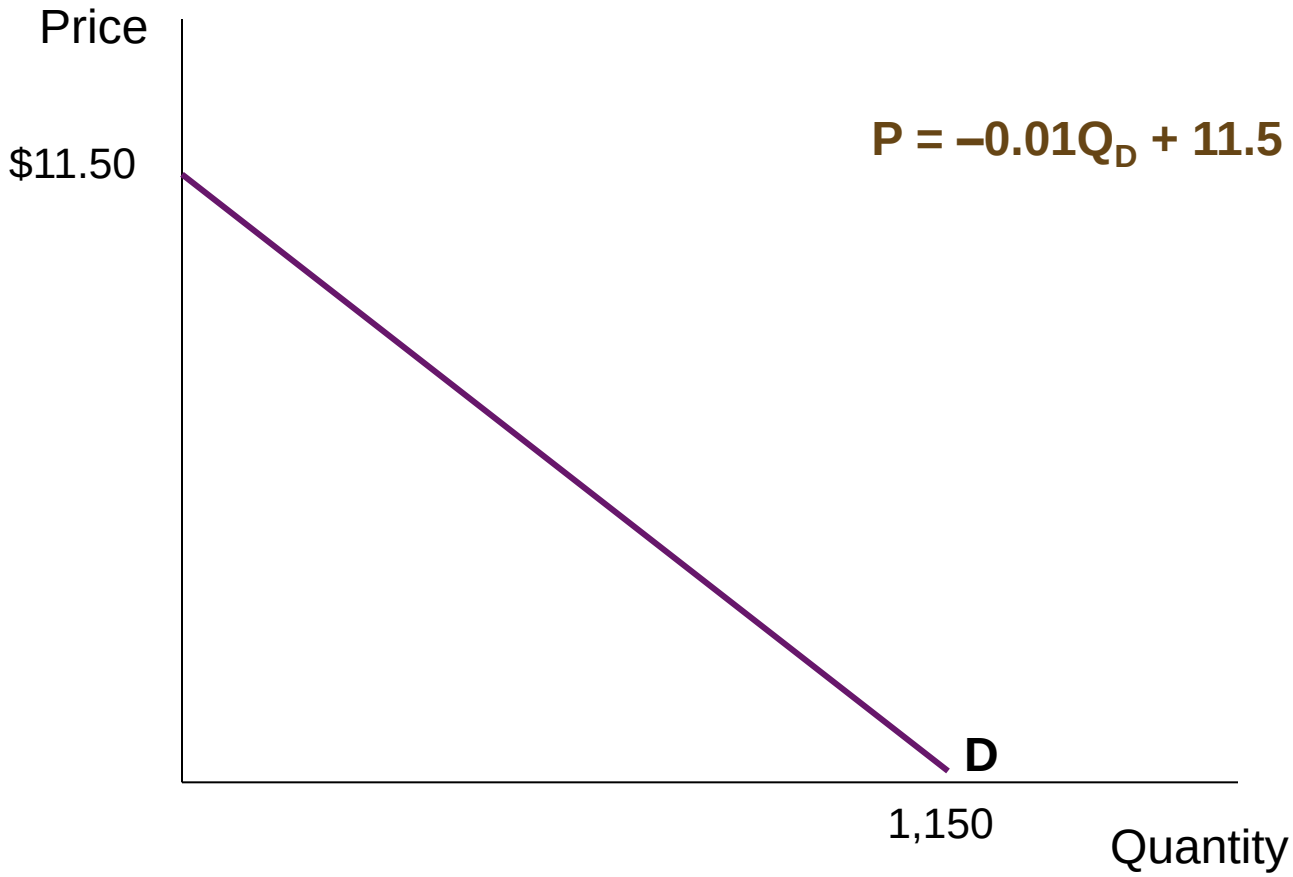
- Demand refers to quantities of a good consumers are willing and able to buy at a set of prices during some time period, *ceteris paribus (c.p.)*
  - The willingness to pay (WTP), or demand price, measures the marginal benefit (MB) from consuming another unit of the good
- Law of Demand says there is an inverse relationship between price (P) and quantity demanded (Qd) of a good, *c.p.*

Demand (continued)

- Economic variables held constant when specifying demand include income, wealth, prices of related goods, preferences, and price expectations
- Market demand captures the decisions of all consumers willing and able to purchase a good
  - For a private good, market demand is found by *horizontally summing* individual demands

Market Demand

Bottled Water



Supply

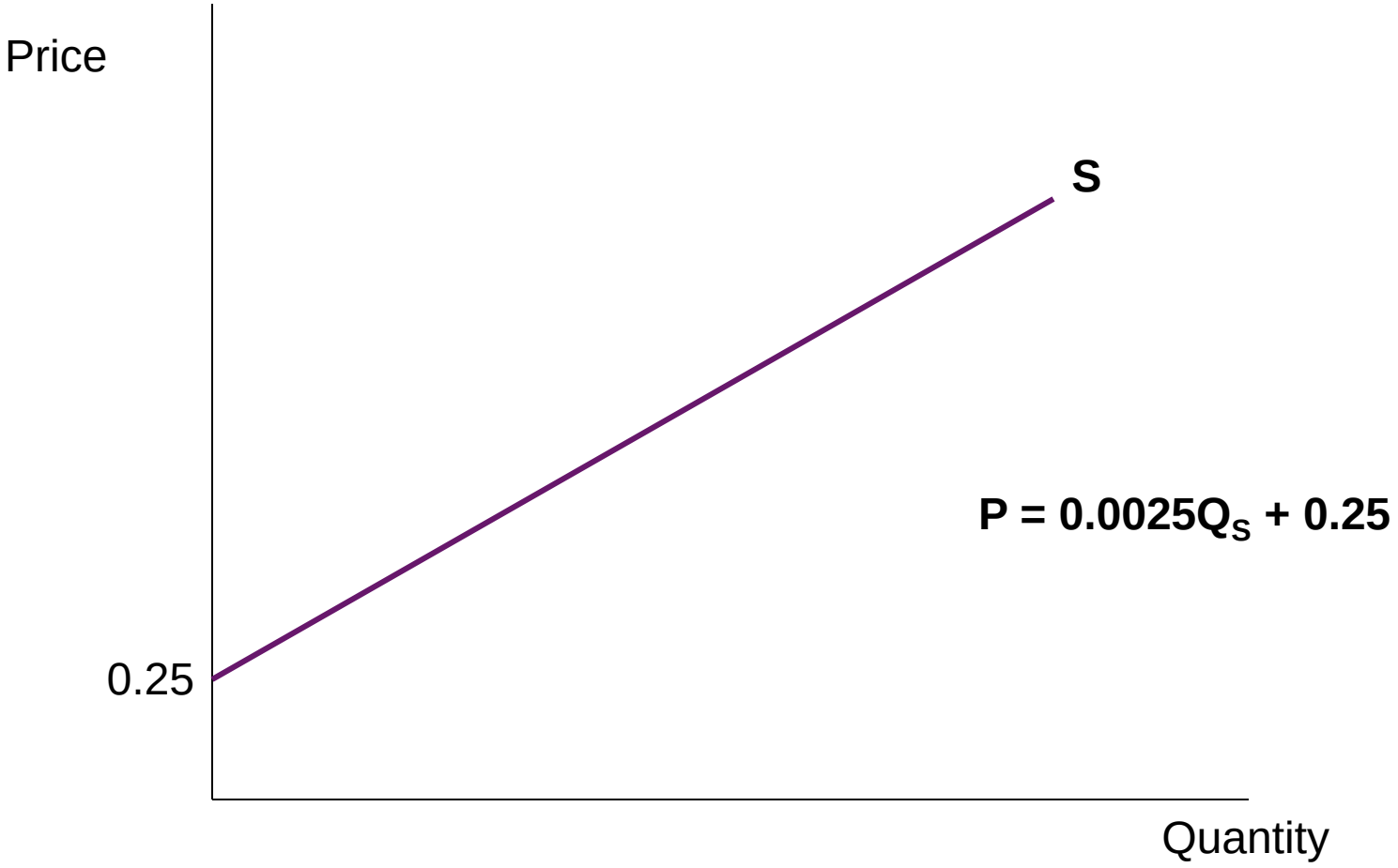
- Supply refers to the quantities of a good the producer is willing and able to bring to market at a given set of prices during some time period, *c.p.*
- Law of Supply says there is a direct relationship between price (P) and quantity supplied (Qs) of a good, *c.p.*
  - Rising marginal cost (MC) supports this positive relationship

Supply (continued)

- Economic variables held constant when deriving a supply curve include production technology, input prices, taxes and subsidies, and price expectations
- Market Supply captures the combined decisions of all producers in a given industry
  - Derived by *horizontally summing* the individual supply functions

Market Supply

Bottled Water

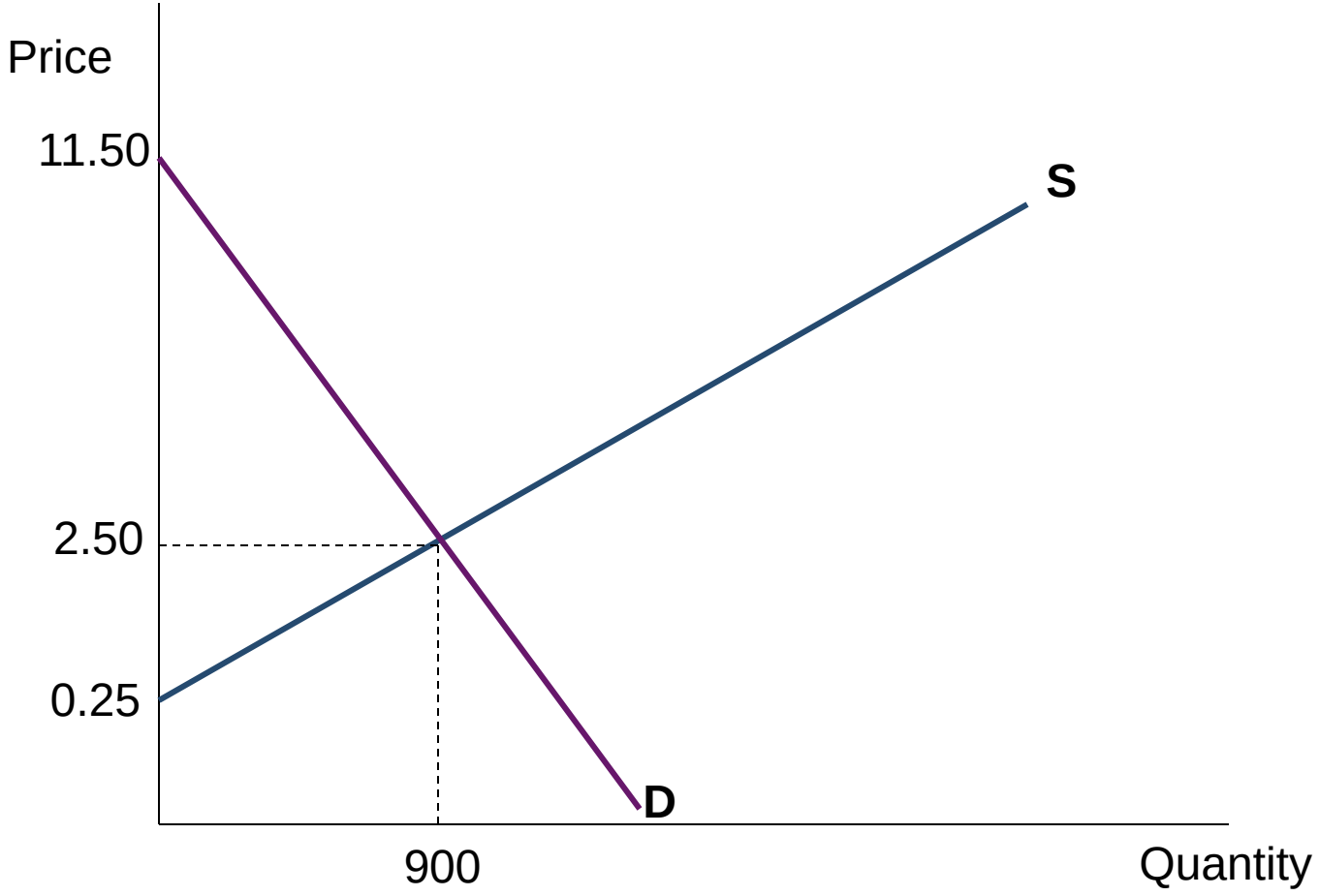


Market Equilibrium

- Supply and demand together determine a unique equilibrium price (P_E) and equilibrium quantity (Q_E), at which point there is no tendency for change
  - P_E arises where $Q_D = Q_S$
- Model for bottled water
  - D: **$P = -0.01Q_D + 11.5$**
  - S: **$P = 0.0025Q_S + 0.25$**
  - Find the equilibrium…

Market Equilibrium

Bottled Water



Market Adjustment to Equilibrium

- Disequilibrium occurs if the prevailing market price is at some level other than the equilibrium level
  - If actual price is *below* its equilibrium level, there will be a shortage
    - **Shortage**: excess demand of a commodity equal to ($Q_D - Q_S$)
  - If actual price is *above* its equilibrium level, there will be a surplus
    - **Surplus** – excess supply of a commodity equal to ($Q_S - Q_D$)
- Price movements serve as a signal that a shortage or surplus exists, whereas price stability suggests equilibrium

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Allocative Efficiency

- At the market level, allocative efficiency requires that resources be appropriated such that additional benefits to society are equal to additional costs incurred, or that MB = MC
  - The value society places on the good is equivalent to the value of the resources given up to produce it
- At the firm level, this efficiency is achieved at a competitive market equilibrium, assuming firms are profit maximizers
  - We illustrate by analyzing profit maximization

Profit Maximization

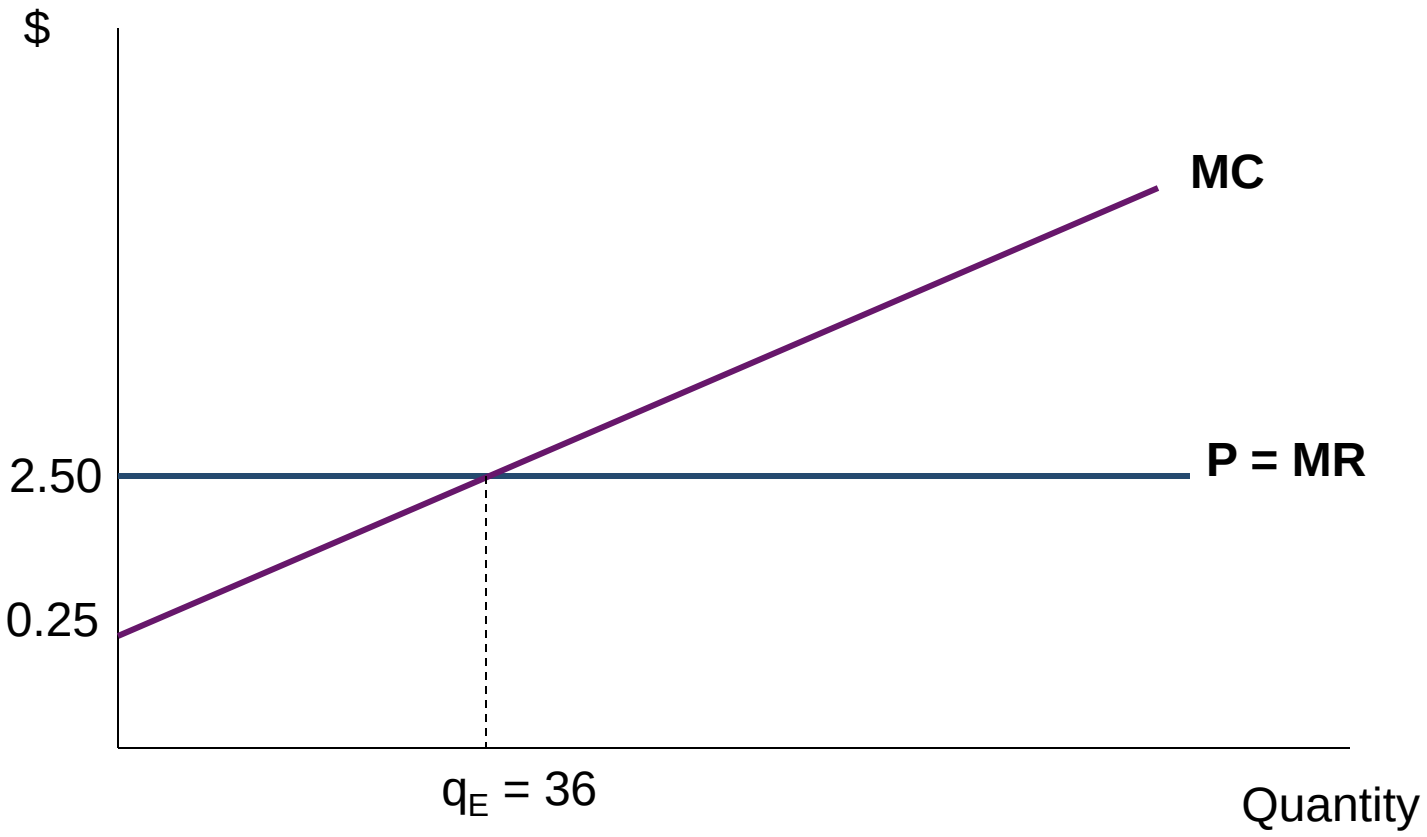
- Total profit (π) = Total Revenue (TR) - Total Costs (TC)
  - TR = P x Q
  - TC is all economic costs, explicit and implicit
- Profit is maximized where the relative benefits and costs of producing another unit of output are equal
  - From the firm's perspective, benefit is measured by TR and costs are measured by TC
  - $\therefore$ Profit is maximized where $\Delta TR/\Delta Q = \Delta TC/\Delta Q$, or where MR = MC, or where $M\pi = 0$
    - MR = $\Delta TR/\Delta Q$, additional revenue from producing another unit of Q
    - MC = $\Delta TC/\Delta Q$, additional cost from producing another unit of Q
    - $M\pi$ = MR – MC, additional profit from producing another unit of Q

Profit Maximization

- In competitive industries, firms face constant prices determined by the market, which means P = MR
- Therefore the competitive market equilibrium achieves allocative efficiency because:
  - π maximization requires: MR = MC
  - Competitive markets imply: P = MR
  - So π maximization in competition means: P = MC, which defines allocative efficiency

Profit Maximization

Bottled Water Market



Technical Efficiency

- Technical Efficiency refers to production decisions that generate maximum output given some stock of resources
  - Preserves the stock of natural resources and minimizes subsequent generation of residuals linked to resource use
- Market forces can achieve technical efficiency so long as competitive conditions prevail
  - Competitive firms must minimize costs to remain viable in the market because they cannot raise price to cover the added cost of inefficient production

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Welfare Measures

Consumer Surplus (CS)

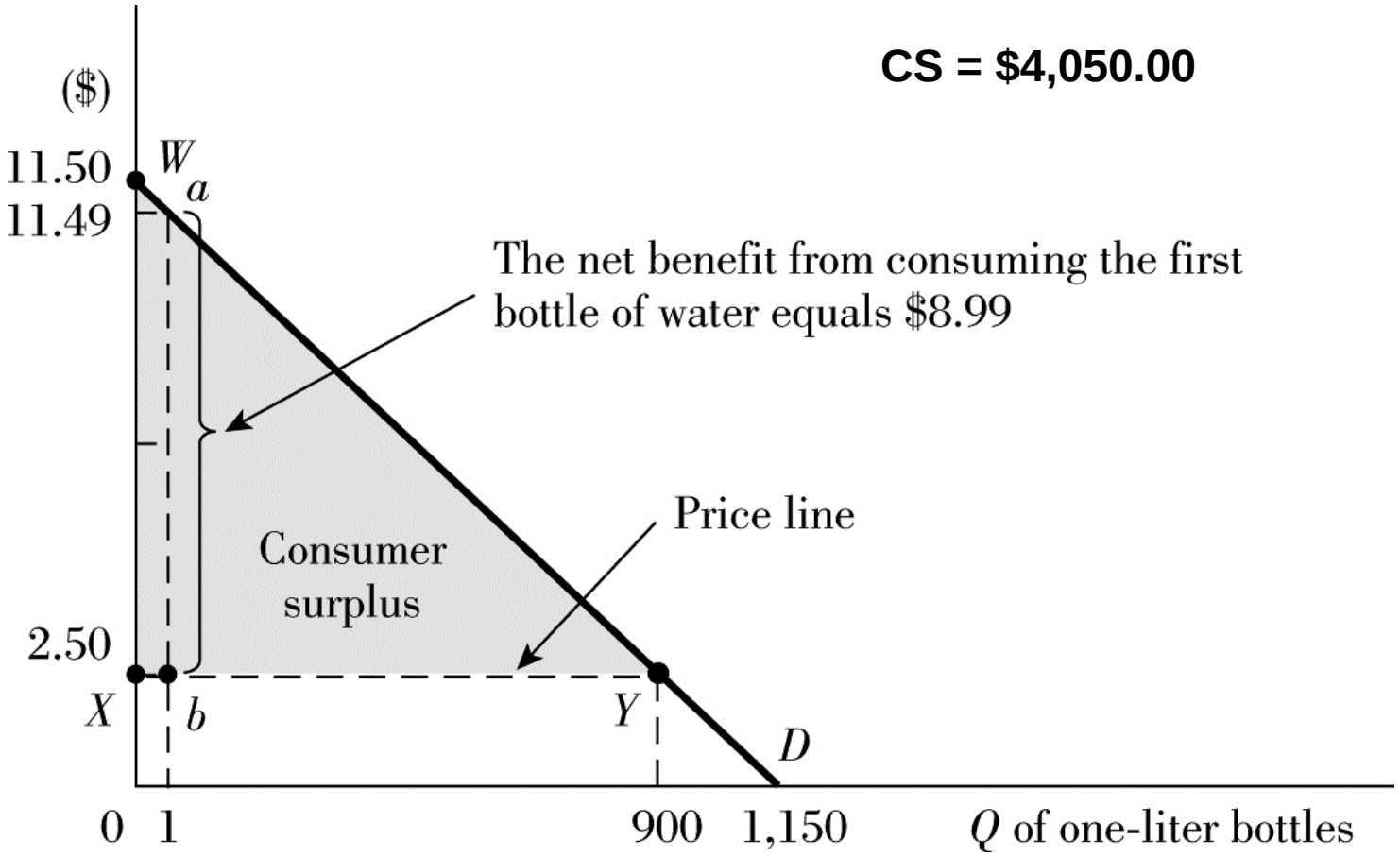
- Consumer surplus is the net benefit to buyers estimated by the excess of marginal benefit (MB) of consumption over market price (P), aggregated over all units purchased

- Graphically measured as the triangular area above the price and below the demand curve

Consumer Surplus

Bottled Water Market

CS = $4,050.00



Welfare Measures

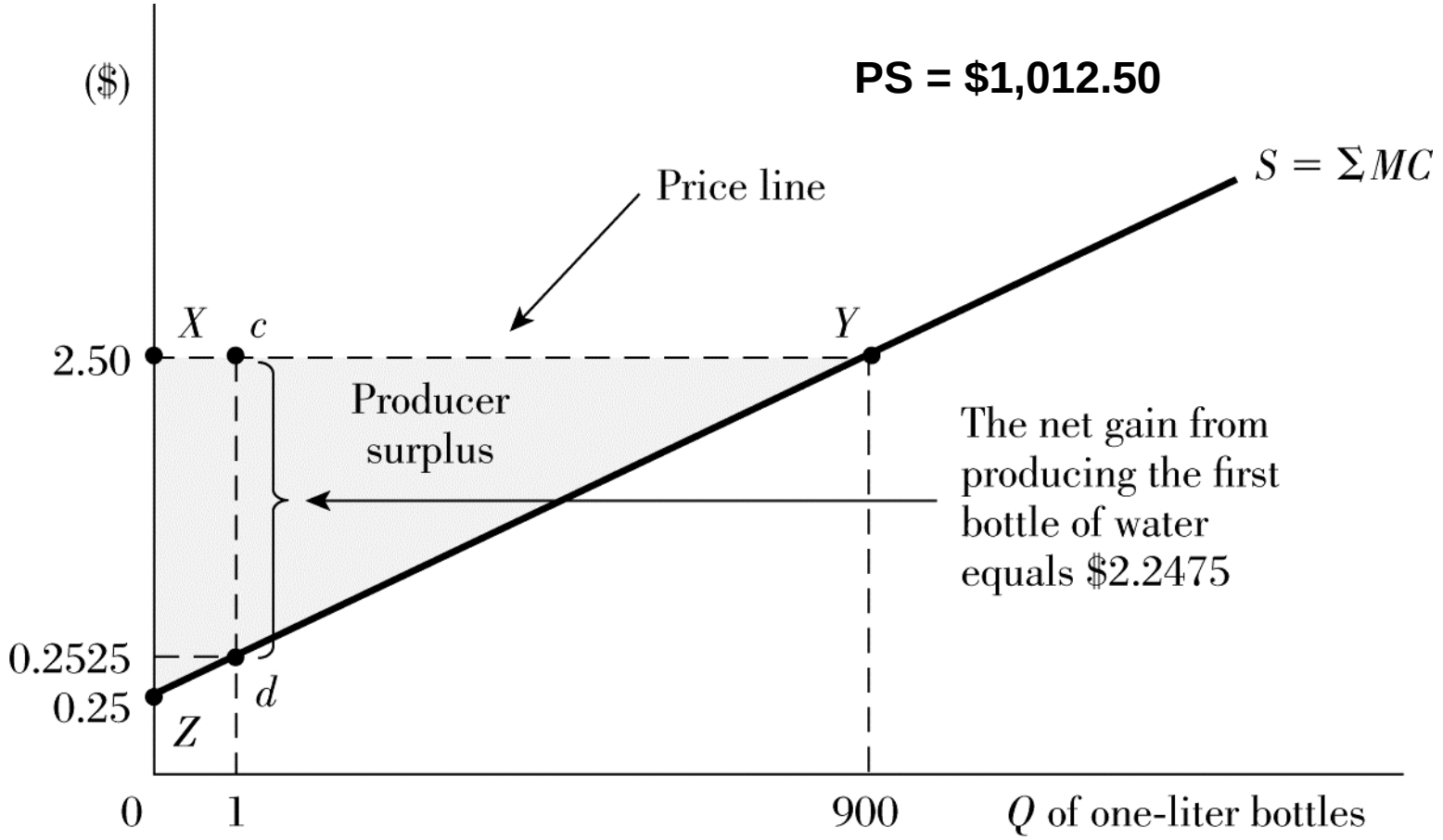
Producer Surplus (PS)

- Producer surplus is the net gain to sellers of a good estimated by the excess of the market price (P) over marginal cost (MC), aggregated over all units sold

- Graphically measured as the triangular area above the MC curve up to the price level over all units sold

Producer Surplus

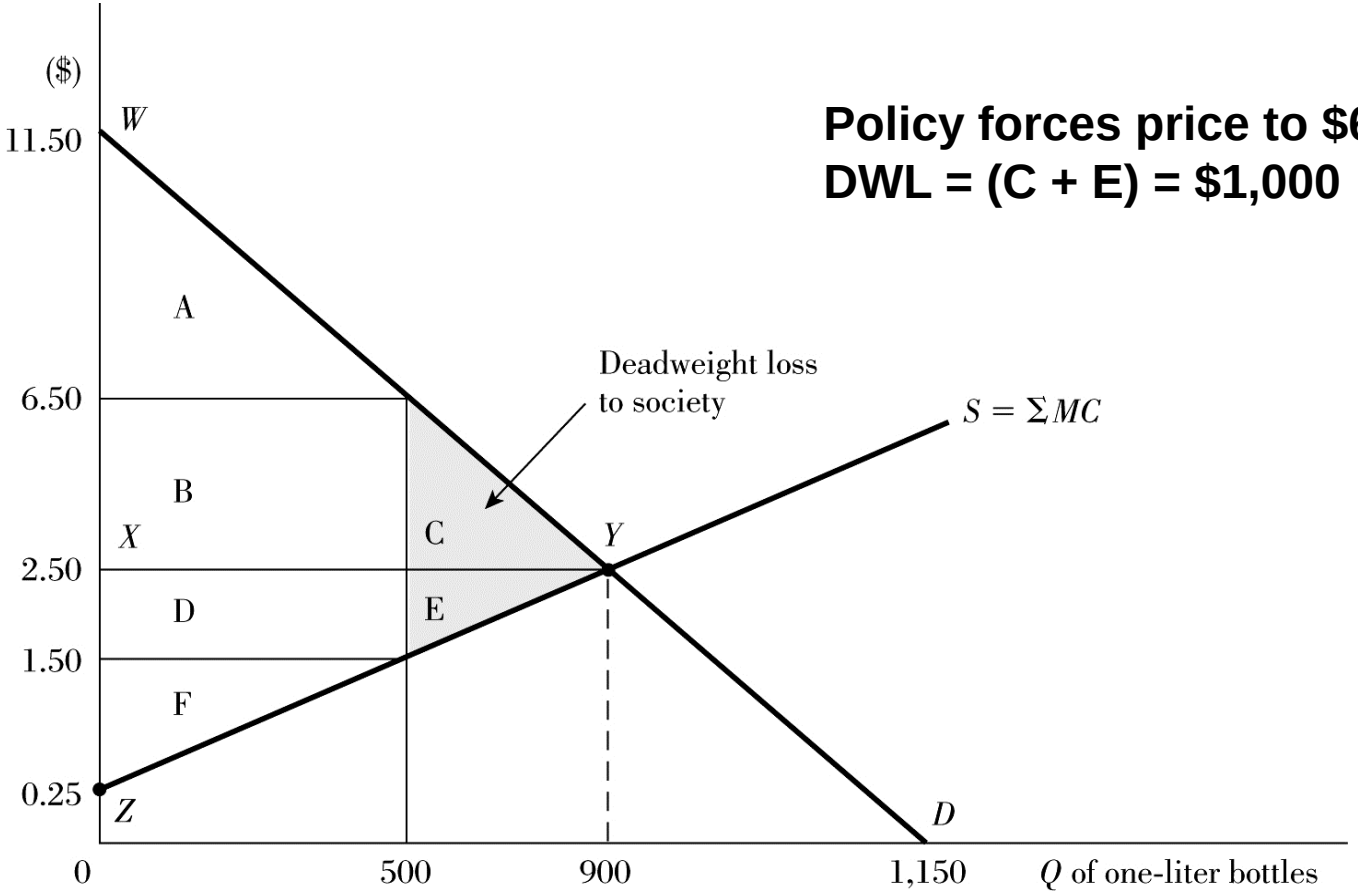
Bottled Water Market



Deadweight Loss (DWL)

- Society's welfare can be captured through the sum of Consumer Surplus and Producer Surplus
- Comparing these measures before and after a market disturbance helps quantify how society is affected by that disturbance through Deadweight Loss (DWL)
- DWL is the net loss of consumer and producer surplus due to an allocatively inefficient market event

DWL of Price Regulated above P_E Bottled Water Market



Policy forces price to $6.50
DWL = (C + E) = $1,000

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Environmental Pollution
A Market Failure

- Market failure is the result of an inefficient market condition
- Environmental problems are modeled as market failures using either the theory of externalities or the theory of public goods
  - If the market is defined as the good whose production or consumption generates environmental damage, then the market failure is due to an externality
  - If the market is defined as "environmental quality," then the source of the market failure is that environmental quality is a public good
    - Common property
  - Sometimes these market failures are due to hidden information and market power/monopoly.

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Externality

- An **externality** is a spillover effect associated with production or consumption that extends to a third party outside the market
  - Negative externality – an external effect that generates costs to a third party
  - Positive externality – an external effect that generates benefits to a third party

Environmental Problems

A Negative Externality

- Environmental economists are interested in externalities that damage the atmosphere, water supply, natural resources, and overall quality of life
- To model these environmental externalities, the relevant market must be defined as the good whose production or consumption generates environmental damage outside the market transaction

Negative Externality Examples

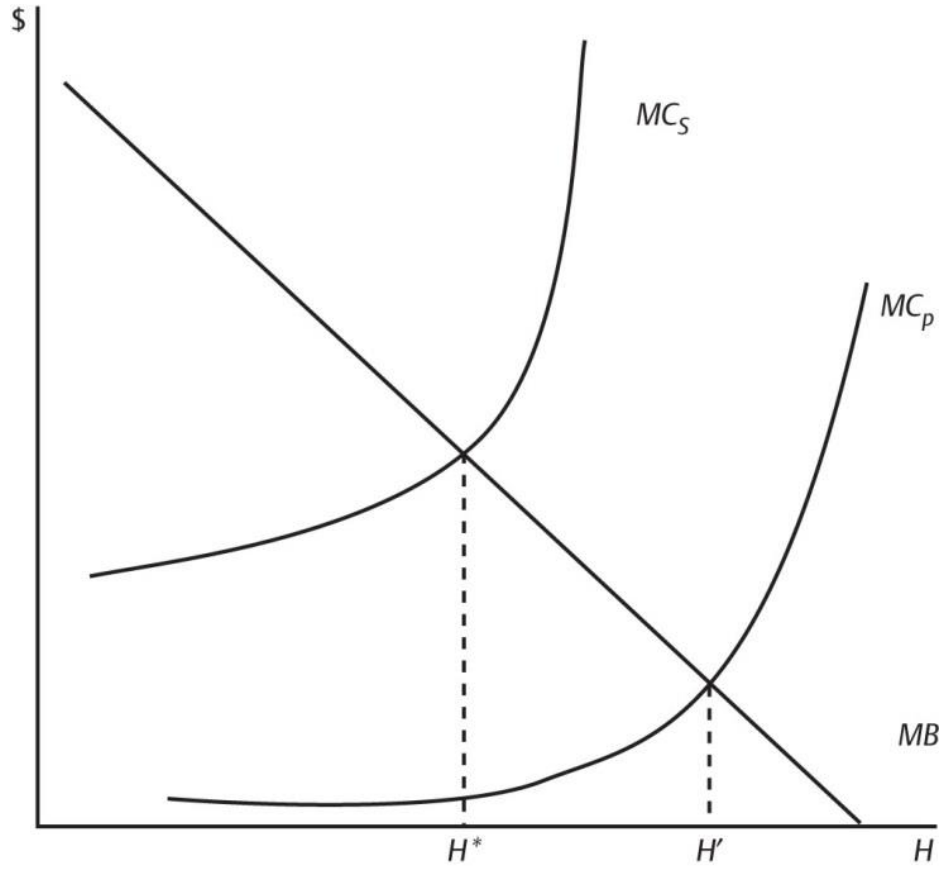
Acid Rain

Dams

Modeling a Negative Environmental Externality

- Define the market as refined petroleum
  - Assume the market is competitive
  - Supply is the marginal *private* cost (MC_P)
  - Demand is the marginal benefit (MB)
  - Production generates pollution, modeled as a marginal *external* cost (MEC)
  - Social supply is $MC_S = MC_P + MEC$
- **Problem**: Producers (refineries) have no incentive to consider the externality
- **Result**: Competitive solution is inefficient

Theoretical Explanation



Finding a Competitive Solution

Refined Petroleum Market

- S: P = 10.0 + 0.075Q
- D: P = 42.0 − 0.125Q, where

  Q is thousands of barrels per day
- Since S is MC_P and D is MB, rewrite as:

$$MC_P = 10.0 + 0.075Q$$

$$MB = 42.0 - 0.125Q$$

- Find the competitive solution and analyze

Competitive Solution

- Set $MB = MC_P$

  42.0 − 0.125Q = 10.0 + 0.075Q

- Solve….

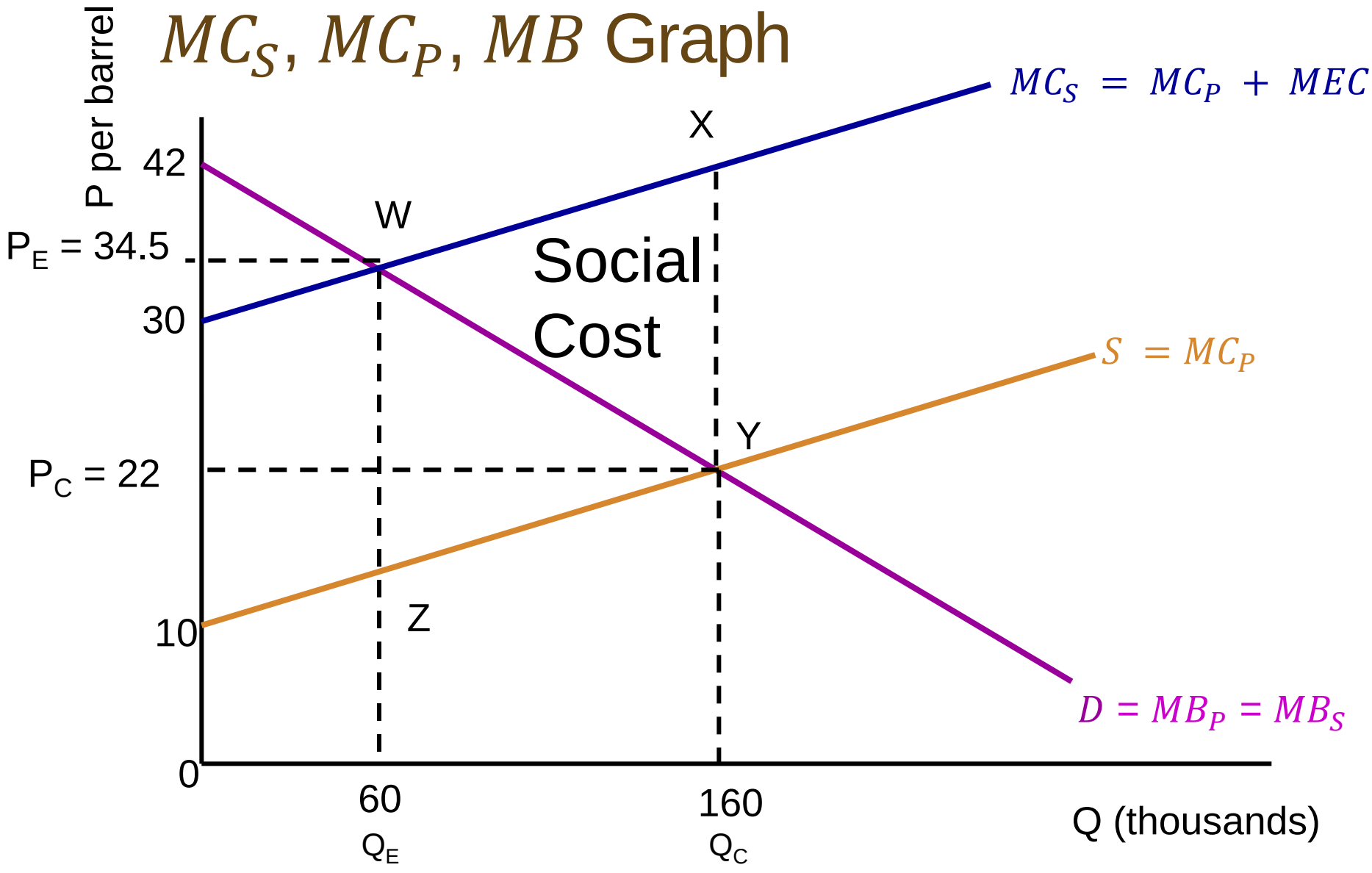
- Analysis:
  - This ignores external costs from contamination
  - Allocative efficiency requires P to equal *all* MC
  - MC_P undervalues opportunity costs of production; Q_C is too high; P_C is too low

Finding an Efficient Solution: Example 1

Refined Petroleum Constant Damage

- Let Marginal External Cost (MEC) = 20
- Marginal Social Cost (MC_S) = MC_P + MEC
  - MC_S = 10.0 + 0.075Q + 20
    = 30 + 0.075Q
- Marginal Social Benefit (MB_S) =MB_P + MEB
  - Assuming no external benefits, MEB = 0, so MB_S= MB_P
- Find the efficient solution; show graphically and compare

MC_S, MC_P, MB Graph



Observations

- Results of negative externality
- Q_C = 160 thousand
  - At this point, MEC = \$8.00 per barrel
    - Q_C is too high, i.e., overallocation of resources (not efficient)
    - P_C is too low, since MEC is not captured by market transaction
- Q_E = 60 thousand
  - At this point, MEC = \$20 per barrel
- Efficiency would improve if output were restricted by 60 thousand (i.e., 160 − 60)

Measuring Society's Net Gain

From Restoring Efficiency

- As Q falls from 160 to 60:
  - Refineries lose π measured as Mπ (or excess of MB over MC_P) for each unit of Q contracted
    - Defines area **WYZ**
  - Society gains accumulated reduction in MEC for each unit of Q contracted
    - Defines area **WXYZ**
  - Net gain =Area WXYZ - Area WYZ =Area WXY

Finding an Efficient Solution: Example 2

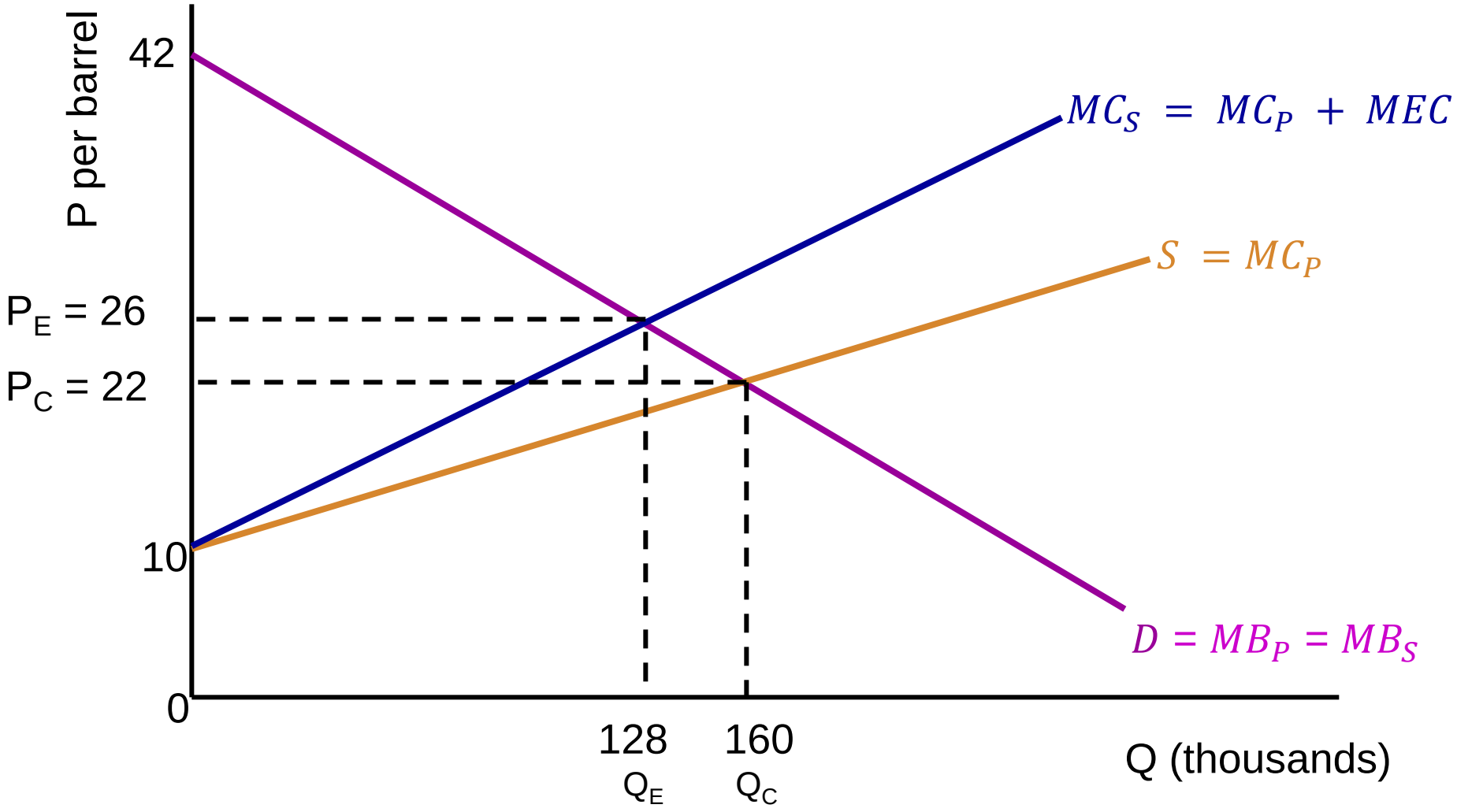
Refined Petroleum Increasing Damage

- Let Marginal External Cost (MEC) = 0.05Q
- Marginal Social Cost (MC_S) = MC_P + MEC
  - MC_S = 10.0 + 0.075Q + 0.05Q
    = 10.0 + 0.125Q
- Marginal Social Benefit (MB_S) =MB_P + MEB
  - Assuming no external benefits, MEB = 0, so MB_S= MB_P
- Find the efficient solution; show graphically

Efficient Solution

- Set $MC_S = MB_S$
  - 10.0 + 0.125Q = 42.0 - 0.125Q
- Solve….
- Observe: In the presence of an externality, market forces *cannot* determine an efficient outcome

MC_S, MC_P, MB Graph



Observations

- Results of negative externality
- Q_C = 160 thousand
  - At this point, MEC = \$8.00 per barrel
    - Q_C is too high, i.e., overallocation of resources (not efficient)
    - P_C is too low, since MEC is not captured by market transaction
- Q_E = 128 thousand
  - At this point, MEC = \$6.40 per barrel
- Efficiency would improve if output were restricted by 32 thousand (i.e., 160 −128)

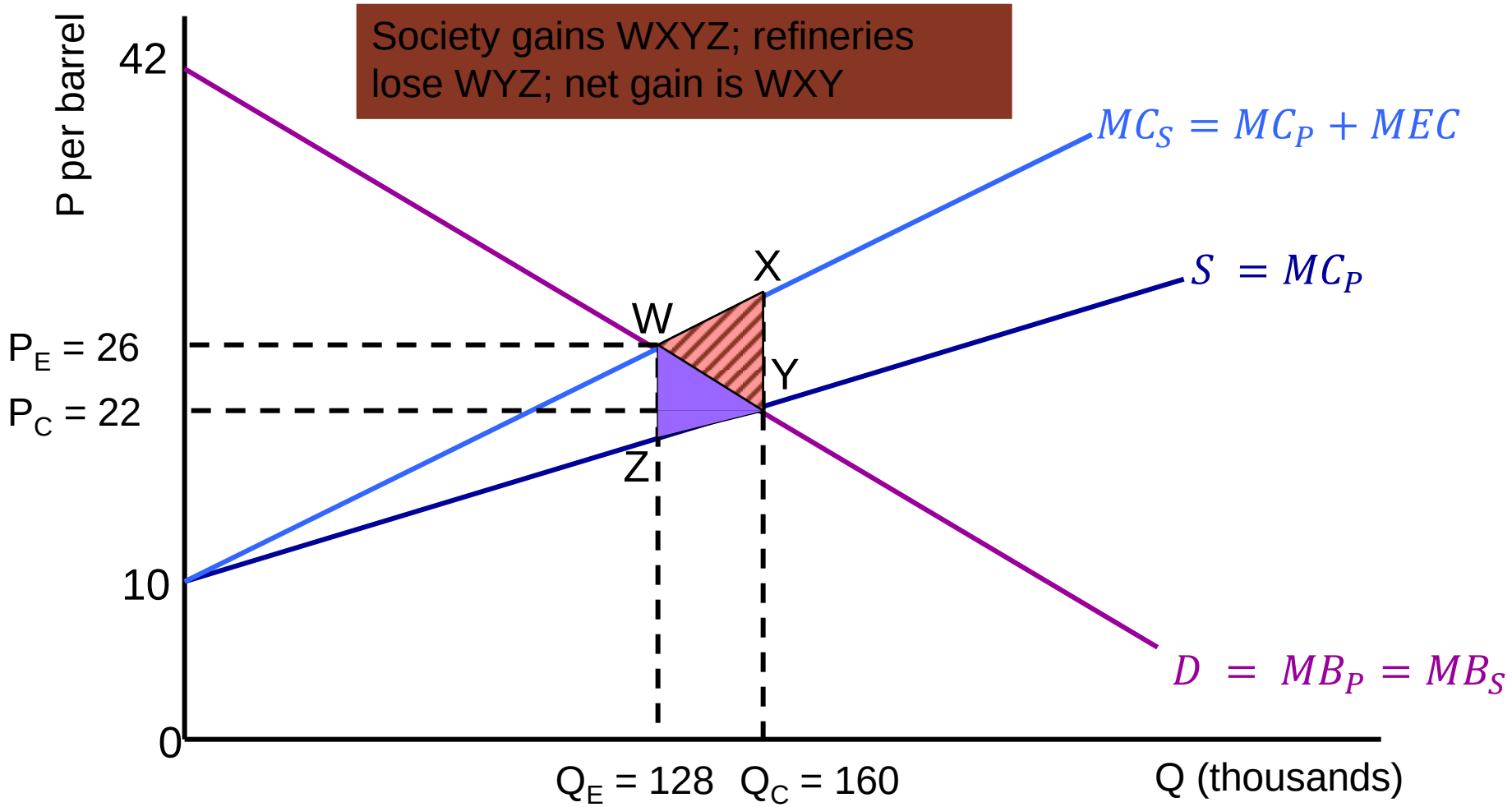
Measuring Society's Net Gain

From Restoring Efficiency

- As Q falls from 160 to 128:
  - Refineries lose π measured as Mπ (or excess of MB over MC_P) for each unit of Q contracted
    - Defines area **WYZ**
  - Society gains accumulated reduction in MEC for each unit of Q contracted
    - Defines area **WXYZ**
  - Net gain =Area WXYZ - Area WYZ =Area WXY

Measuring Society's Net Gain

Refined Petroleum Market



Solution to Externalities

Government Intervention

- Internalize externality by:
  - Assigning property rights, OR
  - Set policy prescription, such as:
    - Set standards on pollution allowed
    - Tax polluter equal to MEC at Q_E
    - Establish a market and price for pollution

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Environmental Quality
A Public Good

- A public good is a commodity that is nonrival in consumption and yields nonexcludable benefits
  - **Nonrivalness** – the characteristic of indivisible benefits of consumption such that one person's consumption does not preclude that of another
  - **Nonexcludability** – the characteristic that makes it impossible to prevent others from sharing in the benefits of consumption
- The relevant market definition is the public good – environmental quality, which possesses these characteristics

Market Demand for a Public Good

- In theory, market D for a public good is found by *vertically summing* individual demands
  - Vertical sum because we must ask consumers *"What **price** would you be willing to pay for each quantity of the public good?"*
- But consumers are unwilling to reveal their WTP because they can share in consuming the public good even when purchased by someone else
  - Due to the nonrival and nonexcludability characteristics
- This problem is called nonrevelation of preferences, which arises due to free-ridership

Modeling Public Goods Market

- Air quality example

Market Demand for a Public Good

- Result is that market demand is undefined
  - Tragedy of the commons
- In addition, lack of awareness of environmental problems (i.e., imperfect information) exacerbates the problem
- Consequently, allocative efficiency cannot be achieved without third-party intervention

Solution to Public Goods Dilemma
Government Intervention

- Government might respond through direct provision of public goods
- Government might use political procedures and voting rules to identifying society's preferences about public goods

Important Observations

- Both externality and public goods models show inefficiency of private market solution, i.e., market failure
- Underlying source of failure is **absence of property rights**
  - Boston Harbor application

Relationship Between Public Goods and Externalities

- Although public goods and externalities are not the same concept, they are closely related
  - If the externality affects a broad segment of society and if its effects are nonrival and nonexcludable, the externality is itself a public good
  - If the externality affects a narrower group of individuals or firms, those effects are more properly modeled as an externality

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Common Property Resources

- Property rights are shared and the resource benefits are **rival.**
- Open-access free-for-all
  - Inefficient use of the resource
  - Example: Fisheries
- Market price failed to signal the true scarcity of the resource

Modeling Common Property Resources

- Monopolist is a conservationists best friend!

Solution to Common Property Dilemma

- Self-governing commons
  - Examples: Torbel, Switzerland and several Japanese villages
- Local vs. global commons

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Hidden Information

- Occurs when people cannot observe either the actions or the types of people
  - **moral hazard**
  - **adverse selection**

- Both types of hidden information slow the creation of markets that could be used to allocate resources to more efficient use

Solutions to Hidden Information

- Government intervention
- Self-selecting contracts