

Externalities

Chapter 34

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Externalities

- An **externality** is a cost or a benefit imposed upon a third party by a the production or consumption of a good.
- Also known as a spillover
- An externally imposed benefit is a positive externality
- An externally imposed cost is a negative externality

Negative Externalities

Examples:

- Pollution
- Noise
- Traffic congestion
- Increased insurance premiums due to smokers
- Lack of trust in financial markets after bank failure
- Production in oligopoly, e.g. cheating on a cartel(???)

Positive Externalities

Examples:

- Well-maintained property next door
- Pleasant bakery smell
- Improved driving habits
- Technological/medical advance
- Good students in a classroom

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 Will See

- 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”

The Power Plant's Problem

- Let the price of electricity be $p_e = 40$
- So revenue is $40e$
- Taking prices as given, Joe chooses quantity of e to produce and level of pollution a , so as to maximize profits:

$$\max_{(s,a)} 40e - C^e(e, a) = \max_{(e,a)} 40e - [e^2 + (4 - a)^2]$$

- To optimize, differentiate w.r.t. each variable:
 - $\frac{\partial}{\partial e}: 40 = 2e$
 - $\frac{\partial}{\partial a}: 0 = -2(4 - a)$
- For each good: Marginal Private Benefit (MPB) = Marginal Private Cost (MPC)
- Solution: $e^* = 20$ and $a^* = 4$

Sarah's Polar Bear Problem

- Let the price of bear pelts be $p_l = 8$, so revenue is $8l$
- Taking prices and the level of polluted air ($a^* = 4$) as given, Sarah chooses l to maximize profits:

$$\max_l 8l - C'(l, 4) = \max_l 8l - l^2 - 4l - 4^2$$

- Optimality condition:
 - $\frac{\partial}{\partial l}: 8 = 2l + 4$
- $MPB = MPC$
- Solution: $l^* = \frac{8-4}{2} = 2$

Social Planner's Problem

- We've seen the result of competitive markets: $e = 20$, $a = 4$, $l = 2$
- What is the socially optimal production level for each good?
- What would benevolent social planner choose?
- Would maximize the total (joint) profit of both firms
- Social Planner's Problem:

$$\max_{(e,a,l)} [p_e e - C^e(e, a)] + [p_l l - C^l(l, a)]$$

- By maximizing joint profit, the planner **internalizes** the effect of polluted air on polar bears

Social Planner's Problem

$$\max_{(e,a,l)} [40e - (e^2 + (4 - a)^2)] + [8l - (l + la + a^2)]$$

Optimality conditions: Marg. *Social* Benefit = Marg. *Social* Cost

- $MSB_e = 40 = 2e = MSC_e$
- $MSB_a = 2(4 - a) = l + 2a = MSC_a$
- $MSB_l = 8 = 2l + a = MSC_l$
- Solutions: $e^P = 20$, $a^P = \frac{8}{7}$, $l^P = \frac{24}{7}$

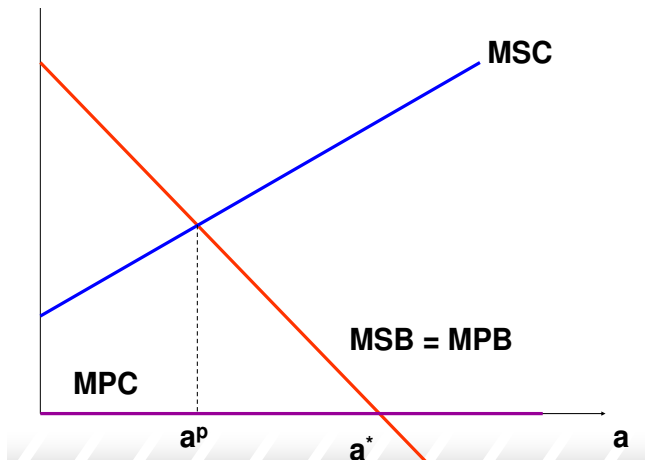
Competitive Outcome vs. Social Optimum

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

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!!

Graphical Illustration

Overproduction of a good with a negative externality



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
- Next time: 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)