

I. Introduction to Externality and Public Goods Problems

- A. The previous part of the course addressed how a government's efforts to raise its revenues and its general pattern of expenditures affect "private" or "ordinary" market equilibria. It did so without explaining why governments might want to raise revenues or spend money in specific ways. The **next two parts** of the course address why democratic governments "need" revenue and why it is spent in particular ways.
- i. The analysis of the course thus far tends to call in to question why we have more than a minimal government, since subsidies and taxes both create dead weight losses, that is, they reduce social net benefits.
 - ii. In the cases of externalities and public goods, governments can adopt policies that increase rather than reduce social net benefits.
 - a. These "problems" are often called "market failures," because in both cases market outcomes will fail to maximize social net benefits, as shown below in these lecture notes.
 - b. The existence of such market failures may also induce voters (or benevolent governments) to demand that particular public services be provided or particular activities be regulated or taxed.
 - c. We take up the politics of public policy in the next lecture block.
 - d. One can think of this handout, the externality and public goods block, as exploring "market failures."
 - e. The next handout explores "government failures," failures by governments to properly address public goods and externality problems or to use inefficient tax instruments.
- B. The first of these "problems" to be analyzed is the case of externalities.
- C. DEF: An *externality* occurs whenever a decision made by an individual or group has effects on others not involved in the decision. That is to say, an externality exists whenever some activity imposes spillover costs or benefits on other persons not directly involved in the activity being analyzed.
- i. In most cases, 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. 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.
 - ii. Note that this (normative) conclusion is partly based on a positive prediction about behavior--that spillover costs and benefits will be ignored by those controlling the activity.
 - iii. [For example, within environmental economics, producers ignore spillover costs generated by their waste products, while government officials ignore spillover costs generated by forcing firms to clean up.]
- D. The existence of externalities is a positive claim. Either there are spillover costs or benefits or there are not.
- E. The existence of externality "problems" is a normative claim and follows from normative theories used by economists. These normative theories are sometimes called "welfare economics."
- i. The problem from the point of view of mainstream welfare economics is not that externalities exist, but rather that **the wrong level (too much or too little) of the externality-generating activity gets produced to maximize social net benefits.**
 - a. Consider, for example, water pollution.
 - b. Water pollution imposes costs on other users of a river or lake, and tends to be overproduced, as we will (see diagrams below).
 - c. The optimal amount of pollution is not generally zero, but the amount produced tends to be too large.

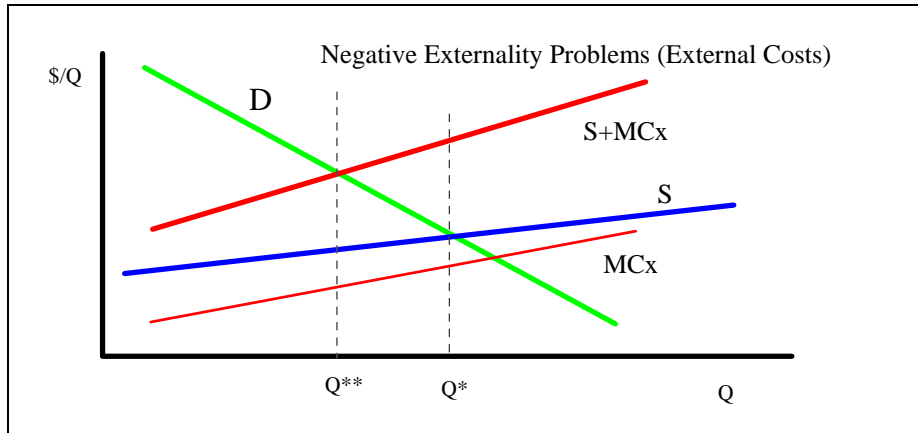
- The "optimal" amount of water pollution sets the marginal cost of cleaning up the pollution equal to the social marginal benefits of engaging in the polluting activity. (See the diagrams below.)
 - In nearly every case in which an *environmental problem* is claimed to exist-- the underlying "economic problem" is an externality problem.
- d. There are a very wide range of externalities, only a few of which are environmental and not all of which are "problems."
 - ii. Generally, activities that produce negative externalities (external costs) tend to be over provided relative to levels that maximize social net benefits, as demonstrated below.
 - iii. In addition to negative externalities, there are also activities that produce spillover benefits (positive externalities).
 - a. Consider, for example, the activity of planting flowers along sidewalks and highways.
 - b. Nearly everyone passing by enjoys them, but the "gardeners" will take account of only their own marginal benefits and costs when deciding how many flowers to plant. There are other activities that may also produce spillover benefits.
 - c. When a driver turns on his or her "blinker" to indicate which direction he or she is planning to turn, most people around that driver are better off because they are now better informed about that driver's intended path.
 - iv. Activities that generate positive externalities tend to be under provided in equilibrium.
 - a. Those involved in activities that produce positive externalities neglect their spillover benefits.
 - b. Thus, they tend to be undertaken at levels below the optimal ones. as illustrated below.
 - v. One way of thinking about "**public goods**" is that they are goods and services that generate positive externalities.

- a. This implies that public goods tend to be under produced in markets, relative to the outputs that maximize social net benefits (or which is Pareto efficient).
- b. However, not all problems associated with positive externalities are public goods problems.

II. The Geometry of Externality Problems

- A. The geometry of externalities and externality problems is fairly straightforward.
 - i. Several illustrations are developed below, but their logic is always the same.
 - ii. In a supply and demand (market) diagram, we introduce a new curve that represents the external marginal costs or external marginal benefits for the activity or product of interest.
 - These are benefits or costs that fall on persons not directly involved in the market of interest.
 - (These other costs or benefits fall on persons who are neither consumers nor producers of the goods sold in the market of interest)
 - iii. The predicted market outcome (Q^*) is not affected by the existence of the new marginal external cost curve, because firms and consumers are assumed to focus on their own costs and benefits, and so ignore the externality generated.
 - (This is actually a positive behavioral assumption or prediction, as noted above. Why?)
- B. To find out whether an externality generating activity or output is over or under supplied, **find the social marginal benefit and social marginal cost curves**, and use them to characterize the social net benefit maximizing activity level (output, Q^{**}).
 - i. **To find the SMB and SMC curves**, recall that the Demand curve is approximately the same as the marginal benefits received by consumers and the supply curve is approximately the industry's marginal cost curve.

- ii. To these market MB and/or MC cost curves, we **add the external marginal benefits and/or external marginal cost curves, which generates** the social marginal benefit and social marginal costs curves--which fully account for spillovers.



C. Geometrically, there is a recipe or algorithm for adding up the marginal cost curves and a similar one for adding up the marginal benefit curves.

- i. To find a **social marginal cost curve** (SMC) in a setting with external costs,
- First pick a quantity, q' .
 - Find the marginal cost that market participants are taking account of (normally from the supply curve) at the output level chosen (q') and add the spillover marginal costs at that quantity (q') to it.
 - Geometrically, this involves adding the **vertical distances** from the Q axis to the respective curves.
 - $SMC(q') = MC_{ind}(q') + MC_{ext}(q')$
 - Repeat the above with another quantity.
 - Continue until the SMC curve is traced out.
- ii. To find a **social marginal benefit curve** (SMB),
- First pick a quantity, q .

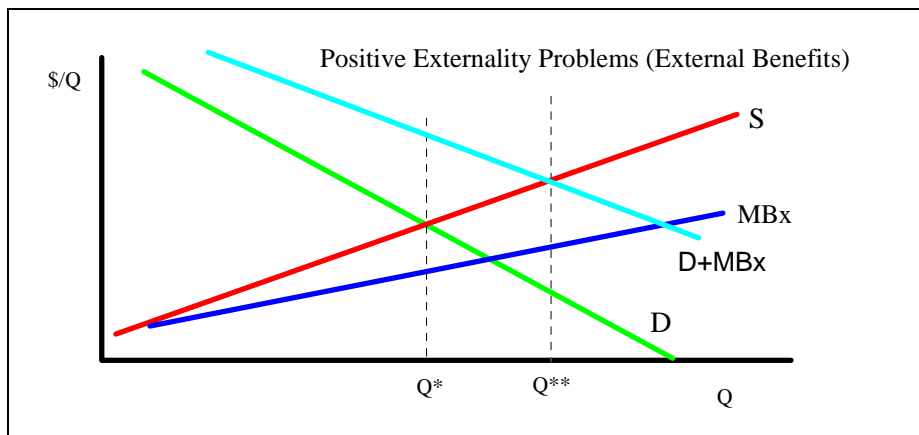
- Find the marginal benefit that market participants are receiving at the output level (q) [normally from the demand curve] and add the spillover marginal benefits at that output level (q) to it.
 - Geometrically, this involves adding the **vertical distances** from the Q axis to values on the respective curves.
 - $SMB(q) = MB_{con}(q) + MB_{ext}(q)$
 - Repeat with another quantity,
 - Continue until the SMB curve is traced out.
- iii. If all the “curves” are straight lines, SMB or SMC can be calculated with just 2 or 3 quantities, but more are necessary for more complicated shapes.

- D. The level of the activity (Q^{**}) that **maximizes social net benefits** is generally found where the social marginal benefit of the activity equals its social marginal cost curve.
- If Q^* does not equal Q^{**} , there is an externality problem.
 - ([Explain why.](#))
 - Notice that this conclusion, the existence of a problem, relies on the “maximize social net benefit” norm.

E. An Illustration of the Case of External Benefits

- The problem of positive externalities is similar to that of external costs. Again there is a spillover that is not accounted for by market participants. Again there are social net benefits that can potentially be realized that are not. The figure below illustrates the geometry of the problem.
- There is an external benefit (MB_x) in the case illustrated, rather than an external cost.
- The market supply and demand cross at Q^* .
- The social marginal benefit curve is found by adding the MB_x and D curves (because the demand curve can be used as the MB curve for consumers).
- There is no external cost, so $SMC(Q) = MC_{ind}(Q) + 0$ which is represented with the supply curve.

- Note that the SMC and SMB curves [S and D+MBx] cross at Q^{**} .
- This is the quantity that maximizes social net benefits.
- Since the observed market clearing output, Q^* , is not equal to Q^{**} there is an **externality problem**.
- As in the external cost case, the market outcome no longer maximizes social net benefits. However, in this case too little, rather than too much of the externality generating activity is provided.
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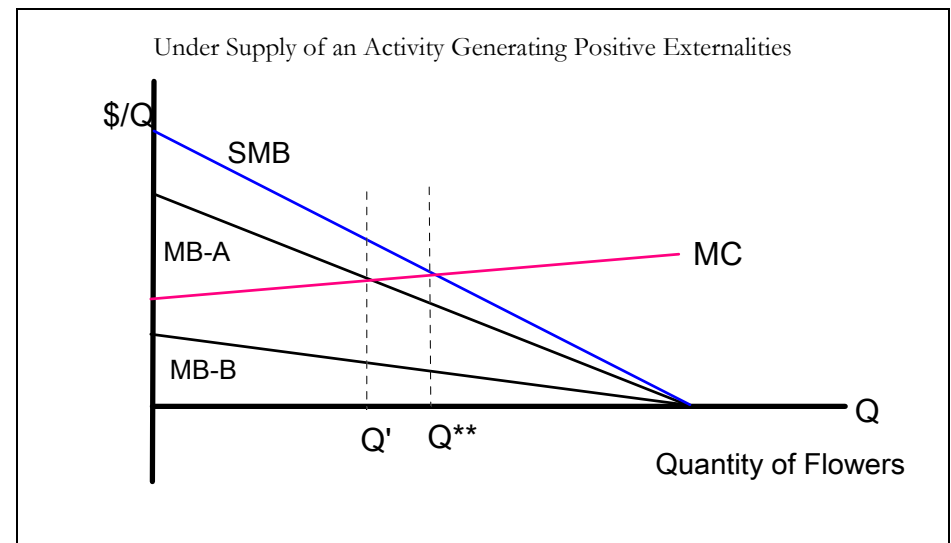
- [As an exercise, determine the increase in social net benefits obtained at Q^{**} relative to those obtained at Q^*]

F. Externality analysis can also be undertaken at the level of small groups of individuals.

- This can be done using marginal benefit and marginal cost curves for the individuals affected by an externality generating activity, rather than market demand curves and aggregate external marginal cost and/or marginal benefit curves.

- To find the private supply, we either assume that someone initially has the right to control the activity in question, or that the “**high demander**” provides the quantity that maximizes his or her own consumer surplus.
- The controlling individual is assumed to maximize his or her own net benefits.
- The social marginal benefit curve is the (vertical) sum of the individual MB curves.
- If the level privately chosen differs from that which maximizes social net benefits, then there is an externality (or public good) problem from the perspective of the SNB maximizing norm (and also the Pareto norm as we shall see later).

G. An external benefit case is illustrated below for Al (A) and Bob (B).



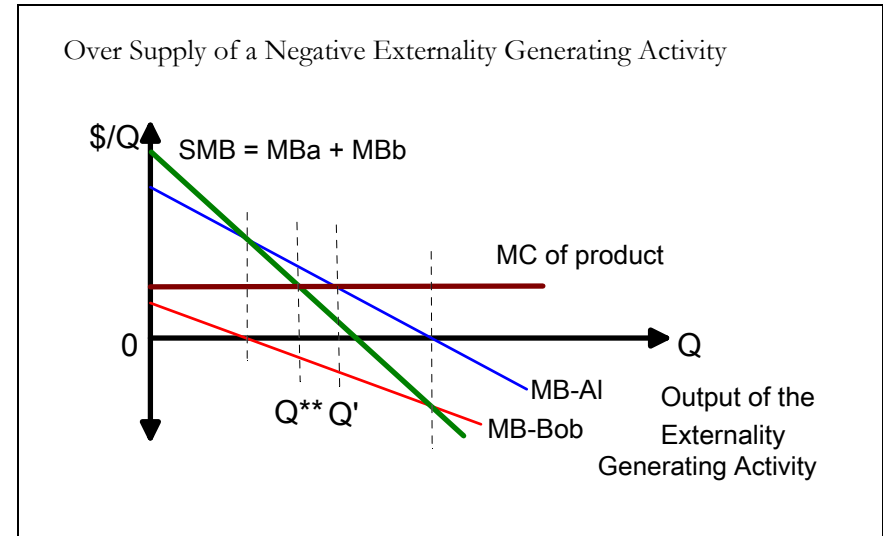
- Note that in the figure above, Al's preferred output level, Q' , (the one that maximizes her own net benefits) and there are spill over **benefits** at the margin at Q' . ($Mbx > 0$ at Q')
 - Al's purchase and use of this good makes Bob better off-
- To find the SMB curve add Bob's MB curve to Al's MB curve (vertically), as described in the “recipe” above.

- iii. Note that the social net benefit maximizing level of the activity is higher than that provided ($Q^{**} > Q'$).
 - [This is the typical case for activities that generate positive externalities and for the private supply of pure public goods.]
 - **Since Q' and Q^{**} are different, there is an externality problem.**
 - Social net benefits are not being maximized at Q' , the private choice.

H. The same general method can be used to illustrate the effect of a negative externality among small groups of individuals.

- i. An negative externality problem among individuals is illustrated in figure 2.
- ii. In Figure 2, Al's activity generates spillover costs, rather than benefits, at the margins.
 - For example, Bob may be Al's neighbor and negatively affected by smoke from her barbecue or loud music.
- iii. The spillover costs can be represented as a negative marginal benefit.
 - a. Again the Social Marginal Benefit curve is the vertical sum of all the individuals affected by the externality generating activity.
 - b. Adding up the curves is, however, a bit different than in the previous case, because we are adding one or more negative numbers, rather than just positive numbers.
 - Note that the addition is always done with MB curves in the small numbers case.
 - (Hint: the easiest place(s) to add the MB's occurs where one of the MB curves cross the horizontal axis and so have the value of zero.)
 -
 - c. As in the positive externality case, the private "high demander provides" equilibrium is different from the activity level (output) that would maximize social net benefits.
 - Thus, there is an externality problem from the perspective of the "maximize social net benefit" norm.

- However, in the negative externality case, the problem is over supply rather than under supply of the externality generating activity.



- (It would be much more complicated to do so, but one could use the negative of the negative range of the MB curve(s) and add the resulting positive numbers (MCx) to the original MC curve to generate a social marginal cost curve.)
- iv. Such negative externalities are typical for pollution, congestion, and commons problems.

III. On the Pure Logic and Normal Cases of Externalities

- A. The existence of externalities normally implies that social net benefits are not maximized at the market equilibrium, because some relevant marginal costs or marginal benefits is being neglected.

- i. In most cases, the existence of an **external cost implies that an activity is over provided** relative to that which maximize social net benefits.
 - ii. In most cases, the existence of an external benefit implies that an activity is **under provided** relative to that which maximizes social net benefits.
 - In many, but not all, of those cases, some form of collective or government action can potentially “solve” the externality problem.
 - Externality problems are one of the areas of life in which economics implies that governments can improve the result over markets.
- B. However, there are exceptions--that is to say special cases that do not conform to these rules of thumb.
- C. **The mere existence of an externality does not always imply that there is an externality problem.**
- i. There are, for example, cases in which externalities exist (infra-marginally) but there are **no external benefits or costs at the margin** (e.g. at Q').
 - a. If the marginal external benefits and marginal external costs are both zero at Q' then it turns out that $Q' = Q^{**}$, and there is no problem.
 - *As a practice exercise, draw such a case.*
 - b. Pareto optimal (and social net benefit maximizing outcomes) may also occur in cases in which spillover marginal costs exactly equal spillover marginal costs at Q' .
 - *As an practice exercise, draw such a case.*
 - *Try to think of examples of such externalities*
 - ii. Of course, such geometry is pretty demanding.
 - (See your lecture notes. One of these cases is usually covered in the class lecture.)
 -
 - The “no problem” cases are more likely if there are costs associated with solving externality problems.

- The marginal cost of reducing the problem may be greater than the marginal unrealized gains from addressing particular externality problems.
- *(For example, consider the problem of sidewalk congestion.)*

IV. Pure Public Goods

- A. The problems associated with **pure public goods** are similar to those associated with activities that generate **spillover benefits**.
- B. However, they occupy a special place in public finance and public economics, because in many cases not only are public goods undersupplied in private markets, **they may not be supplied at all**.
- Some public goods are too expensive for even “high demanders” to provide.
 - Such complete failures may **justify government production** of pure public goods, rather than regulatory solutions.
 - Tax revenues in such cases will be at least partly used to pay for the cost of producing public goods.
- C. DEF: A **pure public good** is a good that is perfectly shareable.
- A pure public good can be simultaneously consumed by “as many people as want” simultaneously, without diminishing anyone’s net benefits.
 - Examples include gravity, national defense, the air (breathing outside), and gravity.
 - [Other professors and textbooks may stress the fact that persons can not be **excluded** from using a pure public good, but I stress the sharability property of the good, for several reasons developed in class.]
- i. DEF A **pure private good** is a good that cannot be shared without proportionately reducing everyone's consumption of the good.
- Essentially, a pure private good can only be consumed by just one person at a time.
 - Examples include a jelly bean, a pair of shoes, a shirt, a hat, or a nap.
 - **(Most micro-economic analyses and models assume that all the goods and services being analyzed are pure private goods.)**
- ii. In between pure private and pure public goods are other goods, most of which can be considered “club goods,” goods which are somewhat shareable, but not completely so.
- iii. DEF A **club good** is a good that is shareable within limits. A club good can be shared by several people, but the “quality” of the consumption experience falls with the number of people sharing the good, although less than proportionately.
- Club goods are “congestible.”
 - Examples include this lecture, the highways, swimming pools, parking lots, parks, etc.
 - Congestibility implies that there is an ideal number of people who can share a good or service, which is greater than one but less than everyone.
- D. Together the existence of pure public, club, and pure private goods implies the existence of **a spectrum of types of goods** that vary according to their “shareability.”
- The more shareable the good is, the closer to the pure public good end of the distribution it is. (See your class notes.)
 - **(As an exercise, draw a “spectrum of good types” and provide examples of goods along the spectrum. We’ll also do this in class.)**
- E. Because pure public goods are shareable and are “goods,” **the private provision of pure public goods tends to generate positive externalities**.
- The private production of pure public goods tend to generate **spillover benefits** for those sharing in the services or goods.
 - As a consequence, **pure public goods tend to be under-provided** in the absence of some kind of collective action (as with a club or governmental action).
 - **[Note that excluding persons from potentially shareable benefits also causes social net benefits to be lower than they could be. Draw and explain why.]**

F. The problem of under providing public goods is sometimes called the **"free rider problem"** and can be illustrated using diagrams similar to those used in the positive externality cases above.

- [See also your in-class notes.]

G. The **free rider problem can also be illustrated using a bit of elementary game theory.**

- Assume that there are two people each of which can contribute to producing a public good or free ride.
- Assume further that the good is "freely available" if the other person pays for it, or if both share the cost of providing it, and that the public good is produces benefits for both persons that are greater than its total cost.
 - [All we really need assume here that if there are N people, each person's benefits are greater than 1/Nth of the cost of providing the good.]
- In the two person case, the net benefits for each person can be represented in a "2x2 game matrix" that characterizes each persons "payoffs" (net benefits) given different combinations of free riding and contributing to the public good.

The Free Rider Problem

Contributions to Providing a Pure Public Good

	Bob: Contributes	Bob: Free Rides
Al: Contributes	A, B 3, 3	A, B 1, 4
Al: Free Rides	4, 1	2, 2

(Payoffs are utility levels or net benefits for Al (A) and Bob (B). Only "rank order" is important. (why?))

- Both Bob and Al are better off if the public good is produced ($3 > 2$) and $4 > 1$, yet each prefers that the other person provide it ($4 > 3$).
 - The result of these payoffs is a game that has a "prisoner's dilemma" format.
 - If each person independently chooses his benefit maximizing strategy, each will choose to free ride.
 - If Bob contributes, Al gets 3 if he/she also contributes, but gets 4 if he/she free rides.
 - If Bob free rides, Al gets 1 if he/she contributes, but gets 2 he/she free rides.
 - Thus, **regardless of what Bob does, Al is best off if he/she free rides**
 - The same logic applies to Bob's choice of strategy.
 - In this game, both Al's and Bob's dominant strategy is to free ride.
 - DEF: strategy X is a dominant strategy for player I, if and only if it generates the highest payoff for I, regardless of what the other players in the game or contest choose to do.
 - Thus in this simple 2x2 game, each person will tend to free ride if their strategy choices are made independently of one another.
 - Essentially the same logic applies to public goods settings in which there are many persons who must contribute in order to produce the service.
 - The predicted result in such "all or nothing" cases that all persons in the game free ride.
- H. Free riding is the Nash Equilibrium of the free rider game.
- DEF: a strategy combination is a **Nash equilibrium**, if no player in the game can alter his or her strategy and achieve a higher payoff.
 - Note that neither person acting alone in the above can make him or herself better off by switching from free riding to contributing, given what the other person is doing!

- b. This is true in spite of the fact that there is a Pareto superior move that is possible.
- c. DEF: A **Pareto Superior** move makes at least one person better off without making any other worse off.
 - **Note that each person would be better off if the public good is produced. There is a Pareto Superior move (3>2)**

- I. The Nash equilibrium is a consequence of individual rational choice.
 - i. However in this case, unlike that in normal markets for private goods without externalities, those choices do not produce the social net benefit maximizing outcome.
 - ii. Privately optimal behavior in this setting, leads to an outcome that is agreed by each to be worse than the case in which they both contribute to providing the public good.
 - iii. DEF: Outcome A is **Pareto efficient** (or Pareto Optimal), if an only if, there are no feasible Pareto Superior moves from A.
 - iv. The free rider equilibrium is not Pareto optimal, because there is a Pareto superior move.

V. Solutions to Externality and Public Goods Problems

- A. For persons interested in maximizing net benefits, both externality and public goods problems provide a good reason to undertake collective activities in a club or by government.
 - i. A variety of solutions to these problems are possible if we use governments coercive authority to address them.
 - ii. In some cases, the improvement is simply an increase in social net benefits (with some winners and some losers).
 - iii. In other cases, the use of coercive threats can produce Pareto superior moves.
 - iv. (Of course, as we will see later in the course, it is not necessarily the case the governments will attempt to maximize social net benefits.

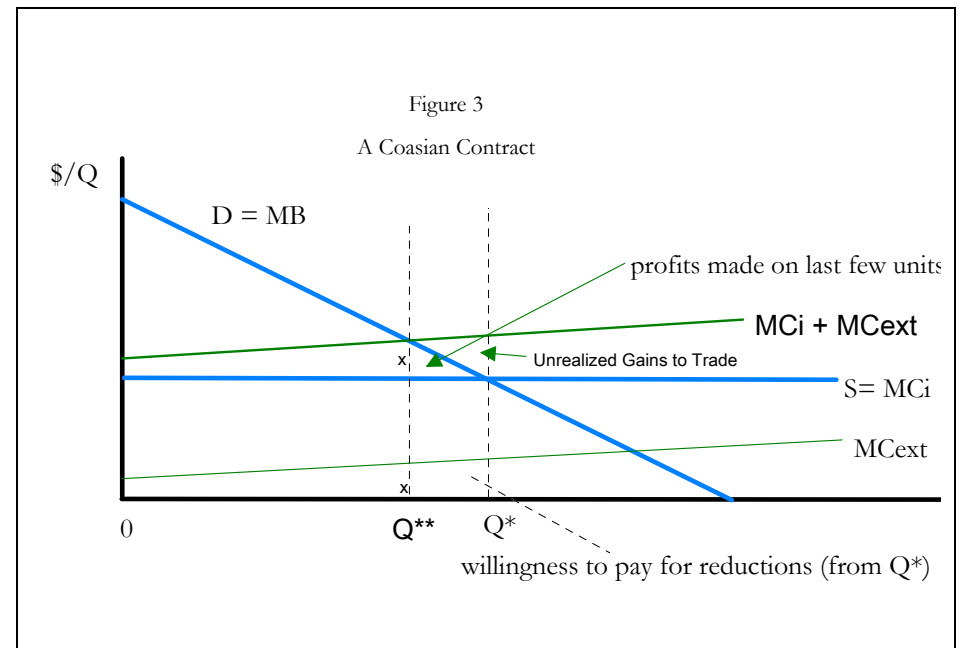
- v. We now analyze both private and public solutions to these problems.

VI. Private Solutions to Externality and Public Goods Problems

- A. Do nothing.
 - i. In some cases, the existence of an externality or pure public good may be compatible with Pareto efficiency or maximizing the net advantage from the activities in question.
 - ii. That is to say, there may not be a "Pareto relevant" externality at the margin even ignoring transactions costs.
 - iii. In other cases, nothing may be done, because transactions costs are too great. In such cases, it may cost more to solve the problem than is gained in social net benefits.
- B. Privatization
 - i. In some cases, the reason for the externality is simply an improper specification of property rights.
 - ii. For example, commons problems involving non-circulating or readily identifiable resources such as land, can be addressed by granting a person, firm, or club exclusive rights to control the usage of the resource in question.
 - a. (Privatization may solve such commons problem even if the "user rights" are not tradable, because *owners have no incentive to overuse their own resources.*)
- C. **Coasian Contracts** (Private Agreements That Solve Externality Problems)
 - i. In other settings, privatization may not be sufficient by itself, but it may make it possible for the affected parties to contract with one another to solve the problem.
 - a. For example those affected by pollution may pay the polluter not to pollute.

- b. Alternatively, those wishing to engage in a negative externality producing activity (pollution) may pay those who will be affected by that pollution for the privilege.
- ii. **The Coase theorem says that if (a) property rights are well defined (or contracts enforced) and (b) transactions costs are negligible, then voluntary exchange can solve essentially all externality problems.**
- iii. **More over if (c) there are no significant income (original endowment) effects, then the final result tends to be the same regardless of the original assignment of property rights**
 - a. "a through c" are sometimes called the Coase theorem.
 - b. (It bears noting that part "c" of the "Coase theorem" requires the Pareto set to be composed of a single point, which is often the case in our diagrams, where there is a unique output level that maximizes social net benefits.)
 - c. [Explain why will not be true in more general circumstances?](#))
- iv. An Intuitive Example.
 - a. Suppose that a factory, Acme, uses a production process that produces smoke along with its marketable output. The wind mostly comes out of the West so that the smoke fall mostly on homeowners who live East of the factory .
 - a. The **weak form of the Coase theorem** (a and b) suggests that voluntary exchange can be used to solve the externality problem. The home owners can band together and pay the firm to reduce its emissions either by reducing output or by using pollution control devices.
 - a. Gains to trade exist because at the margin, the firm realizes no profits from the last unit sold, but the home owners association is willing to pay a positive sum to get the firm to produce less.
 - b. Notice that very similar gains to trade would exist if the home owners initially had veto power over the firm's output. In this case, the firm would be willing to pay the home owner association for the privilege of producing its output and smoke.
- c. Whenever transactions costs are small, contracts can be developed (trade can take place) that completely solve the externality problem in the sense that after the "Coasian contract" all gains from trade are realized, and net benefits are maximized.
- v. The **strong form of the Coase theorem** holds if transactions costs are low and there are no important income effects that arise from the assignment of control over the resource or activity of interest.
 - a. In such cases, Coasian contracts will always reach the same output level, insofar as there is a unique output that maximizes social net benefits--as it often is in our diagrams.
 - b. In this case, the **final outcome is the same no matter who controls the resources** after all gains from trade are realized!
 - c. (In other words, the gains to trade are exhausted at the same output level regardless of the initial assignment of control (property rights). For this and one other important insight about the nature of firms Ronald Coase won the Nobel Prize in economics.)
- vi. The Coasian approach to externalities implies that essentially all externalities are reciprocal in the sense that who "creates" the externality depends on the original assignment of control.
 - a. In the case where the home owners association control the resource, their decision imposed large costs on Acme!
 - b. And vice versa. If Acme controls the output or activity level, then the home owners are made worse off.
 - c. However, the process of exchange always makes both parties better off, given their original circumstances.
 - d. The original property rights assignment affects the direction of payments, although not the final output level in a Coasian world.
- vii. An Illustration of the geometry of the Coase Theorem
 - a. Suppose that the firm, Acme, initially controls the output or emissions. In this case, in the absence of a Coasian Contract, the outcome will be an output that maximizes profits such as Q^* .

- b. Note that unrealized gains to trade exist at Q^* . The home owners are willing to pay more for reductions in output than the firm earns as profits.
- c. The last unit that the homeowners can afford to compensate the firm for "not to producing" is Q^{**} where the marginal compensation required by the firm (the marginal profit labeled x) equals the willingness of the home owner association to pay for it (the marginal external cost labeled x).
- d. Note that the result is not changed by a reassignment of property rights. Had the homeowner association initially had veto power over the firm's activity, they will set output at 0 in the absence of a Coasian contract. ("0" minimizes cost imposed on them by the firm.)
- e. Clearly, gains to trade also exist in this case. The distance from the MR curve to the firm's MC curve is much larger than the size of the marginal external cost borne by home owners at 0.
- f. The firm can, thus, compensate the homeowners for the costs imposed on them by its smoke on all units of output up to the point where Acme's willingness to pay for the privilege of producing more output exactly equals the amount required to compensate home owners at Q^{**} .
- g. In the case depicted, the strong form of the Coase theorem holds. The same output level occurs regardless whether the firm or the home owners initially control the emission or output level. (This counter intuitive result is why Ronald Coase won the Nobel prize in economics in 1991.)
- Of course, the flow of payments clearly differs!
 - Acme prefer the first setting, and the homeowner's association prefer the second.

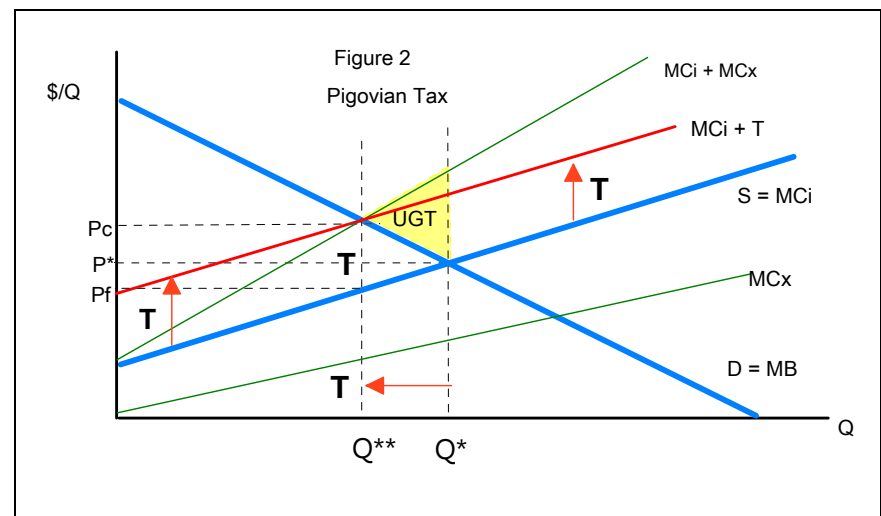


- D. Not all externality problems can be solved with Coasian contracts or with a change in the assignment of property rights.
- a. *Transactions costs may be very large, because many people are involved.*
 - b. The resources of interest might not be easily divided up and assigned to specific users.
 - c. It may be less expensive to use a preexisting institution (government) to solve the problem.

VII. Collective Management of Externality Problems: Pigovian Taxes and Subsidies

- A. There are several possible collective management solutions to externality problems.
- i. Elinor Ostrom won the Nobel prize in 2009 for her analysis of the great variety of such solutions (and related commons problems).
 - ii. We examine just a few of the classic economic solutions in this class--namely the ones most studied by economists.
- B. **Pigovian Taxes:** Excise taxes as a means of “internalizing” negative externalities
- i. A Pigovian tax attempts to change incentives at the margin by imposing a tax (or subsidy) on the activity that generates the externality.
 - a. Notice that if the externality producer is subject to a tax equal to the marginal external cost (benefit) at the Pareto efficient level, the externality producer will now choose to produce the Pareto efficient output/effluent levels.
 - b. Such a tax (or subsidy) is said to **internalize** the externality, because it makes the externality producer bear the full cost of his actions (at Q^{**}).
 - ii. In principle, Pigovian tax schedules can have a variety of shapes, but for the purposes of this class we will assume that they are all "flat excise taxes" that impose the same tax on every unit of the product (or emission) produced.
 - iii. Pigovian taxes may yield substantial revenues although this is not their main purpose.
 - a. *Unlike a neutral tax, the main purpose of a Pigovian tax is to change behavior.*
 - b. Unlike an ordinary excise tax, a Pigovian excise tax generates no excess burden (as developed below and in class.)
 - iv. **Illustration of the Pigovian Tax**

- a. From our analysis of externalities, we know that market equilibria may not maximize social net benefits or necessarily realize all potential gains to trade.
 - a. These unrealized social net benefits (or **gains to trade**) are the triangle labelled UGT at Q^* in the diagram.
 - a. A Coasian bargain might be able to realize those social net benefits if transactions costs are low enough, but they can also be realized by adopting a tax that internalizes the externality.
 - b. Such a tax induces market participants to take account of the external marginal costs.



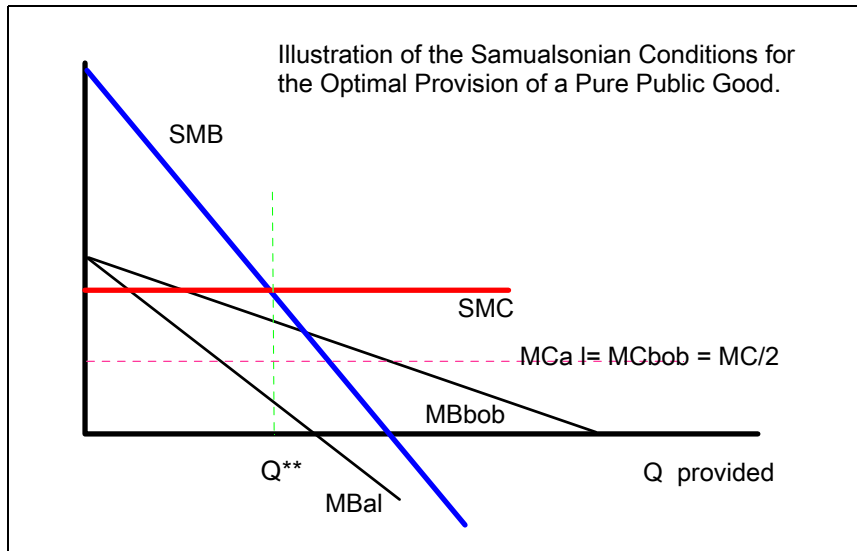
- b. The external cost at Q^{**} is the vertical distance from MC to the $MC + MCx$ curve.
- c. This distance is the level of an ideal **Pigovian tax**. If it is placed on production or sales of this product, it will internalize the externality.
- d. This ideal tax is labeled "T" in the diagram above.
- e. If a tax of T dollars per unit is imposed on the firm's output (or emissions) the firm will now face a marginal cost for production equal to $MC + T$.

- f. Given this new MC curve (which includes the tax that "internalizes" the externality) the firm will produce an output of Q^{**} , the Pareto Efficient level.
- v. Pigovian taxes can be a low cost method of solving an externality problem, because firms and consumers can all independently adjust to the tax.
- a. However, the tax burden required to achieve the desired level of the externality generating activity can be very large, which can make both consumers and firms in the taxed industry worse off.
- b. This tends to make Pigovian taxes politically unpopular (explain why).
- c. (This cost can be reduced by using the revenues for desired public services or by rebating the revenues as lump sum subsidies to people in the market being taxed.)
- vi. Imposing a Pigovian tax requires that the marginal external damages be estimated.
- a. This may be possible at Q^* , the output actually produced in the unregulated setting.
- b. However this will be more difficult to do at Q^{**} because Q^{**} is not observed and has to be estimated using estimates of SMC and SMB.
- C. **Pigovian Subsidies** are essentially similar to that of the Pigovian tax, except in this case the externality generating activity is under produced, and the subsidy attempts to encourage additional production.
- (Internalizing the externality in this case requires producers to take account of unnoticed benefits falling on others outside the decision of interest.)
 - A Pigovian subsidy is set equal to $M_b x$ at Q^{**} and will cause the market to produce Q^{**} units of the good after it is imposed.
 - A Pigovian subsidy increases social net benefits (beyond the cost of the subsidy) and so has no DWL.
 - (As a practice exercise draw such a case.)

VIII. Collective Provision of Pure Public Goods

- A. In some cases, it will be easier for a group to take over production of a public good rather than to provide the proper Pigovian subsidies to encourage Pareto efficient private production. This may be done privately through clubs, or publicly through governments of one kind or another.
- i. Within democracies, many government services can be understood as attempts to solve free rider problems.
- ii. In these cases, a democratic government can be thought of as a special kind of club with the power to tax.
- (This tends to be more true of local governments than national governments, insofar as membership (residence) in a local government's jurisdiction tend to be "more" voluntary than those in national jurisdictions.)
- B. In 1954, Paul Samuelson wrote a very influential paper in which he characterized the ideal solution to a pure public goods problem.
- His solution requires Q^{**} to be produced, as in our diagrams above.
 - And, it also characterizes Pareto efficient tax systems for paying for the pure public goods.
- C. Samuelson's ideal way to finance the "collective" production of pure public goods requires:
- i. Taxes that do not impose a deadweight loss. (Broad-based or lump sum taxes)
- ii. Taxes that generate just sufficient revenue to cover the cost of the public services.
- iii. Taxes for which the sum of the marginal costs imposed on users of the public good equals the marginal cost of producing them.
- iv. (These conditions, optimal production of government services financed by an efficient tax system just sufficient to cover the costs of the services, are sometimes called the **Samuelsonian conditions for the optimal provision of a pure public good.**)

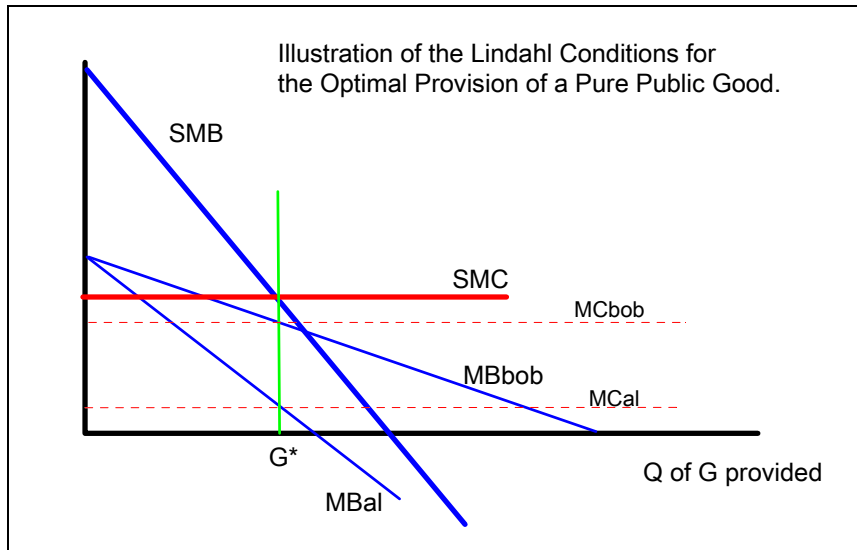
- v.
- vi. (The figure below provides a simple illustration.)



D. There are several important features of Samuelsonian solutions to public goods problems.

- i. First, it is an attempt to take account of both sides of the fiscal equation: both expenditures and taxes are simultaneously optimized.
- ii. Second, it shows that even when people disagree, there is a Pareto efficient outcome--which in our diagrams is often unique.
- iii. Third, it shows that there are a lot of Pareto Efficient methods of financing a pure public good--once Q^{**} is determined, more or less any division of the cost of Q^{**} units will be Pareto efficient.
- iv. (However, not every shift from a free rider solution to a Samuelsonian solution will be a Pareto superior move. Explain why and provide an illustration.)

- E. One problems with most "Samuelsonian Solutions" to public good problems, is that the individual tax payers are often "unhappy" with the amount of the public service provided, given their tax cost.
- F. A special case of the Samuelsonian Solution that avoids this problem is the **Lindahl tax system**. (Erik Lindahl, a Swedish economist, figured out his solution decades before Paul Samuelson figured out his more general solution.)
- G. To the Samuelsonian conditions, **Lindahl** suggests that the *taxes should equate marginal benefits and marginal costs for individuals at the desired output of government services*.
 - i. **Lindahl taxes** are, thus, said to be idealized **benefit taxes**.
 - a. Lindahl taxes are a special case of a Samuelsonian solution for the efficient government (or club) provision of a pure public good.
 - b. Note, however, that the Lindahl solution is an important special case, because in this case, everyone in the society of interest is completely satisfied with the level of public goods provided.
 - c. (In the usual Samuelsonian case, it is possible that essentially all people will be quite dissatisfied with the services levels provided by government! Those whose marginal tax cost are below their marginal benefits from the service will demand more, whereas those whose marginal tax cost is above their marginal benefits will want less!)



b. Although it is always possible to devise a Lindahl tax scheme that will generate a Pareto Superior move.)

- ii. Lindahl is important because it shows that even in cases in which people disagree about the value of a public service, there are tax systems that can increase consensus.
 - a. Indeed in the Lindahl case, it is possible to produce a tax system under which there is unanimous agreement about the ideal service level (given the tax shares).
- iii. Lindahl taxes are also of interest, because it turns out that every shift from a "pure" free rider outcome, an outcome in which $Q^*=0$, to a Lindahl solution will be a Pareto superior move.
 - a. Everyone will be made better off (consumer surplus increases from 0 to Q^{**} when it is paid for with Lindahl taxes).
 - b. (As an exercise, illustrate why this is true.)
- iv. It bears noting, however, that shifts from "high demander supplies" equilibria with significant services under private supply to a Lindahl solution (with uniform tax rates) will not necessarily be a Pareto superior move.
 - a. (Explain why a high demander outcome might be preferred by a free rider to a Lindahl tax solution.)

IX. Appendix: Pareto Superior Moves and Pareto Efficiency

- A. DEF: Outcome A is **Pareto superior** to Outcome B, if and only if at least one person is better off at A than at B and no one is worse at B than at A.
- B. DEF: Outcome A is **Pareto efficient** (or Pareto Optimal), if and only if, there are no feasible Pareto Superior moves from A.
- i. Outcomes that maximize social net benefits are normally Pareto efficient.
 - ii. However, outcomes that do not maximize social net benefits may also be Pareto efficient.
 - (Such cases often occur in game matrices, although not market-based diagrams. Coasian bargains are both Pareto efficient and maximize social net benefits.)
- C. Consider the Diagram below and explain why:
- i. Z is Pareto superior to X
 - ii. Z and Y are Pareto Efficient
 - iii. Y is not Pareto superior to X
 - iv. The outer edge of the feasibility set, is often called the “Pareto frontier” because it includes all the Pareto optimal points. (Explain why this is often true. Draw an exception to this rule.)
 - v. Shade in all the possibilities that are Pareto superior to X.
 - vi. Explain the implicit economic assumptions behind the “utility possibility set.”

