

#### IV. Externalities and Externality Problems

**A.** DEF: An *externality* may be said to exist whenever a decision made by an individual or group has effects on others not involved in the decision. That is to say, an externality occurs whenever some activity imposes spillover costs or benefits on persons not directly involved in the activity of interest.

**B.** In nearly every case in which *environmental problems* may be said to exist--the underlying "economic problem" is an externality problem.

- i. Generally, activities that impose *external losses* (costs) on third parties at "the margin" are carried out at levels greater than those that maximize the social net advantage from those activities.
- ii. This follows because the people who decide the level of the activity that gets carried out tend to focus only on their own costs and benefits.
- iii. [Note that this is a positive prediction about behavior--that spill over costs and benefits will be ignored by those controlling the activity.]
- iv. Within environmental economics, polluters ignore spillover costs, while pollution reducers ignore spillover benefits from cleaning up their production.

**C.** Given these (positive) predictions about the behavior of firms and consumers, welfare economics (both Paretian and Net Benefit maximizing theories) implies that environmental problems exist and that well-designed public policies can reduce the implied environmental "problems."

- i. The "problem" from the point of view of standard welfare economics is not pollution itself, but rather that **too much pollution gets produced to maximize social net benefits.**
- ii. In Paretian terms, there will be unrealized gains to trade between polluters and those damaged by polluters.

**D.** Note that **the optimal amount of pollution is not generally zero!**

- i. The "optimal" amount of pollution is greater than zero if the social marginal benefits of engaging in the polluting activity exceeds its social marginal costs.
- ii. Remember that firms, in effect, produce several outputs simultaneously, and the value of the outputs that are sold can be sufficient to make it worth "putting up with" the negative externalities of pollution generated--at the margin.

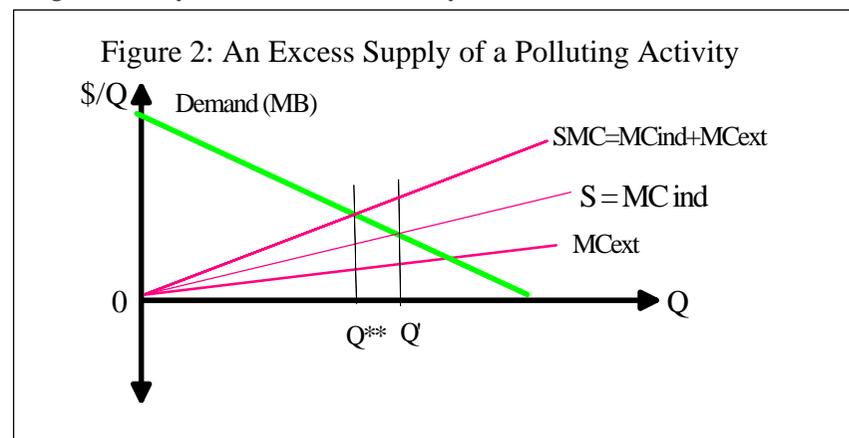
**E.** To use our **geometric tools** to find out whether an activity or output is over or under supplied, we first add up ALL the marginal benefit and marginal cost curves to find the social marginal benefit and social marginal cost curves for the activity in question.

i. **Geometrically the social marginal benefit and marginal cost curves are "vertical" sums of the private (consumer and industry) and "externality" MB and MC curves, because externality generating activities affect many persons simultaneously.**

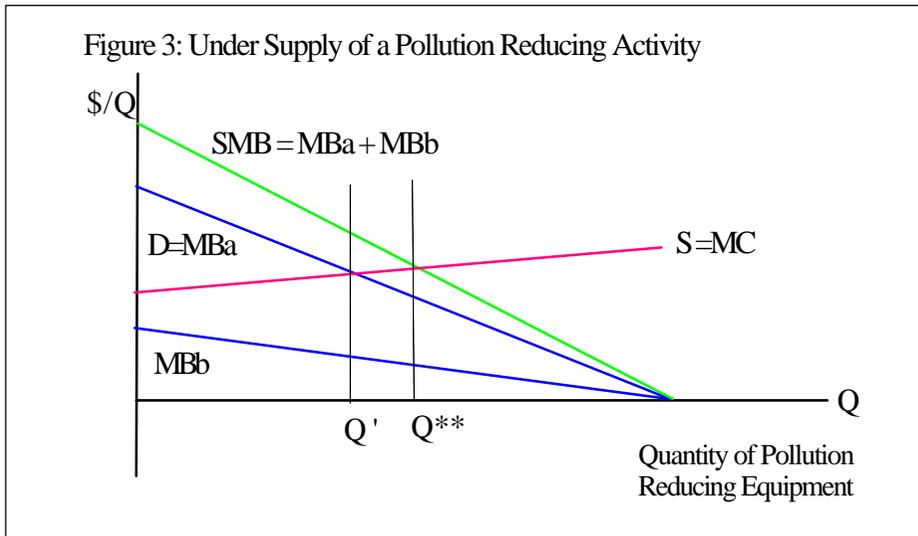
- ii. As in all of our previous diagrams, the level of the activity that maximizes social net benefits is generally the quantity,  $Q^{**}$ , at which the social marginal benefit of the activity equals its social marginal cost.
- iii. (Recall that net benefits are *usually* maximized where the relevant MB and MC curves intersect.)

**F. ILLUSTRATION:** In Figure 2, market output tends to be at the point where supply equals demand, which is labelled  $Q'$ . However, the production (and/or consumption) of this product imposes external costs on people not directly involved. ( $MC_{ext}$  is greater than zero over the range of interest.)

- i. Consequently, the activity being analyzed is produced at greater than optimal levels. That is to say,  $Q'$  is larger than  $Q^{**}$  where  $Q^{**}$  is the output that maximizes net social benefits.
- ii. Externalities might arise, for example, if a firm disposes of its waste products using the "freely available air or water systems."



**G.** Of course, not all spillovers are negative. "Public goods" problems arise when there are spillover **benefits** from an activity of interest. The problem with public goods is that they tend to be under produced.



- i. ILLUSTRATION: In Figure 2, the adoption of pollution reducing equipment (Q) create spillover benefits at the margin.
- ii. Normally, consumers do not know whether or not a producer produces a lot or a little pollution.
- iii. However, a firm that uses a less polluting technology of production provides external benefits for residents downwind or downstream of its factories.
- iv. Thus, a firm that uses costly equipment that reduces its pollution generates a positive externality, that is not "internalized" into its MB (marginal revenue) curve.
- v. And, consequently, **too little** of this equipment is used to maximize social net benefits.
- vi. [As an exercise, label all the areas and find the extent of the social loss associated with Q'. Can Q' ever be so small that it is not worth pursuing? In what sense is there a loss?]

**H.** It also bears noting, however, that there are cases in which an activity produces externalities, but **not at the margin**. In such cases, markets will produce the social net benefit maximizing level of the good, and although there are external costs, there are no "externality problems." (See class notes.)

**I.** However, as a **rule of thumb**, pollution producing activities are **over** provided relative to that which maximize social net benefits, and pollution reducing activities are **under** provided relative to that which maximizes social net benefits.

## V. The Commons Problem

**A.** One special case of an externality problem that is very relevant for many environmental problems is the "tragedy of the commons."

- i. The tragedy of the commons involves the excess use of a resource that is freely available to all who wish to use it.
- ii. For example, in medieval Europe there were often common pasture lands and communal forests that could be used by the peasants for their own cattle and firewood.
- iii. Many resources remain common property today; for example, air and water supplies are often freely available to anyone that wants to use them.
- iv. The oceans largely remain "commons" for fishing firms and shippers.
- v. (Environmental laws have begun to regulate access to these very large common resources only fairly recently.)

**B.** A **commons problem** arises when a common resource is **over utilized**, that is used at a level that diminishes its total output.

- i. Excess usage occurs, because individual users bear only part of the cost of using the common.
- ii. Each person's use of a communal resource reduces somewhat the productivity of the resource or access for other users, but this external cost can be ignored by all users when they make their decisions.
- iii. In this sense, a "commons problem" is a type of externality problem that involve the use of a common resource (pasture, forest, fishing hole, system of air or water).

### The Tragedy of the Commons as a Two Party Game

Herd Size	Bob: Small Herd	Bob: Large Herd
Al: Small Herd	A, B 3, 3	A, B 1, 4
Al: Large Herd	4, 1	2, 2

**C.** Analysis of the "Tragedy of the Commons" game illustrated above:

- i. Note that regardless of what Bob does, Al has an incentive to place a large herd on the commons. Note that 4 > 3 and 2 > 1. (Use vertical comparisons for Al)

- ii. Similarly, regardless of what Al does, Bob has an incentive to place a large herd on the commons. Again  $4 > 3$  and  $2 > 1$ . (Use horizontal comparisons for Bob's payoffs.)
- iii. Thus both Bob and Al will graze large herds and the pastures output of beef falls to 4 (2+2) from 6 (3+3).
- iv. [The commons problem is a special case of the "Prisoners Dilemma Game."]
- v. Note that there are potential gains to trade that both Al and Bob could realize if they could each agree to restrain themselves from placing larger herd sizes on the commons.
- vi. On the other hand, if they agree to place small herds on the commons, each may cheat--note that there remain incentives for each to graze large herds on the commons.

**D.** The commons problem associated with land management problem has largely been solved by privatizing the commons (worldwide).

- i. Privatizing gives complete control over a parcel of land, or other resource, to a single individual, group, or firm.
- ii. This individual or firm will want to maximize output from his/her assets and will place the herd size on the pasture that maximizes output.
- iii. [Are there cases where privatization will not work? Why?]

## VI. Economic Growth, Scarcity, and the Environment

**A.** Both the standard production external cost problem (pollution) and the tragedy of the commons problem (over use) imply that as use of resource become more intensive, that the magnitude of externality problems becomes greater.

- i. Holding technology and the legal setting constant, it is clear that as production increases there are more wastes to be discarded using "free" disposal via the circulating systems of the water and air systems.
- ii. Holding technology and the legal setting constant, it is clear that the more intensive the use of a common resource tends to be, and the more likely common resources are to be over utilized in the sense that the value of aggregate output is smaller than it should.
  - As a body of water is fished by more and more fisherman and women, fewer and fewer fish remain for others, and eventually the overall harvest falls when the fish left can not reproduce at rates sufficient to replace those caught.
  - As more head of cattle are grazed, less and less grass remain for other users of a common pastureland.

**B.** That is to say, holding technology and the legal environment constant, environmental problems increase with economic development.

**C.** However, the technology and the legal environment also changes through time in periods of economic growth.

- i. These changes **may reduce** or increase the magnitude of externality and commons problems.
- ii. For example, technological change may allow producers to reduce their costs (and consumers to save money) by using new production methods that make better use of existing resources and, therefore, reduce waste flows.
- iii. ("Waste outputs" of production "sell" with negative prices--that is to say, firms and consumers have to "pay" people to carry their "waste products" away.)
- iv. Technological change may create production processes that reduce waste flows by discovering new ways to use "waste products," as with many new wood products that are made from sawdust and other cost-effective forms of recycling
- v. Moreover, the material used to produced goods and services tends to **fall** as technology increases.
  - Thus a modern house has far less wood in its structure than a log cabin.
  - A modern plastic bag has far less plastic, an automobile less steel, and a modern aluminum can less aluminum, than similar products of twenty or thirty years ago.
  - **It is literally true that "They don't build them like the used to."**

**D.** The laws that frame economic decision making can also change in a manner that reduces or increases the magnitude of environmental externality and commons problems.

- i. Polluting activities may be subsidized or encouraged as with agricultural policies and zoning laws
- ii. However, in many cases, an increases in the magnitude of externality and commons problems lead to new laws that reduce environmental problems.

## VII. On Technological and Legal Foundations of Common Problems: Stationary and Circulating Resources

**A.** Natural resource management issues can be divided into two types: those regarding the management of stationary resources and those regarding the management of freely circulating resources.

- i. Both these policy areas have long been subjects of government regulation, and both exhibit similar problems insofar as free access to either sort of natural resources tends toward excessive use: what Hardin (1968) termed the tragedy of the commons.
- ii. However, the cost, effectiveness and feasibility of alternative management methods differs substantially across these two types of resources.

- Regulating access to stationary resources is generally easier than regulating access to freely circulating resources because monitoring costs are lower and the problems associated with mismanagement are more obvious.

## B. Stationary Resources

- Historically, a variety of management methods have been used to limit access to stationary resources in order to promote their productive and sustained use.
  - One broad class of methods widely used for centuries involves the assignment of "use rights" for particular stationary resources, such as grazing lands, gardens, or lodging sites.
  - Here political authorities do not directly regulate the use of natural resources, but rather define and protect the use rights of lawful "owners" or lawful "users."<sup>1</sup>
- In cases where "use rights" are exclusive *and* tradable, markets for "use rights" give owners incentives to consider both the current and future productivity of the resource over which they have control.
  - The current income and resale value of a well managed site tends to be higher than one that is poorly managed.
  - Exclusive and marketable "use rights" also create a low cost method whereby resources may be shifted from more talented resource managers.
  - Better managers are naturally willing to pay a higher price for use rights than poor managers because they anticipate greater output from the same resources.
- The property rights solution to the management of stationary resources is relatively permanent and unobtrusive, and requires little political oversight on a day to day basis.<sup>2</sup>
  - Monitoring the unauthorized use of privately owned resources is largely undertaken by property owners themselves, which further reduces the cost of this solution to the commons problem.
  - Privatization may not solve all the problems of managing stationary resources, but the efficiency of the property rights solution as a method of encouraging the production of valued services for humankind is attested to by the fact that formal chains of title to real estate in Western Europe and in the Eastern United States generally predate current governments, often by several centuries.<sup>3</sup>

## C. Circulating Resources

- Management of freely circulating resources is more difficult, and it is partly for this reason of greater modern policy interest.
  - Circulation and diffusion give air and water systems a substantial capacity for dissipating and neutralizing many of the undesired byproducts of farming, manufacturing, and transport.
  - Circulation and diffusion also imply that access to these resources is largely unimpeded by inconvenient distances, no trespassing signs, or fences.
- These properties have long been relied on (at least implicitly) as inputs in the production process.
  - It is, after all, what makes fire, farming, and indeed breathing, possible. Unregulated free access to these systems can eventually lead to over exploitation of their productive capacities in much the same manner as for stationary resources.
  - New users gain average net benefits from use rather than marginal net benefits. Marginal net benefits are below average benefits (and may even be negative) because a large proportion of productivity losses are borne by other users in the form of reduced air or water quality.
  - In short, a commons problem can arise from the unfettered use of circulating resources for the same reasons developed for non-circulating resources.
- However, the same properties of the air and water systems which make them valuable inputs for production and convenient vehicles for waste disposal also make them far more difficult to regulate and/or to privatize than noncirculating resources.
- Communities can not assign use rights to *particular units* of freely circulating air and water in the same manner that they can for land and mineral resources.<sup>4</sup>
  - Air and water are unlike railroad box cars and cattle in that particular "pieces" of air or water can not be readily identified and assigned to particular "owners."
  - This contrasts with, for example, homogeneous acreage in a featureless desert or plain that can be assigned to owner/users on the basis of geometric coordinates.
  - Tradable rights to *use* air and water can be established, but such rights are *user rights to a common property resource* rather than ownership in the usual sense.<sup>5</sup>

<sup>1</sup> Ostrom (1990, ch. 3) analyzes a variety of long standing methods of managing access to common property resources including: grazing lands in the Swiss Alps, communal forest land in Japan, and canal systems in Spain. She concludes (p. 90) that enduring methods for resolving commons problems share eight characteristics: (i) clearly defined boundaries, (ii) congruence between appropriation and provision rules and local conditions, (iii) collective choice arrangements, (iv) monitoring for appropriate behavior, (v) graduated sanctions, (vi) conflict resolution methods, (vii) minimal rights to organize locally, and for larger commons problems, (viii) organization of monitoring, enforcement, and conflict resolution as "nested" enterprises.

<sup>2</sup> The above argument is not meant to imply that privatization has very often been adopted with the conscious intent of solving commons problems. Rather, it is likely that regions of the world that adopted ownership rights avoided commons problems that others societies using more politicized methods had to cope with. Through time, as legal institutions evolved, better assignments of use rights tend to supplant management methods that yielded significantly inferior outputs.

It may be argued that there has been a gradual restriction of private use rights through time. Often these restrictions do not substantially restrict the uses of the stationary resource, but rather access to *circulating* resources that pass under, over, or through the stationary resource. For example, modern rules governing solid waste disposal attempt to ensure that "disposal" is undertaken in a manner that does not affect local water or air quality.

<sup>3</sup> See Macfarlane (1978) for an overview of English property law during the medieval period.

<sup>4</sup> One can own bottles of air or water. But, generally bottled air and water are only temporarily partitioned from the common circulating air and water systems. "Purchase" of a bottle of water is more analogous to renting than owning an asset.

- v. Political conflict over the management of circulating resources is nearly unavoidable.
- Controversy over appropriate access to communal resources is likely because common ownership implies that decisions to curtail, maintain and/or increase "use rights" directly affects the interests of all other users of the common property resource.
  - The physical properties of circulating natural resources imply that a relatively large number of affected parties will disagree over the importance of controlling particular point sources of effluent emissions.
  - Diffusion generally diminish the impact of effluents as distance from the point of origin increases.
  - Consequently, even if there were no other disagreement regarding acceptable emission rates, diffusion provides a physical basis for political controversy at all levels of government with authority over the affected parties.
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### **VIII. Solutions to Externality and Commons Problems (next handout)**

**A.** Privatization

**B.** Coasian Contracts

**C.** Collective Management of Access: Use Rights and Use Fees

**D.** Pigovian Taxes

**E.** Direct Regulation

**F.** [If so many solutions are possible, why is it that so few "ideal" policies are observed? We will analyze the politics of environmental policy in a few weeks.]

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<sup>5</sup> See Block (1990) for several extended discussions of the merits of market based environmental regulation. These discussions generally neglect the fact that determining the optimal quantity of use permits, and/or the range of uses (permissible effluent rates) allowed are bound to remain ongoing political/regulatory issues.