

Econ 301: Microeconomic Analysis

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Externalities

1 / 20

2 / 20

Introduction

- ▶ Last time, saw that if all interaction between agents happened in a market, would obtain Pareto efficient outcome
- ▶ However, in general we have *externalities*, where agents have preferences for things that are not sold on the market
- ▶ Question for today: Will we still get Pareto efficient outcomes if there are goods with no market?

3 / 20

Types of Externalities

- ▶ *Consumption externality*: when a consumer cares directly about the consumption or production of others
 - ▶ Positive consumption externalities:
 - ▶ Negative consumption externalities:
- ▶ *Production externality*: when production possibilities of one firm influenced by choices of other firms or consumers
 - ▶ Positive production externalities:
 - ▶ Negative production externalities:

4 / 20

Consumption Externality Example: Smoking Roommate

- ▶ Let A and B be two people sharing a room
- ▶ A prefers to smoke while B prefers clean air
- ▶ A and B each endowed with some money: m_A, m_B
- ▶ Note that we can represent this situation with Edgeworth box:
 - ▶ Money on horizontal dimension, eg
 - ▶ Then vertical axis represents percent of smoky air for A, or conversely clean air for B
 - ▶ Total amount of air is fixed
 - ▶ Preferences for A increasing in money and in smoky air
 - ▶ Preferences for B increasing in money and in clean air

5 / 20

Smoking Roommate: Endowments

- ▶ Only one thing left to specify for Edgeworth analysis: endowments
- ▶ First, suppose A has the right to smoke; where will endowment be?
- ▶ Next, suppose B has the right to clean air; where will endowment be?
- ▶ These are just two extremes; a whole continuum of possible property rights
- ▶ As long as property rights are clear and agreed upon, Pareto efficient allocation will be obtained

6 / 20

Smoking Roommate Edgeworth Box

The Coase Theorem

- ▶ Suppose preferences of both agents are quasilinear in money
- ▶ What does this imply about indifference curves of each consumer?
- ▶ What does this imply about contract curve?
- ▶ Whatever the initial endowment, agents end up consuming same amount of clean air
 - ▶ This is called *The Coase Theorem*
 - ▶ Big implication (if assumptions hold): initial property rights do not affect final allocations of clean/smoky air

7 / 20

8 / 20

Coase Theorem Graphically

Production Externalities

- ▶ Consider economy with two firms: steel mill and fishery
- ▶ Steel mill produces steel s and pollution x at cost $c_s(s, x)$
 - ▶ Steel sells at price p_s
 - ▶ No market for pollution
 - ▶ Assume $\frac{dc_s}{dx} \leq 0$
- ▶ Fishery downstream produces fish f at cost $c_f(f, x)$
 - ▶ Fish sells at price p_f
 - ▶ Note the steel mill can choose pollution amount x but fishery must take it as given
 - ▶ Assume $\frac{dc_f}{dx} \geq 0$

9 / 20

10 / 20

Production Externalities (cont)

- ▶ Steel mill's profit max problem:

- ▶ FOC:

- ▶ Fishery's profit max problem:

- ▶ FOC:

Socially Optimal Production Levels

- ▶ What is socially optimal amount of pollution x to produce?
- ▶ To find out, combine firms into one firm
- ▶ Combined profit max problem:

- ▶ New FOC:

- ▶ Note that first two FOC are same, but third FOC implies a lower level of pollution x that if firms were separate

11 / 20

12 / 20

Terminology

- ▶ When the firms are acting independently, they are trying to minimize *private cost*
- ▶ The steel firm, which creates the pollution, does not pay *social cost* of steel production
- ▶ However, by combining the firms they *internalize* the externality by minimizing social cost
- ▶ Note that if all costs are fully internalized, market equilibrium should give Pareto efficient outcome, as we expect from last lecture

13 / 20

Market for Pollution

- ▶ Rather than government imposing pollution price through tax, we can add a market for pollution
- ▶ Then government just has to set property rights
- ▶ Assume fishery has right to clean water
- ▶ Then steel mill has to pay price q to fishery to pollute
- ▶ Fishery can sell pollution rights for price q

15 / 20

Pigouvian Tax

- ▶ Other than merger, can we get socially optimal levels of production?
 - ▶ Yes, we can change steel firm's incentives by changing price of pollution
- ▶ Consider putting quantity tax t on pollution (called a *Pigouvian tax*)
- ▶ Steel firm profit maximization problem now?
- ▶ New FOC:
 - ▶ If we set $t = \frac{d}{dx}C_f(f, x)$ we get optimal level of x
 - ▶ Note: government has to know cost structures to set correct tax

14 / 20

Firm Decisions

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|-------------------------|----------------------|
| ▶ Steel mill's problem: | ▶ Fishery's problem: |
| ▶ FOC: | ▶ FOC: |

16 / 20

Property Rights Reversed

- ▶ If fishery has the property right, we get the socially optimal solution
- ▶ What if the steel mill has the right to pollute?
- ▶ In particular, steel mill can pollute up to \bar{x} and fishery can pay price q to lower this amount
- ▶ Steel mill's problem:
- ▶ Fishery's problem:

17 / 20

Tragedy of the Commons

- ▶ Suppose some villagers are grazing cows on the village green
- ▶ If c cows are grazing, total value of milk produced is $f(c)$, which is concave
- ▶ Each cow costs a to buy and maintain
- ▶ Village's socially optimal number of cows?
- ▶ Villagers' individual decisions
 - ▶ Suppose each villager can choose to buy a cow or not
 - ▶ Since number of villagers is relatively small, Nash Equilibrium is an appropriate tool here

18 / 20

Tragedy of the Commons (cont)

- ▶ Suppose c villagers choose to buy a cow, and the rest stay out
- ▶ When is this a Nash Equilibrium?

- ▶ Is this social optimum?

- ▶ What happened?

19 / 20

Tragedy of the Commons Graphically

20 / 20