Externalities and the Environment

Externalities and the Common Pool Problem

Optimal Level of Pollution

Environmental Protection

Positive Externalities

Exhaustible and Renewable Resources

- ***Exhaustible resource***
  - **does not renew itself**
  - **Available in a finite amount**
  - **Ex: Coal, oil, etc**
- ***Renewable resource***
  - **if it is used conservatively, it can be drawn on indefinitely**
  - **Ex: Trees, fish, atmosphere, water**

Common-pool Problem

- **Some renewable resources are open-access goods**
  - **Open-access resource is rival in consumption but exclusion is costly**
- **Ex: fish in the ocean**
  - **Not available when it's caught**
    - **rival in consumption**
  - **difficult for one to "own" fish still in the ocean and prevent others from catching**
    - **exclusion is costly**

Common-pool Problem

- **An *open-access good* is often subject to the common-pool problem**
  - **People consume a good until the marginal value drops to zero**
  - **Often overused**

研究表明過度捕撈導致深海魚瀕於滅絕（記者曹麗君）

- 加拿大科學家在５日出版的最新一期《自然》雜志上報告說，上世紀７０年代開始的深海捕撈活動導致多種深海魚類數量大減，瀕於滅絕。

　　加拿大紀念大學的科學家對生活在北大西洋深海的圓鼻鱈、長尾鱈、藍鱈、刺鰍和灰鰩等５種魚類的數量進行分析發現，１９７８年到１９９４年間，這５種深海魚的數量減少了８９％至９８％。根據世界自然保護聯盟的指導意見，這些魚類都屬於嚴重瀕危物種。

　　深海魚生長緩慢、成熟晚、壽命長、生育能力低，因此過度捕撈很容易造成其數量大幅減少。科學家指出，被研究的５種魚的壽命大約都在６０歲左右，身長大約１米左右，到１０幾歲才能成熟，它們數量驟減的時段正好是在深海捕撈活動開始以后，而其他的深海魚類數量減損的程度可能更大

Private Property Rights

- **Specific individuals own the rights to resources**
  - **allow individuals to use resources**
  - **charge others for their use**
  - **have a strong interest in using those resources efficiently**
- **Private property rights**
  - **Defined and enforced by government, social actions, and ethical norms**
  - **For open-access resources, specifying and enforcing property rights is costly**

Negative Externalities

- **Ex: Pollution**
- **No practical, enforceable, private property rights to open-access resources**
  - **Ex: air, water**
- **Market prices usually fail to include the costs that negative externalities impose on society**

Resolving the Common-Pool Problem

- **Imposing property rights would be too costly**
- **Government regulations may improve allocative efficiency**
  - **By imposing restrictions on resource use (Ex:地下水抽取)**
  - **Output restrictions**
  - **taxes**

  force firms to use the resources at a rate that is socially optimal
- **Next section illustrates the problem of negative externalities under**
  - **fixed-production technology**
  - **variable technology**

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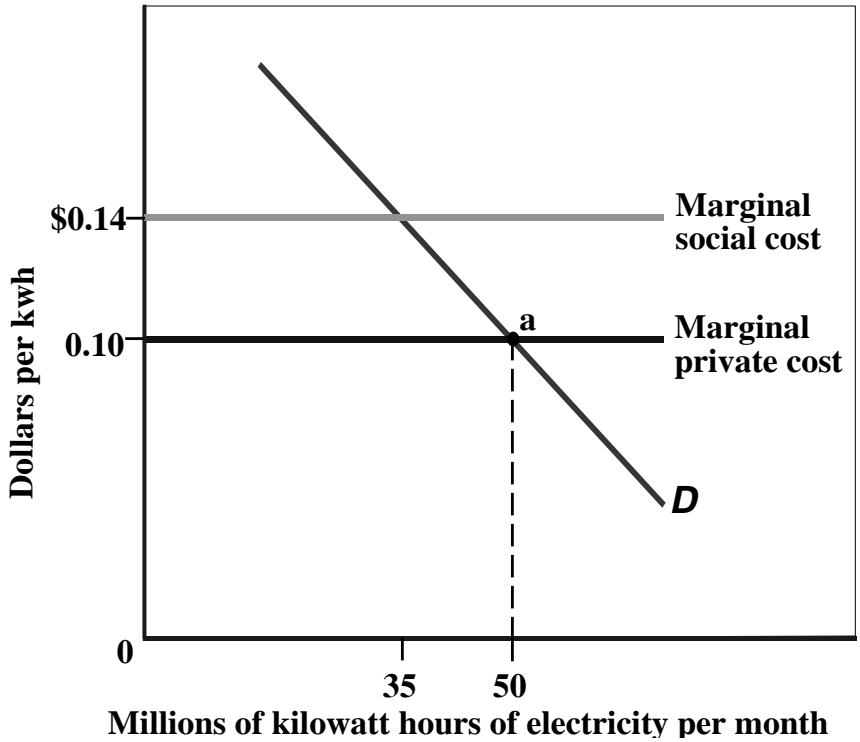
Positive Externalities

Negative Externalities: Under Fixed Technology

Recall demand curve reflects consumers' marginal benefit.



If producers decision base on their costs, (point *a*)
Price=0.1
Quantity=50 million.

Electricity production involves the external cost: Gas dump.

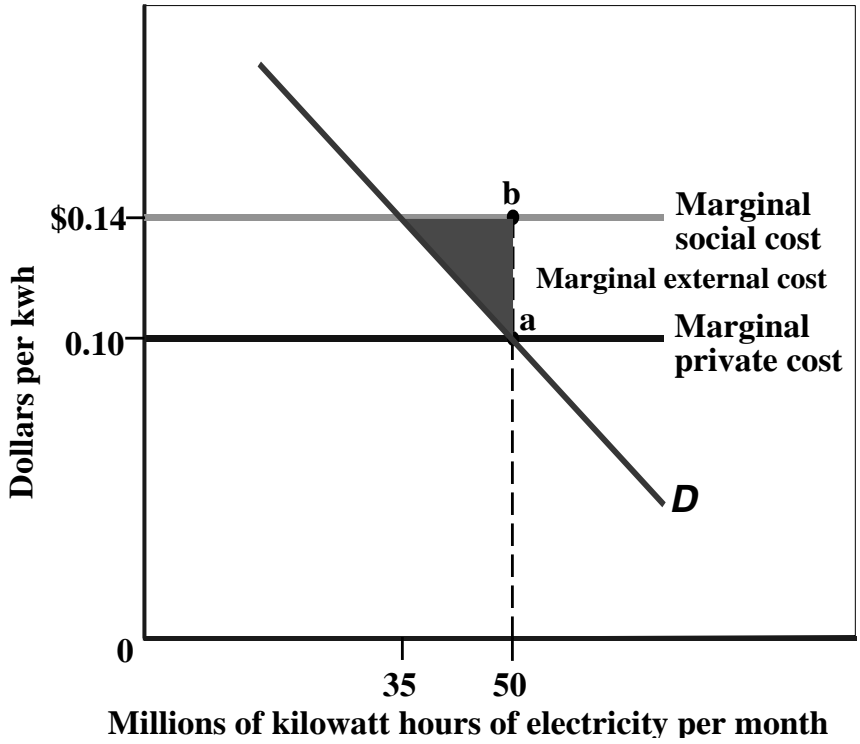
Marginal external cost imposed on the environment = $0.04 per kilowatt-hour

Negative Externalities: Fixed Technology

Fixed-production technology:

If the only way of reducing pollutions is by reducing the generation of electricity.

→the relationship between electricity and pollution is fixed

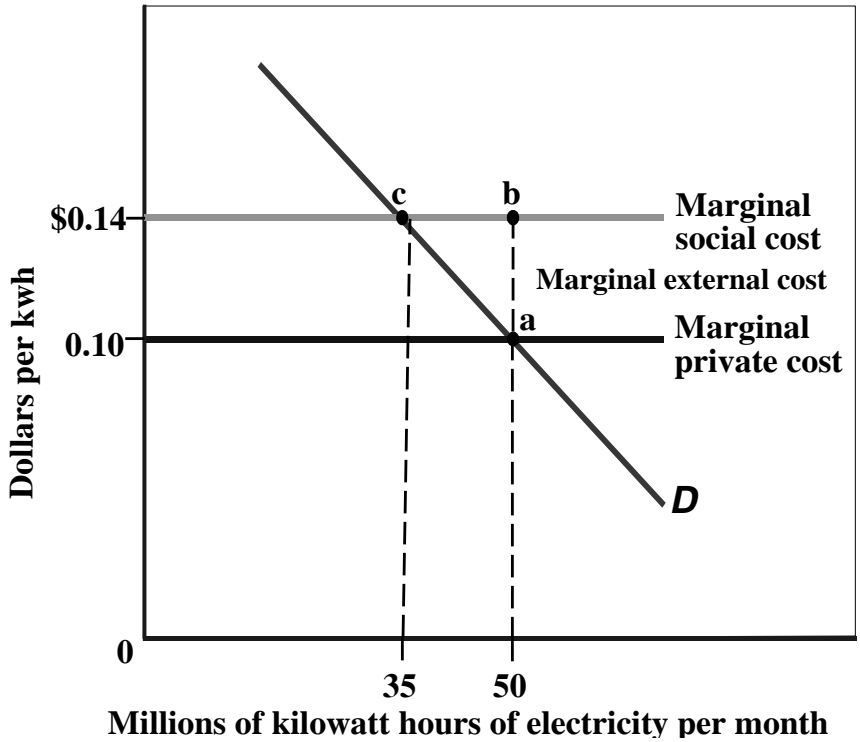


Marginal external cost:
vertical distance between marginal private cost and marginal social cost

marginal social cost=marginal private cost+marginal external cost

Private-sector equilibrium: 50mkw
Marginal social cost: b
is larger than
marginal benefit: *a*

Negative Externalities: Fixed Technology



Market failure:
Marginal social cost: $0.14>
marginal benefit:$0.10

Too much pollution is produced:
Electricity price fails to reflect the social cost

From society's point of view, efficient output: 35 mkw (point c).

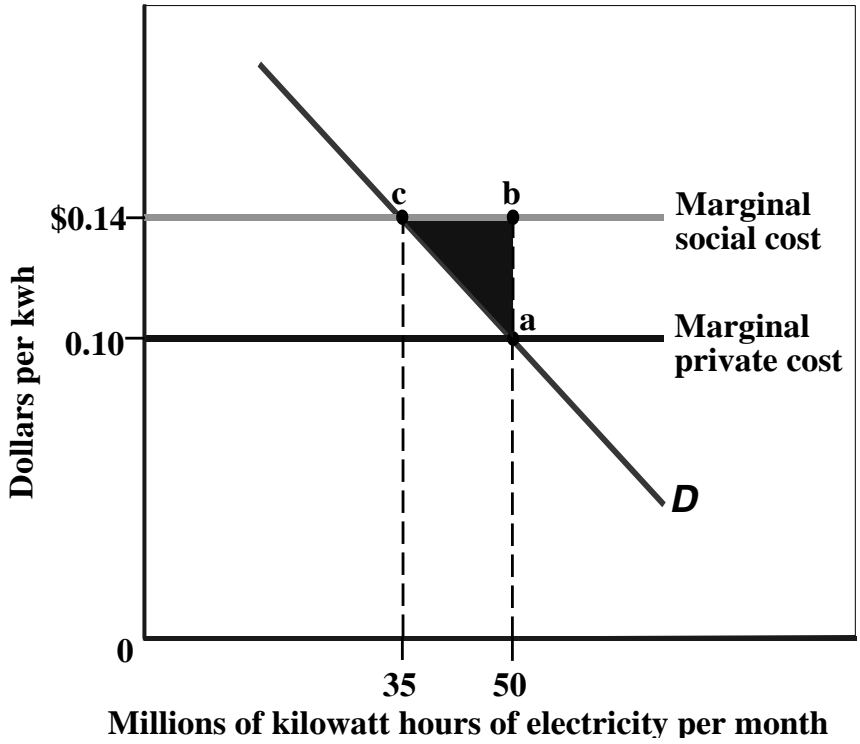
Negative Externalities: Fixed Technology

- **How could output be restricted to the socially efficient level?**
- **Government policy makers can**
  - **restrict electric utilities to produce that optimal level**
  - **Impose a *pollution tax***

Negative Externalities: Fixed Technology

- **If pollution tax for each unit= marginal external cost**
  - **marginal private cost curve= marginal social cost curve**
  - **results in a level of output that is socially efficient**
    - **marginal social cost of production equals the marginal benefit**

Negative Externalities: Fixed Technology



At c,
Pollution still exist!

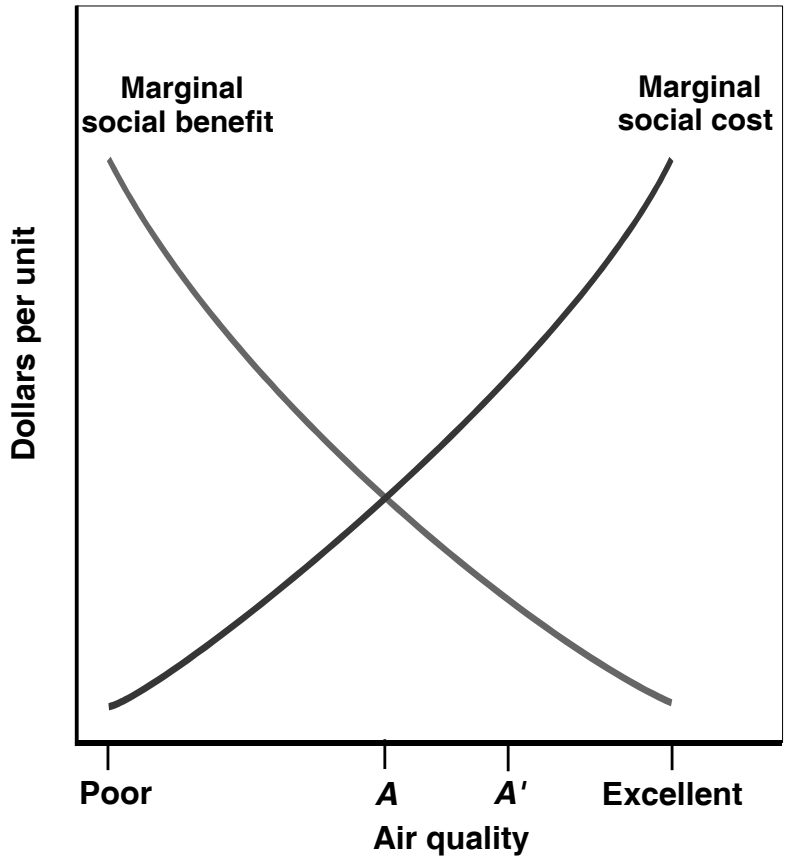
Utilities no longer generate electricity if MC>MB

The total social gain of ignoring the negative externalities :
Blue shaded triangle.

Negative Externalities: Variable Technology

- **Last example assumes**
  - **reduce pollution → must reduce output**
  - **Fixed technology**
- **Power companies can change resource mix to reduce pollution**
  - **Altering the production process instead of adjusting the rate of output,**
  - **Produced under *variable technology***
  - ***See next slide***

The Optimal Level of Air Quality

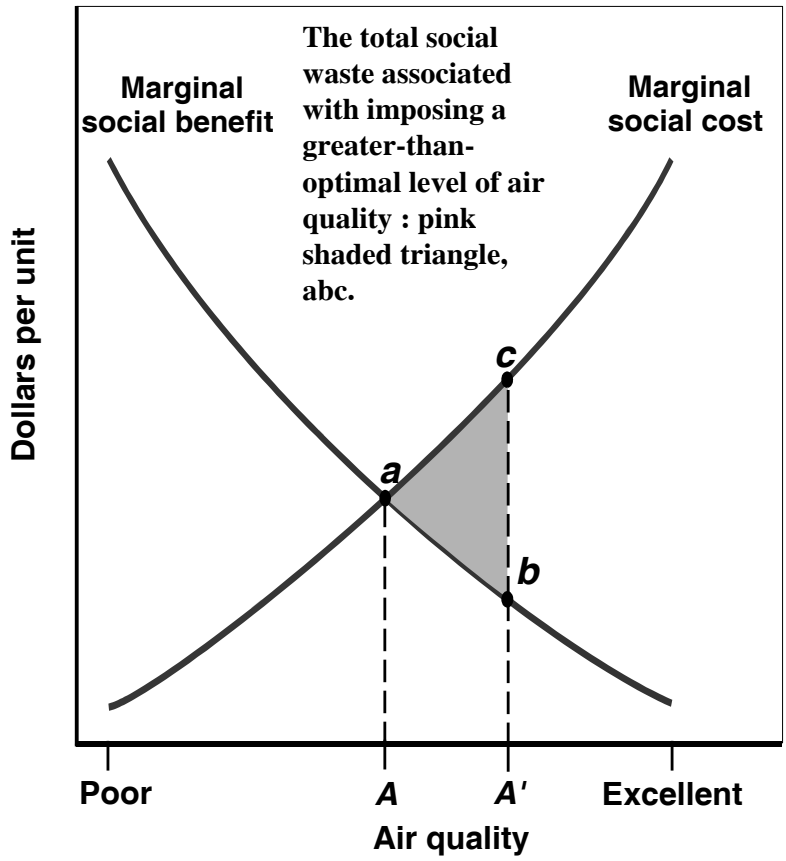


Production of cleaner air is subject to diminishing returns
➔ the *marginal social cost curve* slopes upward.

Air quality can be improved by adopting cleaner production technology.

Cleaner air has a declining marginal benefit to society
➔ marginal social benefit curve slopes downward.

The Optimal Level of Air Quality



The total social waste associated with imposing a greater-than-optimal level of air quality : pink shaded triangle, abc.

The optimal level of air quality: point *a*,

Firms would not reach this level voluntarily.
If firms made production decisions only on private costs
→No incentive to search for production methods that reduce pollution
➔ Too much pollution

If the government decrees that the minimum level of air quality: A'

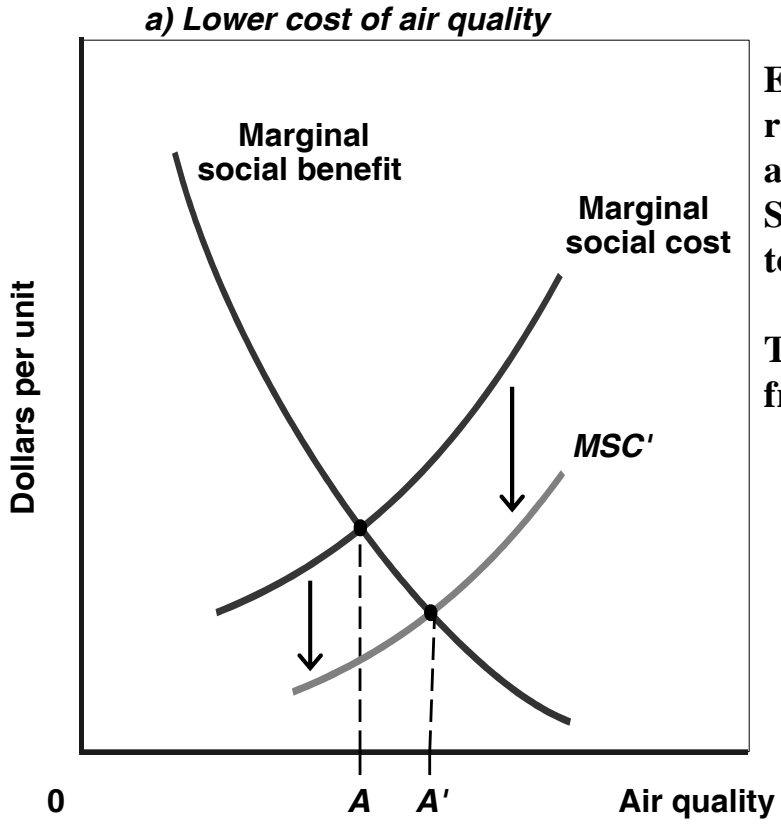
Marginal social cost: *c*, is lager than Marginal social benefit: *b*.

Negative Externalities: Variable Technology

- **Thus, "all air pollution should be eliminated" is a popular misconception**
- **Some pollution is consistent with efficiency**
  - **➔ improving air quality If MB>MC**
- **What would happen to the optimal level of air quality if either MC or MB changed**

See next slide

Effect of Changes in Costs

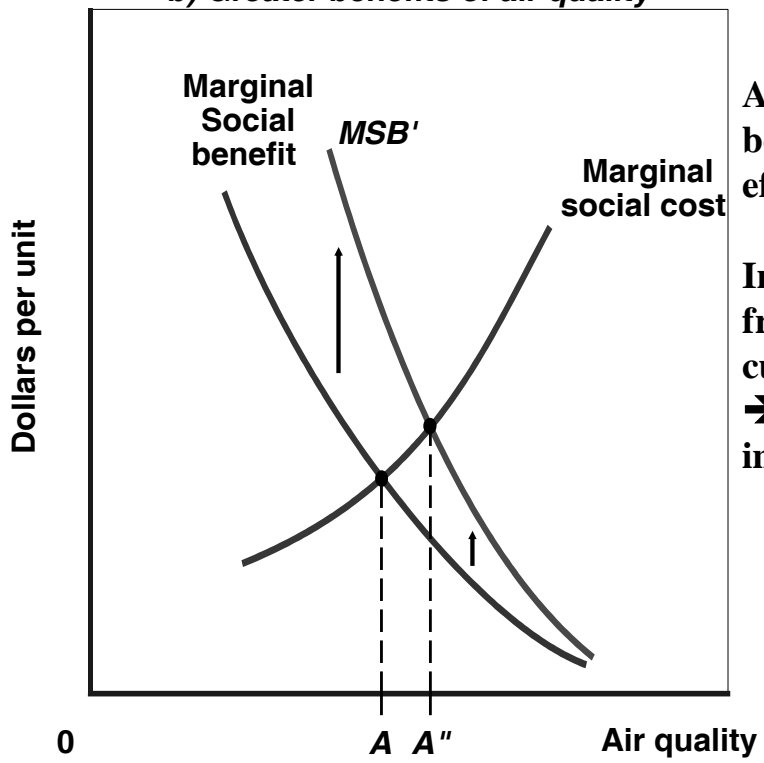


Ex: Technological breakthrough reduces the MC of cleaning the air:
Shift marginal social cost curve to MSC'.

The optimal level of air quality from A to A'

Effect of Changes in Benefits

b) Greater benefits of air quality



An increase in the marginal benefit of air would have similar effects.

Increase the marginal benefit from marginal social benefit curve to MSB'
➔ Optimal level of air quality increases from A to A''

Traditional Analysis of Externalities

- **Market failures arise because people ignore the external effects of their actions**
- **Ex:**
  - **Neighborhood:**
    - **A research laboratory tests delicate equipment**
    - **manufacturer of heavy machinery**
  - **The vibrations caused by the manufacturing process throw off the delicate machinery in the lab**

The Coase Theorem
An Example

- Coase pointed out that the negative externality (vibrations) is not necessarily imposed by the machinery producer on the testing lab
- The externality is the result both of
  - vibrations created by the factory
  - the location of the testing lab
- Two efficient solutions:
  - Modify the machines in the factory, or
  - Move the lab elsewhere
- The efficient solution depends on which party can avoid the problem at the lower cost

The Coase Theorem
An Example

- Assume that
  - It costs the factory $2 million to reduce vibrations
  - The testing lab cannot alter its equipment to reduce the effects of the vibrations
  - It can move at a cost of $1 million
- The most efficient resolution to the externality problem
  - Testing lab relocation

The Coase Theorem

- ***When property rights are assigned to one of the parties***
- ***Two parties will agree on the efficient solution to an externality problem***
  - ***if transaction costs are low***
- ***Efficient solution will be achieved regardless of which party gets the property rights***

The Coase Theorem

Testing lab is granted the right to operate free of vibrations

- **It has the right to ask the factory to reduce its vibrations**
- **Cut vibrations at a cost of $2 million**
  - **Factory can offer to pay the lab to relocate**
- **Payment by the factory owners:**
  - **$1 million ~$2 million → the lab will move**
  - **It will make both better off,**
  - **Efficient outcome**

The Coase Theorem

The factory is granted the right to generate vibrations

- **The factory works as usual**
- **The lab may consider:**
  - **paying the factory: At least $2 million**
  - **Move the lab would: $1 million**
- **Move the lab!**

The Coase Theorem

- **Whether property rights are granted to the lab or to the factory,**
  - **the lab will move**
  - **the most efficient solution**
- **Note**
  - **Regardless of who is given the property rights, an efficient outcome results**
  - **Particular assignment of property rights**
    - **determines only who incurs the externality cost**
    - **but not the efficient outcome**

Markets for Pollution Rights

- **Primary implication of the Coase Theorem**
  - **Assignment of property rights is often sufficient to resolve the market failure with externalities**
  - **No further government intervention is necessary**

- **If**
  - **pollution is easily monitored**
  - **Polluters are easily identified,**

the government may achieve an efficient solution by assigning the right to pollute

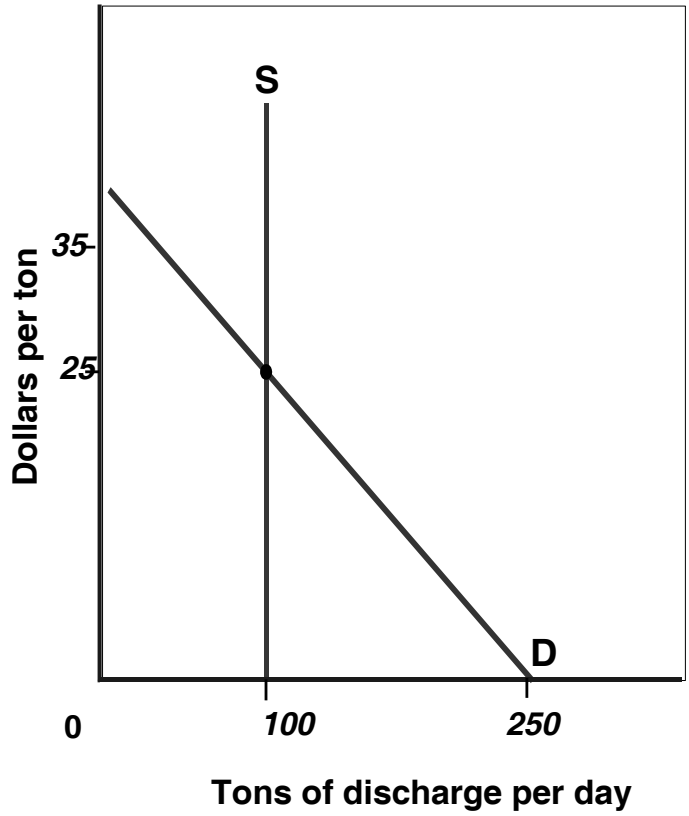
Markets for Pollution Rights
An Example

- **Firms that dump waste into a river**
  - **An inexpensive outlet for pollutants**
  - **value the ability for river to discharge waste**

- **The river provides disposal services**

- **The demand curve for this pollutant slopes downward → See next slide**

Optimal Allocation of Pollution Rights

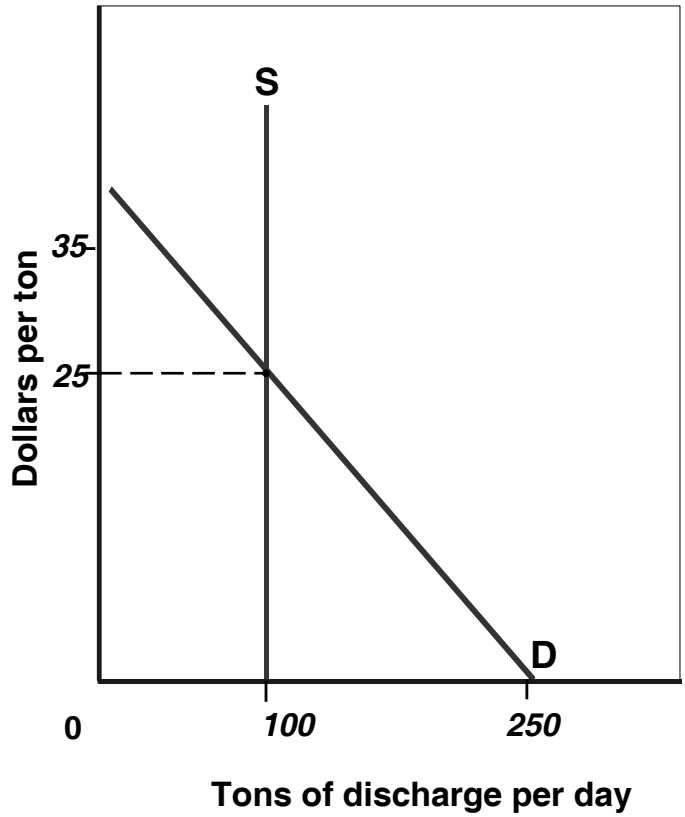


The demand curve for the river as a discharge system: D
→measures the marginal value of using the river for discharging pollutants.
With no restrictions, dumping continues until it yields no benefits → 250 tons

The river can absorb a certain amount of pollution without deteriorating in quality.
Ex: 100 tons

The "supply" of the river available as a discharge resource is a vertical supply curve S.

Optimal Allocation of Pollution Rights



If regulators can easily identify polluters and monitor the pollution→ Allocate permits to discharge 100 tons per day.

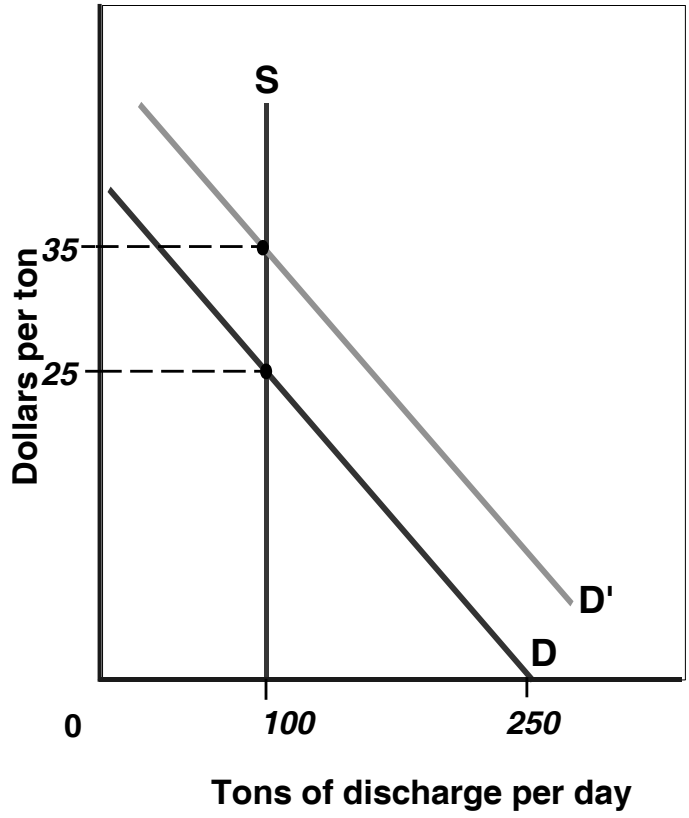
If the price of these permits is zero →an excess demand for pollution.

An alternative is to sell 100 tons of pollution permits at the market:
→ $25 per ton

Markets for Pollution Rights

- **The beauty of this system:**
  - **Producers who value the discharge rights the most get them.**
  - **Producers who attach a lower marginal value obviously have cheaper ways of resolving their waste**
  - **If conservation groups want a higher quality than the government's standard,**
    - **Ex: clean enough to drink,**
    - **Purchase the pollution permits**

Optimal Allocation of Pollution Rights



If additional firms want to discharge wastes? D→D'.

Bid up the market price from $25 to $35 a ton.

Permit holders will sell their rights to those who value them more.

Markets for Pollution Rights

- **If the right to pollute could be**
  - **granted, monitored, and enforced,**

  negative externality problem could be solved through market allocation
- **In 1989, a pollution-rights market for fluorocarbon (碳氟化合物) emissions was established**
- **In 1990 by a market for sulfur dioxide (二氧化硫) and**
  - **in 1990s sulfur-dioxide emissions fell by more than half**
  - **The market for pollution is glowing**

Markets for Pollution Rights Legislation

- **Legislation dealing with pollution is affected**
  - **Polluters have a special interest in government proposals relating to pollution**
  - **The public remain rationally ignorant about pollution legislation**
- **Pollution regulations may be less in accord with the public interest than with the special interests of polluters**
  - **Ex: a portion of pollution permits are given free to existing firms**

Markets for Pollution Rights

command-and-control *environmental regulations*

- **Before 1990, traditional *command-and-control* environmental regulations:**
  - **Required polluters to introduce particular technologies to reduce emissions by specific amounts**
  - **Based on engineering standards**
  - **Did not recognize unique circumstances across plants**

Markets for Pollution Rights

Economic efficiency approach

- ***Economic efficiency approach***
  - **Reflected by the pollution rights approach**
  - **Offers each polluter the flexibility to reduce emissions in the most cost-effective manner given its unique costs**
  - **Firms with the lowest emission control costs have an incentive to implement the largest reduction in emissions, and then sell unused allowances to those with greater control costs**

Externalities and the Environment

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Optimal Level of Pollution

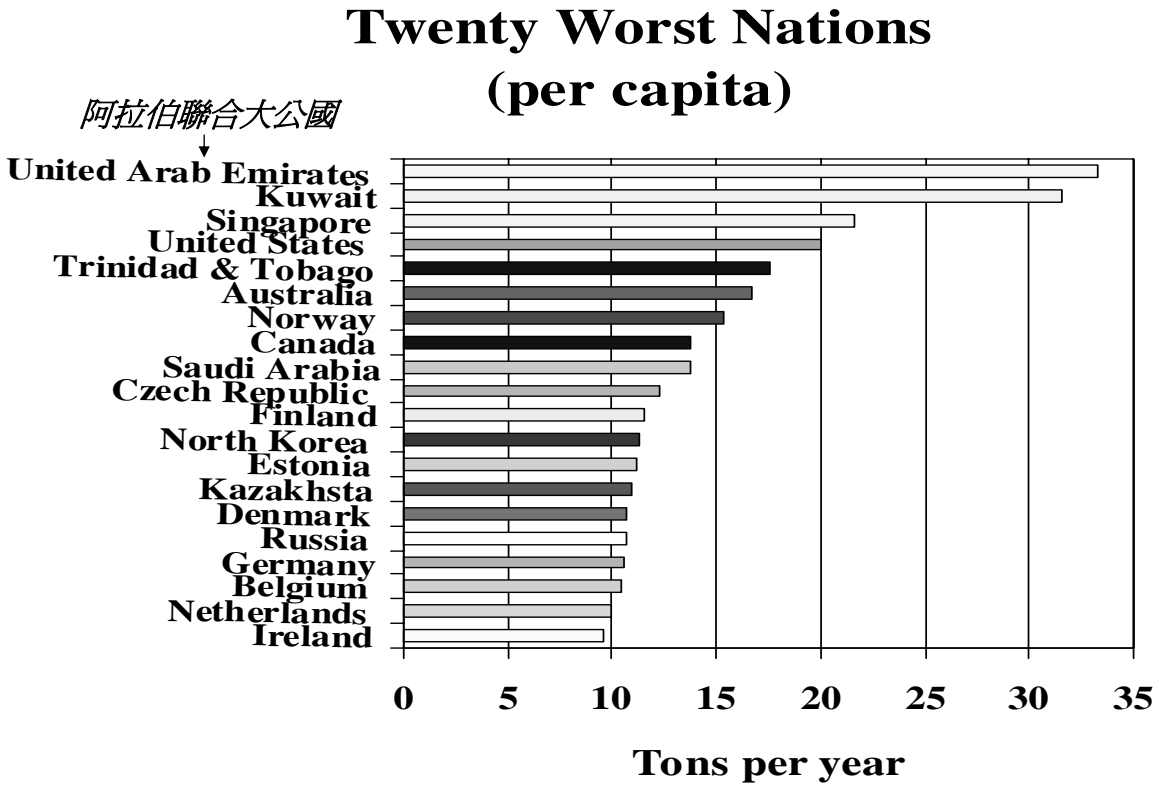
Environmental Protection (Highlight)

Positive Externalities

Air Pollution

- **U. S. is a major source of carbon dioxide (二氧化碳)emissions**
- **Kyoto accord(京都議定書) require**
  - **38 industrial countries reduce emissions of CO2 by 1/3 over ten years**
  - **cost to U.S. of $300 billion a year**
- **But this accord requires nothing from developing countries**
  - **like China and India**
- **See next slide for the world's twenty worst nations in carbon dioxide emissions**

Carbon Dioxide Emissions



Solid Waste: Paper or Plastic

- **About 70% of the U.S. garbage is covered with soil in landfills**
- **As the cost of solid-waste disposal governments requires *recycling***
  - **The process of converting waste products into reusable material**

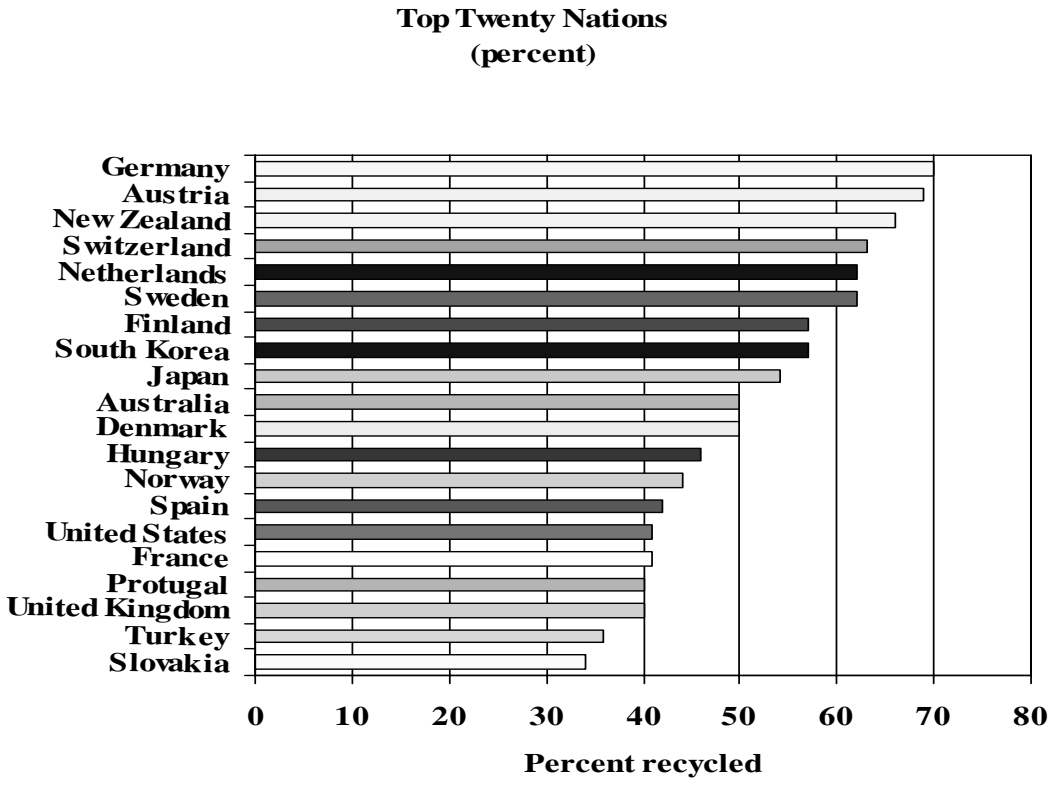
Solid Waste: Paper or Plastic

- **15% of U.S. garbage gets recycled,**
- **15% is incinerated (焚化)**
- **70% goes into landfills**

- **Of the recycled material, 3/4 consists of paper related materials**

- **Next slide ranks the top twenty paper recyclers**

Exhibit 6: Top Twenty Nations in Paper Recycled



Externalities and the Environment

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Optimal Level of Pollution

Environmental Protection

Positive Externalities

Positive Externalities

- **Positive externalities occur if:**
  - **Unpriced by-products or**
  - **production**

  benefit other consumers or other firms

- **Ex: people who get inoculated against a disease (預防注射)**
  - **reduce the risk of disease**
  - **Also reduce the risk of transmitting the disease to others**

  ➔ external benefits

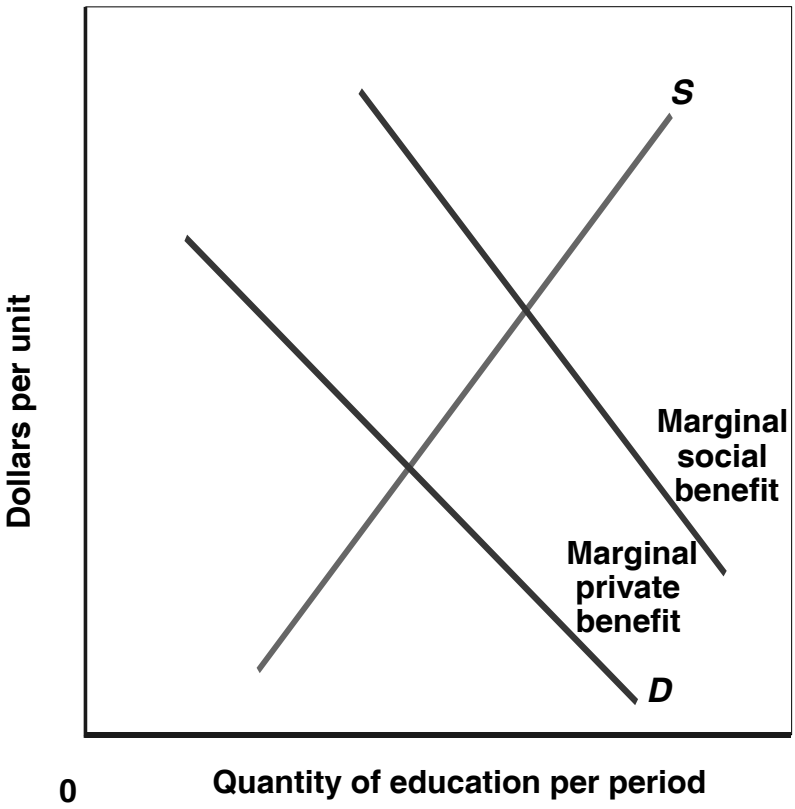
Positive Externalities

- **Education confers external benefits on society because those who acquire more education**
  - **Become better citizens**
  - **more able to support themselves and their families**
  - **Less likely to require public assistance**
  - **Less likely to resort to crime**
- **Thus, education confers private benefits and additional social benefits to others**
- **See next slide**

Education and Positive Externalities

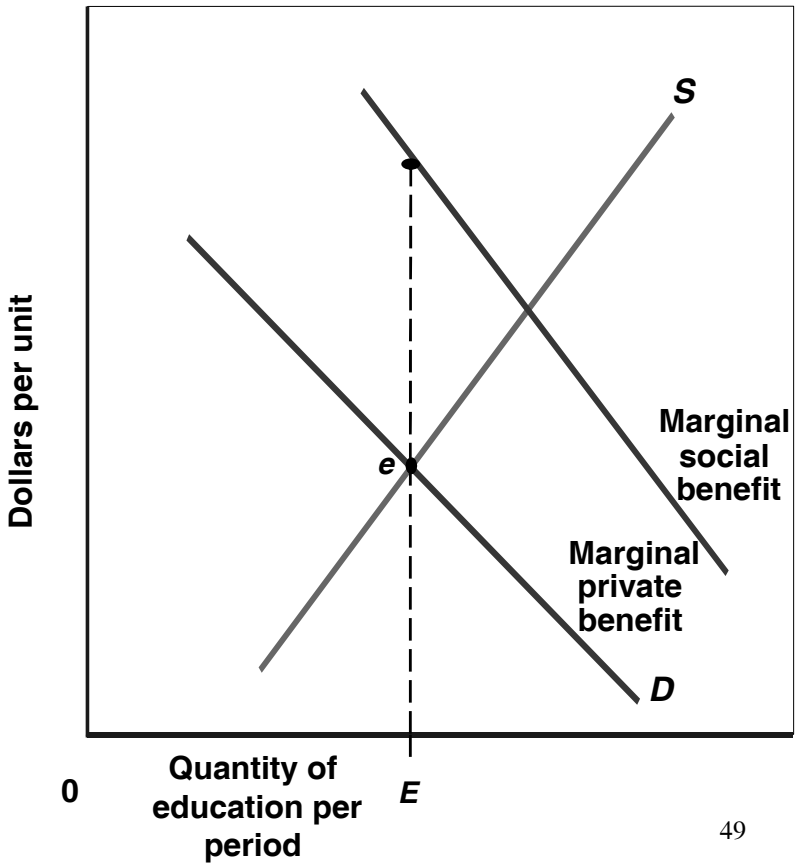
The demand curve, D, reflects the *marginal private benefit* for acquiring the education
➔ more education is demanded at a lower price.

The benefit of education spills over to others
→Add marginal external benefit to the marginal private benefit,
→marginal social benefit of education.



Education and Positive Externalities

If education were a strictly private decision:
Equilibrium point *e* ➔ education level E



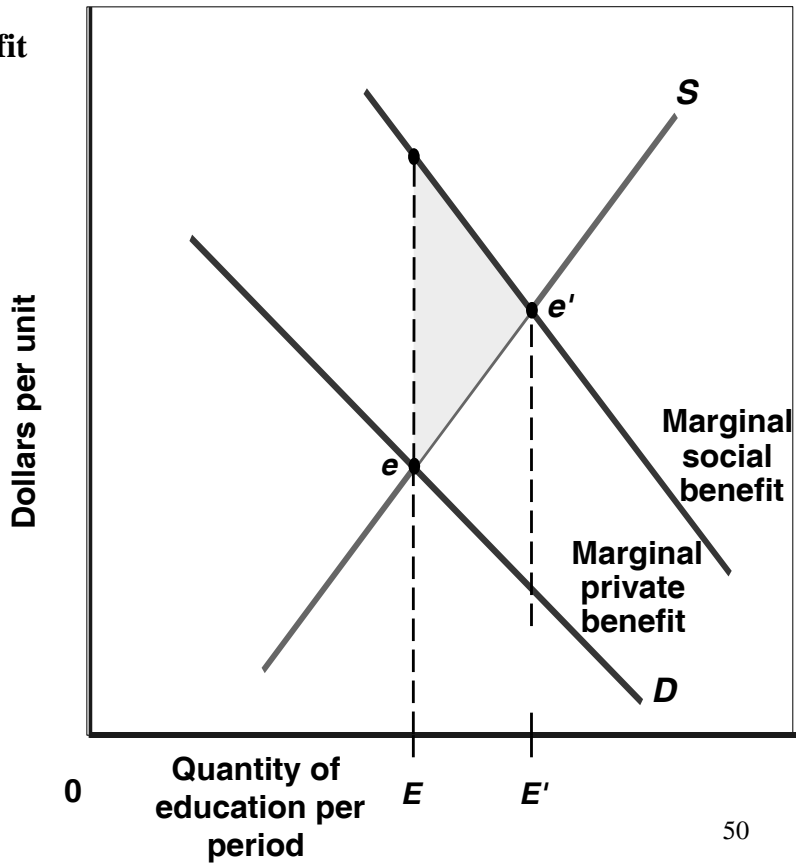
Education and Positive Externalities

At level E, marginal social benefit >marginal cost
➔net social welfare increases if education expands!

Social welfare maximized:
Equilibrium point: *e'*
E' units of education are provided.

The yellow shaded triangle identifies the net increase in social welfare

Society is better off if the level of education exceeds the private equilibrium



Positive Externalities

- **If positive externalities are present,**
  - **decisions based on private MB result in less than the socially optimal level of the good**
- **A market failure!**
  - **Government often gets into the act**
  - **Public policy aims to increase the level of output**

課堂報告

- 請解釋何謂exhaustible 和renewable resources
- 請舉例說明何謂common pool problem
- 請說明如何解決common pool problem.
- 請舉例說明何謂negative externalities
- 請說明何謂Coase theorem
- 請舉例說明何謂positive externalities

Homework

- 10. Analyze of external cost
- 12 Discuss the market for pollution right