I. Some Fundmental Geometry of Net Benefit Maximizing Choice

A. Nearly all economic models can be developed from a fairly simple model of rational decision making that assume that individuals **maximize** their private **net benefits**.

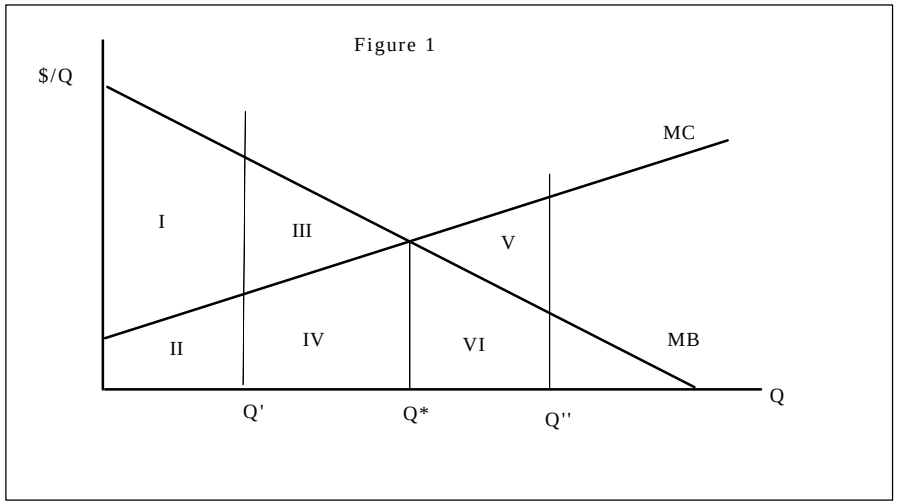
i. Consumers maximize consumer surplus: the difference between what a thing is worth to them and what they have to pay for it. CS(Q) = TB(Q) - TC(Q)

ii. Firms maximize their profit:, the difference in what they receive in revenue from selling a product and its cost of production: Π = TR(Q) - TC(Q)

B. The change in benefits, costs, etc. with respect to quantity consumed or produced is generally called Marginal benefit, or Marginal cost.

i. DEF: **Marginal "X"** is the change in Total "X" caused by a one unit change in quantity. It is the slope of the Total "X" curve. "X" ∈ {cost, benefit, profit, product, utility, revenue, etc.}

ii. *Important Geometric Property*: Total "X" can be calculated from a Marginal "X" curve by finding the area under the Marginal l "X" curve over the range of interest (often from 0 to some quantity Q). This property allows us to determine consumer surplus and/or profit from a diagram of marginal cost and marginal revenue curves.



C. Examples:

i. Given the marginal cost and marginal benefit curves in Figure 1, it is possible to calculate the total cost of Q' and the total benefit of Q' . These can be represented geometrically as areas under the curves of interest. TC(Q') = II ; TB(Q') = I + II .

ii. Similarly, one **can calculate the net benefits** by finding total benefit and total cost for the quantity or activity level of interest, and subtracting them. Thus the net benefit of output Q' is TB(Q') - TC(Q') = [I + II] - [II] = I.

iii. Use Figure 1 to determine the areas that correspond to the total benefit, cost and net benefit at output Q* and Q".

iv. Answers:

- TB(Q*) = I + II + III + IV , TC(Q*) = II + IV , NB(Q*) = I + III
- TB(Q') = I + II + III + IV + VI , TC (Q") = II + IV + V + VI , NB(Q") = I + III - V

D. If one attempts to maximize net benefits, it turns out that generally he or she will want to consume or produce at the point where marginal cost equals marginal benefit (at least in cases where Q is very divisible).

i. There is a nice geometric proof of this. (The example above, C, nearly proves this. Note that NB(Q*) > NB(Q') and NB(Q*) > NB(Q").)

ii. In the usual chase, a net-benefit maximizing decision maker chooses consumption levels (Q) such that their own marginal costs equal their own marginal benefits. They do this not because they care about "margins" but because **this is how they maximizes net benefits** in most common choice settings of interest to economists. (Another common choice that maximizes net benefits is Q* = 0. Why?)

iii. This characterization of net benefit maximizing decisions is quite general, and can be used to model the behavior of both firms and consumers in a wide range of circumstances.

iv. Moreover, the same geometry can be used to characterize ideal policies if "all" relevant costs and benefits can be computed, and one wants to maximize *Social Net Benefits*.

E. That each person maximizes their own net benefits does not imply that every person will agree about what the ideal level or output of a particular good or service might be.

i. Most individuals will have different marginal benefit or marginal cost curves, and so will differ about ideal service levels.

ii. To the extent that these differences can be predicted, they can be used to model both private and political behavior:

- (What types of persons will be most likely to lobby for subsidies for higher education?
- What types of persons will prefer progressive taxation to regressive taxation?
- What industries will prefer a carbon tax to a corporate income tax?)

F. One can **use the net benefit maximizing maximizing model to derive a consumer's demand curve** for any good or service (given their marginal benefit curves) by: (i) choosing a price, (ii) finding the implied marginal cost curve for a consumer, (iii) use MC and MB to find the CS maximizing quantity of the good or service, (iv) plot the price and the CS maximizing Q*, and (v) repeat with other prices to trace out the individual's demand curve.

G. Similarly, one can use a profit maximizing model (another measure of net benefit) to derive a competitive firm's **short run** supply curve, given its marginal cost curve. Again, one (i) chooses a price (which is a price taking firm's MR curve), (ii) finds the profit maximizing output, (iii) plot P and Q*, (iv) repeat to trace out a supply curve.

H. (See your class notes for sample derivations of individual demand and supply curves.)

II. Markets, Externalities, and Social Net Benefits

A. Market Demand can be determined by varying price and adding up the amounts that consumers want to buy at each price.

i. **Market Demand** curves for ordinary private goods, thus, can be shown to be "horizontal" sums of individual demand curves

ii. Similarly, **Market Supply** (for an industry with a fixed number of firms) can be derived by varying price and adding up the amounts that each firm in the industry is willing to sell at each price.

iii. **Market Supply** curves for ordinary private goods can be shown to be "horizontal" sums of individual firm supply curves.

- In the **short and medium run**, the number of firms in the industry can be taken as fixed.
- However, supply in the "Marshallian" long run reflects entry and exit of firms from the industry.
- The process of entry and exit can also be analyzed. Incentives for exit and entry end when profits fall to zero. This fact allows the equilibrium numbers of firms to be found in Marshallian industries using long run average cost curves of firms. "Zero" profit output levels for a typical firm in the industry can be computed using MR and MC and/or AR and AR curves.
- In the long run, such firms and outputs are simply replicated until market demand is satisfied.
- (Note that entry and exit can also be ignored in the long run if Richardian assumptions rather than Marshallian ones are used.)

B. Note that derived in this way, it is clear that:

i. Every market **demand curve is the sum of the marginal benefit** curves of the individual consumers, because each consumer's demand curve is essentially his or her MB curve.

ii. Every short and middle run **market supply curve is the sum of the marginal cost** curves of the individual firms in the market, because each firm's supply curve is essentially its MC curve.

iii. Consequently, market demand and supply curves can be used as social marginal benefit and marginal cost curves to estimate the net benefits realized by all firms and consumers in an industry.

C. In competitive markets, prices tend to move to "market clearing levels," that is to prices that set the total quantity supplied by all firms equal to the total amount demanded by consumers. (This defines equilibrium market P*, and Q*.)

i. In competitive markets, this occurs where the supply and demand curve cross.

ii. At any other price, there will either be surpluses (which tend to cause prices to fall) or shortages (which tend to cause prices to rise).

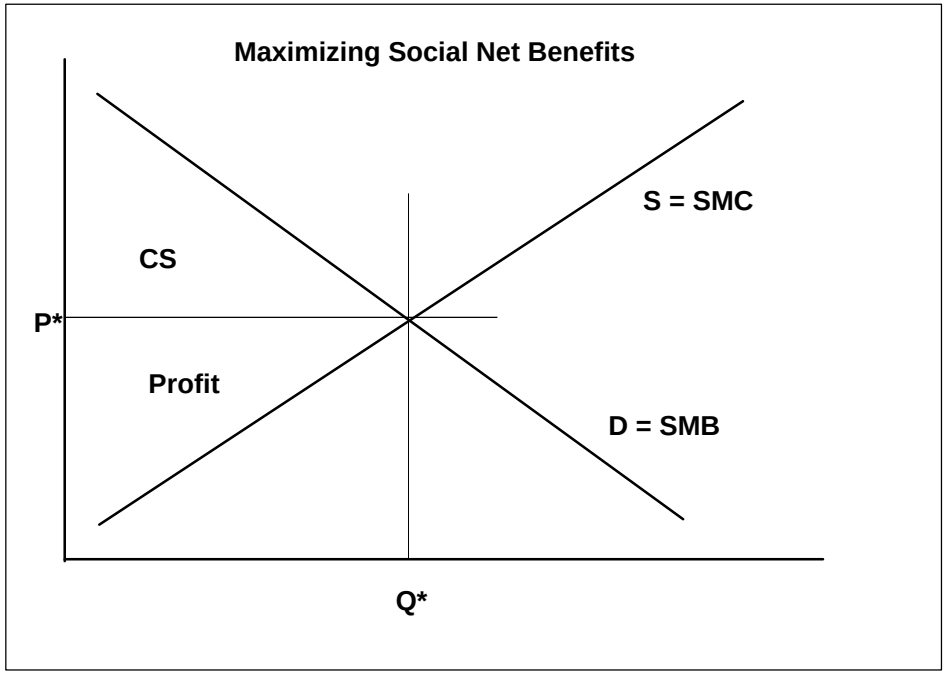
iii. Note that this is, in principle, an entirely decentralized process requiring governments to do nothing more than enforce property rights and contracts.

D. In the absence of externalities or market concentration, **markets tend to produce social net benefit maximizing outcomes**!

i. Note that the "market clearing" price causes markets to produce the **social net benefit maximizing** level of output (in cases where there are not externalities, e.g. relevant costs or benefits).

ii. Q* sets social marginal benefit (the demand curve) equal to social marginal cost (the supply curve).

iii. This is one very widely used **normative** argument favoring markets as a method of social organization.



E. In cases where **external costs** exist, however, that is to say there are cost imposed on others outside the market of interest, market outcomes will (often) fail to maximize social net benefits.

i. In this case, either demand or supply will not include all marginal benefits or all marginal costs.

ii. The existence of externality problems provides a **normative** basis for government policy (if one wants to maximize social net benefits).

iii. In cases where significant external costs exist at the margin (at Q*), markets will tend to **over produce** the output of interest relative to that which maximizes social net benefits.

iv. In cases where significant external benefits exist at the margin (at Q*), markets will **under produce** the service of interest relative to that which maximizes social net benefits.

v. Governments might adopt policies to discourage production in the first case (perhaps with taxes) or encourage it (perhaps with subsidies) in the second case.

vi. (Tools for analyzing externality and public goods problems will be developed after the midterm.)

III. Externalities and Public Goods

A. 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. Generally, any activity that imposes *external losses* (costs) on third parties at "the margin" will be carried out at levels greater than those which maximizes 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 is a positive prediction about behavior--that spill over costs and benefits will be ignored by those controlling the activity.

iii. For example, within environmental economics, polluters ignore spillover costs, while pollution controllers ignore spillover benefits from cleaning up.]

B. The existence of externality "problems" follows from the normative framework of welfare economics given these (positive) predictions about firms and consumers.

i. The problem from the point of view of welfare economics is not externalities themselves, but rather that **the wrong level (too much or too little) of the externality generating activity gets produced to maximize social net benefits**.

- Consider, for example water pollution.
- Water pollution imposes costs on other users of a river or lake, and tends to be over produced. However, the optimal amount of pollution is not generally zero! 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.

ii. It bears noting that not all externality problems involve external costs.

- Some externalities generate external benefits.
- Consider, for example, the activity of planting flowers along sidewalks and highways.
- 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. Activities that generate positive externalities tend to be under provided in equilibrium.
- The problem with "**public goods**" is that they tend to be under produced.

iii. Moreover, some activities generate external benefits for some people, but external costs for others.

- For example, some people might be allergic to the flowers planted under "b."

C. To find out whether an externality generating activity or output 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.

i. **In effect, an externality generating activity generates benefits or costs for a wide range of people simultaneously.**

ii. **So, the social marginal benefit and marginal cost curves for such activities are "vertical" sums of the relevant individual and firm MB and MC curves**.

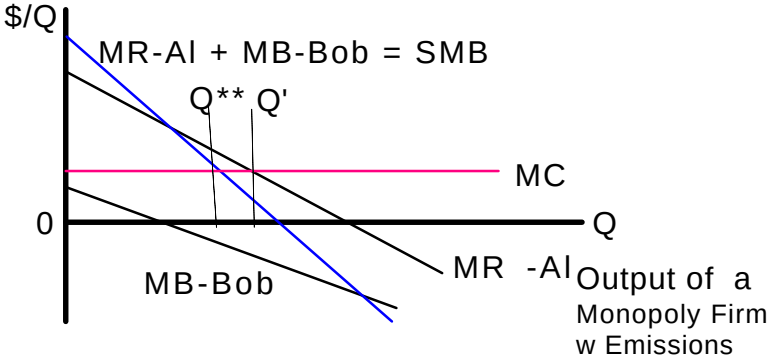
D. The level of the activity that maximizes social net benefits is generally found where the social marginal benefit of the activity equals its social marginal cost curve.

i. (Recall that net benefits are "normally" maximized where the relevant MB and MC curves intersect.)

E. EXAMPLE: In Figure 1, note that at Al's preferred output level, Q', (the one that maximizes her own net benefits) there are spill over **costs** at the margin. Al's production makes Bob worse off *at the margin.*

i. Consequently, the activity being analyzed is provided at greater than optimal levels. That is to say Q' is larger than Q**, the quantity where net social benefits are maximized.

Figure 1: An Excess Supply of a Polluting Activity

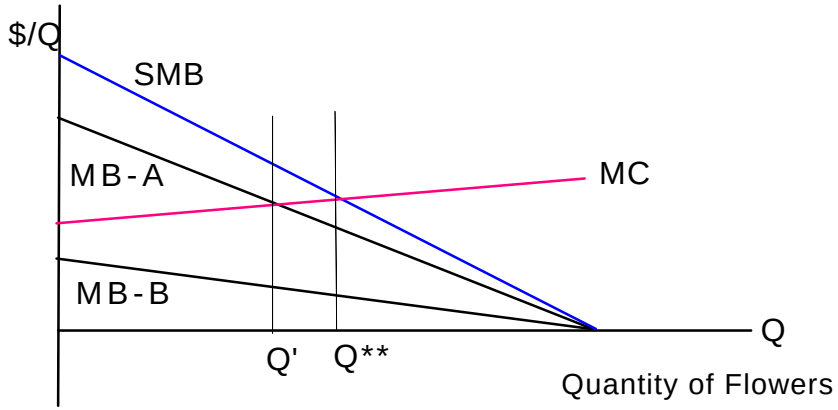


ii. This is the usual case for a pollution problem. In the case where a firm disposes of its waste products using the "freely available air or water systems," , there are often spill over costs at the margin that are neglected by the firm.

F. EXAMPLE: In Figure 2, the use of pollution reducing equipment (Q) generate spill over benefits rather than costs at the margin.

i. Normally, consumers will not know whether or not a producer produces a lot or a little pollution, and although consumers may be willing to pay a higher price for the produces of

Figure 2: Under Supply of an Activity Generating Positive Ext



firms that reduce their emissions, prices for the same type or product whether produces in an evironmentally nasty way or not tend to have the same price..

ii. 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.

iii. And, consequently, too little of this equipment is used, relative to that which maximizes social net benefits.

iv. [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?]

G. Note that the mere existance of an externality does not necessarily imply that there is an externality problem.

i. One may privately reach the Pareto optimal level of an externality generating activity if there are no 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. For example, marginal benefits or marginal costs may be zero at Q'.

H. However, as a rule of thumb, external cost producing activities are over provided relative to that which maximize social net benefits, and external benefit producing activities are under provided relative to that which maximizes social net benefits.

IV. Pure Public Goods

A. DEF: A **pure public good** is a good that is perfectly sharable. A pure public good can be simultaneously consumed by "as many people as want" simultaneously. Examples include gravity, national defense, the air (quality), and gravity.

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 only one person at a time.
- Examples include a jelly bean, a pair of shoes, a shirt, a hat, or a nap. (Most economic analysis assumes that goods and services are pure private goods.)

ii. DEF A **club good** is a good that is sharable within limits. A club good can be shared by several people, but the "quality" of the consumption falls with the number of people sharing the good, although less than proportionately.

- Club goods are "congestable."
- Examples include this lecture, the highways, swimming pools, parking lots, parks, etc.

B. Because provision of pure public goods tends to generate positive externalities, pure public goods tend to be underprovided in the absence of some kind of collective action (which may or may not be a governmental action).

C. The problem of under providing public goods is sometimes called the "**free rider problem.**"

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

(Individual payoffs are in each "cell" of the free rider game. Note that only "rank order" is important.)

i. Note that both Bob and Al are better off if the public good is produced (3>2), 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.
- Such games allow extreme forms of the free rider problem to be analyzed.

ii. If each person independently chooses his benefit maximizing strategy, each will choose to free ride.

- Note that if Bob contributes, Al gets 3 if he/she also contributes, but gets 4 if he/she free rides.
- Note that 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**.

iii. Note that essentially the same logic applies to Bob's choice of strategy.

- Each person will tend to free ride if their strategy choices are made independently of one another.
- The same logic applies to public goods settings in which there are many persons who must contribute in order to produce the service.

iv. The result is individually rational, **but each person would be better off if the public good is produced. (3>2)**

- 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.
- Indeed, (3, 3) is Pareto superior to (2, 2).
- 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.

D. There are a variety of solutions to public goods problem, including explicit coordination among those free riding, the formation of "public goods" clubs, private contracts (agreements) to contribute to produce the public good, and government action.

V. Private Solutions to Externality 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.

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.

- (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)

i. In other settings, privatization may not be sufficient, but it may be possible for the affected parties to contract with one another to solve the problem.

ii. For example those affected by pollution may pay the polluter not to pollute.

iii. 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.

iv. 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.

v. 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 through c" is sometimes called the Coase theorem.
- (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. Explain why will not be true in more general circumstances?)

vi. An Intuitive Example.

- 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 .
- 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.
- 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.
- 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.
- 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.

vii. 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.

- 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.
- In this case, the **final outcome is the same no matter who controls the resources** after all gains from trade are realized!
- (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.)

viii. 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.

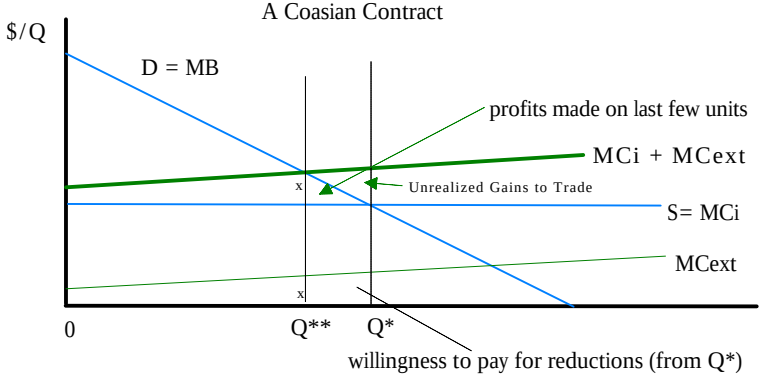
- In the case where the home owners association control the resource, their decision imposed large costs on Acme!
- And vice versa. If Acme controls the output or activity level, then the home owners are made worse off.

- However, the process of exchange always makes both parties better off, given their original circumstances.
- The original property rights assignment affects the direction of payments, although not the final output level in a Coasian world.

ix. An Illustration of the geometry of the Coase Theorem

- 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*.
- 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.
- 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).

Figure 3
A Coasian Contract



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- 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.)
- 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.
- 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**.
- 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.)

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

A. Not all externality problems can be solved with Coasian contracts or with a change in the assignment of property rights.

- *Transactions costs may be very large*, or the resources of interest might not be easily divided up and assigned to specific users.

i. In such cases, some form of *collective management* will be necessary to address externality problems.

B. There are several possible collective management solutions to externality problems.

C. Pigovian Taxes: Internalizing 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.

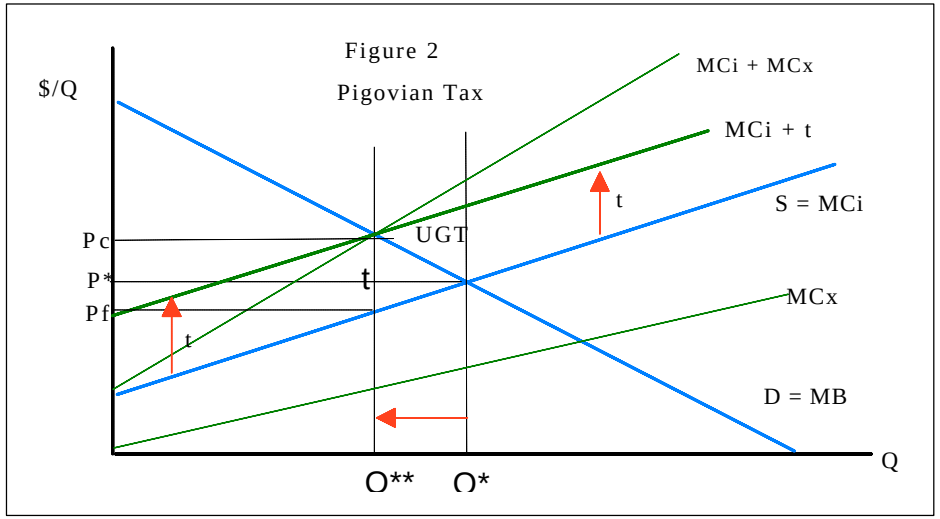
ii. Notice that if the externality producer is subject to a tax equal to the marginal external cost (benefit) at the Pareto efficient level, the externality producer will now choose to produce the Pareto efficient output/effluent levels.

iii. 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**).

iv. (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 taxes" that assess the same tax on every unit of the product (or emission) produced.

v. Pigovian taxes may yield substantial revenues although this is not their main purpose. *Their main purpose is to change behavior*.

- Note that without a Pigovian tax, there are unrealized gains to trade (see triangle UGT) at Q*, between the firm and those affected by the externality.



- The external cost at Q** is the vertical distance from MC to the MC + MCx curve.
- This distance also represents the Pigovian the tax that should be put on production to internalize the externality. It is labeled "t."
- 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.
- 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.

vi. Pigovian taxes tend to minimize the overall costs of reaching an externality target because firms can all independently adjust to the tax and minimizes their own total costs of production (including the tax).

- However, the tax burden required to achieve the desired level of the externality generating activity can be very large, which tends to make both consumers and firms in the taxed industry worse off.
- This tends to make Pigovian taxes politically unpopular (explain why).

vii. Imposing a Pigovian tax requires that the marginal external damages be estimated.

- This may be possible at Q* , the output actually produced in the unregulated setting.
- 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.

D. 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.)

VII. 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 sufficient 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 various free rider problems.

ii. In these cases, government can be thought of as a special kind of club with the power to tax.

B. Ideally, the government would provide services at the Pareto optimal level, or, equivalently, at the level that maximizes social net benefits.

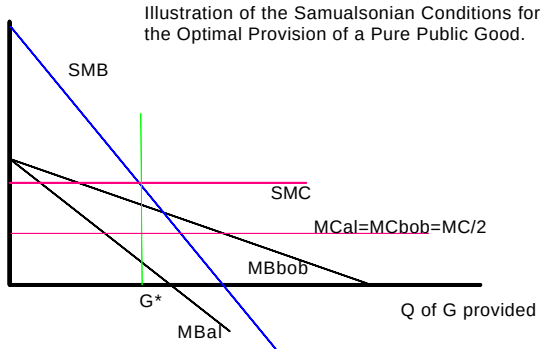
C. The ideal way to finance the "collective" production of such public goods requires:

i. Taxes that do not impose a deadweight loss. (Broad-based or lump sum taxes)

ii. They should raise just sufficient revenue to cover the cost of the public services.

iii. The sum of the marginal costs imposed on users of the public good should equal the marginal cost of producing them.

iv. (These three 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**.)



D. One problems with most "Samualsonian Solutions" to public good problems, is that the individual tax payers are generally "unhappy" with the amount of the public service provided, given their tax costs.

E. A special case of the Samualsonian Solution that avoids this problem is the Lindahl tax system. (Lindalh, a Swedish economist, surprisingly figured out his solution decades before Samuelson figured out his generalized solution.)

F. To these three conditions, Lindalh suggests that the *taxes should equate marginal benefits and marginal costs for individuals at the desired output* of government services.

i. Lindalh taxes are, thus, said to be idealized **benefit taxes**.

ii. They are, also, a special case of a Samuelsonian solution for the efficient government (or club) provision of a pure public good.

iii. Note, however, that the Lindalh 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.

iv. (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!)