

Externalities

Chapter 34

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Externalities cause market failure

- They affect people who are not buyers or sellers of the good
- That is, they occur **outside** markets
- The market for the external effect is **missing**
- Private cost \neq social cost; private benefit \neq social benefit
- Goods w/ negative externalities are overproduced
- Goods w/ positive externalities are underproduced

How can we correct this market failure?

- Regulate market activity
 - Corrective (Pigouvian) tax/subsidy
 - Quotas
- Create the missing market
 - Assign property rights (Coase Thm.)
 - Tradeable permits (Cap n' trade)

Two Firm Example

Firm 1: Joe's coal-burning power plant

- Costs:

$$C^e(e, a) = e^2 + (4 - a)^2$$

- Produces electricity (e)
- CO_2 (a for polluted *air*) emissions as a byproduct
- $\frac{\partial C^e}{\partial e} = 2e > 0$: more costly to produce more power
- $\frac{\partial C^e}{\partial a} = -2(4 - a) < 0$ (assuming $0 \leq a \leq 4$): it's cheaper to make electricity while polluting

Two Firm Example

Firm 2: Sarah's polar bear farm

- Costs:

$$C^I(l, a) = l^2 + la + a^2$$

- Produces polar-bear pelts (l)
- CO_2 emissions cause global warming, making it more difficult to raise polar bears
- $\frac{\partial C^I}{\partial l} = 2l + a > 0$: it costs more to produce more polar bear pelts
- $\frac{\partial C^I}{\partial a} = l + 2a > 0$: raising bears is more costly with lost of CO_2 in the air (global warming)

What We Saw

- There are three goods: electricity, bears, and polluted air
- However, there are only two markets: electricity and bears—the polluted air market is missing!
- Without this market, the power plant does not take into account—does not **internalize**—the effect of its pollution on the polar bears
- Sarah loves clean air, so there is a cost of pollution from a social point of view
- Joe will release “too much” polluted air: a will be “too high”

Competitive Outcome vs. Social Optimum

- $e^* = 20 = e^P$
- $a^* = 4 > \frac{8}{7} = a^P$
- $l^* = \frac{3}{2} < \frac{24}{7} = l^P$

Joe doesn't internalize the cost of his pollution and produces too much. Sarah produces less than the social optimum: she suffers the cost of Joe-caused global warming, and isn't compensated for it. Inefficiency!!

Summary

- Competitive outcome: $MPB = MPC$
- Socially optimal outcome: $MSB = MSC$
- If there is a market for good i :

$$MSB_i = MPB_i \text{ and } MSC_i = MPC_i$$

- If the market for good a is missing:

$$MSB_a \neq MPB_a \text{ and/or } MSC_a \neq MPC_s$$

- Example: there is no market for polluted air, so

$$MPC_a = 0 \neq MSC_a = 1 + 2a = \frac{40}{7}$$

Corrective Policies

- Externalities lead to market failure
- Market inefficiencies indicate a role for government
- Today: two broad approaches to correcting problems caused by externalities
 - Government regulation: quotas, corrective (Pigouvian) taxes/subsidies (e.g. carbon tax)
 - Create the missing market: assign property rights (that can then be bought and sold), i.e. apply Coase Theorem (e.g. cap n' trade)

Government Regulation

Quotas

- Govt. could set emissions quota/ceiling
- Command & control approach
- Set quota equal to socially optimal level $a^P = \frac{8}{7}$
- Let Joe and Sarah decide how much e, l to produce
- Choosing e^P and l^P now maximizes profits
- Very clumsy tool
 - Target is overall emissions: how to set target for individual producers?
 - Difficult to modify law as technology/costs change

Government Regulation

Another regulatory approach: Pigouvian (or corrective) taxes

- Government imposes a unit tax τ on a .
- This **internalizes** the cost to Joe of his power plant's pollution
- Now his profit maximizing problem is

$$\max_{(e,a)} p_e e - C^e(e, a) - \tau a$$

- Optimality conditions:

- $p_e = \frac{\partial C^e(e,a)}{\partial e}$
- $\tau = -\frac{\partial C^e(e,a)}{\partial a}$

- Recall: $\frac{\partial C^e(e,a)}{\partial a} = -2(4 - a)$ and $e^P = 20$, $a^P = \frac{8}{7}$
- So the Pigouvian tax rate is

$$\tau = -[-(2(4 - \frac{8}{7}))] = \frac{40}{7}$$

Problem: requires very good information about preferences, demand, social objectives, etc.

Property Rights Approach

Coase Theorem

- Ronald Coase: externality exists because neither Joe nor Sarah owns the air being polluted
- Creating a property right to the air and assigning it to one of the firms can reduce inefficiency
- **Coase Theorem:** assume all agents' preferences are quasilinear in money. If there are no transaction costs, i.e. negotiation is costless, then assigning a property right for the externality to *any agent* will restore the socially optimal outcome.
- Note: transferring the right to different parties may lead to different outcomes, but they will all be efficient.

Giving Sarah The Right To Clean Air

Sarah's choice

- Suppose Sarah's polar bear farm is given the property right to clean air
- She can sell this right at price p_a
- Her profit maximizing problem becomes

$$\max_{(l,a)} p_a a + 8l - (l^2 + la + a^2)$$

- Optimality conditions:
 - $8 = 2l + a$
 - $p_a = l + 2a$

Giving Sarah The Right To Clean Air

Joe's choice

- His profit maximizing problem becomes

$$\max_{(e,a)} 40e - (e^2 + (4 - a)^2) - p_a a$$

- Optimality conditions:
 - $40 = 2e$
 - $p_a = 2(4 - a)$

Giving Sarah The Right To Clean Air

Equilibrium:

- Optimality conditions:
 - $8 = 2l + a$
 - $p_a = l + 2a$
 - $40 = 2e$
 - $p_a = 2(4 - a)$
- Solutions: $a = \frac{8}{7} = a^p$, $l = \frac{24}{7} = l^p$, $e = 20 = e^p$, $p_a = \frac{40}{7}$

Property Rights Approach

What if we assign the property right to Joe instead?

- Suppose Joe has the right to pollute as much as he wants
- He can sell this right
- Is the competitive outcome still optimal?
- Yes, though it may be different– in this case Sarah would pay him to cut pollution down to the socially optimal level
- Assigning property rights results in the same socially optimal amount of pollution, regardless of to whom they are assigned
- However, assigning the rights is results in a windfall profit– so the outcomes (profits) are not the same in either case

Property Rights Approach

Cap and Trade:

- The cap and trade approach to reducing greenhouse gas emissions: govt. issues a fixed amount (a^p) of tradeable pollution permits
- The permits can be used by Joe to pollute, or sold to another power plant so it can pollute instead, or bought by Sarah, who will hold them and not pollute anything
- This creates the missing market for air, individual parties negotiate to the efficient allocation

Comparing Three Methods of Correcting Externalities

- Quotas/command-and-control regulation: require knowledge of social optimum, production structure. Not very “libertarian”
- Pigouvian tax: makes it so that individuals’ optimal choices result in the social optimum, but risky if you’re trying to get pollution level *just right*.
- Cap and trade:
 - Easy to set particular level of emissions
 - Simple to implement—doesn’t require separate rule/treatment for individual plants
 - Firms optimally reallocation pollution amongst selves—don’t need to know cost structures
 - *However, initial assignment of permits/rights leads to windfall profits for recipients.*

Externalities: Conclusion

- Externalities lead to inefficiency, but can be fixed through the market
- Coase Theorem: gives conditions needed for efficient market solution—property rights and no transaction costs
- Can sometimes achieve these conditions by assigning property rights, creating a market for the externality
- Understanding why externalities persist in equilibrium means understanding why the conditions of the Coase Theorem fail
- If can't find way to make them hold, external regulation may be necessary.