Lecture 5: Externalities

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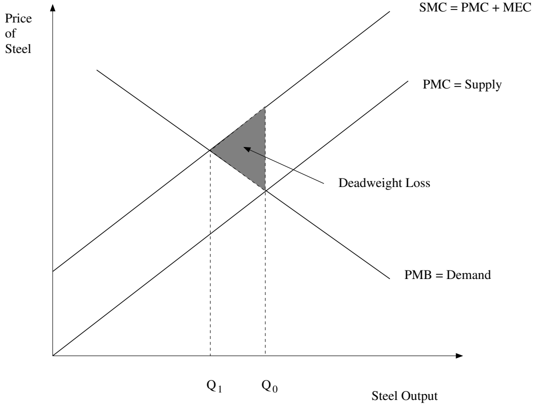
Externality: an action by one agent that results in costs or benefits accruing to another agent, for which no compensation is paid or redress given.

1. Review of the basic issue:
   - Standard example: air pollution (a *negative* externality).
   - Unregulated actions of private agents results in too much of a negative externality like pollution being provided – First Welfare Theorem does not apply.
2. Dealing with externalities:
   - private market solutions
   - public policy solutions based on prices
   - public policy solutions based on quantities

Classic example: a steel plant located next to a laundry. A *negative production externality*:

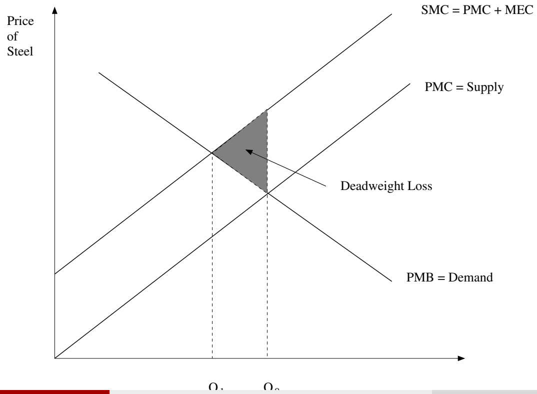
- The steel mill uses coal to produce steel, which produces soot.
- Soot makes it more costly for the laundry to clean clothes.



Key concepts:

- *private marginal cost*: MC of steel borne by steel firm.
- *marginal external cost*: MC of steel borne by laundry.
- *social marginal cost*: MC of steel to society.

In this case, the First Welfare Theorem fails: private costs do not equal social costs.



Exercise: Externalities in competitive markets

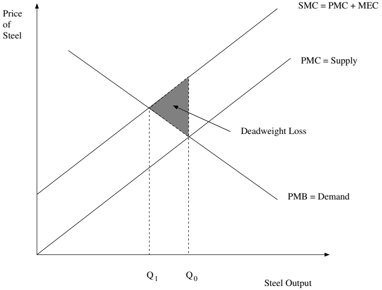
Let the cost functions of the firms

$$C_s(y_s) = \frac{1}{2}y_s^2$$
$$C_l(y_l, y_s) = \frac{1}{2}y_l^2 + \frac{1}{2}y_s$$

where y_s = steel output, y_l = laundry output. Suppose that the prices (p_s, p_l) are fixed in world markets.

1. Solve for the unregulated equilibrium output of steel, and the socially optimally level.
2. How much higher is social welfare (joint profit) in the socially optimally outcome, compared to the unregulated equilibrium?

In our initial example, too much steel was produced because steel plant ignored marginal external costs.



Now suppose that laundry has a legal right to clean air and could force the steel plant to shut down. Then the steel plant could offer to pay MEC to the laundry for each unit of steel to avoid legal action.

The laundry should accept this compensation, and steel plant should reduce output to Q_1 to maximize profit.

Coase Theorem I

Where there are well-defined property rights and efficient bargaining, negotiations between polluter and victim will *internalize the externality* and lead to efficient outcomes, without government regulation.

All government needs to do is establish property rights and enforce them through the courts – no taxes or regulation.

Role of property rights: Now suppose that the law assigns property rights to the steel plant, not the laundry – more realistic in this case. Can efficiency be achieved?

Coase Theorem II

The assignment of property rights is irrelevant to the efficiency of the negotiated outcome.

The Coase theorem required efficient bargaining, and this may not be realistic. For example:

- **Asymmetric information.** If parties do not know each other's cost and benefits, bargaining may break down, leading to excessive transaction costs and inefficient pollution. Examples?
- **Holdups and Free-riding.** Many externalities are *widespread*: there are many polluters and many victims. So negotiations to abate pollution are a public good: no party has the right incentives to conclude the efficient bargain. When number of affected parties is large, transactions costs to private solutions may be high.
- **Compensation and excessive damage.** If victims anticipate compensation, they have incentives to increase scale of exposure to externality, in order to increase compensation. Example: Compensation for homeowners living near airports/railways lines: What effect will this have on housing markets?

Efficiency is achieved when polluter internalizes marginal external cost. This is called a *Pigouvian tax*.

In the example, a unit tax on steel production equal to $t = MEC = \partial C_l / \partial y_s$ achieves efficiency.

At the optimum, polluter can pay for the right to pollute.

- there is some price people are willing to accept to tolerate the pollution.

Alternative policies often used:

- *Fines on polluters:* Set maximum pollution quantity and a "fine" of *MEC* if this level exceeded. (What difference would this make?)
- *Abatement subsidies:* A subsidy of *MEC* paid to polluter for reducing its pollution. (What difference would this make?)

In practice, governments often use quantity regulations, not prices or taxes, to address externalities. Examples:

- Quantity limits on pollution, e.g. fuel economy standards for cars, bans of lawn pesticides and other chemicals, plant-by-plant limits on sulphur dioxide emissions to control acid rain.
- Technology standards: Regulations require “best available technology” to control pollution; e.g. catalytic converters in gasoline engines, ban on styrofoam cups, elimination of coal-fired power plants in Ontario, etc.

How do we evaluate quantity regulations, compared to tax/price policies?

Simple model: single steel plant with initial pollution level Y^0, abates pollution to $Y = Y^0 - A$. The cost of abatement is $C(A)$, the external benefit of abatement is $B(A)$. (What are the supply and demand curves for abatement?)

Quantity standard. The social planner solves $\max B(A) - C(A)$ so optimal abatement A^* solves

$$B'(A^*) = C'(A^*)$$

which can be achieved with a quantity standard $Q = Y^0 - A^*$.

Pollution tax. With a tax on pollution $t = B'(A^*)$, steel firm maximizes profit

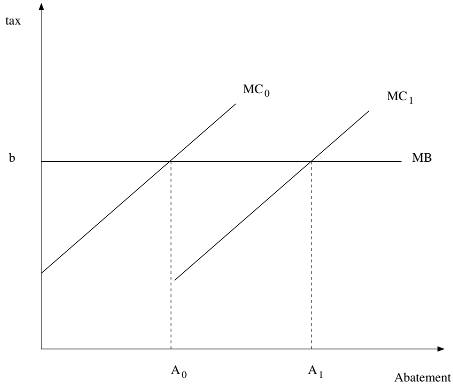
$$\max -t(Y^0 - A) - C(A)$$

and so sets

$$C'(A^*) = t = B'(A^*)$$

A Pigouvian tax decentralizes the optimum.

Suppose now there are two polluters with abatement cost functions $C_i(A), i = 0, 1$. Suppose that $C_0'(A) > C_1'(A)$: abatement is more expensive at the margin for polluter 0.



With two polluters, the social planner solves

$$\max B(A_0 + A_1) - C_0(A_0) - C_1(A_1)$$
$$\implies B'(A_0^* + A_1^*) = C_0'(A_0^*) = C_1'(A_1^*)$$

Since $C_0'(A) > C_1'(A)$, we know that $A_0^* < A_1^*$: more abatement by those for whom it is less costly, not necessarily the bigger polluters:

- We can get efficient abatement with a uniform pollution tax $t = B'(A_0^* + A_1^*)$.
- But a uniform abatement standard $\bar{A} = (A_0^* + A_1^*)/2$ is inefficient!
  - Exercise: Demonstrate this in the preceding graph.
- But if pollution permits can be traded, they will be efficiently allocated
  - called "cap and trade": often proposed for greenhouse gases, in lieu of a carbon tax
  - permits can be given freely to polluters, or they can be auctioned off by government

Let Q_i pollution permits be granted to polluter $i = 0, 1$, with $Q_0 + Q_1 = A$. Suppose the market price of pollution permits is p.

Polluters maximize profits

$$p(Q_i - Y_i^0 + A_i) - C_i(A_i)$$

so polluter chooses $C'(\hat{A}_i) = p$.

In equilibrium, the permit price adjusts so that

$$\hat{A}_0 + \hat{A}_1 = A$$

so that $p = B'(A)$ in equilibrium.

We know that a Pigouvian tax $t = B'(A)$ achieves the same outcome. For any cap-and-trade limit A, there is an equivalent Pigouvian tax rate $t = B'(A)$.

Greenhouse gas policies in Canada

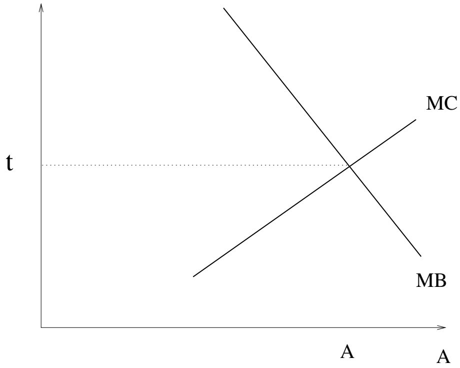
Currently (mid-2018),

- two provinces have implemented small carbon taxes
- two provinces have tradable permit ("cap-and-trade") schemes
- federal government will impose a carbon tax beginning in 2019 on those provinces that do not (have something?)

Issues:

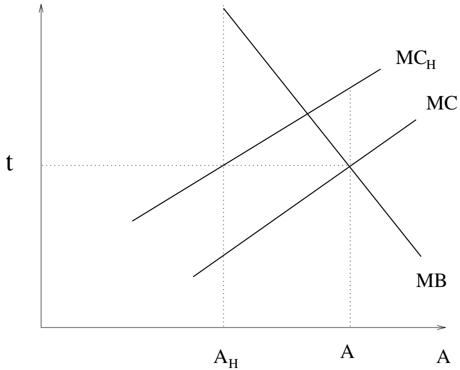
- Should Canada reduce GHGs?
- Carbon tax or cap-and-trade?
- How should revenues be distributed?
- Should policy apply to consumption of GHGs, or production? How should international trade be treated?
- Why have governments not done more on climate change?

How does the planner choose t or A if abatement cost functions are unknown? See analysis in Metcalf (2009), based on Weitzman (1974).



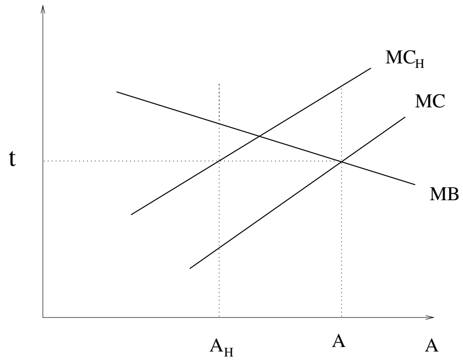
Suppose initially that the benefit of abatement MB and the cost to polluters of abatement MC are known with certainty.

The figure again shows that either a Pigouvian tax t or an abatement standard A achieves efficiency in this case.



Now suppose that the planner acts as though abatement cost is MC, but there is some probability true abatement cost is $MC_H > MC$.

What are the deadweight costs of the two policies in the event that true abatement costs are MC_H? Which policy is more efficient?



Now suppose uncertainty about abatement costs is as before, but the marginal benefit of abatement is different. (In the previous case, the polluting activity has a "threshold effect"; here, $B'(A)$ is fairly constant.)

What are the deadweight costs of the two policies in the event that true abatement costs are MC_H? Which policy is more efficient?

Key concepts

negative externality
positive externality
marginal external cost
marginal social cost
Coase theorem
Pigouvian tax
command-and-control regulation
carbon tax
cap-and-trade regulation