# Undergraduate Program in Central European Studies

CERGE-EI and the School of Humanities at Charles University
Address: Politických vězňů 7, 110 00 Praha 1
Tel. : +420 224 005 201, +420 224 005 133, Fax : +420 224 005 225
E-mail: upces@cerge-ei.cz
Web: http://www.cerge-ei.cz/abroad

# Environmental Policy in the Central European Context

Time: Tuesday 4pm
Location: at CERGE-EI, Room # 10

**Professor: Jana Krajcova**
**Email: jana.krajcova@cerge-ei.cz**
**Reading materials: http://home.cerge-ei.cz/richmanova/TeachingUPCES.html**

**What is your background?**

- **environmental?**
- **economic (statistical/econometric analysis)?**
- **environmental economics?**
- **experimental economics?**

**What do you expect from this course?**

**OUTLINE OF THE COURSE:**

The aim of this course is to introduce students to some basic economic principles and theories explaining environmental issues and problems today and to explore existing policies at the national, international, and world level. Students will learn about concepts such as externalities, the tragedy of the commons, enforcement as a public good, interventionist solutions to the externality problem such as taxes and marketable pollution permits, as well as non-interventionist solutions to the externality problem such as the Coasian solution and self-regulation. We will also review the debate over the environmental Kuznets curve. We will discuss the field data and environmental policies of the Czech Republic and place them into international context. Finally, we will touch current topics such as renewable resources and the controversy about their support schemes. Because experimental evidence complements theoretic insights, field data and simulating models nicely, review some research articles that draw on the experimental methodology.

**GRADING POLICY:**
Class participation and activity (10%),
Quick quizzes (20%)
Presentation (20%)
Final exam (50%)

**Course Outline:**

| **WEEK:** | **TOPICS:** |
|---|---|
| **1 - Sep 28** | **National Holiday** |
| **2 - Oct 5** | Introduction, Market failures - externalities, tragedy of the commons, enforcement as public good |
| **3 - Oct 12** | Interventionist solutions to the Externality problem – Pigouvian taxes and standards and charges |
| **4 - Oct 19** | Interventionist solutions to the Externality problem – Marketable pollution permits |
| **5 - Oct 26** | Non-Interventionist solutions to the Externality problem – The Coasian solution **Presentation topics to be agreed on** |
| **6 - Nov 2** | Non-interventionist solutions to the Externality problem – Voluntary programs and self-regulation |
| **7 - Nov 9** | Environmental Policy in the Czech Republic – History and current issues |
| **8 - Nov 16** | **Students' Presentations** |
| **9 - Nov 23** | Environmental Policy in the EU – History and Current problems |
| **10 - Nov 30** | Environmental Policy in the world context – History and Current problems |
| **11 - Dec 7** | Renewable Resources (guest lecture + discussion) |
| **12 - Dec 14** | **Final Exam** |

**Some useful links**

CENIA (www.cenia.cz) – website of the Czech Ministry of the Environment's information agency.

Environment Center of Charles University (http://www.cuni.cz/COZPENG-5.html)

European Environment Agency (http://www.eea.europa.eu/) - environment agency of the EU

http://ec.europa.eu/environment/enveco/index.htm - web site of the EC

**READINGS list contains both required and optional readings. It will be revised as we go, always check out the website for updates)**… see the syllabus/website;

the first part of the course follows: **Schotter, Andrew (1997), Microeconomics. A Modern Approach.** Second Edition. Addison-Wesley. Of particular importance: **Chapter 17** in that book – there are several editions of that book, when I refer to page/problem numbers it will always be consistent with the scanned version which can be downloaded from the course web page.

## Introduction

### Why do we care about the environment?

a) life supporting function (location and the basic conditions for the existence of life)
b) natural resources (inputs for consumption and production)
c) amenity values (natural beauty)

### Natural resources:

a) flow resources (solar radiation, wind or water energy – the current use does not affect the future availability)
b) stock resources (the current use affects future availability)
    - renewable resources (forests, stock of fish, etc…)
    - non-renewable (fossil fuels, mineral ores)

The problem is that with increasing human activity, industrial production unclean technologies, there are adverse and often permanent impacts on biophysical environment.

### Nature of environmental problems

a) nature degradation due human activity (deforestation, pollution)
b) conflicting usage of the natural resource (e.g. amenity vs. production)
c) distribution of usage over time (this or future generation?)
d) distribution among agents (too many fishermen)

### Current issues in Europe and the CR

**a)** water and air pollution, greenhouse effect (how to manage with growing industrial production, transportation)
**b)** soil pollution (industrial fertilizers)
**c)** energy intensity
**d)** noise (transportation air/road/railway)
**e)** waste management
**f)** decrease in biological diversity and ecological stability (due agricultural production and fragmentation of the landscape due transportation)

### Instruments of environmental protection

a) regulations
b) economic and financial (standards and charges, marketable pollution permits, taxes, fines, tax reliefs and subsidies, property rights)
c) voluntary programs (environmental labeling), environmental education and public awareness

### From Wikipedia, the free encyclopedia

**Environmental economics** is a subfield of economics concerned with environmental issues. Quoting from the National Bureau of Economic Research Environmental Economics program: Environmental Economics undertakes theoretical or empirical studies of the economic effects of national or local environmental policies around the world. Particular issues include the costs and benefits of alternative environmental policies to deal with air pollution, water quality, toxic substances, solid waste, and global warming.

Central to environmental economics is the concept of **market failure**. Market failure means that markets fail to allocate resources efficiently. As stated by Hanley, Shogren, and White (2007) in their textbook Environmental Economics[2]: "A market failure occurs when the market does not allocate scarce resources to generate the greatest social welfare. A wedge exists between what a private person does given market prices and what society might want him or her to do to protect the environment. Such a wedge implies wastefulness or economic inefficiency; resources can be reallocated to make at least one person better off without making anyone else worse off."

**Externality** is one of the key concepts of environmental economics, one of the common causes of market failure.

**Externality:**
**(some bits and pieces here are from Wikipedia)**

In economics, an externality or spillover of an economic transaction is an impact on a party that is not directly involved in the transaction. The basic idea is that an externality exists when a person makes a choice that affects other people that are not accounted for in the market price and thus the prices do not reflect the full costs or benefits in production or consumption of a product or service. An advantageous impact is called an external benefit or positive externality, while a detrimental impact is called an external cost or negative externality. Producers and consumers in a market may either not bear all of the costs or not reap all of the benefits of the economic activity.

- **Positive externalities -** an action that imposes a positive side effect on a third party
- **Negative externalities -** an action that imposes a negative side effect on a third party; many negative externalities are related to the environmental consequences of production and use.

**Can you think of couple of examples on**

**a) positive externalities**
**b) negative externalities**

**Examples of positive externalities:**

- A **beekeeper** keeps the bees for their honey. A side effect or externality associated with his activity is the pollination of surrounding crops by the bees. The value generated by the pollination may be more important than the value of the harvested honey.
- An individual planting an **attractive garden** in front of his or her house may provide benefits to others living in the area, and even financial benefits in the form of increased property values for all property owners.
- **Home ownership** creates a positive externality in that homeowners are more likely than renters to become actively involved in the local community.
- **Education** creates a positive externality because more educated people are less likely to engage in violent crime, which makes everyone in the community, even people who are not well educated, better off.

**Examples of Negative Externalities**

- **Transportation:** drivers imposing congestion cost on other drivers
- **Industrial Production:** producing (as a by-product) greenhouse gas emissions from burning oil, gas, and coal -> climate change imposing cost on whole society
- **Water pollution** by industries that adds poisons to the water, which harm plants, animals, and humans.
- **Industrial farm animal production** – farm that were maybe more efficient as regards the production costs/revenues but they contributed to the increase in the pool of antibiotic-resistant bacteria because of the overuse of antibiotics + air quality problems + the contamination of rivers, streams, and coastal waters with concentrated animal waste + animal welfare problems, mainly as a result of the extremely close quarters in which the animals are housed.
- **Fishing:** harvesting by one fishing company in the ocean depletes the stock of available fish for the other companies and overfishing may be the result. This is an example of a common property resource, sometimes referred to as the **Tragedy of the commons**.
- **Consumption of alcohol** in some cases leads to drinking and driving accidents which injure or kill pedestrians and other drivers.

In these situations the marginal social benefit of consumption is less than the marginal private benefit of consumption. This leads to the good or service being over-consumed relative to the social optimum -> **Market failure.** Without any corrective measure, the good or service will be under-priced and the negative externalities will not be taken into account (recall interventionist vs. non-interventionist solutions).

**Market failure**

In economics, a market failure occurs when there is an inefficient allocation of goods and services in a market. That is, there exists another outcome where market participants' overall gains from the new outcome outweigh their losses (even if some participants lose under the new arrangement). Market failures can be viewed as scenarios where individuals' pursuit of pure self-interest leads to results that are not efficient – that can be improved upon from the societal point-of-view.

**Pareto Efficiency**

**Pareto efficiency**, or **Pareto optimality**, is a concept in economics with applications in all areas of the discipline as well as engineering and other social sciences. The term is named after Vilfredo Pareto, an Italian economist who used the concept in his studies of economic efficiency and income distribution. Informally, Pareto efficient situations are those in which it is **impossible to make one person better off without necessarily making someone else worse off**.

Given a set of alternative allocations of goods or outcomes for a set of individuals, a change from one allocation to another that can make at least one individual better off without making any other individual worse off is called a "**Pareto improvement**". An allocation is defined as "Pareto efficient" or "Pareto optimal" when no further Pareto improvements can be made.

**Allocative efficiency** also referred to as **Pareto Efficient Allocation**

a) **on consumption side:** resources cannot be re-allocated to make one consumer better off (in terms of utility) without making another worse off; or
b) **on production side:** allocation of production inputs (capital and labor) is Pareto-efficient if it is not possible to re-allocate these inputs and produce more of at least one good in the economy without decreasing the amount of some other good that is produced

**A simple illustrative example:**

Imagine that Robinson Crusoe has invented a machine that can make two mangoes out of one coconut. Conversely, the machine can make one coconut out of two mangoes. Assume that Crusoe's utility is U(c,m)=c*m (and thus marginal utilities are $U'_m$=c and $U_c$=m. Suppose Crusoe has, initially, four mangoes and four coconuts. Is that Pareto-optimal allocation? If not, what would Crusoe has to do to get a P-O allocation?

| | he'll end up with | Robinson's final utility (c*m) |
|---|---|---|
| doing nothing | 4 coconuts + 4 mangoes | 16 |
| converting 1 coconut into 2 mangoes | 3 coconuts + 6 mangoes | 18 |
| converting 2 coconuts into 4 mangoes | 2 coconuts + 8 mangoes | 16 |
| converting 2 mangoes into 1 coconut | 5 coconuts + 2 mangoes | 10 |
| converting 4 mangoes into 2 coconuts | 6 coconuts + 0 mangoes | 0 |

It is easy to see in which case his utility function will be the highest… Robinson would obviously end up with 3 coconuts and 6 mangoes in the P-E allocation.

Note that more formally, you can solve the problem using the concepts of Marginal rate of transformation… those interested can find the solution in Schotter's textbook, Chapter 15, Solved Problem 15.1 (p. 581 in the 3rd edition)

But, this is just a simplest case, with just one individual, Robinson Crusoe. What if we take into account also his "Man Friday", whose utility over coconuts and mangoes might be different? Or even a larger economy with number of consumers and producers…. with potential externalities…

⟶ **Social efficiency** – total social (also external) costs are accounted for

**Causes of market failures:**

i) **externalities**
ii) **public goods or common goods ("the tragedy of the common")**
iii) market power (imperfect/no competition)

i) and ii) are interesting from the point of view of environmental economics (more details to follow), iii) is not so important for us now…

**Public good**

**(From Wikipedia, the free encyclopedia)**

In economics, a public good is a good that is **non-rivalrous** and **non-excludable**. This means, respectively, that consumption of the good by one individual **does not reduce availability of the good for consumption by others**; and that **no one can be effectively excluded from using the good**. In the real world, there may be no such thing as an absolutely non-rivaled and non-excludable good; but

economists think that some goods approximate the concept closely enough for the analysis to be economically useful.

Non-rivalness and non-excludability may cause problems for the production of such goods. Specifically, some economists have argued that they may lead to instances of **market failure**, where uncoordinated markets driven by parties working in their own self interest are **unable to provide these goods in desired quantities**. These issues are known as public goods problems, and there is a good deal of debate and literature on how to measure their significance to an economy, and to identify the best remedies. These debates can become important to political arguments about the role of markets in the economy. More technically, public goods problems are related to the broader issue of externalities.

**Examples of public goods** (can you think of any?):

a) light houses (cannot exclude shops from using it)
b) defense and **law enforcement**
c) fireworks
d) streetlights
e) roads
f) informational goods (software development, authorship, invention)
**g) environmental goods (clean air, clean water….environmental protection in general)**

Some goods are **"mixed"** in a sense that they have the properties of both, private and public goods
a) excludable but non-rival (like cable TV)
b) non-excludable but rival (like public park… with too many visitors it becomes less enjoyable)

**Free rider problem**

Public goods provide a very important example of market failure, in which market-like behavior of individual gain-seeking does not produce efficient results. The production of public goods results in positive externalities which are not remunerated. If private organizations don't reap all the benefits of a public good which they have produced, their incentives to produce it voluntarily might be insufficient. Consumers can take advantage of public goods without contributing sufficiently to their creation. This is called the free rider problem, or occasionally, the "easy rider problem" (when consumer's contributions are small but non-zero).

The free rider problem depends on a conception of the human being as homo economicus: purely rational and also purely selfish—extremely individualistic, considering only those benefits and costs that directly affect him or her. Public goods give such a person an incentive to be a free rider.

For **example,** consider national defense, a standard example of a pure public good. Suppose homo economicus thinks about exerting some extra effort to defend the nation. The benefits to the individual of this effort would be very low, since the benefits would be distributed among all of the millions of other people in the country. There is also a very high possibility that he or she could get injured or killed during the course of his or her military service.

On the other hand, the free rider knows that he or she cannot be excluded from the benefits of national defense, regardless of whether he or she contributes to it. There is also no way that these benefits can be split up and distributed as individual parcels to people. The free rider would not voluntarily exert any extra effort, unless there is some inherent pleasure or material reward for doing so (for example, money paid by the government, as with an all-volunteer army or mercenaries).

To establish a national defense system, the government needs to determine how much money to spend on it – small vs. huge military complex? Need to know the cost plus the maximum willingness of each member of the society to pay these costs -> how to find out? Well, the government could try to ask…

Suppose you know that everyone is reporting their true willingness to pay. You also know that there are so many people in the society that your response, however small, will not affect the level of national defense. In that case, you have no incentive to report truthfully -> your "economically rational" response would be to say that you are not willing to pay for national defense. But if everyone would do so…..

**Questions for an economist? (Schotter, Chapter 18)**

i) what is the optimal amount of public good to produce , and what conditions must be satisfied at such optimum?
ii) How can economy achieve that optimum?
iii) Will free markets be able to achieve that optimum, or must the government help the economy to coordinate its activities?

**Solutions:**

a) **Lindahl "free market solution"** – relies on everyone's truthfully revealing their preferences for public good; then the government serves as a "coordinator" (no intervention) – sets everyone's' share on the total cost if the good is provided →people will face prices and the market will take care of the rest: people will maximize their utility and state their demand for the public (as well as private) good. In the equilibrium, prices of private goods and shares on cost of public good are set such that no one wishes to change his/her demand for private and for public goods + supply of private good equals the demand + everyone consumes the same amount of public good (due to non-excludability).
   **Problem:** incentives not to be truthful in revealing one's preferences.
   **Proposed solution:**
      i) a **demand-revealing mechanism** (imagine a dark street and three equally costly plans to install streetlights (one very bright streetlight or combinations of less bright streetlights) – then ask inhabitants, how much they are willing to pay for each of the proposed plans and implement the one that maximizes the total willingness to pay) → still there is no guarantee that collected contributions will cover the total cost of implementing the streetlight plan.
      ii) an **auction election mechanism:** people submit their bids (bidding the money one is willing to pay and the quantity demanded); then if public good is produced, everyone pays the difference between the cost and sum of the bids made by other people. Everyone has a right to refuse his or her cost share If all people agree to pay their costs share the demanded quantity is produced. If no agreement is reached, public good is not produced – the experimental evidence suggests that truth-telling does not seem to be the general rule (Smith, 1977)
b) **Coase argument**: with no transaction cost and unilateral property rights, most conflicts could be resolved by private bargaining (more on that later)

c) **Government provision** (then financed by tax revenues) - it might be difficult to ensure the government has an incentive to provide the optimum amount even if it were possible for the government to determine precisely what amount would be optimum
d) A government may **subsidize** production of a public good in the private sector; unlike government provision, subsidies may result in some form of a competitive market. Principal-agent problems can arise between the citizens and the government or between the government and the subsidized producers.
e) an **exclusion mechanism (club goods)** is another solution, which has evolved for information goods, is to introduce exclusion mechanisms which turn public goods into club goods. One well-known example is copyright and patent laws. These laws, which in the 20th century came to be called intellectual property laws, attempt to remove the natural non-excludability by prohibiting reproduction of the good. Although they can address the free rider problem, the downside of these laws is that they imply private monopoly power and thus are not Pareto-optimal.
f) support public mindedness by **tradition** and **social norms** (a non-market solution)

**Tragedy of the commons (Hardin + Wikipedia)**

**Tragedy of the commons**

**(From Wikipedia, the free encyclopedia)**

"The Tragedy of the Commons" was an influential article written by Garrett Hardin and first published in the journal Science in 1968. The article describes a dilemma in which **multiple individuals acting independently and solely** and rationally consulting their **own self-interest** will **ultimately destroy a shared limited resource** even when it is clear that it is not in anyone's long term interest for this to happen. More usually, the phrase does not refer to the article per se, but to the dilemma itself, typically in application to some circumstance to which it is thought to apply. Many, perhaps most, who use it are not aware of, nor have read, Hardin's essay, but are looking at conceptually parallel situations.

Central to Hardin's article is an example, a hypothetical and simplified situation from medieval land tenure in Europe, of herders sharing a common parcel of land (the commons), on which they are each entitled to let their cows graze. In Hardin's example, it is in each herder's interest to put the next (and succeeding) cows he acquires onto the land, even if the carrying capacity of the commons is exceeded and it is damaged for all as a result. The herder receives all of the benefits from an additional cow, while the damage to the commons is shared by the entire group. If all herders make this individually rational economic decision, the commons will be destroyed to the detriment of all.

- the problem arises when property rights are not well defined
- private property then provides a mechanism to avoid externalities – he who owns, cares about the property and controls its use + can exclude others from overusing it (see the discussion in Hardin as well)
- private property is not the only available mechanism – regulations work as well (with legal system to enforce them)

**Examples** (can you think of any?):

a) over-herding cows (see Hardin)
b) overfishing (each fisherman has a negligible impact on the total fish stock… but too many fisherman might result in serious depletion)
c) automobile pollution – each automobile lower the air quality and it is not likely that the free market would result in the optimal amount of pollution → emission standards for automobiles → **Illustration:**
    - 1963 Clean Air Act and its amendments set automobile emission standards for the manufacturers of vehicles in the US and Lawrence White examined the costs and benefits of this program
    - cost of emission control equipment is estimated at $600 per car, extra maintenance cost at $180 per car, the cost of reduced gasoline mileage and the necessity of unleaded gasoline at about $670 per car → total coast at $1450 (in 1981 dollars)
    - White identifies following problems:
        - everyone who buys a car must pay extra $1450, whether they live in high pollution area or not
        - most of the responsibility falls on the manufacturer, only little on the user → car owners have little incentives to keep the pollution control equipment in working order unless they are inspected
        - no incentive to economize driving – people who drive 2000 miles in less polluted areas pay exactly the same amount of money as people who drive 500,000 miles in heavily polluted areas → it would make sense to encourage people to drive less (at least in heavily polluted areas)
    - Alternative solution that White offers: **effluent fees**
        - annual inspection of all vehicles estimating the car's likely emissions during the past year
        - different communities (areas) could levy different fees → people would face the true cost of generating pollution, which would encourage them to generate "socially optimal amount of pollution" (or, well, at least closer to it)
        - **Why should it work better?**
        - the system would encourage the owners to search for low-cost ways of reducing their emissions, including changing their driving habits and type of vehicle (more eco)

## Hoyt, Ryan, Houston, The Paper River: A Demonstration of Externalities and Coase's Theorem

A classroom simulation designed to examine a negative externality generated by a productive process that elicits a Coasian solution.

*"It is necessary to know whether the damaging business is liable or not for damage caused since without the establishment of this initial delimitation of rights there can be no market transactions to transfer and recombine them. But the ultimate result (which maximizes the value of production) is independent of the legal position if the pricing system is assumed to work without cost."*

*R. H. Coase*

**In-class experiment**

Students create and experience an externality first hand and then conceptualize a correction procedure that is consistent with Coase's Theorem.

[Give out pencils with eraser to all students]
"Clear your desks except for a pencil. Each person on the right side represents Firm A, and each person on the left side represents Firm B. No calculators of any kind and no scratch paper please."

[Give five pieces of paper and a record sheet to each Firm A student.]
[Explain (have assistant explain) to Firm B students how to build a paper plane (that can fly)]

"Here are 10 multiplication problems (production tasks) for Firm A students:

You will get **one bonus** point for each problem solved correctly. The Firm A student with the most correct answers will earn [REWARD]. You may only use the pieces of papers that were distributed and the pencil. This round of production is over **when the first Firm A student has finished all problems.**"

[Check solutions for multiplication problems (production tasks)]
[Have Firm A students record their performance on the record sheet. Then have them give their five pieces of paper and record sheet to a Firm B student.]

"You will receive **two bonus** points for each paper airplane you can produce in **two minutes** using the paper that was just given to you from Firm A. If you wish to use your own airplane design, you will get paid as long as it is the required size, can fly, and has **no writing** on it. You are allowed to completely erase pencil marks, but you are not allowed to tear off portions of the paper to remove pencil marks. The Firm B student with the most correct answers will earn [REWARD] "

[Announce end of production period.]
[Check which airplanes are acceptable.]

"Record your earnings based on the number of acceptable airplanes that you have produced."

"**How much of a cost was imposed on you in terms of the number of bonus points you were prevented from earning?**"

[Discuss externality problems in the present context.]

1. two firms located along a river in which one firm (A) pollutes the water used by another firm (B) downstream
2. river water is represented by small sheets of papers that are given to firm A students (upstream firm) who use them to generate answers to math problems
3. used paper is then passed on to firm B students (downstream firm) who must clean up the "pollution" before using the paper to produce paper airplanes

**What do you think?**
"What could be changed in order to make Firm A take into account not only its costs but also the costs it is imposing on Firm B?"

"How much did Firm A have to pay to use the paper?"

"How does the lack of a private cost to Firm A for using the paper influence its decision regarding paper utilization?"

"How could society insure that a firm takes into account not only its private costs but also the social costs of production?"

"Should Firm A pay? Should Firm B pay? How should it pay? Who should it pay?"

**What are the typical responses?**
" Students typically assign the property rights to Firm B by suggesting that Firm A pay Firm B one or two bonus points for each piece of paper that has been used in order to compensate them for the lost resource. Occasionally, students will grant the property rights to Firm A by suggesting that Firm B pay to get the blank pieces of paper from Firm A. However, it should be noted that to make a profit Firm B would have to pay a price lower than two bonus points per sheet. Regardless, Firm A will now have an incentive to use the paper more efficiently and as a result will conserve the resource."

Then the experiment could be repeated in round 2, with chosen payment scheme…

"Let's assume that Firm A must pay firm B one bonus point for each piece of paper used [=assigning property rights to firm B]"

"How many problems were you able to solve in the first round vs. the second round?"
"Did you change how you used your paper and did that affect your output?"

Coase's Theorem is illustrated at this point by explaining that regardless of which firm receives the property rights, the externality is internalized. For instance, the instructor can ask the class the following question,

**Question:** "Would the outcome of the last round have changed if Firm B had bought the pieces of paper from Firm A? "

Because Firm A knows it will be able to sell unused pieces of paper to Firm B; it will tend to conserve the resource just as it did when Firm A had to pay for using the resource.
One could use Coase's example of the farmer and rancher to further illustrate that regardless of which party is granted the property rights , the problem is corrected assuming transaction costs are sufficiently low (Coase 1960).

This is <u>one possible solution</u> to externality problem, relying on assumption of low transaction cost and unilaterally defined property rights (more on this later). Coase's theorem is an example of **NON-INTERVENTIONIST** solutions. Other examples from this category are voluntary programs such as

- self-regulation, or
- environmental labeling.

**INTERVENTIONIST SOLUTIONS:**

- (Pigovian) taxes (tax the producer of externality by the "damage" he/she causes)
- Standards and charges (charge per unit of pollution to induce "standard"=acceptable level of pollution)
- marketable pollution permits (a.k.a "cap and trade", unit of pollution can be only produced with permits, limit # of permits, let producers trade)

more on this within next few weeks…

**Use of Experimental Methods**
**(OPTIONAL READINGS)**

**(G&G)** Greenstone, M., Gayer, T., (2007), Quasi-Experimental and Experimental Approaches to Environmental Economics, RFF Discussion Paper 07-22.

**(L&L)** Levitt, S., D., List, J., A. (2009), Field experiments in economics: The past, the present, and the future, European Economic Review 53, 1-18

**Wikipedia:**

*In scientific inquiry, an **experiment** (Latin: ex- periri, "to try out") is a method of investigating particular types of research questions or solving specific problems. An experiment is a cornerstone in the empirical approach to acquiring deeper knowledge about the world and is used in both natural sciences as well as in social sciences. An experiment is defined, in science, as a method of investigating less known fields, solving practical problems and supporting or negating theoretical assumptions.*

**Brief History (L&L)**

1) **Natural science experiments:** Among the first experimenters

   - **Galileo Galilei** in the 17th century: The falling bodies experiment (dropping objects from the leaning tower of Pisa in order to prove that all objects fall at the same rate, whatever their mass to disprove Aristotle's assertion that heavier bodies fall faster than light ones.),
   - **Sir Isaac Newton** showed that the white light is a mixture of colored lights and shattered down another Aristotle's theory that the white light is equal to purity,
   - **Pasteur** rejected the theory of spontaneous generation with an experiment – he showed that microorganisms grow in boiled nutrient broth when exposed to the air, but not when exposed to the carefully filtered air.

2) **"The dawn of field experimentation" in 1920s - 1930s:** Experiments were used to help to answer important economic questions. None of those studies involved human subjects.

3) **Large-scale social experiments in mid 20th century** conducted by government agencies that involved individuals to evaluate employment programs, electricity pricing schemes, housing allowances … Experiments were used to test new programs later also reforms to existing programs – important influence on policy making.

   **Social Experiment:**

   *Ferber and Hirsch (1982,p.7) '' a publicly funded study that incorporates a rigorous statistical design and whose experimental aspects are applied over a period of time to one or more*

*segments of a human population, with the aim of evaluating the aggregate economic and social effects of the experimental treatments.''*

*Greenberg and Shroder (2004) define a social experiment as having at least the following four features: (i) random assignment, (ii) policy intervention, (iii) follow-up data collection, and (iv) evaluation.*

4) **Growing popularity and expansion to diverse areas of interest over the past decade** economists have increasingly used the field experiments and controlled small(er)-scale experiments to explore economic phenomena.

**Use of experimental methods in economics:**

- education and training, public finance, industrial organization, labor and public economics, consumer behavior, game theory, development economics, **environmental economics** (see more in L&L and G&G)

**Benefits of employing Experimental Methods**

- A new drug is tested to make sure that it has the expected effect and at the same time that it is not outweighed by possible side-effects – to minimize potential cost on public health
- The effect of planned policy change can be tested at relatively low cost (compared to allocation of much larger resources to an inefficient program; e.g. training program for the unemployed, new pricing scheme for electricity,…)
- Explaining or predicting non-experimental outcomes (e.g. Barr and Serneels 2004: correlation of wage outcomes of employees with their behavior in a trust game experiment) – again, relevant policy/strategy implications at relatively low cost
- Testing theoretical predictions at relatively low cost (economic theory)
- Help to generate the data which are difficult to be obtained from "the field"
- Estimation of a cost that the firm which produces pollution should internalize so that the (socially) more efficient outcome can be achieved **-> ENVIRONMENTAL ECONOMICS**

**Externalities -> correction? -> Environmental Economics -> (G&G)**

- air or water pollution as a byproduct of the production of marketable good
- imposes health costs on inhabitants and/or costs on the down-the-river company not internalized by the firm which is responsible for producing the pollution
- government intervention might help to maximize net (social) benefits/welfare – require reliable estimates of the costs and benefits => ENVIRONMENTAL ECONOMICS
- **EE** addresses the inefficiencies resulting from production externalities –> experimental and quasi-experimental methods
- hinge upon proper design, implementation, appropriate approach to the data analysis

## Possible Difficulties when employing Experimental Methods

**L&L:**

*"The aim of the researcher is to estimate a causal effect of some action (a new government program, change in price,…), i.e. how outcomes differ when the action is taken vs. when it is not."*

*"The fundamental difficulty that arises is that either the action is taken or it is not—we never directly observe what would have happened in an alternative universe where a different action is taken. Thus, the construction of a control group becomes critical. Although we cannot observe what your outcome would have been had you not been treated, we can, for instance, observe outcomes for other similar individuals who were not treated."*

**G&G:**
Causal Hypothesis

Illustrative Examples:
1) observational study analyzing the use of estrogen replacement therapy (ERT) to maintain the menopausal symptoms and their potential dangers such as higher incidence of heart disease
2) testing impact of a new regulation which restricts pollution that can be produced by a company; what is the impact on health

- want to test a treatment effect (like e.g. receiving drug vs. placebo, exposure to high vs. low pollution)
- outcome may or may not respond to the treatment(=drug/high pollution) effect (heart disease/ other health problems) - > every individual has two potential outcomes but only one can be in fact observed
- to isolate the effect of treatment – all other factors need to be held constant (ideally, we would want to observe the outcome for the same individual in both treatments – with and without drug/ exposed to high and to low pollution – not possible -> **Fundamental problem of Causal Inference)**

➔ can observe the health outcome for treated individuals (with drug/high pollution = TREATMENT GROUP) and for not-treated (no drug/low pollution = CONTROL GROUP) -> average difference in health outcome treated vs. untreated

➔ PROBLEM -> **SELECTION BIAS**: our individuals might have some "special characteristics" that affect both, selection to treatment AND the outcome of the treatment (women with healthier lifestyles/ people with lower income living in more polluted areas) -> the effect of special characteristics can be, in some situations validly assumed zero, in other situations it can be controlled for -> the researchers need to be aware of it to be able to make valid inferences!

The problem arises when the selection for the treatment is not up to the researcher – individuals are exposed (to treatment) by nature, politics, accident … -> NON-RANDOM ASSIGNMENT => possible source of SELECTION BIAS

➔ Still can make VALID inferences under the assumption that the assignment to the treatment is not related to any determinant of the outcome
  - **Neg. Exmample 1:** Observational studies of estrogen replacement therapy (ERT) concluded no direct causality between ERT and heart disease. **Problem:** Maybe women with healthier life style were more likely to participate, take ERT and therefore per se less likely to have heart problems (reasons to believe that -> self-selection -> special

characteristics that might affect the results of an observational study) **Solution:** A randomized study -> Concluded that ERT substantially contributes to heart disease

- **Neg. Example 2:** similarly, in the pollution example if the housing prices are significantly lower in the affect area and therefore it is colonized by poorer people with less healthy lifestyles, less resources to spend on healthcare

- **Pos. Example:** If e.g. the government decides to enroll the unemployed in a special training program and selects randomly (or by some other rule, completely unrelated to their profession, abilities, education… anything that might affect their probability of success on the job market after the training) a half of the currently unemployed to receive the training (only a half for e.g. budgetary reasons, randomly to avoid e.g. accusations of discrimination) – their success after the training (if received) is not correlated with their selection for the group even though the assignment to treatment is not in the control of the researcher who will analyze the data

Other problems and biases:
**MEASUREMENT ERRORS:**

- more sensitive people (health wise) might have migrated from the more polluted area – the time of their exposure is shorter than of individuals that stayed

- difficult to measure exact "exposure to pollution" (if interested in long term effects) over time (it might have varied)

- exposure to pollution might also vary location-vise (some people live closer to the source than other)

In Controlled Experimends (Field and Lab) the researcher typically uses **RANDOMIZATION** to avoid the problem of **SELECTION BIAS** -> **Randomized experiments**

➔ A classical experiment where subjects are randomly selected for treatment -> on average, individuals in treatment and in control group have (statistically) the same characteristics except of exposure to the treatments -> it is no longer the women themselves that decide whether to take the ERT or not, now it becomes to be under the control of the experimenter (like in the medical trials they accept the patients but part of them, randomly selected, receives the real drug, the rest receives placebo -> the **selection bias** disappears and the comparison of the outcomes in the two groups gives a credible estimate of the average effect of the treatment.

The use of randomized experiments in economics is growing rapidly.

**Other possible problems:**

**RANDOMIZATION BIAS** (L&L)

- some individuals might be reluctant to subject themselves to a random assignment =>

experimental sample might differ from the population of interest because of randomization. For example, in medical trials, it is typically more difficult to persuade patients to participate in randomized than non-randomized studies; in social experiments difficult (this could be a problem in both large and small-scale field experiments)

- participants in small-scale experiments might not be representative of individuals that would participate in a large-scale study; Heckman (1992), Heckman and Smith (1995), Manski (1995) (lab experiments, not natural field exp, when subjects are not aware of their participation)

**SUBSTITUTION BIAS** (L&L)

- subjects in the control group might seek available substitutes for treatment (large-scale experiments, NOT lab or framed experiments)

**ATTRITION BIAS** (L&L)

- within-subject design => some social experiments can be going on for several years during which subjects are surveyed – subjects might become tired of keeping detailed records, some might move,... (large-scale social experiments, not lab or framed experiments which are typically short-term)

**GENERALIZATION OF THE RESULTS** (L&L)

- even with proper estimation of the treatment effect, the generalizations of the results to other domains might prove difficult (lab experiment, framed experiments, NOT natural field experiments)
    - lab experiments: student subjects, relatively small-scale
    - subjects are aware that they are monitored and recorded
    - psychological effect of being in the experiment, expecting the experimenter to expect specific result (see e.g. List 2006, or Benz and Meter 2008 for the difference in behavior when subjects are and are not aware they are participating in an experiment)

**PUBLICATION BIAS** (G&G)

- researchers more likely to submit, and journals are more likely to accept, for publication the studies that confirm the "expected results" (e.g. pollution is detrimental to health) – solution in leading medical journals, the researchers have to register their clinical trials, their study before knowing the results

**REGULATORY BIAS** (G&G)

- regulators put more weight on results that find a negative impact on health (to protect the public they require stronger evidence to support the " no risk to health" than the "risk to health" results -> overestimated risk than reduces the chances to achieve the most efficient outcomes (risk-aversion is reflected in the willingness to pay and thereby effect the policy benefit calculations -> over-regulation -> E.g. pollutant A may be more risky than pollutant B, but if studies over-estimate the riskiness of B at the end the policy maker might not choose the most efficient allocation of resources to reduce the pollution.

→ need to be very careful and employ proper techniques for data analysis, taking into consideration all possible biases and errors resulting from the nature of the experiment, concerned individuals and their selection for the experiment, their unobservable characteristics that might affect their "outcome." Econometrics has means to deal with such problems.

**Cherry, Kroll, Shogren - Environmental Economics, Experimental Methods** argue nicely why use of experimental methods in environmental economics might be so usefull…

*"Environmental economists quickly adopted the methods of the newly emerging area of experimental economics in the 1970s and 1980s; in fact, "some of the earliest work in experimental economics was done by environmental economists." (Kling; see also Plott article assigned as required reading for lectures 1 – 3 and articles by Hoffman & Spitzer and Harrison &*
*McKee lecture 5)*

*Today, the experimental method is commonly applied to environmental economic questions, as evidenced by the research in this book and in the general economics literature." (p.1)*

*"A reader might be asking him- or herself whether such small scale experiments are the appropriate tool to test large-scale environmental policy. … Do the attempts to use the experimental method to understand better the micromotives that underpin the theory of environmental economics have anything to say about the efficiency and fairness of global environmental policy?*
*…*
*Yes, it does, would be our answer.*
*…*
*By supplying information on the behavioral link between incentives, values, and choice, experiments might affect how policy is formed and evaluated. … Experimental evidence complements theoretical insight, field data, and simulation models to improve our understanding of the underlying assumptions and incentives that drive behavioral responses to policy." (pp. 1 - 2)*

*Experiments – "a useful tool to stress-test theory, look for empirical patterns of behavior, and testbed new institutions designed to protect nature. … laboratory experiments are used as a testbed for institutional design, markets, and mechanisms designed to improve resource allocation*

*John C. Whitehead … states that despite their flaws due to the lack of context, economic experiments have done a reasonable job in* ***getting contingent valuation*** *economists 'out of their orbit around a far off hypothetical planet.' He sees laboratory experiments and stated preference surveys as complementary approaches, where one's strength can help to cover the other one's weaknesses." (p. 4)*

*" … the perpetual scientific tension between control and context. At the core, the experimental method is about control. One controls the experimental circumstances to avoid confounding; i.e. two or more elements change, which confounds our understanding of cause-and-effect. Without control, it is unclear whether unpredicted behavior is due to a poor theory or experimental design, or both. In contrast, others argue context is desirable to avoid a setting that is too sterile and too removed from reality … . All experiments face this challenge. Therein lies the beauty of the experimental method as applied to human beings rather than terrestrial plants or subatomic partials – one can use one's imagination to experiment with alternative degrees of control versus context." (pp. 4 – 5)"*

Another issue here also addressed by experimental methods (important e.g. for Pigouvian taxes, one of the interventionist solutions) is how to assign value to a non-market good? i.e.

- what is the value of dirty water/air (for the down the river company)?
- what is the value of clean and healthy environment to citizens?

### From Wikipedia, the free encyclopedia

**Contingent valuation** is a survey-based economic technique for the valuation of non-market resources, such as environmental preservation or the impact of contamination. While these resources do give people utility, certain aspects of them do not have a market price as they are not directly sold--for example, people receive benefit from a beautiful view of a mountain, but it would be tough to value using price-

based models. Contingent valuation surveys are one technique which is used to measure these aspects. Contingent valuation is often referred to as a stated preference model, in contrast to a price-based *revealed preference* model. Both models are utility-based. Typically the survey asks how much money people would be willing to pay (or willing to accept) to maintain the existence of (or be compensated for the loss of) an environmental feature, such as biodiversity.

Many economists question the use of stated preference to determine willingness to pay for a good, preferring to rely on people's revealed preferences in **binding market transactions**. Early contingent valuation surveys were often open-ended questions of the form "how much compensation would you demand for the destruction of X area" or "how much would you pay to preserve X". Such surveys potentially suffer from a number of shortcomings; strategic behavior, protest answers, response bias and respondents ignoring income constraints.

**Horowitz, McConnell, Murphy, Behavioral Foundations of Environmental Economics and Valuation**

"For at least 60 years, economists have worked on empirical approaches to measuring the value of non-market goods and services. In its beginnings, this research employed models of **revealed preferences**, such as the travel cost approach for recreation…"

Economists working on empirical approaches to measuring the value of nonmarket goods and services often **cannot rely on revealed preferences** (e.g., one could not have conducted a revealed preference study of the value of reducing pollution in Lake Erie in the 1970s because the lake was so polluted that there was little use, and no alternative, comparable, cleaner lake to observe. In this case, there is no revealed preference data on which to base valuation, and hence no ability to estimate the value of pollution reduction." (p.1)

"The failure of revealed preference methods for valuation tasks was the first impetus for developing **state preference methods**. Pure public goods with substantial existence values such as visibility, regional air quality or pristine environments could not be valued with revealed preference approaches but were important for environmental policy.

"**Stated preference studies now make up a large proportion of valuation research.**
…
[here] we are concerned with **two problems** that have arisen as economists have applied stated preference approaches to valuation. In particular, we review **two issues** – **differences between values derived from real and hypothetical surveys** and **the gap between willingness to pay and willingness to accept** – that are crucial to the acceptance and advancement of stated preference techniques. Both of these have been identified as problems for the use of **contingent valuation** in damage assessment."