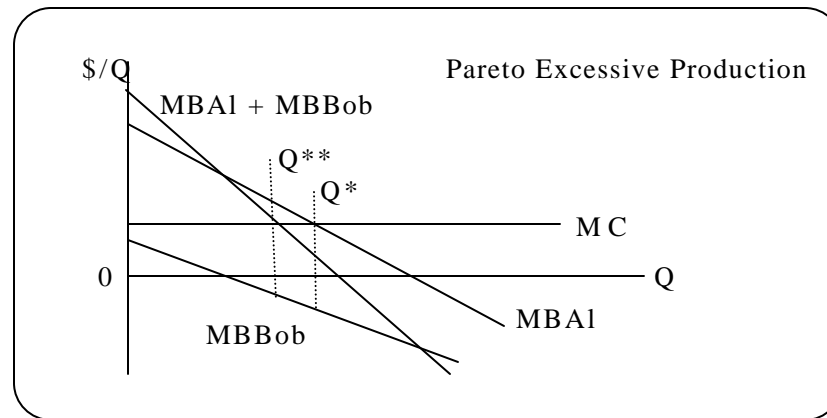


## I. Externalities

- A.** DEF: An *externality* may be said 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 other persons not directly involved in the activity.
- B.** The essential predictions of the core neoclassical models do not really change when externalities exist, because decision makers are assumed to ignore external effects of their behavior on other consumers and firms.
- C.** On the other hand, the normative properties of the final equilibrium do change. Generally, private behavior in competitive markets will no longer tend to generate Pareto efficient results.
- In the usual case, an activity that imposes *external losses* (costs) on third parties at "the margin" will be carried out at levels greater than those which maximize the social net advantage from the activity.
  - [Recall that this is a positive prediction about behavior: that spill over costs and benefits will be ignored by those controlling the activity.]
  - Similarly, any activity that generates benefits for third parties at "the margin" will tend to be under provided. Again, self interested parties will generally ignore the effects of spill overs--here beneficial spill overs.
- D.** A wide variety of public policy problems can be analyzed as special cases of the externality problem.
- For example, within environmental economics, polluters ignore spill over costs, while pollution controllers ignore spill over benefits from cleaning up. Thus pollution producing activities are over provided relative to those which maximize social net benefits, and producing reducing activities are under provided relative to that which would maximize social net benefits.
  - The *commons problem* is similarly a problem where individual users of a common resource fail to take account of the effects of their use on the benefits obtained by others.
  - Signaling and rent seeking games are also situations in which the efforts of one party tends to reduce the net benefits obtained by others in the game. That is, the more intensively one person lobbies for special favors the less successful the efforts of other rivals tends to be.
  - The external benefit argument is the basis of the so called *public goods problem*. The production of pure public goods tends to provide benefits for all individuals (insofar as pure public goods are non-excludable and perfectly shareable), and would tend to be under provided by private producers.
- E.** Although the mathematical representation externality problems vary with the particular problem of interest, the basic structure of the analysis is generally fairly similar.
- First characterize the objective functions of the various participants in the externality setting.
    - For example:  $N^A = B^A(Q) - C^A(Q)$  and  $N^B = B^B(Q) - C^B(Q)$
  - Second characterize the decision(s) of the relevant controlling parties. In a case where one party controls the activity and the other benefits or losses from that activity this is ordinarily just the utility or net benefit maximizing level for the party of interest.
    - In the above, find the  $Q^*$  that sets  $dN^A/dQ = 0$  which occurs when  $dB^A/dQ = dC^A/dQ$ .

- Third compare the private result to the Pareto efficient level of the activity in question. This is usually obtained by maximizing a social welfare function or total net benefits.
  - In the example the Pareto Efficient output,  $Q^{**}$ , can be characterized by maximizing the sum of the net benefits:  $N^A + N^B$ , which requires  $Q^{**}$  such that  $dB^A/dQ + dB^B/dQ = dC^A/dQ + dC^B/dQ$ .
  - In the case of an external cost  $dC^B/dQ > 0$  and in the case of an external benefit  $dB^B/dQ > 0$ .
  - It is clear that as long as  $dB^B/dQ \neq dC^B/dQ$  at  $Q^*$ , there will be a difference between  $Q^{**}$  and  $Q^*$ .

**F.** Illustration: Figure 1: An Excess Supply of a Polluting Activity:



- G.** To geometrically determine whether the activity in question is over or under supplied, we first add the marginal benefit (or marginal cost curves) up to find the social marginal benefit (or cost) of the activity in question.
- Note that at Al's preferred output level,  $Q^*$ , (the one that maximizes her own net benefits) that there are spill over costs at the margin. That is, Al's production makes Bob worse off at the margin.
  - Consequently, the activity being analyzed is provided at greater than optimal levels. That is to say  $Q^*$  is larger than  $Q^{**}$  where net social benefits are maximized.
  - [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? Why?]
- H.** Note that one may privately reach the Pareto optimal level of an externality generating activity if there are not external benefits or costs at the margin (e.g. at  $Q^*$ ), but in other cases some form of collective action will be required to "solve the externality problem."

## II. The Commons Problem

- A.** The "tragedy of the commons" involves an externality problem in which the predicted result is the excess use of a resource that is freely available to all who wish to use it. Communal "ownership" has historically been, and continues to be, fairly widespread.
- For example, in medieval Europe there were often common pasture lands or forests that could be used by the peasants for their own cattle or firewood.

- ii. Note that air and water supplies are often used as commons these days. They are freely available to all that wish to use them. Consequently, commons problems are a common way of representing many environmental problems.
- iii. The oceans largely remain "commons" for fishing firms.
- iv. Most water fountains, roads, side walks, and parks are "commons" in the United States, in the sense that they are freely available to all who wish to use them.
- v. (A wide variety of rules, customs, and laws have been used to control commons problems (See Ostrom 1990), but probably the most common solution has involved various forms of privatization.)

**B.** The **commons problem** arises when a common resource is *over* utilized, that is used at a rate that diminishes its overall output.

- i. Commons problems generally are characterized by *reciprocal externalities*. That is to say many person are involved in a setting where each person's behavior affects the benefits or returns secured by other users of the common resource.
- ii. The most common method of representing a commons problem is as a game between independent players. The Nash equilibrium of the game will not be Pareto optimal in the case where a commons problem exists. (Excess usage often occurs in equilibrium because individual users bear only part of the cost of using the common.)
- iii. Consider a modest revision of the previous illustration. Let  $N^A = B^A(Q^A) - C^A(Q)$  and  $N^B = B^B(Q^B) - C^B(Q)$  where  $Q = Q^A + Q^B$ 
  - a. Each person will maximize his or her own net advantage. So  $Q^{A*}$  tends to be where  $dB^A/dQ = dC^A/dQ$  and  $Q^{B*}$  tends to be where  $dB^B/dQ = dC^B/dQ$ .
  - b. Joint maximization would require:  $dB^A/dQ^A = dC^A/dQ^A + dC^B/dQ^A$  and  $dB^B/dQ^B = dC^B/dQ^B + dC^A/dQ^B$ .
  - c. Unless both  $dC^A/dQ^B = 0$  and  $dC^B/dQ^A = 0$ , the optimal combination of usage,  $Q^{A**}$ ,  $Q^{B**}$  required to satisfy "b" will differ from the privately "optimal one" satisfying "a."
  - d. In this case there is a tragedy of the commons, and the common will be over utilized. (See the PD game representation of this problem above.)

### III. The Public Goods Problem

**A.** The public goods problem can be characterized in either a reciprocal or non-reciprocal external benefit problem depending on the circumstance of interest. No harm is involved in this case, but still the end result tends to be an output level where the public good is under provided.

**B.** Samuelson (1954) in a classic little piece characterized the optimal level of a pure public good as follows:

- i. Let  $W = s(U_1, U_2, \dots, U_N)$  be a Bergstrom social welfare function, with  $U_i = u_i(G, X_i)$ ,  $\sum_i X_i = X$  and  $R = r(G, X)$  where  $r$  characterizes the production possibility frontier.  $G$  is a pure public good and  $X$  is a pure public good.
- ii. Form the Lagrangian  $L = W - \lambda (R - r(G, X))$  with control variables  $G, X_1, X_2 \dots X_N$
- iii. Differentiation with respect to the control variables we find that Pareto Efficiency requires:  $\sum_i W_{U_i} U_{iG} = \lambda r_G$ ,  $W_{U_i} U_{iX} = \lambda r_X$  for each of the  $N$  individuals, and  $R = r(G, X)$
- iv. Dividing the first term by the second yields:  $\sum_i W_{U_i} U_{iG} / W_{U_i} U_{iX} = \lambda r_G / \lambda r_X$
- v. Or:  $\sum_i (W_{U_i} U_{iG} / W_{U_i} U_{iX}) = r_G / r_X$

### The Tragedy of the Commons

(payoffs as net benefits)

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

- vi. Now, there is some cleverness. Note that since  $W_{U_i} U_{iX} = \lambda r_X$ , that this implies  $W_{U_i} U_{iX} = W_{U_j} U_{jX}$ . (Private goods are allocated (tax burden divided up) such that each individual's marginal contribution to social welfare is the same at the private goods margin.) Thus as the "counter" in the summation varies from  $i = 1$  to  $N$  we could substitute in a different person's  $W_{U_i} U_{iX}$  each time with out affecting the result. So:
  - vii.  $G^*$  requires:  $\sum_i (W_{U_i} U_{iG} / W_{U_i} U_{iX}) = r_G / r_X$  or  $\sum_i (U_{iG} / U_{iX}) = r_G / r_X$
  - viii. That is, The sum of the marginal rates of individual rates of substitution between the public and private good should equal the marginal technical rate of substitution (in production) between the private and public good.  $G^*$  is *independent* of the social welfare function used to characterize the Pareto Efficient production of the public good!
  - ix. The fact that the society is still on the production possibility frontier,  $R = r(G, X)$ , implies that any tax used to finance the public good must (a) have no dead weight loss, and (b) be just sufficient to pay for production of the public good.

### IV. Some Possible Solutions to Externality Problems

- i. Privatization (There are surprisingly many forms of privatization.)
- ii. Coasian Contracts (How important are transactions costs and income effects?)
- iii. Collective Management of Access: Use Rights and User Fees
- iv. Pigovian Taxes (user charges and fines)
- v. Direct Regulation (mandates)
- vi. Government Provision (Commonly used models of government provision of public goods include: Social Welfare maximization, Maximize Median Voter Utility, and Net Tax Revenue maximization (Leviathan).)