Externalities

April 12, 2007

1 Outline of Chapter

1. Define externalities: positive/negative
2. Inefficiency and externalities

    basic problem: lack of property rights
3. Restoring efficiency in the presence of externalities

    Private Solutions: Coase solution, mergers
4. Public Solutions

    Pigouvian tax/subsidy

    emissions fees

    cap and trade programs

2 Externalities: definitions and examples

Definition:

An externality occurs when the activity of one entity affects the welfare of another in a way that is not transmitted via market prices, i.e., it is outside of the market mechanism.

Remarks:

1. Can occur from consumer to consumer (loud upstairs neighbor)
2. can occur from producer to producer (paper and pulp mill upstream from fishery)
3. can occur between producers and consumers (noise pollution from airport)
4. can be positive (R & D) or negative (pollution)
5. has some nonrival/nonexclusion characteristics
6. generally results in inefficient allocations

Example:

Bart: owns a paper and pulp mill

Lisa: fishes for a living downstream from Bart

Problem: no one owns the river (no market for river water)

Bart dumps dioxin in the river (he treats water—a scarce resource with alternative uses—as a free input)

The dioxin adversely affects Lisa's fishing business

Marginal Social Cost>Marginal Social Benefit→market failure

assigning property rights can restore efficiency: Coase Solution

3 Graphical Illustration

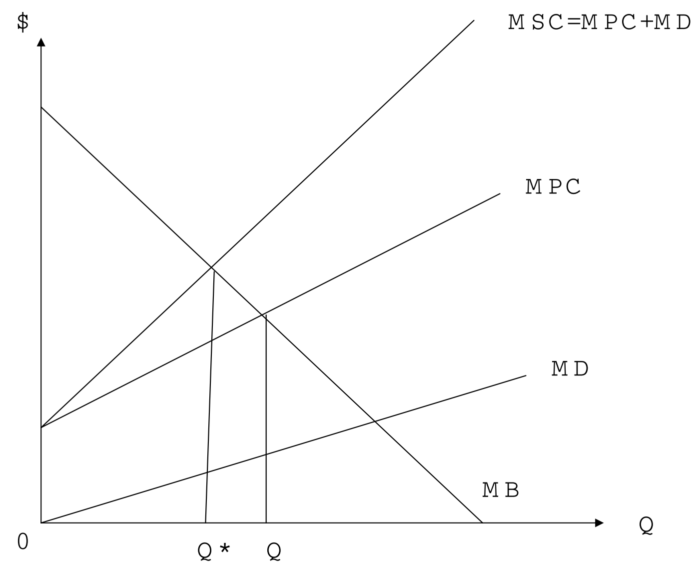

Figure 1: Inefficiency of Negative Externality

Bart maximizes profit where private marginal cost (MPC) equals marginal benefit (MB), ie., he produces output Q

At Q the marginal social cost (MSC) which includes the marginal damage (MD) to Lisa, is greater than the marginal benefit (MB), i.e., MSC>MB, which is inefficient.

The socially efficient level of output from Bart is at Q* where MSC=MB.

$Q^* < Q$, the market solution results in too much production from Bart

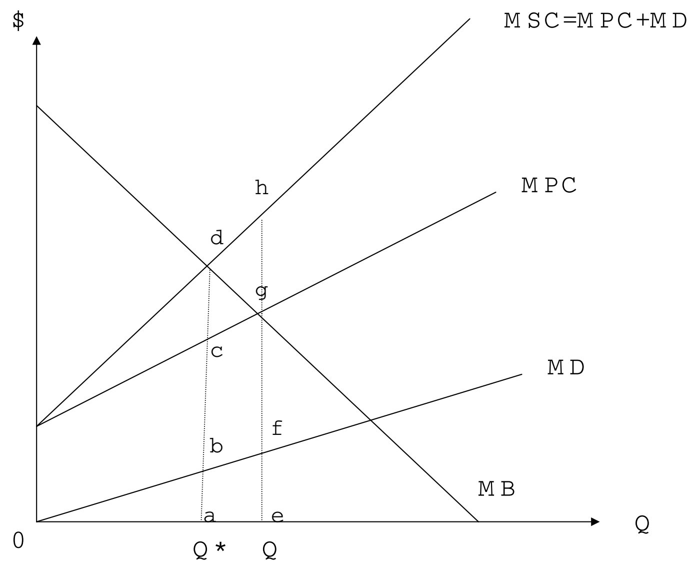

Figure 2: Gains and Losses: moving from **Q** to **Q***

Bart loses profit (MB-MPC): in total the area dcg

Lisa reduces her damages: in total the area abfe, which is equal to cdhg

Lisa's 'gain' exceeds Bart's loss, net gain equal to dhg

Note that zero pollution is not socially efficient here.

4 Practical Issues

1. Which pollutants do harm?

   TSP, but experimental studies unavailable

2. What activities produce pollutants?

   : acid rain—production or nature

3. Determining the value of damage.

   Difficult to measure willingness to pay in the absence of a market.

   Use housing market to estimate willingness to pay for clean air.

5 Private Responses to restore efficiency

5.1 Bargaining and the Case theorem

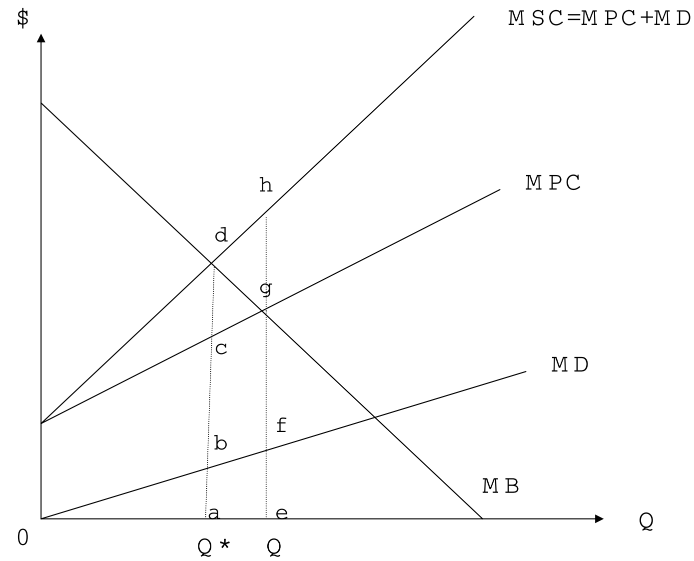

Figure 3: Coase: Assign property rights, bargain to Q*

1. Assign property right to Bart

   Bart initially chooses Q but willing to reduce output if he is compensated for lost profit, MB-MPC.

   Lisa willing to pay Bart to reduce output if it costs no more than her reduction in MD

   reduction occurs as long as MD $\geqq$ MB-MPC,

   This holds between Q and Q*

2. Assign property right to Lisa

   Lisa would initially choose Q=0, but would be willing to allow Bart to increase output if he can compensate her for the resulting damages (MD)

   Bart is willing to pay at most his marginal profit MB-MPC to compensate Lisa

   MB-MPC $\geqq$ MD up to production level Q*

When will this work?

- The costs of bargaining are low.
- The parties can identify the source of damages to their property and legally prevent them.

Conda (1995) points out that this has worked in England Scotland, where rivers and waterways are privately owned.

Where won't this work?

6 Other private responses to externalities

6.1 Mergers

If Bart and Lisa merge, that will internalize the externality.

6.2 Social Conventions

Golden Rule

Recycling taught in school

7 Public Responses

7.1 Pigouvian tax

Definition A tax levied on each unit of an externality-generator's output in an amount equal to the marginal damage *at the efficient level of output.*

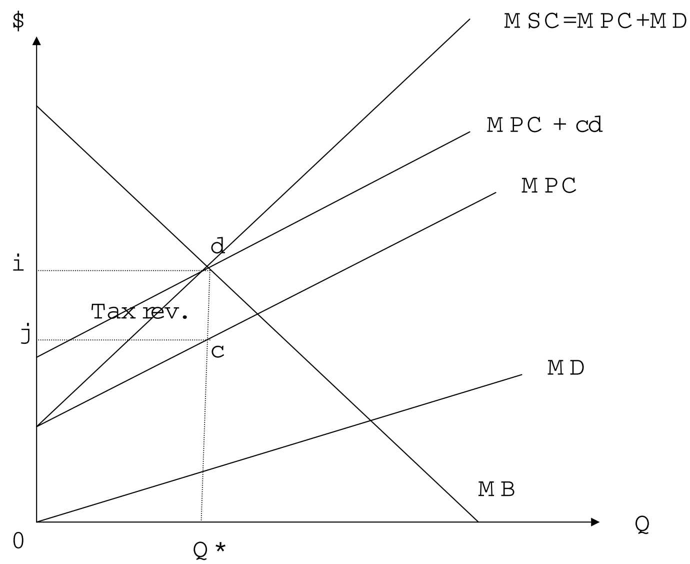

Figure 4: Pigouvian tax

The tax would be cd per unit, with total tax revenues of cdij. This increases Bart's cost to the marginal social cost at Q*.

Example: a tax on gasoline to control for pollution.

7.2 Emissions Fees and Cap-and-Trade programs

Tax each unit of emissions or pollution directly rather than taxing each unit of output; this is an **emissions fee**.

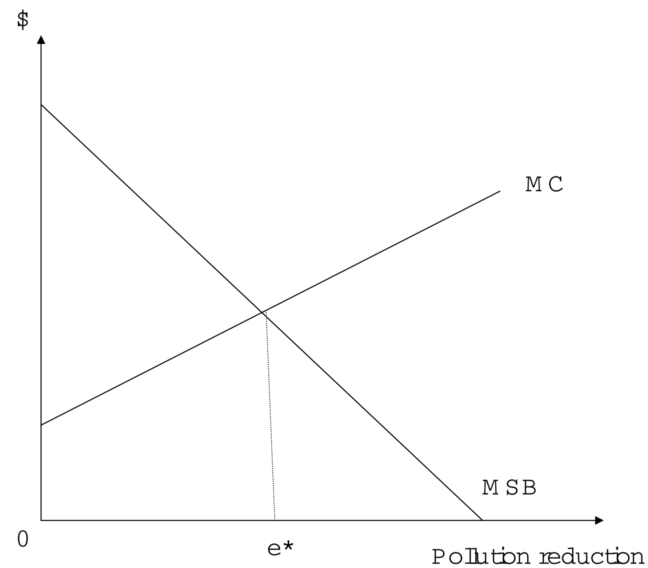

Figure 5: Market for pollution reduction

MC represents the cost to Bart of reducing emissions. MSB represents the benefit to Lisa of those emissions reductions.

The efficient level of emissions is at e* where MSB=MC.

What can government do to reach e*?

1. incentive-based regulations

    emissions fee

cap-and-trade

2. command-and-control regulation

7.3 Emissions fee

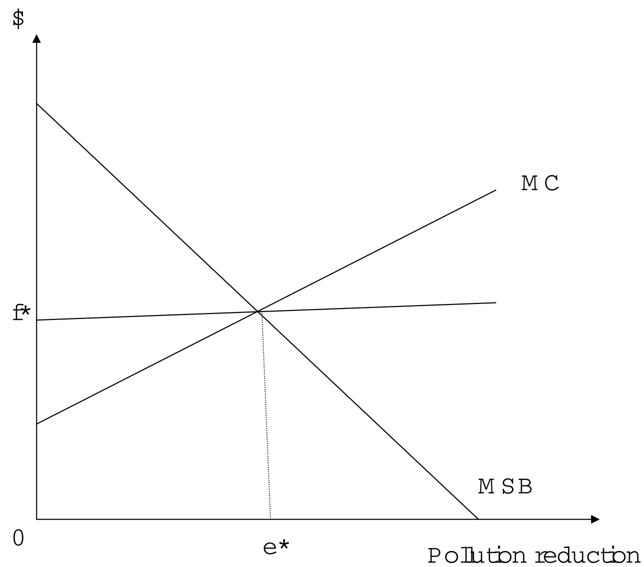

Figure 6: Emissions fee

Analogous to the Pigouvian tax, set the tax equal to the MSB at the efficient level of emissions e*.

If f* > MC, Bart will reduce emissions rather than pay the tax.

What if there is more than one polluter?

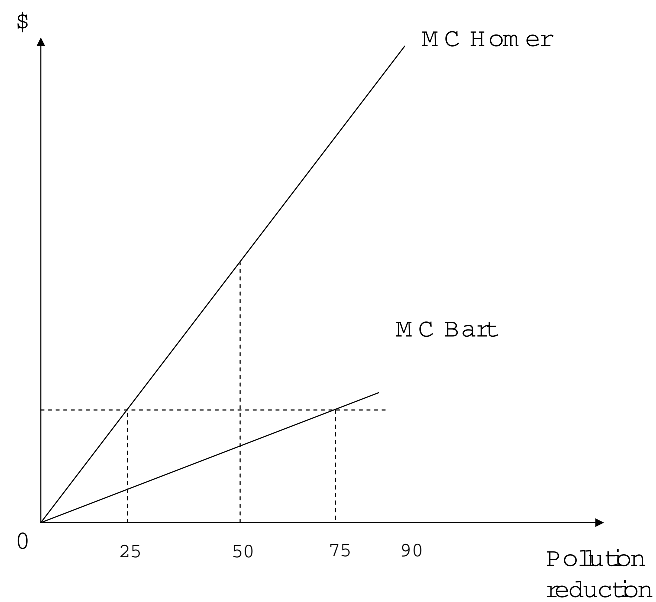

Figure 7: optimal reductions with two polluters

- Initially, Homer and Bart each emit 90 units of pollution (180 total)
- Suppose the efficient level is 80 units in total
- uniform reduction would require that each reduce 50 units (180-100=80)
- the marginal cost is much higher for Homer than Bart
- the cost effective solution is to equate the marginal costs to reach the target, Bart reduces emissions by 75 units, Homer by 25 units

Is this fair?

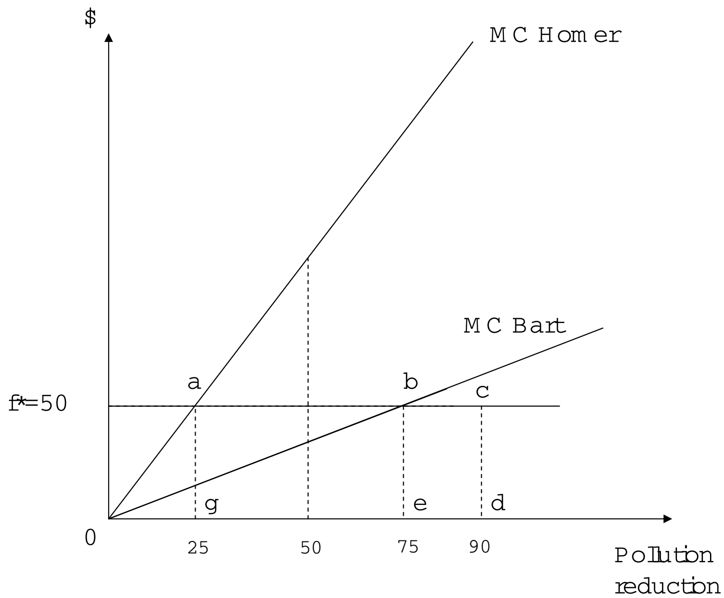

Figure 8: Emissions fee payments

Suppose the cost effective emissions fee is f*=50.

Bart reduces emissions by 75 units, but pays the fee on 15 units, i.e., the area bcde=$750

Homer reduces emissions by 25 units, but pays the fee on the 65 units, i.e., the area acdg = $3250

8 Cap-and-Trade

Introduce permits: If total emissions are to be 'capped' at 80 units, then 80 permits will be issued by the govt. This establishes a property right to the air or water; if the permits are tradeable, the outcome is cost-effective.

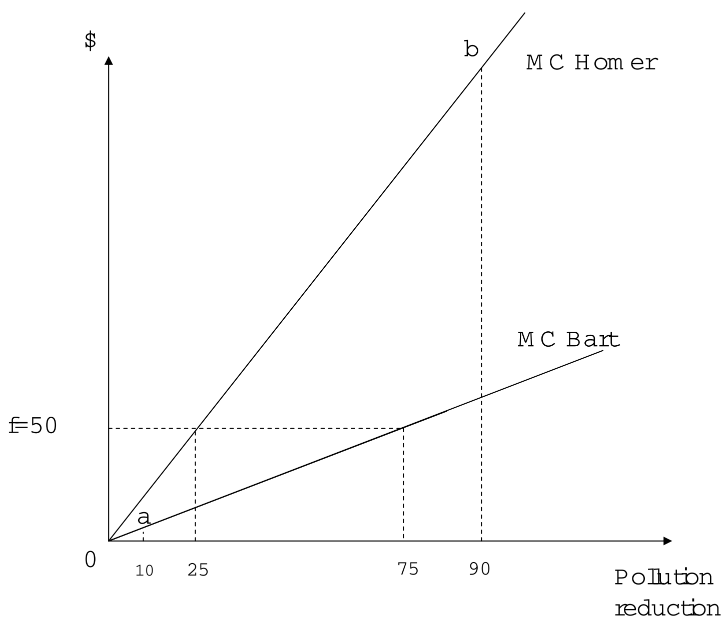

Figure 9: Cap-and-trade is cost effective

Recall: Bart and Homer each initially emit 90 units of pollution. Suppose that the entire 80 permits are given to Bart. He would then need to reduce emissions by only 10 units, with a very low marginal cost at point a. Homer would be at point b, facing a very high marginal cost, i.e., there are potential gains from trade. Homer is willing to pay Bart a lot for the first permit, and it continues to be worthwhile for him to buy permits from Bart up to the point where their marginal costs are equal, which is the cost-effective outcome. At this point the market price for permits is $50, the same as the cost-effective emissions fee.

Q: would we get the same outcome if Homer gets all 80 permits?

8.1 Emissions fee vs cap-and-trade

- Inflation: does not affect cap-and-trade, will affect emissions fees
- Change in MC: if MC increases, total reduction in emissions will fall under the emissions fee, under cap-and-trade there is no change in emissions, but there would be an increase in the market price for permits. Can introduce a safety valve price.
- Uncertainty: may result in inefficient reductions, effect depends on elasticity of MSB; cap-and-trade preferable when MSB is inelastic, emissions fee is preferred when MSB is elastic
- Distributional issues: emissions fees generate revenue, cap-and-trade doesn't unless the govt sells the permits.

General Conclusion: incentive-based systems are generally cost-effective and flexible in terms of how to achieve the emissions goal and who should reduce emissions.

9 Command and Control Regulation

Generally require a given amt of pollution reduction with little flexibility in how to achieve that reduction.

Types:

1. technology standard

   requires polluters to install a particular technology for clean up, eg, scrubbers

   not cost-effective

2. performance standard

   sets an emissions goal for each polluter

   more cost effective than technology standard, not as cost-effective as emissions fee or cap-and-trade (why?)

Is command-and-control ever better than incentive based regulation?

10 U.S. environmental policy

Clean Air Act: 1970 amendments require EPA to establish national air quality standards that are uniform and 'provide an adequate margin of safety'. Courts have ruled that EPA may not consider costs in setting standards. Thus we have a command-and-control system with technology and performance standards for new sources of air pollution and emissions standards for cars, trucks and buses.

Is this efficient? Why or why not?

Have these regulations been effective? Why or why not?

10.1 Examples of cap-and-trade in the US

1. Cap-and-trade has been introduced under the 1990 amendments to the Clean Air Act to address acid rain. Emissions of sulfur dioxide are capped and all electric utilities must have 'allowances' for each ton they emit, the total number of allowances sets the cap; the allowances are initially distributed to the utilities for free, after which they may be bought and sold.

2. Individual transferable quotas (ITQs) have been introduced in several fisheries: halibut, clam, sablefish, Bering Sea crab.

11 Positive Externalities

Example: R&D

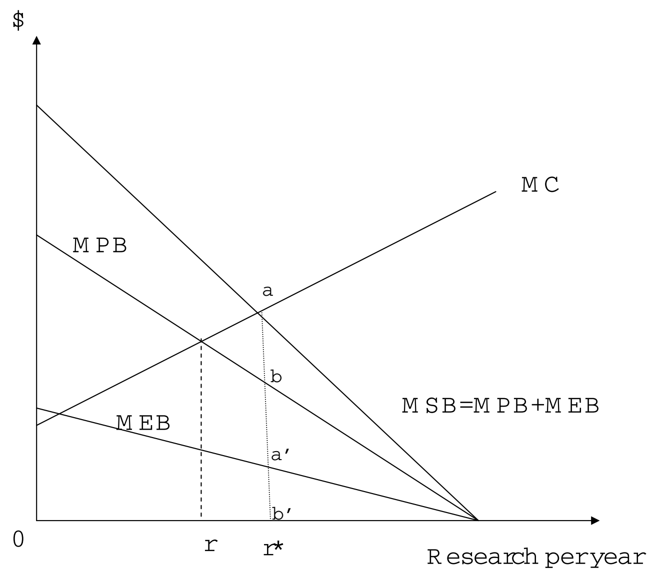

Figure 10: Positive externality

The private market solution would be at r, where marginal cost (MC) equal marginal private benefit (MPB). However, that amount of research generates external benefits to other firms, which is labeled MEB. The socially efficient level occurs at r* where MSB= MC. Note that MSB=MEB+MPB, and r< r*.

Pigouvian subsidy: provide a subsidy—ab—equal to the MEB at the efficient outcome, r*.