EE311: Externality*

THAMMASAT

- **Based on Besanko, David, and Ronald R. Braeutigam, *Microeconomics,* (5th ed). *John Wiley & Sons, 2015* and Harvey S Rosen and Ted Gayer, Public Finance, McGraw-Hill, 2019**

Externalities

Externality is the "effect" imposed on the third party, as a result of an action by any decision maker.

The effect can be **negative (cost) or positive (benefit)**.

The action of an agent can be **production or consumption**.

Externality is a cause of market failure.

Market Failure is a situation in which the allocation of goods and services by a free market is not Pareto efficient.

Examples of Externalities

- Negative Externalities
  - Pollution
  - Cell phones in a movie theater
  - Congestion on the internet
  - Drinking and driving
  - Student cheating that changes the grade curve
  - The “Club” anti-theft device for automobiles
- Positive Externalities
  - Research & development
  - Vaccinations
  - A neighbor’s nice landscape
  - Students asking good questions in class
  - The “LoJack” anti-theft device for automobiles
- *Not* Considered Externalities
  - Land prices rising in urban area
  - Known as “pecuniary” externalities

Externalities

4 Catagories

1) Negative Consumption Externality

Consumption of cigarettes harms nearby people.

2) Positive Consumption Externality

Consumption of vaccine helps prevent contagious diseases.

3) Negative Production Externality (We will focus on this one.)

Production of some goods creates pollution.

4) Positive Production Externality

Bees from beekeeping help pollinate surrounding trees.

Key Terms (Production Side)

Marginal Private Cost (MPC) is the MC of private firms.
Hence, MPC can be considered as the supply curve in a competitive market.

Marginal External Cost (MEC) or Marginal Damage (MD) is the MC on the third party.

Marginal Social Cost (MSC) is the MC of the society (private firms + the third party).

Thus, **MSC = MPC + MEC or MSC = MPC+MD**

Without production externality, MSC = MPC .

Graphical Analysis: Negative Externalities

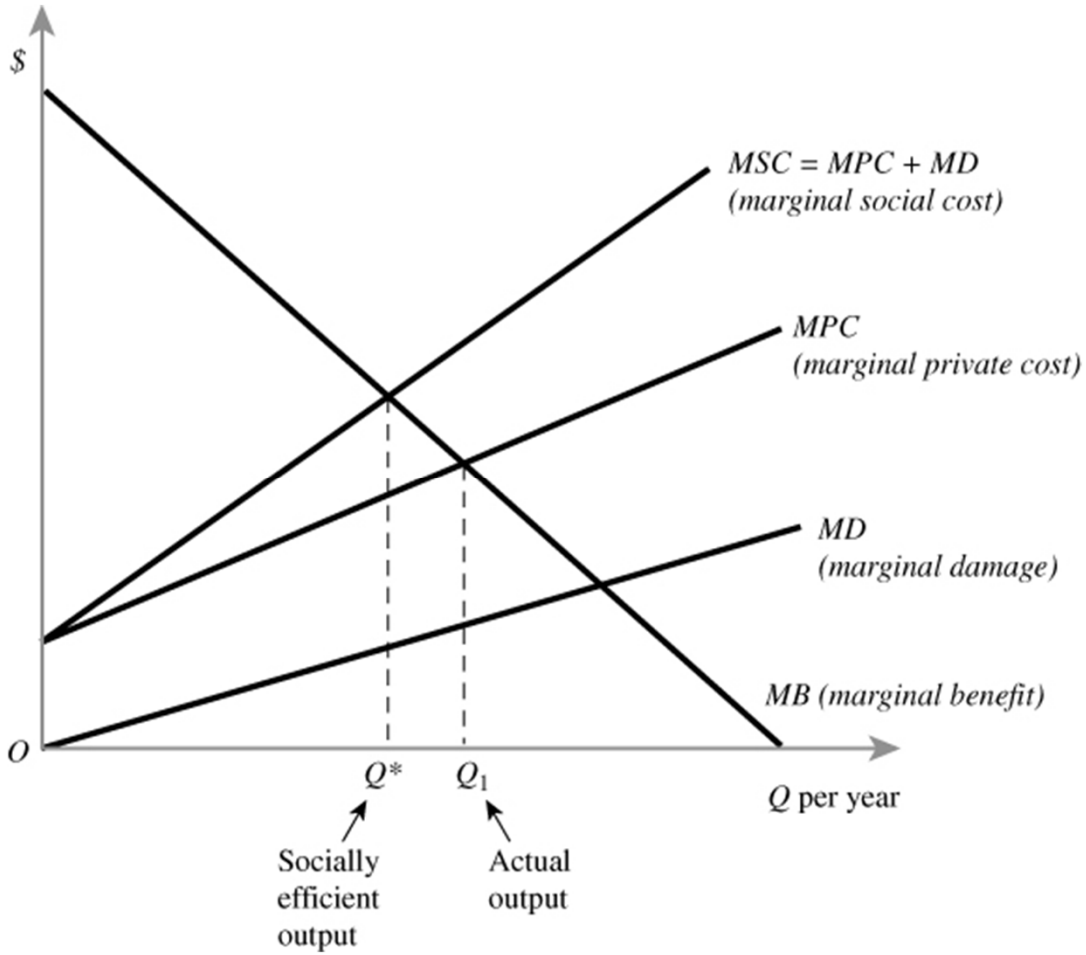
- For simplicity, assume that a steel firm dumps pollution into a river that harms a fishery downstream.
- Competitive markets, firms maximize profits
  - Note that steel firm only cares about its own profits, not the fishery's profits.
  - Fishery only cares about its profits, not the steel firm's profits.

Graphical Analysis: Negative Externalities

- MPB = marginal *private* benefit of steel (or in short, MB)
- MPC = marginal *private* cost to steel firm
- MD = marginal damage to fishery

  (Note: in Besanko's text, it is called MEC)
- MSC = marginal *social* cost = MPC+MD or = MPC+MEC

Figure 1


$
MSC = MPC + MD
(marginal social cost)
MPC
(marginal private cost)
MD
(marginal damage)
MB (marginal benefit)
O
Q*
Q1
Q per year
Socially efficient output
Actual output

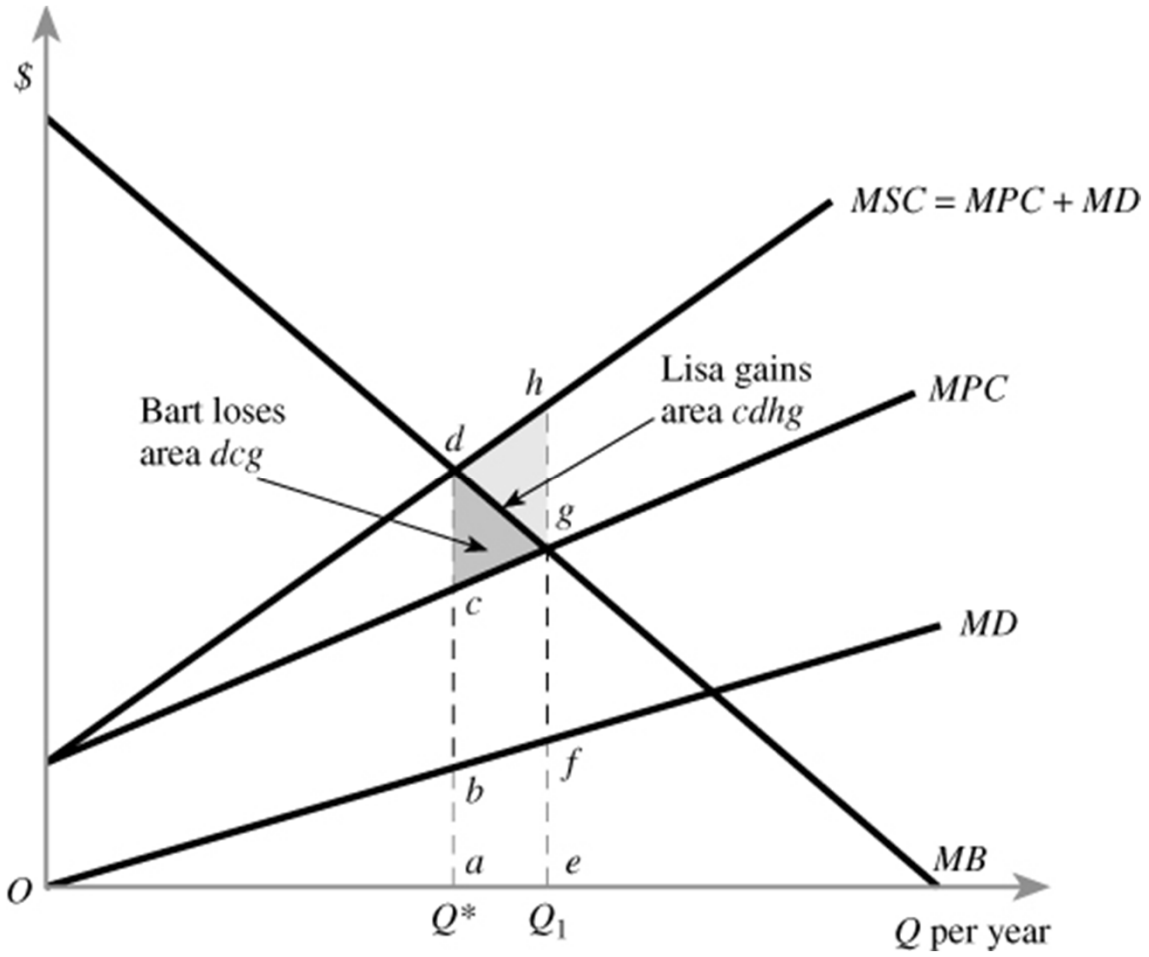
Graphical Analysis: Negative Externalities

- From Figure 1, as usual, the steel firm maximizes profits at ***MB=MPC***. This quantity is denoted as Q_1 in the figure.
- Social welfare is maximized at ***MB=MSC***, which is denoted as Q^* in the figure.

Graphical Analysis: Implications

- ***Result 1***: $Q_1 > Q^*$
  - Steel firm privately produces "*too much*" steel, because it does not account for the damages to the fishery.
- ***Result 2***: Fishery's preferred amount is 0.
  - Fishery's damages are minimized at MD=0.
- ***Result 3***: Q^* is not the preferred quantity for either party, but is the best compromise between fishery and steel firm.
- ***Result 4***: Socially efficient level entails some pollution.
  - Zero pollution is not socially desirable.

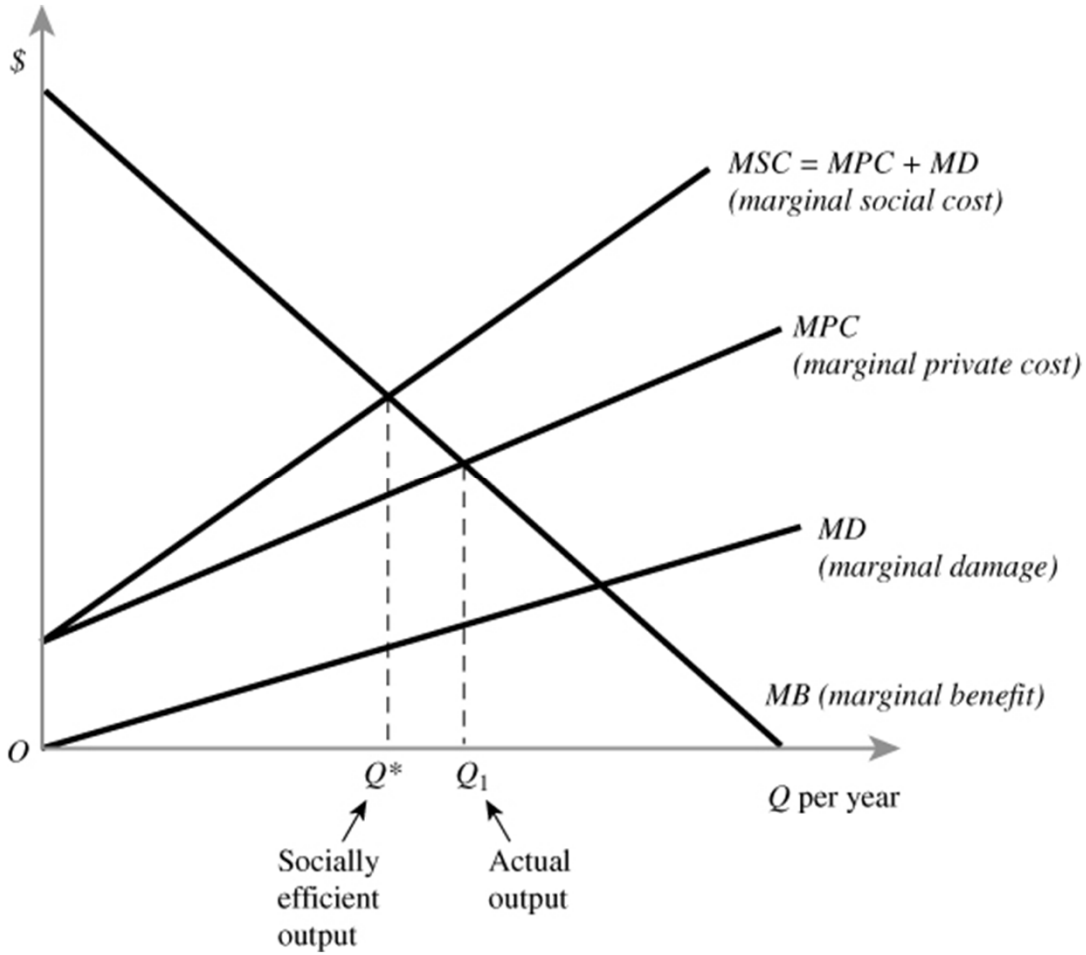
Figure 2


$
MSC = MPC + MD
MPC
MD
MB
Bart loses
area dcg
Lisa gains
area cdhg
h
d
g
c
b
f
a
e
O
Q*
Q1
Q per year

Graphical Analysis, Intuition

- In Figure 2, loss to steel firm of moving to Q^* is shaded triangle ***dcg***.
  - This is the area between the MB and MPC curve going from Q_1 to Q^*.
- Fishery gains by an amount ***abfe***.
  - This is the area under the MD curve going from Q_1 to Q^*. By construction, this equals area ***cdhg***.
- Difference between fishery's gain and steel firm's loss is the efficiency loss from producing Q_1 instead of Q^*.

Welfare Analysis of Negative Externality



Negative Production Externalities

	Equilibrium (price = P_1)	Social Optimum (price = P^*)	Difference between Social Optimum and Equilibrium
Consumer surplus	$A + B + G + K$	A	$-B - G - K$
Private producer surplus	$E + F + R + H + N$	$B + E + F + R + H + G$	$B + G - N$
−Cost of externality	$-R - H - N - G - K - M$	$-R - H - G$	$M + N + K$ (external cost savings)
Net social benefits (consumer surplus + private producer surplus − cost of externality)	$A + B + E + F - M$	$A + B + E + F$	M (increase in net benefits at social optimum)
Deadweight loss	M	Zero	M

Exercise

LEARNING-BY-DOING EXERCISE 17.1

The Efficient Amount of Pollution

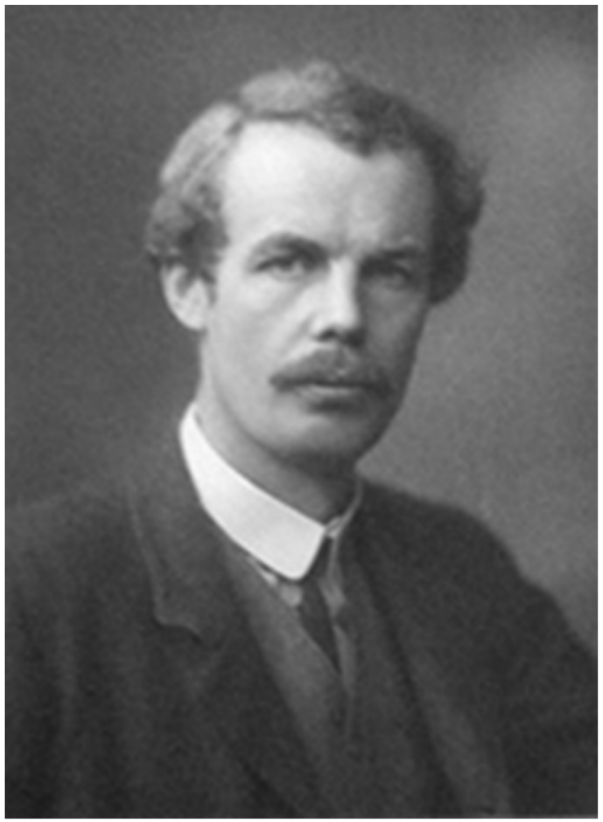
Problem Evaluate the following argument: "Since pollution is a negative externality, it would be socially optimal to declare illegal the use of any production process that creates pollution."

Solutions to Pollution

To correct externalities, the government should intervene the free market. Solutions to pollution include:

1. Emissions Fees (We will focus on this one.)
   A per unit tax on pollution released into the environment. Emission Fees works as Pigovian tax (also spelled Pigouvian tax) is a tax on any market activity that generates negative externalities.
2. Emissions Standards
   An official limit on the amount of pollution emission.
3. Emissions Permits (also called "Cap and Trade")
   The government sets a fixed number of permits to emit pollution. Polluting firms can sell and buy these permits.

Arthur C. Pigou



Arthur Cecil Pigou was an English economist. As a teacher and builder of the School of Economics at the University of Cambridge, he trained and influenced many Cambridge economists who went on to take chairs of economics around the world. Wikipedia

Born: November 18, 1877, Ryde, United Kingdom

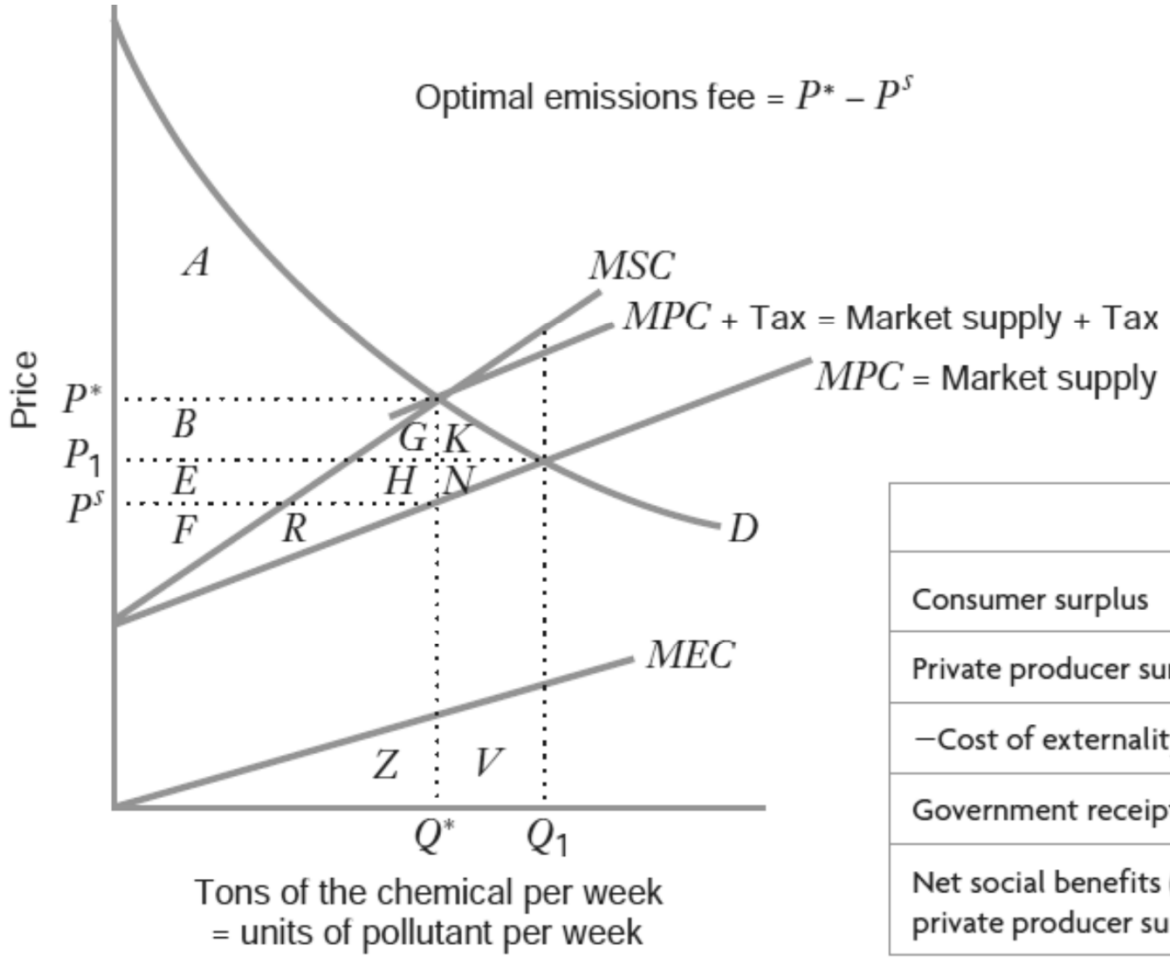
Died: March 7, 1959, Cambridge, United Kingdom

Contributions: Externalities; Pigou effect; Pigovian tax

School or tradition: Neoclassical economics

Influenced: John Maynard Keynes, Paul Krugman, N. Gregory Mankiw, William Baumol

Emission Fees / Pigouvian Tax



	Equilibrium (with tax)
Consumer surplus	A
Private producer surplus	$F + R$
−Cost of externality	$-R - H - G$
Government receipts from emissions tax	$B + G + E + H$
Net social benefits (consumer surplus + private producer surplus − cost of externality)	$A + B + E + F$

Emission Fees / Pigouvian Tax

Tax on firms means they face higher cost of production.

This will shift the supply curve or MPC upward by the magnitude of the per unit tax.

The optimal tax/fee will make supply curve or MPC intersect demand curve at Q* (where MSC = MSB = D).

To find the optimal tax, TAX = MEC(Q*).

At Q*, the market now becomes socially efficient.

LEARNING-BY-DOING EXERCISE 17.2

Emissions Fee

Consider a variation of the chemical manufacturing example. Suppose the inverse demand curve for the chemical (which is also the marginal benefit curve) is $P^d = 24 - Q$, where Q is the quantity consumed (in millions of tons per year) when the price consumers pay (in dollars per ton) is P^d.

The inverse supply curve (also the marginal private cost curve) is $MPC = 2 + Q$, where MPC is the marginal private cost when the industry produces Q.

The industry emits one unit of pollutant for each ton of chemical it produces. As long as there are fewer than 2 million units of pollutant emitted each year, the external cost is zero. But when the pollution exceeds 2 million units, the marginal external cost is positive. The marginal external cost curve is

$$MEC = \begin{cases} 0, & \text{when } Q \leq 2 \\ -2 + Q, & \text{when } Q > 2 \end{cases}$$

where MEC is marginal external cost in dollars per unit of pollutant when Q units of pollutant are released.

Also suppose the government wants to use an emissions fee of $\$T$ per unit of emissions to induce the market to produce the economically efficient amount of the chemical.

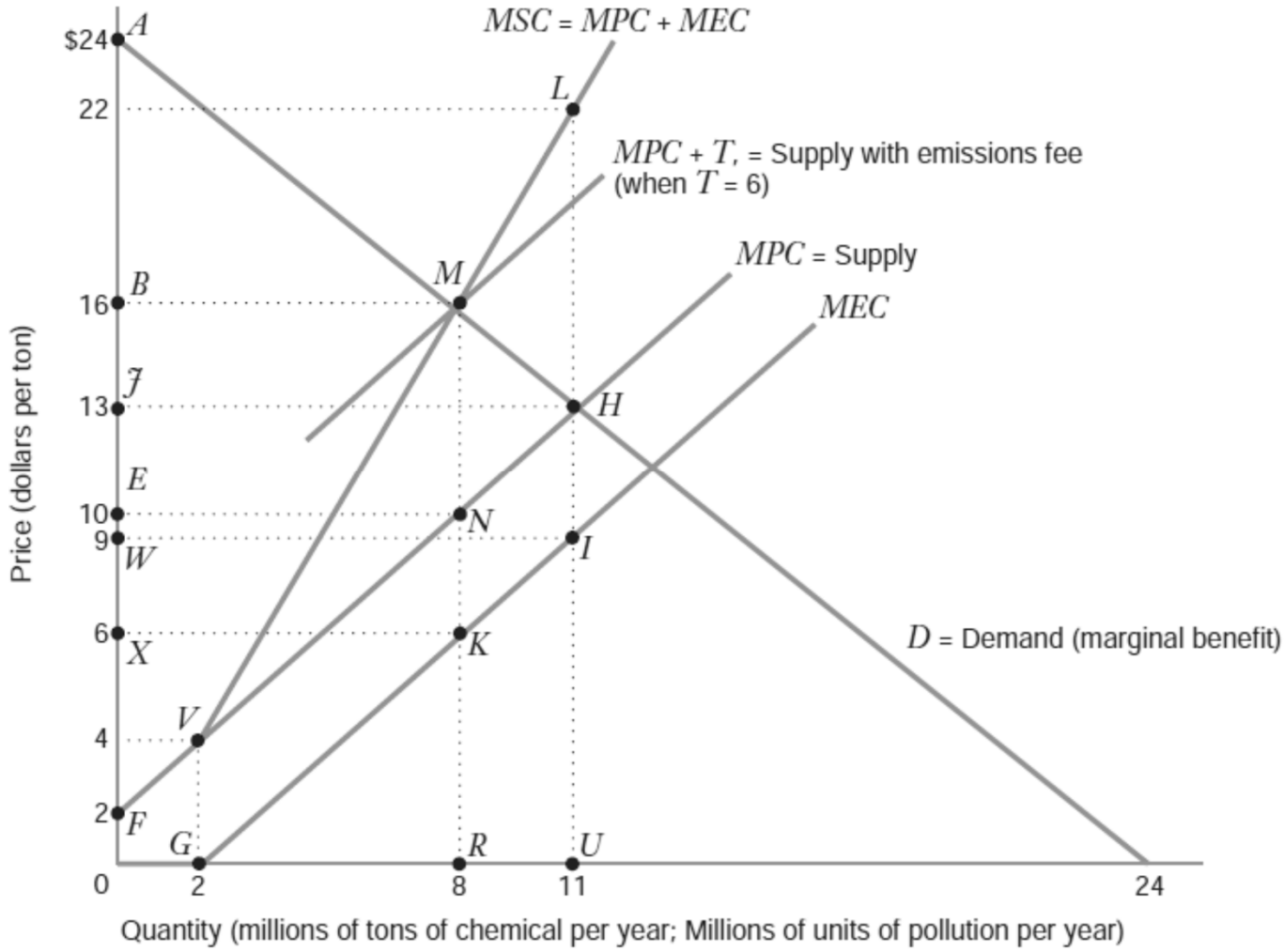
Problem

(a) Construct a graph and a table comparing the equilibria with and without the emissions fee:

- Graph the demand, supply (with no emissions fee), marginal external cost, and marginal social cost curves. Label two points on the graph: the point that represents the equilibrium price and quantity when there is no correction for the externality (i.e., no emissions fee) and the point that represents the amount of the chemical the market should supply at the social optimum. Indicate the actual price and quantity at each point.
- Graph the supply curve after the imposition of an emissions fee that induces the production of an economically efficient amount of the chemical. Indicate the price consumers will pay and the price producers will receive.
- In the table, indicate the amount of the emissions fee (dollars per unit) that will lead to the economically efficient production of the chemical. Fill in the table with the following information for the equilibria with and without the fee (indicate both the areas on the graph and the actual dollar amounts): consumer surplus, private producer receipts from the fee, net social benefits, and deadweight loss.

(b) Explain why the following sum is the same with and without the fee: consumer surplus + private producer surplus − external cost + government receipts from the fee + deadweight loss.

Graph for Exercise 17.2



Positive Consumption Externalities

Key Terms

Marginal (Private) Benefit (MPB) is the MB of private consumers. Hence, MPB can be considered as the demand curve in a competitive market.

Marginal External Benefit (MEB) is the MB on the third party.

Marginal Social Benefit (MSB) is the MB of the society (private consumers + the third party).

Thus, **MSB = MPB + MEB**

Without consumption externality, MSB = MPB = D.

Positive Consumption Externalities

Consider the case of consumers using vaccine

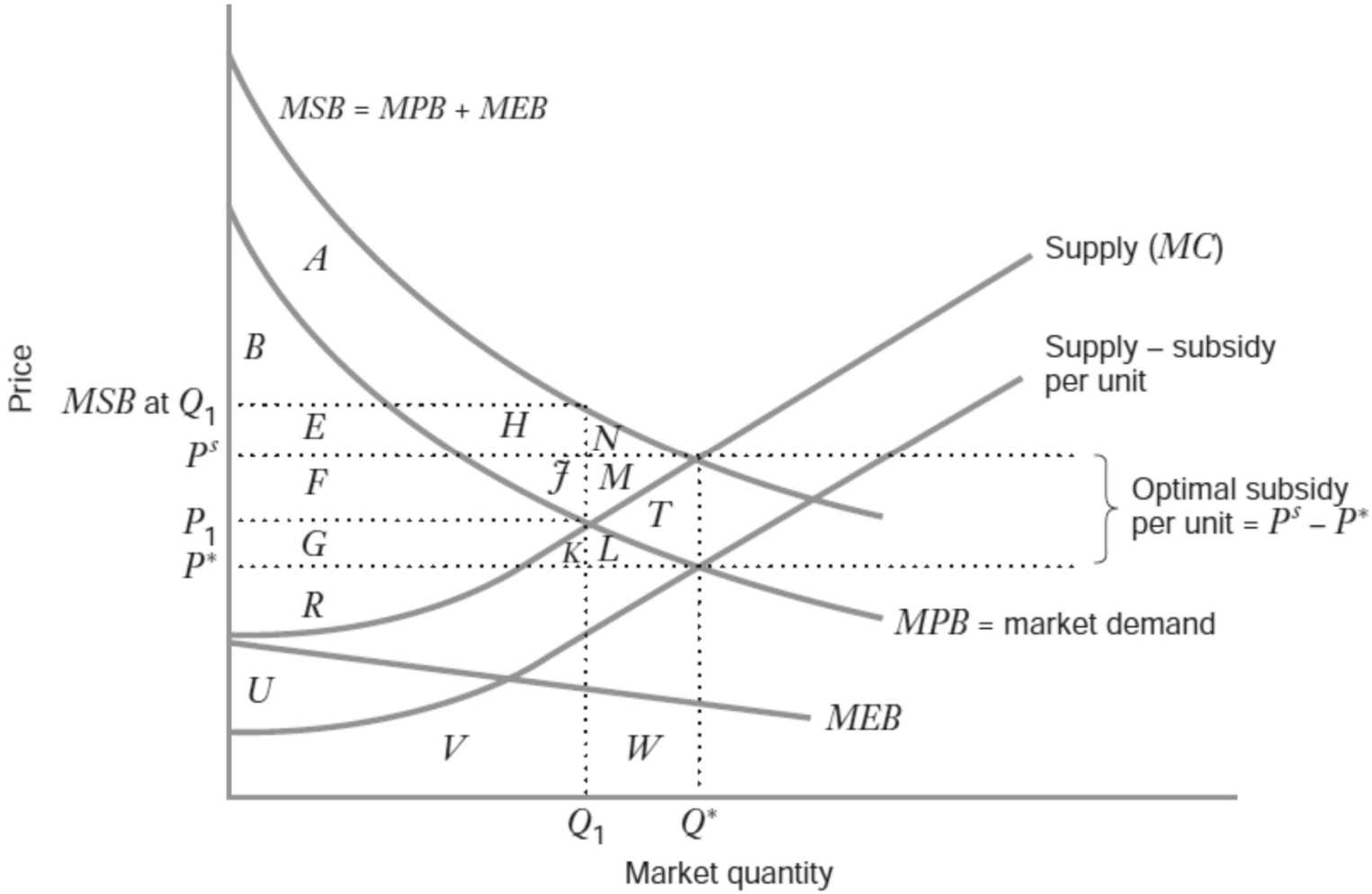
Given NO "production" externality, we have S = MPC = MSC.

Because of the vaccine, there is now benefit to the third party.

MEB > 0, and thus we have MSB > MPB = D.

MSB lies above MPB.

Positive Consumption Externalities



Positive Consumption Externalities

	Equilibrium (no subsidy)	Social Optimum (equilibrium with subsidy)	Difference in Benefits between Social Optimum and Equilibrium with No Subsidy
Private consumer surplus	$B + E + F$	$B + E + F + G + K + L$	$G + K + L$
Producer surplus	$G + R$	$F + G + R + \mathcal{J} + M$	$F + \mathcal{J} + M$
Benefit from externality	$A + H + \mathcal{J}$	$A + H + \mathcal{J} + M + N + T$	$M + N + T$
−Government cost from subsidy	zero	$-F - G - \mathcal{J} - K - L - M - T$	$-F - G - \mathcal{J} - K - L - M - T$
Net social benefits (private consumer surplus + producer surplus + benefit from externality − government cost)	$A + B + E + F + G + H + \mathcal{J} + R$	$A + B + E + F + G + H + \mathcal{J} + M + N + R$	$M + N$

Positive Consumption Externalities

Consider the case of consumers using vaccine

MPB = D intersects S at Q_1. This is the market quantity.

MSB intersects S = MSC at Q*.
This is the socially optimal quantity.

Since $Q_1 < Q^*$. This shows "underconsumption" of the good.
At Q_1, MSB > MSC, thus the social welfare is not maximized.

That is, people are consuming too little. To increase social welfare, the government can subsidize vaccine production.

Subsidy

Subsidy on firms means they face lower cost of production.

This will shift the supply curve or MPC to the right.

The optimal subsidy will make supply curve or MPC intersect demand curve at Q* (where MSB = MSC = S).

To find the optimal subsidy, SUBSIDY = MEB(Q*).

At Q*, the market now becomes socially efficient.

Coase Theorem

Photo from the Nobel Foundation archive.

Ronald H. Coase
The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1991

Born: 29 December 1910, Willesden, United Kingdom

Died: 2 September 2013, Chicago, IL, USA

Affiliation at the time of the award: University of Chicago, Chicago, IL, USA

Prize motivation: "for his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy."

Contribution: Important contributions on the borderline between economics, law and organization.

Prize share: 1/1

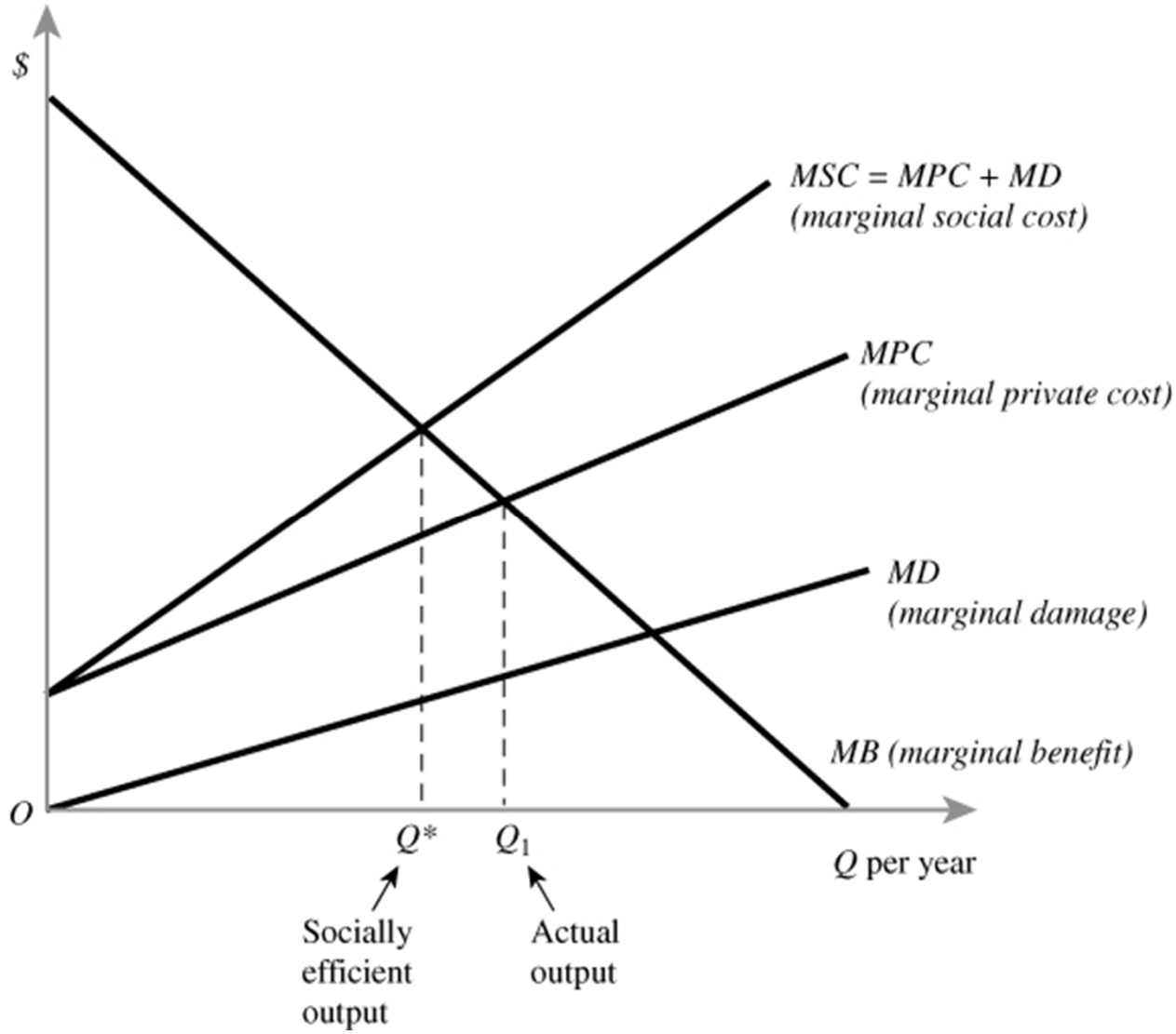
Source: www.nobelprize.org

Coase Theorem

- Insight: root of the inefficiencies from externalities is the absence of property rights.
- The ***Coase Theorem*** states that once property rights are established and transaction costs are small, then one of the parties will bribe the other to attain the socially efficient quantity.
- The socially efficient quantity is attained *regardless* of to whom the property rights were initially assigned.

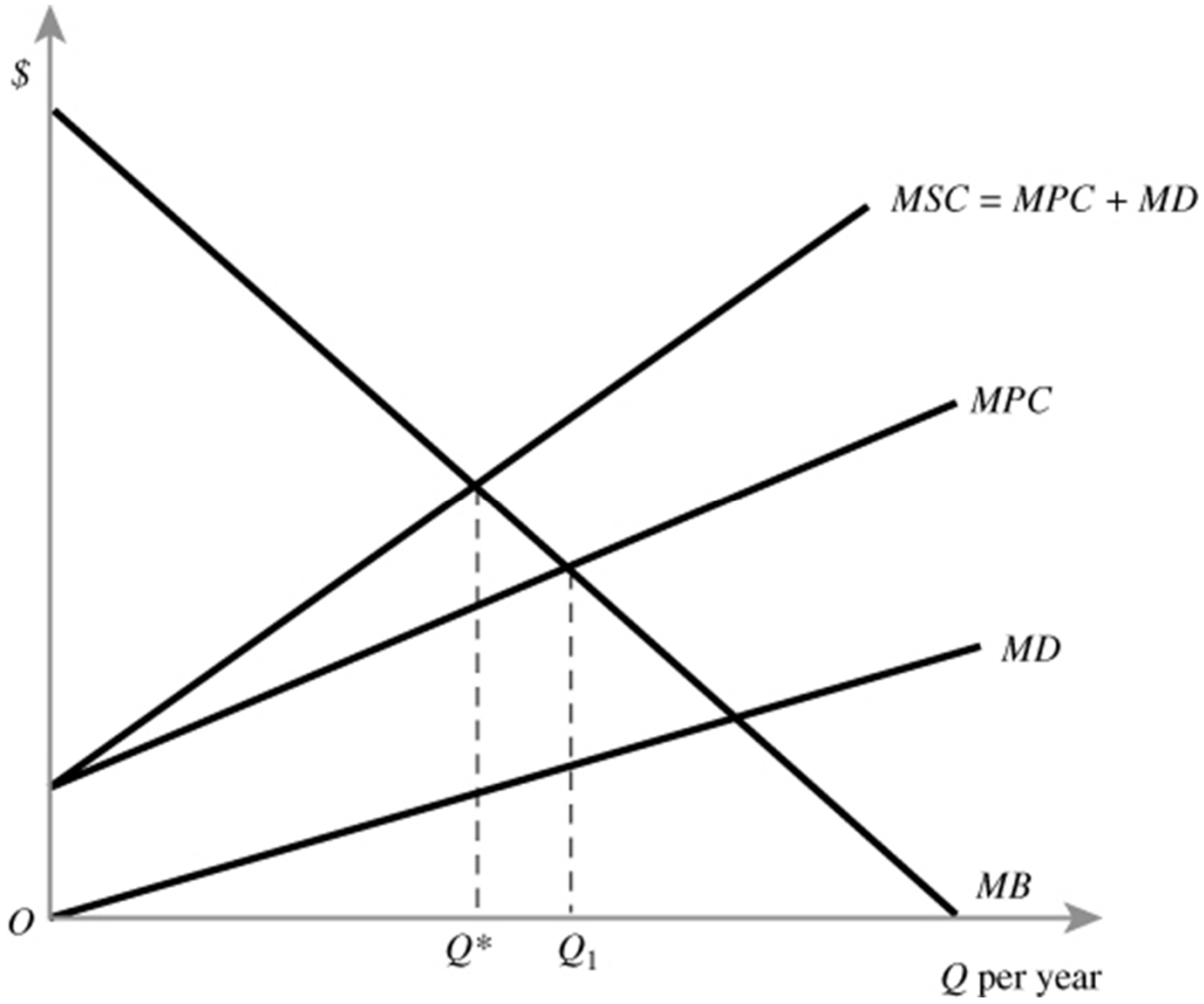
Illustration of the Coase Theorem

- Recall the steel firm/fishery example. If the steel firm were assigned property rights, it would ***initially produce Q_1***, which maximizes its profits.
- If the fishery were assigned property rights, it would ***initially mandate zero production***, which minimizes its damages.


$
MSC = MPC + MD
(marginal social cost)
MPC
(marginal private cost)
MD
(marginal damage)
MB (marginal benefit)
O
Q*
Q1
Q per year
Socially efficient output
Actual output

Graphical Analysis

- MB = marginal benefit to steel firm
- MPC = marginal *private* cost to steel firm
- MD = marginal damage to fishery
- MSC = MPC+MD = marginal *social* cost


$
MSC = MPC + MD
MPC
MD
MB
O
Q*
Q1
Q per year

Coase Theorem: Assign Property Rights to Steel Firm

- Consider the effects of the steel firm reducing production in the direction of the socially efficient level, Q^*. This entails a cost to the steel firm and a benefit to the fishery:
  - The steel firm (and its customers) would lose surplus between the MB and MPC curves between Q_1 and Q_1-1, while the fishery's damages are reduced by the area under the MD curve between Q_1 and Q_1-1.
  - Note that the marginal loss in profits is extremely small, because the steel firm was profit maximizing, while the reduction in damages to the fishery is substantial.
  - A bribe from the fishery to the steel firm could therefore make all parties better off.

Coase Theorem: Assign Property Rights to Steel Firm

- When would the process of bribes (and pollution reduction) stop?
  - When the parties no longer find it beneficial to bribe.
  - The fishery will not offer a bribe larger than its MD for a given quantity, and the steel firm will not accept a bribe smaller than its loss in profits (MB-MPC) for a given quantity.
  - Thus, the quantity where MD=(MB-MPC) will be where the parties stop bribing and reducing output.
  - Rearranging, MC+MPC=MB, or MSC=MB, which is equal at Q^*, the socially efficient level.

Coase Theorem: Assign Property Rights to Fishery

- Similar reasoning follows when the fishery has property rights, and initially allows zero production.
  - The fishery's damages are increased by the area under the MD curve by moving from 0 to 1. On the other hand, the steel firm's surplus is increased.
  - The increase in damages to the fishery is initially very small, while the gain in surplus to the steel firm is large.
  - A bribe from the steel firm to the fishery could therefore make all parties better off.

Coase Theorem: Assign Property Rights to Fishery

- When would the process of bribes now stop?
  - Again, when the parties no longer find it beneficial to bribe.
  - The fishery will not accept a bribe smaller than its MD for a given quantity, and the steel firm will not offer a bribe larger than its gain in profits (MB-MPC) for a given quantity.
  - Again, the quantity where MD=(MB-MPC) will be where the parties stop bribing and reducing output. This still occurs at Q^*.

Coase Theorem and Property Rights

Consider the following example

Farm A: raise cattles Farm B: raise crops

Cattles of Farm A damage Crops of Farm B (Neg. Externality).

Some party can build a fence to prevent the damage.

LEARNING-BY-DOING EXERCISE 17.3

The Coase Theorem

Problem

(a) In the case of the roaming cattle just described, suppose it is costless for the parties to bargain. Verify the Coase Theorem when the cost of the fence is $2,000 and the cost of the damage is $1,000.

(b) Verify the Coase Theorem if the fence costs $2,000 and the damage cost is $4,000.

More on Coase Theorem

Consider the following example

Farm A: raise cattles Farm B: raise crops

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LEARNING-BY-DOING EXERCISE 17.3

The Coase Theorem

Problem

(a) In the case of the roaming cattle just described, suppose it is costless for the parties to bargain. Verify the Coase Theorem when the cost of the fence is $2,000 and the cost of the damage is $1,000.

(b) Verify the Coase Theorem if the fence costs $2,000 and the damage cost is $4,000.

More on Coase Theorem

We can use Game Theory to demonstrate Coase Theorem:

Let cost of the fence = 200 and cost of the damage = 100.

Suppose cattle farmer and crop farmer have initial income of X.

Consider two cases when one of them has the property right.

		Cattle Farmer	
		Build a fence	Do not build
Crop Farmer	Build a fence		
	Do not build		

More on Coase Theorem

Crop Farmer	Cattle Farmer (with Property Right)	
	Build a fence	Do not build
Build a fence	X – 200, X – 200	X – 200, X
Do not build	X, X – 200	**X – 100, X**

Crop Farmer (with Property Right)	Cattle Farmer	
	Build a fence	Do not build
Build a fence	X – 200, X – 200	X – 200, X
Do not build	X, X – 200	**X, X – 100**

Note that the BOLD text indicated the NE.

When Crop Farmer has property right, Cattle Farmer has to pay for the damage.

More on Coase Theorem

With a property right, the most "SOCIALLY" efficient outcome is guaranteed.

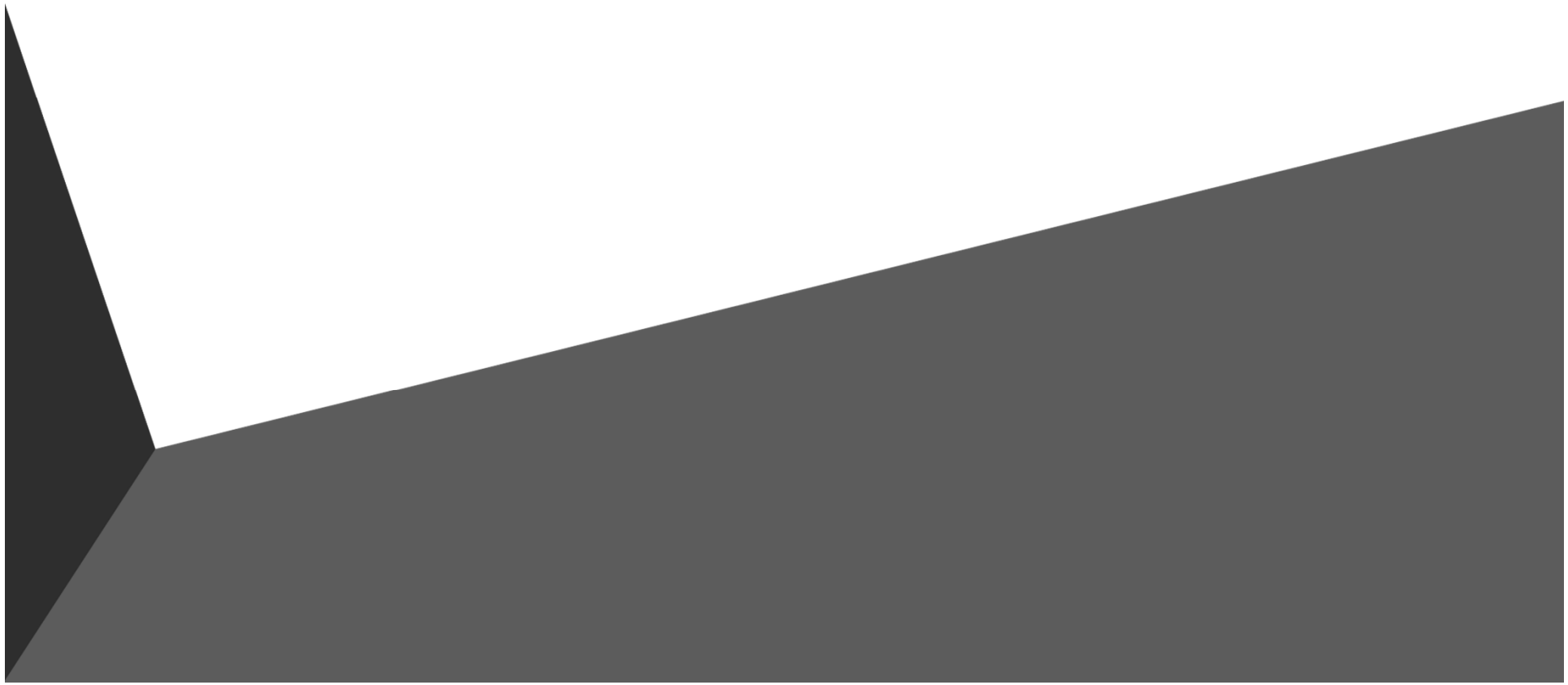
The total payoff for the whole society will be 2X – 100, which is the highest possible.

However, as previously mentioned, the "DISTRIBUTION of income" is affected by whoever owns a property right.

In this example, the one who owns the property right is better off with payoff of X while the one who does not own the right gets payoff of X – 100.

EE311: Public Goods

THAMMASAT



Public Goods

- Pure public goods share two characteristics
  - ***Nonrival*** – Cost of another person consuming the good is zero
  - ***Nonexcludable*** – Very expensive to prevent others from consuming the good

Public Goods

- Public Goods
  - National defense
  - House cleaning in an apartment with many roommates
  - Fireworks display
  - Music file sharing
  - Uncongested freeway
- Private goods
  - Pizza
  - Health care
  - Congested freeway
  - Public housing

Valuation of Public Goods

- Everyone consumes same *quantity* of public good
- Marginal benefit of public good varies by person
  - In the housecleaning example, different roommates value the clean apartment differently.

Impure Public Goods

- Most goods that are thought of as public goods may not strictly satisfy the *nonrival* or *nonexcludable* assumption.
  - A scenic view is a public good without congestion, but the quality diminishes as more the number of sightseers increases.
  - Thus, a scenic view becomes *rival*.

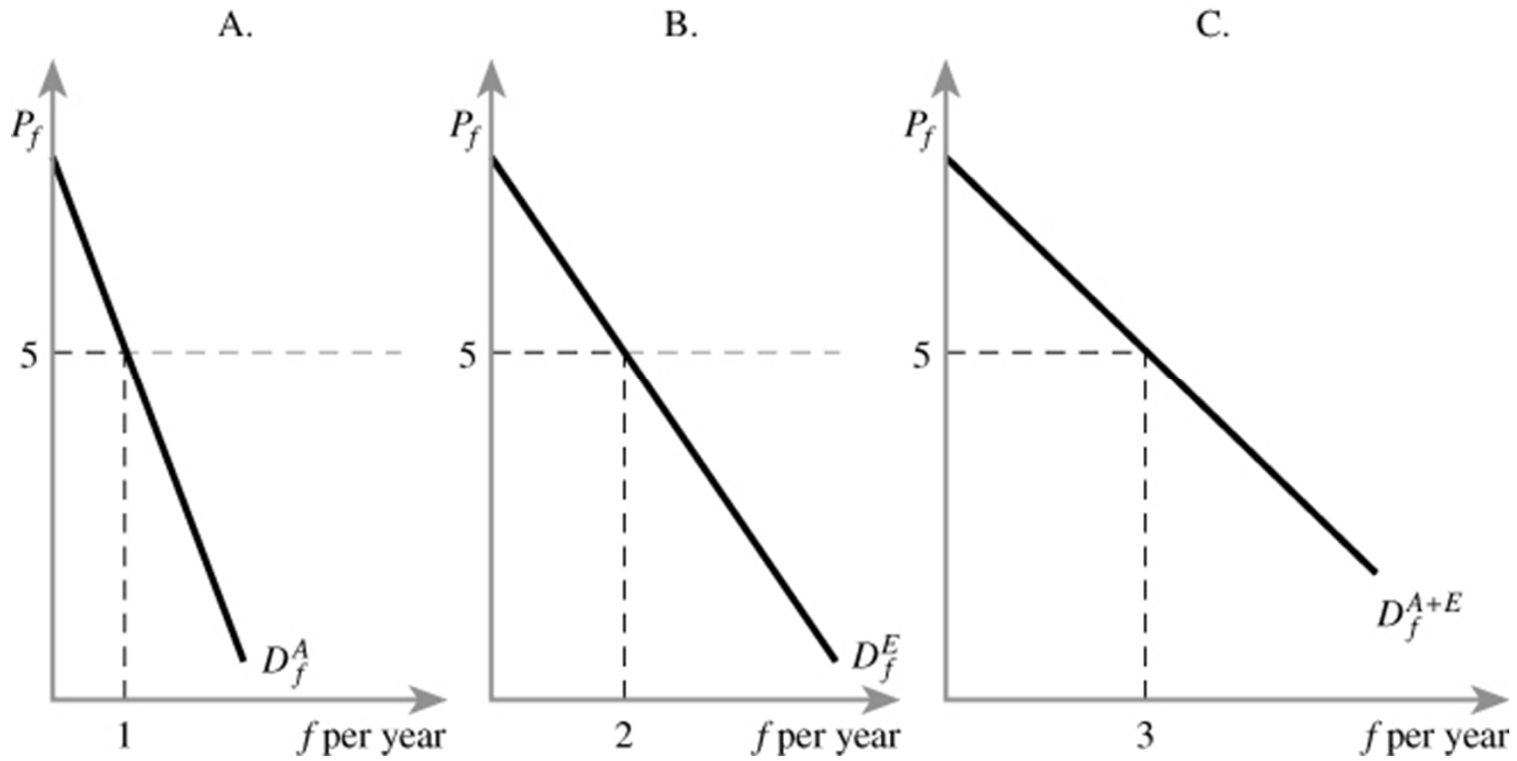
Private Goods can Be Provided by the Public Sector

- These are called “publicly provided private goods.”
- Key criteria: is the good *rival* and *excludable*?
- Public housing is rival (one family consumes one apartment) and excludable (easy to prevent consumption).

Efficient Provision of Private Goods

- Derivation of aggregate demand
- Each person's demand curve represents the willingness-to-pay for an additional unit of a good
- Private good: holding *P* constant, add together individual quantities to get *Q*
- Horizontal summation

Efficient Provision of Private Goods



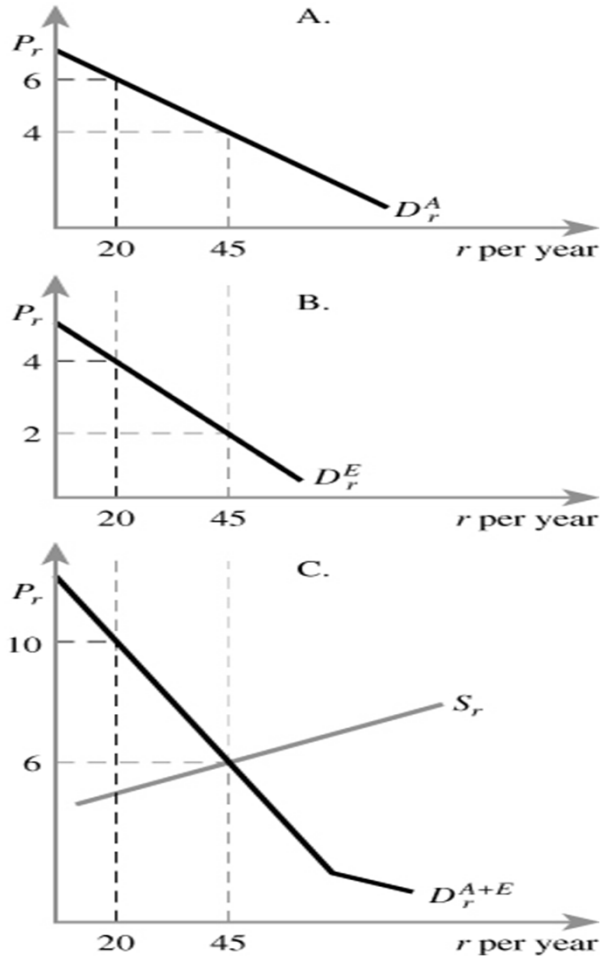
Equilibrium in private good market

- Equilibrium where supply curve intersects aggregate demand curve
- Everyone pays the same price, *P*
- Individuals consume different quantities, *Q*
- Pareto efficient

Efficient Provision of Public Goods

- Consider a fireworks display as a public good – it is nonrival and nonexcludable.
- Bigger displays give higher benefit.
- Public good: holding *Q* constant, add together individual willingness-to-pay to get *P*.
- Vertical summation.

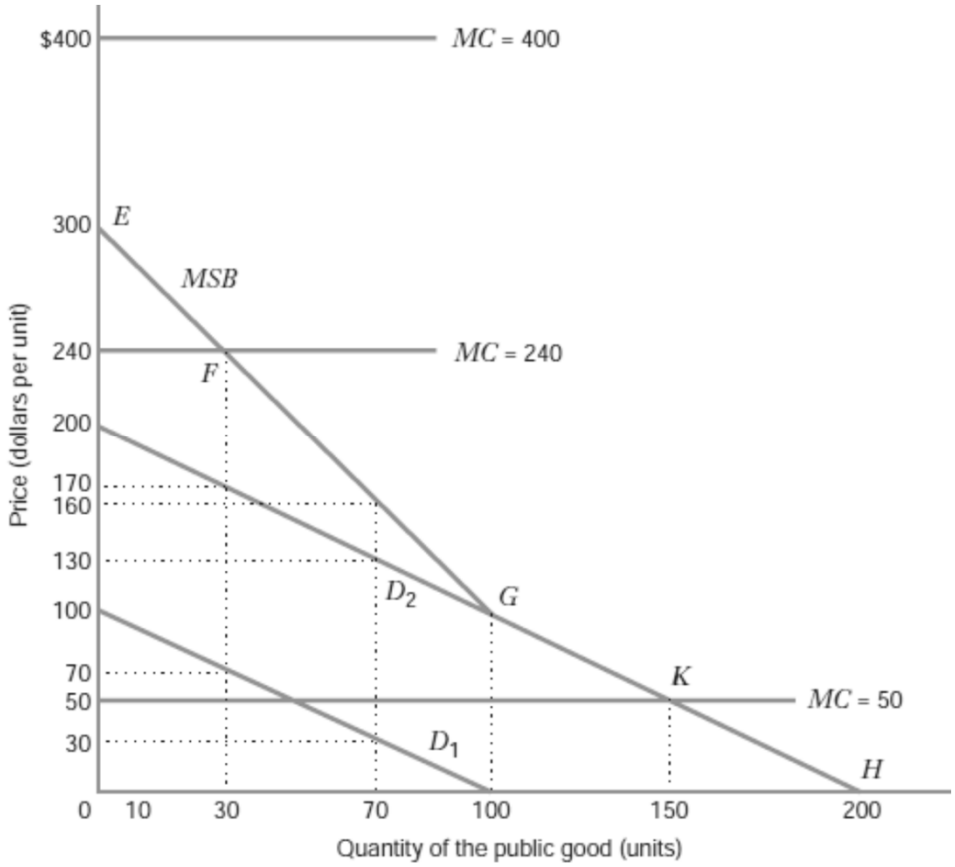
Efficient Provision of Public Goods



Efficiency in Public Goods Market

- Everyone consumes the same quantity, *Q.*
- Individual's marginal benefit varies.
- Efficiency requires that the *sum* of individual marginal benefits equals the marginal cost.

Efficient Provision of Public Goods



The MC (= MSC = MPC = S) of a public good is constant because it is the opportunity cost of using resources to produce the good instead of other goods.

The MSB will be the "VERTICAL" sum of all individual demands. For example, at Q = 30, MR.1 values the good at P = 70, while MR.2 values the good at P = 170. Thus, MSB = 240 at Q = 30.

If MC = 50, Q* = 150. If MC = 240, Q = 30. If MC = 400, Q* = 0.

Efficient Provision of Public Goods

LEARNING-BY-DOING EXERCISE 17.4

Optimal Provision of a Public Good

In Figure 17.7, demand curve D_1 is $P_1 = 100 - Q$, and demand curve D_2 is $P_2 = 200 - Q$. (We have written these in *inverse* form, with price on the left and quantity on the right, for reasons explained below.)

Problem

(a) Suppose the marginal cost of the public good is \$240. Determine the efficient level of production of the public good algebraically.

(b) Suppose the marginal cost of the public good is \$50. Determine the efficient level of production of the public good both graphically and algebraically.

(c) Suppose the marginal cost of the public good is \$400. Determine the efficient level of production of the public good both graphically and algebraically.

Hint:

1) MSB = $P_1 + P_2$
2) MSB = MC

Answer:

a) Q* = 30
b) Q* = 150
c) Q* = 0

A well-known Free Rider Problem

- Although a competitive market will provide private goods efficiently, will the same be true for public goods?
- People may have incentives to hide their true preferences for a public good.
- If Adam can get Eve to pay for the public good, he can use his income for other purposes and still enjoy the public good.

A well-known Free Rider Problem

- This incentive to let others pay for the public good while still enjoying the benefits is known as the ***"free rider problem."***
- The private market may therefore fall short of providing the efficient amount of the public good.

A well-known Free Rider Problem

- This incentive to free ride occurs because the public good is nonrival and nonexcludable.
- A person gets to consume the good even if he does not pay for it.

Summary: Causes of Market Failure

1) Lack of Competition (Monopoly Power)
2) Externalities
3) Provision of Public Goods
4) Asymmetric Information
    1) Adverse Selection (hidden information): One party with better private information about the quality of a product will selectively participate in trades which benefit them the most, at the expense of the other party.
    2) Moral Hazard (hidden action): Some people increases their exposure to risk when they are insured.
    3) Principal-Agent Problem (hidden action): Agents may act according to their own interests, instead of the interests of principals, e.g. citizens and politicians.