Externalities
(Chapter 34)
Quiz 3

- In section next week

- Two questions
  1. Relates to exchange
  2. Relates to externalities
An **externality** is a cost or a benefit imposed upon a third party by 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)
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 lots 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:

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

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:

\[
\max_l 8l - C^l(l, 4) = \max_l 8l - l^2 - 4l - 4^2
\]

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

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

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

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

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

MSC

MSB = MPB

MPC

Social Optimal Outcome

a

marginal

a*
a

ap

a*
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

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