

Ch18. Externalities and the Environment

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In 1990 Federal government stipulated new standards for the dumping of sulfur dioxide, which is a pollutant partly responsible for acid rain. This law imposes a ceiling or quota on the amount of sulfur dioxide a utility company can dump a year. A utility company that does not use up the quota is allowed to sell the unused quota to other firms. This legislation allows firms to buy and sell the pollution permits, but the total amount of pollution is regulated by government. Rights to dump sulfur dioxide are traded at the Chicago Board of Trade

Externality occurs when an activity carried on by one decision maker affects the decisions by others.

- Benefits occur due to external economies (a.k.a. spillover benefits)
- Costs occur due to external diseconomies (a.k.a. spillover costs)

Benefits: apple orchards and beekeeper. Beekeepers provide cross-fertilization. e.g., California almond producers rely on and pay beekeepers to bring bees to the orchards. (watch: The last beekeeper)

Costs: Flower shop and steel mill.



When a paper mill pours toxic chemicals into the river, downstream swimmers and fishermen are adversely affected.

Example: Rivers in Hong Kong are not suitable for swimming. Only rowing contests are allowed annually.

Two popular movies also show the extent of pollution and how consumers fight back against the pollution caused by big businesses.



A CIVIL ACTION: John Travolta is a lawyer trying to show the adverse health effects on property owners.



ERIN BROCKOVITCH: A former Miss Wichita goes through a lot of trouble, but eventually succeed in forcing the utility company to pay \$333 million to the residents of Hinkley, CA, whose health was adversely affected by the contaminants (Chromium 6) poured into the area.

Because of growth of world population and its concentration in a few cities,

externalities have mushroomed during the modern era of industrial production. There is no indication that this trend will abate in the future. There is need for international agreement.

Social Costs and Benefits

The **private cost** of producing a good is the cost paid by the private firms. Sometimes producing a good imposes costs on other people in the society. For example, a factory may cause air pollution that harms people who live nearby. Consumption of some goods also imposes costs on other people. For example, when a driver on the highway is polluting the air. The **social cost** of producing a good is the total private cost *plus* the cost to other people.



Drunken driving also kills people. Mistakes made by a drunken driver imposes huge costs on other drivers that cannot be recovered.

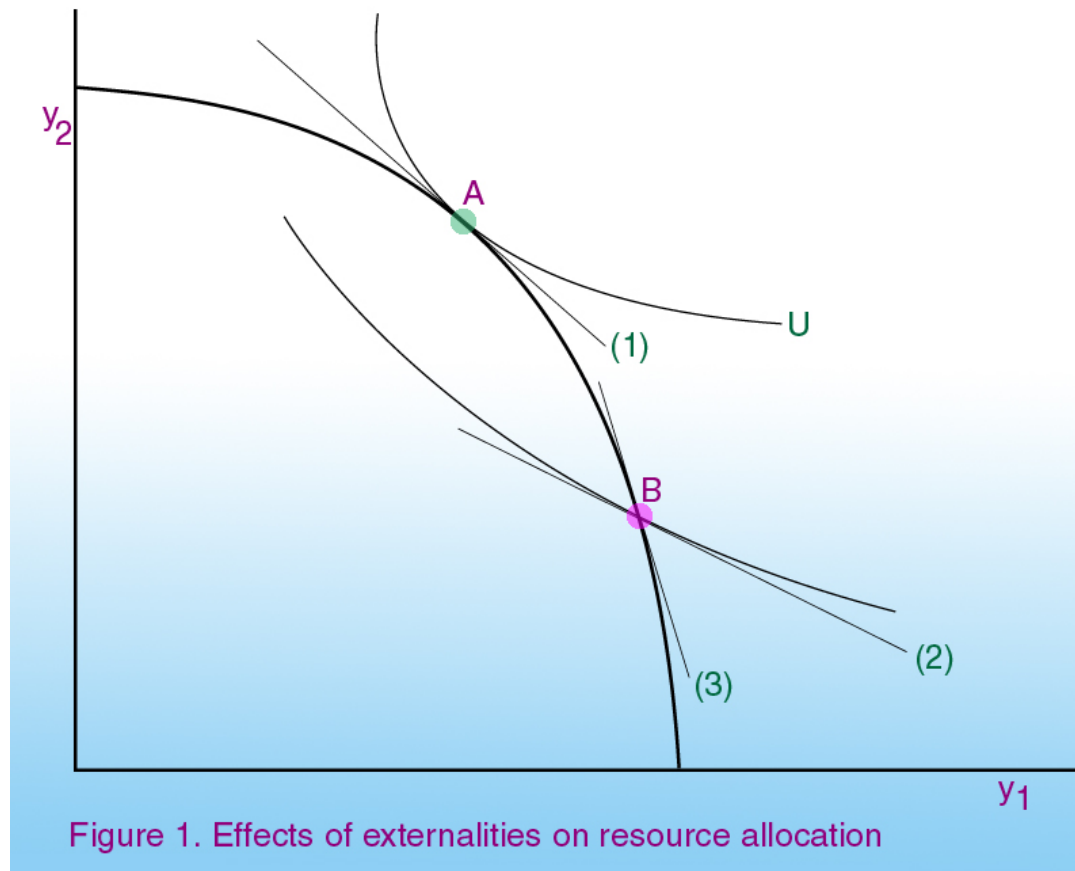


cell phone users, especially texters. One in three teenagers drive while thumbing. Roughly half the children under 17 were in such cars.

The **private benefit** of consuming a good is the benefit to the people who consume it. The **social benefit** is the private benefit *plus* the benefit that accrues to other people. An **externality** occurs when the private benefit/cost differs from the social benefit/cost.

A *negative* externality occurs when the social cost of a good exceeds the private cost. A *positive* externality occurs when the social benefit exceeds the private benefit.

Effects of Externalities



In a closed economy, the problem is to maximize utility subject to the production possibility frontier.

Along an indifference curve,

$$\frac{\Delta U}{\Delta y_1} \Delta y_1 + \frac{\Delta U}{\Delta y_2} \Delta y_2 = 0,$$

or

$$\frac{dy_2}{dy_1} = -\frac{MU_1}{MU_2} \text{ (a.k.a. Marginal Rate of Substitution)}$$

Along the production possibility frontier (PPF), cost is given,

$$wL + rK = \bar{C}.$$

Thus, along the PPF,

$$\frac{\Delta C}{\Delta y_1} \Delta y_1 + \frac{\Delta C}{\Delta y_2} \Delta y_2 = 0,$$

or

$$\frac{dy_2}{dy_1} = -\frac{MC_1}{MC_2} \text{ (a.k.a. Marginal Rate of Transformation)}$$

Maximization of utility subject to the budget constraint implies that at an optimal solution on the PPF, $MRS = MRT$. That is, it is a tangency point, like point A in Figure 1, between the highest indifference curve and the PPF.

Equilibrium price ratio is the slope of the line tangent to both the indifference curve and the PPF. Here, MRT is the ratio of marginal costs incurred by the society as a whole, not private costs. That is, at point A, output price ratio is equal to the ratio of social marginal costs, i.e.,

$$\frac{p_1}{p_2} = MRT = \frac{MSC_1}{MSC_2}.$$



This would be the end of the story, if there were no externalities. However, the presence of external costs or benefits disturbs the equilibrium and introduces a distortion in a market economy.

At point B, marginal social costs deviate from marginal private costs. Line (3) reflects the ratio of social marginal costs,

$$\frac{MSC_1}{MSC_2}.$$

However, the private sector faces a different price ratio,

$$\frac{p_1}{p_2} = \frac{MPC_1}{MPC_2}.$$



In the presence of external costs in Sector or industry 1,

$$MPC_1 < MSC_1.$$

Thus,

$$\frac{p_1}{p_2} = \frac{MPC_1}{MPC_2} < \frac{MSC_1}{MSC_2} = \frac{MPC_1 + \beta}{MPC_2},$$

where β is the additional pollution cost the society bears. In the absence of regulation, an equilibrium occurs at a point like B, where the above inequality holds for consumers [line 2 is flatter line 3].

As a result,

Excessive production of the pollution intensive industry, y_1 ($\uparrow\uparrow$)

Insufficient production of the clean industry, y_2 (\downarrow).

Remark: While ignoring the externality causes inefficient allocation of resources, it does not imply that complete elimination of pollution is optimal. The optimal output mix occurs at point A, not either end of the PPF in Figure 1.

Maximizing the Net Benefits of Pollution

Pollution exists when human activity generates a sufficient concentration of a substance in the environment to cause harm to people or to valuable resources. Harmful substances naturally exist in the environment and they are not considered as pollutants. Pollutants are by definition, the products of people, not nature.



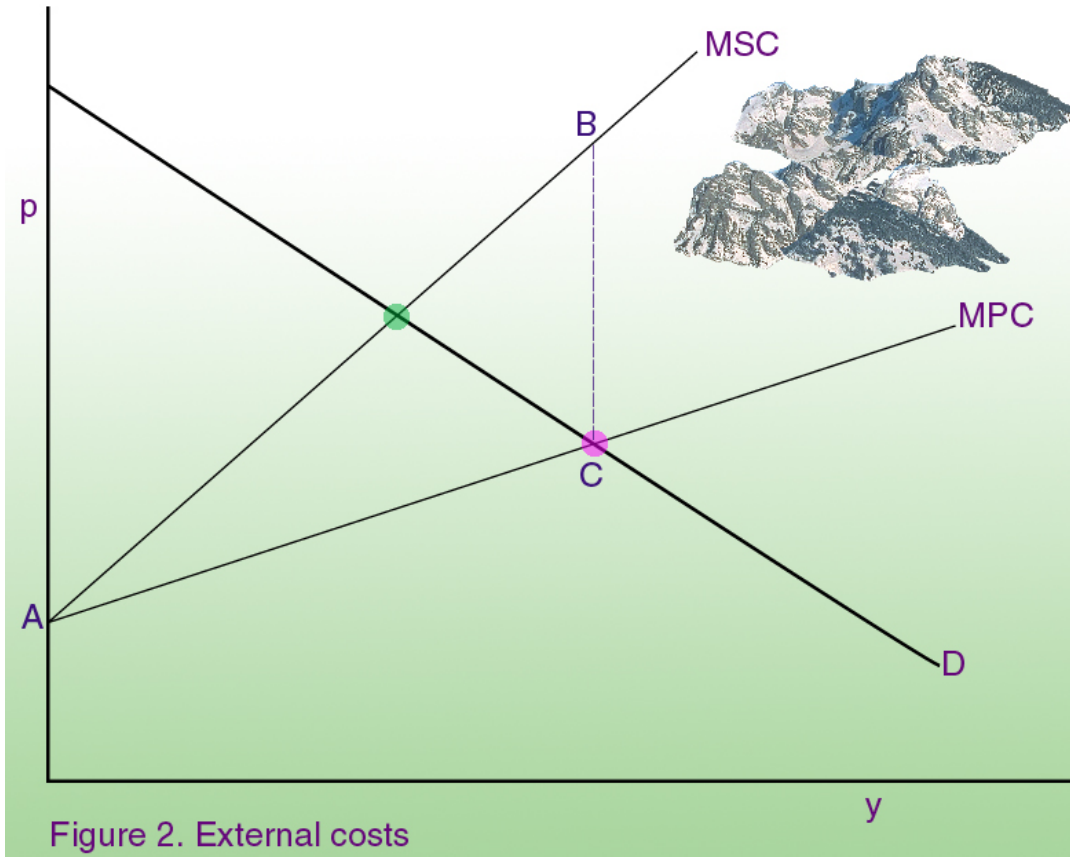
Population control should be a major control variable. However, population control is being ignored altogether at the Copenhagen Climate Conference of 2009.


What about pollution that harms plants or animals? Economists generally argue that such pollution imposes a cost *if* the plants or animals are valued by people.

Negative Externality

Figure.

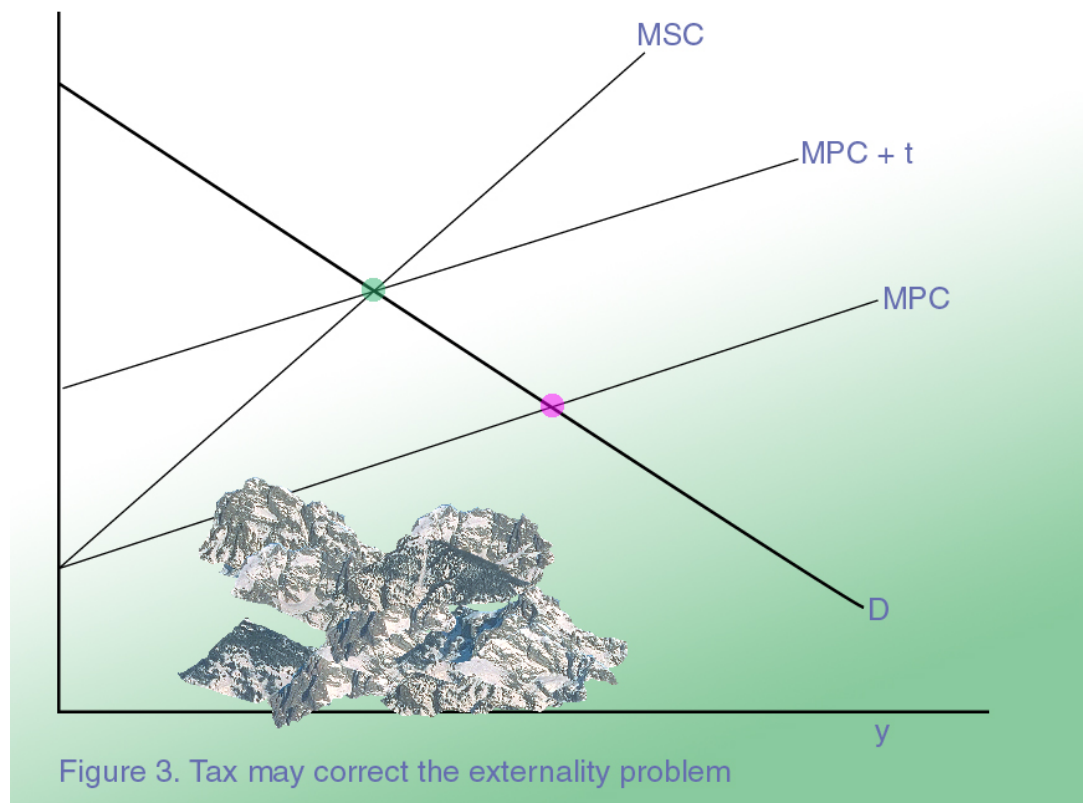
The intersection of MSC and D represents an economically efficient quantity. Without intervention, however, the free market equilibrium occurs at the intersection of MPC and D.





 If no output is produced, pollution is completely eliminated. However, *it would not be economically efficient to eliminate pollution completely*. This implies no production, which is not allocatively efficient. The deadweight loss from overproduction is ΔABC .

HOW TO INTERNALIZE EXTERNALITIES

TAX ON THE POLLUTER:



 If property rights are well defined, the government can impose taxes on the polluter. It all depends on who owns the property right. If the non-polluters own the property right, Pigouvian tax may be appropriate. However, sometimes the property right is not well defined.

(e.g., in the suburb of Kiev, people build houses as they please, but at private costs.)

Internalizing an externality means changing private costs or benefits so that they equal social costs or benefits. People can make side payments to others in return for a specific action. This side payment is in effect a bribe. People that suffer harm from a factory's pollution may offer to pay the polluter to stop. This may be *unfair*, but it *works*.



Obama's Cap-and-Trade Plan

The U.S. Chamber of Commerce is gearing up to rally coal-state politicians to alter the President's plan to control carbon emissions (John Carey's report)

http://www.businessweek.com/magazine/content/09_11/b4123022554346.htm

Obama's proposal:

- Reduce U.S. emissions 14% below 2005 levels by 2020 and 83% below by 2050. And he'd raise \$646 billion from 2012 to 2019 by auctioning the rights to emit such gases—in effect putting a price on carbon emissions.
- A concrete proposal removes uncertainty about the future cost of carbon emissions.
- Reduction of carbon emissions in the US alone will not have much impact on global warming. There are other giant energy users. China and India are not likely to agree to binding limits.
- Obama's plan: charge \$13 to \$20 per ton. (Those permits could also be bought and sold.) Even at the lower range of \$13 per ton, energy companies and utilities would likely pass along the added cost to consumers.
- Impacts on other prices: The price of gasoline would go up by 12 cents a gallon and the average electricity bill by about 7% nationally



CHINESE POLLUTERS POINT TO WESTERN DEMAND

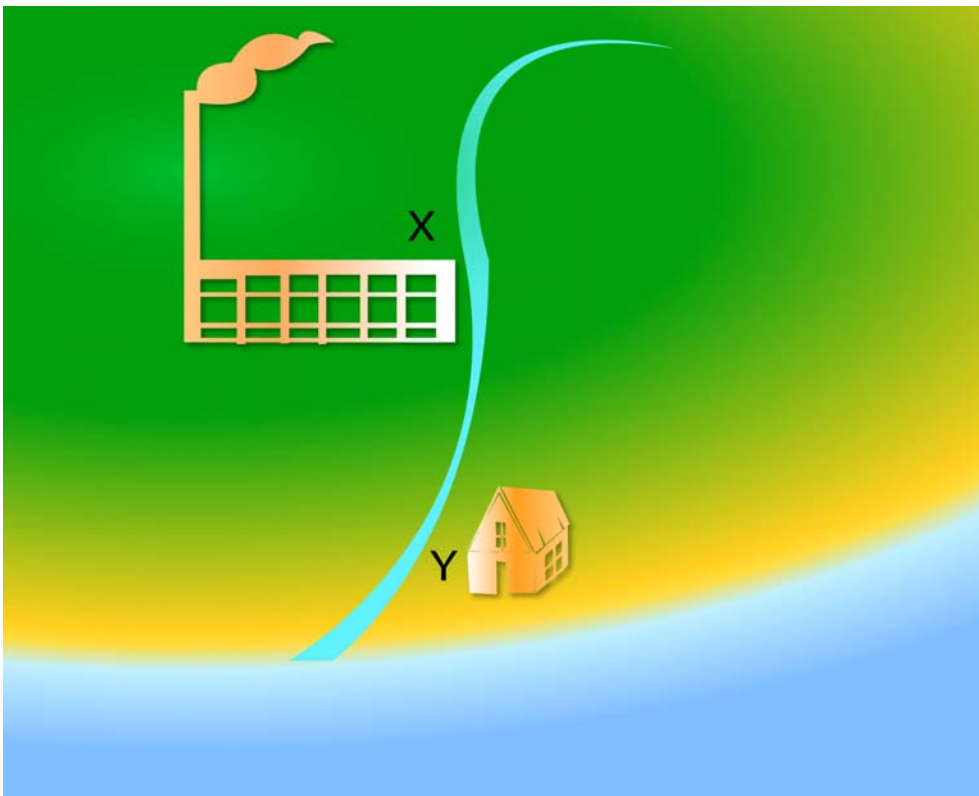
(Businessweek, April 6, 2009)

One price the world pays for attractive, affordable Chinese goods, from apparel to flat-panel TVs to steel beams, is more [greenhouse gas](#) spewing from Chinese factories. Last year the nation surpassed the U.S. as the world's top [emitter](#). And with pressure mounting on Beijing to clean up its act, its leaders are starting to point right back at the West. "[Up] to 25% of China's emissions come from the products we make for the world," and consumers--not the producers--should pay for them, said Gao Li, director of China's Climate Change Dept., at a recent forum held by the [Pew Center on Global Climate Change](#). The [Pew Center on Global Climate Change](#) is a non-profit advocacy organization that was established in 1998. Its Board of Directors includes Kenneth Arrow and Klaus Töpfer. [1] It is supported by The Pew Charitable Trusts, which "is working to create a policy environment . Indeed, a portion of the recent emissions reductions claimed by both the U.S. and Europe came simply from moving production to China. Accounting fairly for the carbon in imported goods, says [Pew](#). And, although a man has the exclusive right to it, yet, it seems, he cannot maintain trespass against a person Vice-President Elliot Diringer, will be a focus of the coming round of global climate talks.

SIDE PAYMENTS

Who should pay? The party that does not have the right. However, these rights are not often defined clearly. If rights are not clearly defined, then pollution is an inevitable outcome.

Suppose there are two firms, Y and X, producing two goods Y and X, respectively. Y is an upstream firm and pollutes the water, thereby increasing the production cost of X.



Case I: X has the Riparian right (The upstream firm has the right to water)

Then the downstream firm Y bribes the upstream firm X. Let p be the price of X, and let b be the amount of money X receives per unit of output reduced. Then the upstream firm's profit is:

$$\pi = pX + b(\bar{X} - X) - c(X), \quad (1)$$

where \bar{X} is the amount of output the upstream firm would produce in the absence of any bribe. Optimal production of the polluter is given by:

$$\frac{d\pi}{dX} = p - b - MC = 0. \text{ or } p = b + MC. \quad (2)$$



Case II: Y has the *riparian right*. (The downstream firm or residents have the right to water)

In this case the upstream firm or the polluter X bribes the downstream firm Y, b dollars per unit of its output produced. Then the upstream polluter's profit is:

$$\pi = pX - bX - C(X). \quad (3)$$

The First order condition (FOC) is:

$$\frac{d\Pi}{dX} = p - b - MC = 0. \text{ or } p = b + MC. \quad (4)$$



The two problems yield an *identical* solution. The only difference between the two is that the upstream firm's profit changes by the amount of bribe, $b\bar{Y}$, or the value of the right to water.

The Coase Theorem states that if transactions costs are sufficiently low and income effects are negligible, the equilibrium is efficient, regardless of whether the polluters have the right to pollute.

Remark: Negotiation (transactions) cost is not negligible. It is difficult to organize the interested parties. It is not easy to get unanimity for negotiation.

Side payments may not be realized. People harmed by pollution may find it impractical to get together, identify polluters, agree on the side payments, and on how to share their costs, make the offers, and make sure that polluters honor the agreements. It requires patience and time. If the transactions costs are too high, side payments may not be materialized.

Common Property Resources

Common properties are resources to which everyone has free access. Sometimes simply called “Commons.”

Private property: one can exclude others from using the property.

<http://www.dieoff.org/page95.htm>

Tragedy of the Commons

Each household feels it has the right to take resources from the Commons and dump wastes on the Commons. If there are n individuals, when an individual dumps a waste on the Commons, it bears only a small fraction of the external cost ($1/n$). However, whenever he takes resources, he becomes the single beneficiary. Thus, resources in the Commons are overexploited, and excessive wastes are dumped on the Commons.

The socially optimal level of the Commons occurs where marginal benefit is equal to social marginal cost,

$$MB - SMC = 0.$$

However, if it is a common property, he uses the Commons until

$$MB - \frac{SMC}{n} = 0.$$

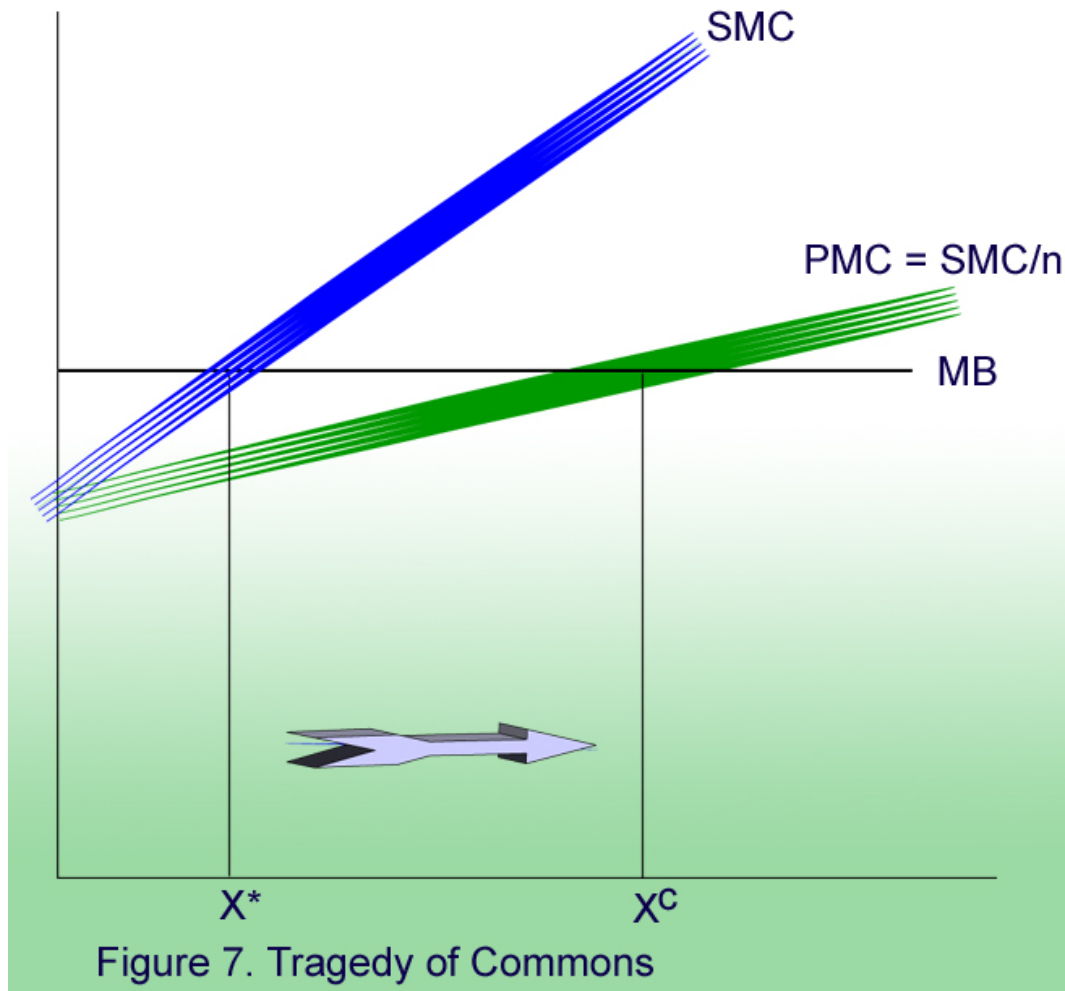


Figure 7. Tragedy of Commons

Each individual has an incentive to overexploit. All individuals behave the same way. Consequently, the Commons is overexploited. Thus, the “tragedy of the Commons,” Moreover, to get rich some households use their surplus to take more resources from the Commons, thereby expediting this process of ruining the Commons.

There is a simple solution to this problem. Let a single person or entity own the common property resource. Then he equates social cost as his own cost, equating SMC with MB. Thus, private ownership of the Common property resource yields a socially optimal utilization. However, most common property resources are vast beyond the reach of a single individual. For this reason, either government ownership or government regulation is needed.

This explains why many beaches and mountains were overexploited and wasted.

Only recently, governments are stipulating fines and totally ban private access to such resources.



Theory of Second Best

Efficiency of resource allocation requires $MB = p = MSC$.

If the mining firm is a monopolist, $MR = PMC$.

Under normal circumstances, a monopolist produces too little, less than is socially optimal.

In the polluting industry such as mining, refining, the extra cost on the society is not taken into account, and the mining firm produces too much. If there is a monopolist in the mining industry, it produces less than competitive firms, and hence produces less pollution. In this case, there is no need to break up the monopoly. Breaking up the mining monopoly only increases pollution.



The theory of second best states that satisfying one more marginal condition for social optimum does not necessarily improve resource allocation.