Lecture 2 (AO)

Environmental Policy in the Central European Context

Time: Thursdays 3 p.m. – 6 p.m.
Location: at CERGE-EI, Room # 7

Professors: Andreas Ortmann & Jana Krajcova
E-mails: andreas.ortmann@cerge-ei.cz, aortmann@yahoo.com and jana.krajcova@cerge-ei.cz
See also: home.cerge-ei.cz/ortmann and home.cerge-ei.cz/richmanova

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

WEEK: TOPICS: DATE: INSTRUCTOR
1 Introduction (history/outline) Feb 19 JK/AO
2 Market failures: externalities, tragedy of the commons, enforcement as public good, also, (rise and fall) of the environmental Kuznets Curve February 26 AO
3 Interventionalist solutions to the Externality problem – Pigouvian taxes and standards and charges, also environmental labeling and incomplete consumer information in laboratory markets March 5 JK
4 Interventionalist solutions to the Externality problem – Marketable pollution permits March 12 AO
5 Non-Interventionalist solutions to the Externality problem – The Coasian solution March 19 JK
6 Non-interventionalist solutions to the Externality problem – Self-regulation March 26 AO
7 *Mid-term exam April 2*
8 Environmental Policy in the Czech Republic – History and current issues April 9 JK
9 Environmental Policy in the EU – History and current problems April 23 (April 16 falls into Semester break and on Easter Holiday) AO
10 Environmental Policy in the world context – History and Current problems April 30 JK/AO
11 Contingent valuation and related issues May 7 AO
12 To be determined by the interests of the class

Final exam: to be determined (according to schedule May 18 – 21)

REQUIRED READINGS (this list will be revised as we go):

See website: http://home.cerge-ei.cz/ortmann/UpcesCourse/Upcescourse.html

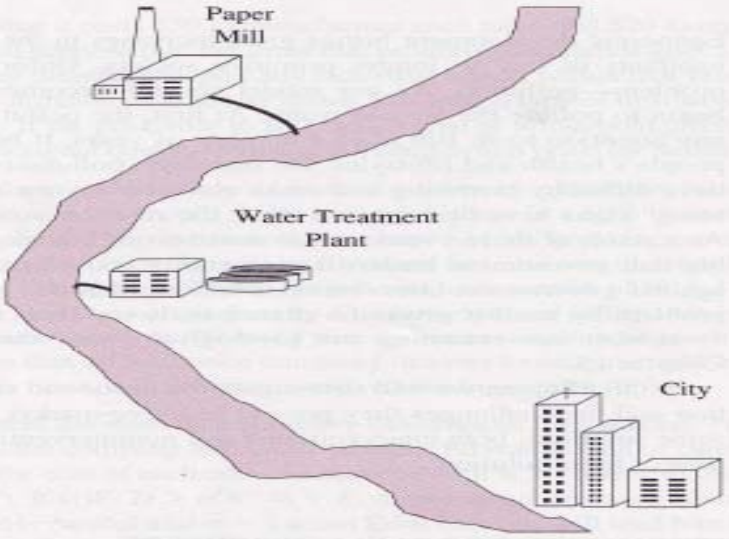
Textbook excerpt (Schotter, Microeconomics. A Modern Approach (Second Edition))

CHAPTER 17

EXTERNALITIES: THE FREE MARKET–INTERVENTIONIST BATTLE CONTINUES

FIGURE 17.1 Dolan's water-paper society.

The paper mill imposes an external cost on the water treatment plant by dumping its wastes into the river. These wastes increase the treatment plant's cost of cleaning the water.



[1]Edward Dolan, *TANSTAAFL: Economic Strategy for the Environmental Crisis* (New York: Holt, Rinehart & Winston, 1969), pp. 24–27. *TANSTAAFL* stands for "there ain't no such thing as a free lunch."

Paper mill produces

- paper at private cost
- waste at a cost to be borne by society (here represented by a water treatment plant that provides drinkable water to the city), i.e. a cost external to the paper mill

Water treatment plant produces

- clean water

Typical scenario for situations involving “common goods” such as water, air, other environs

An externality arises anytime when someone’s economic (or other) activity imposes a cost on someone else.

In terms of the Dolan’s water – paper society,

Given the externality created by the paper mill’s wastes, can we expect our model society to produce Pareto-optimal amounts of clean water and paper? (Recall that a Pareto-optimal outcome requires that there be no other amounts of clean water and paper that, if produced, would make someone in the society better off without making anyone worse off.)

Intuitively, we might expect the answer to be no.

The paper mill is imposing an additional cost on the water treatment plant, but there is no mechanism to make the mill accountable for this cost, so it seems unlikely that the outcome for society will be Pareto-optimal. Indeed it is not …

Three conditions must be fulfilled for a perfectly competitive economy to be to produce Pareto-optimal outcomes:

- the marginal rate of substitution (the ratio of the MU (paper) to the MU (water), which in equilibrium has to be equal to the price ratio of the price of paper and the price of water) between of paper for water has to be the same for all consumers.
- the marginal rates of technical substitution of paper mill and water treatment plant ought to be the same (this is about production inputs and we can ignore it for now)
- the marginal rate of substitution of water for paper must be equal to the marginal rate of transformation of water for paper, which in equilibrium is supposed to be equal to the ratio of the marginal cost of producing paper to the marginal cost of producing clean water

But … the (private) marginal costs of paper and water are not what their (social) marginal costs, and the marginal utilities are … PROBLEM

There are essentially three “corrective policies “

- Pigou taxes
- Standards
- Tradable permits

Here they are (well, one of them), in Figures from Plott’s article:

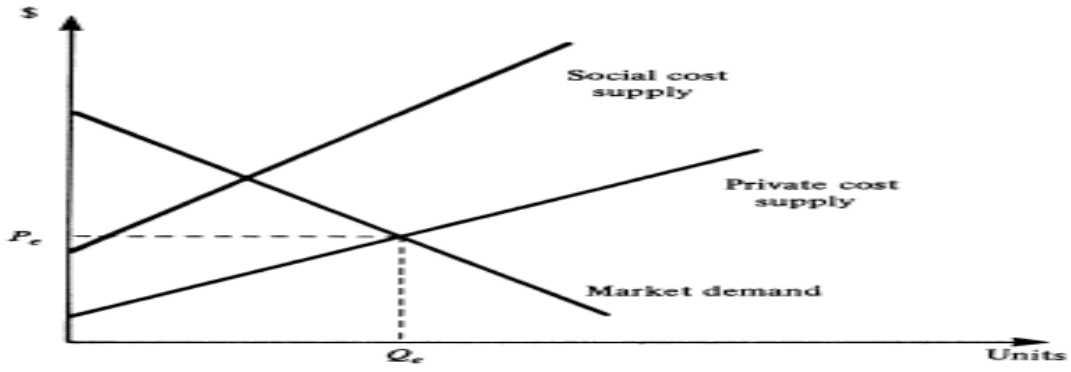


Fig. 1

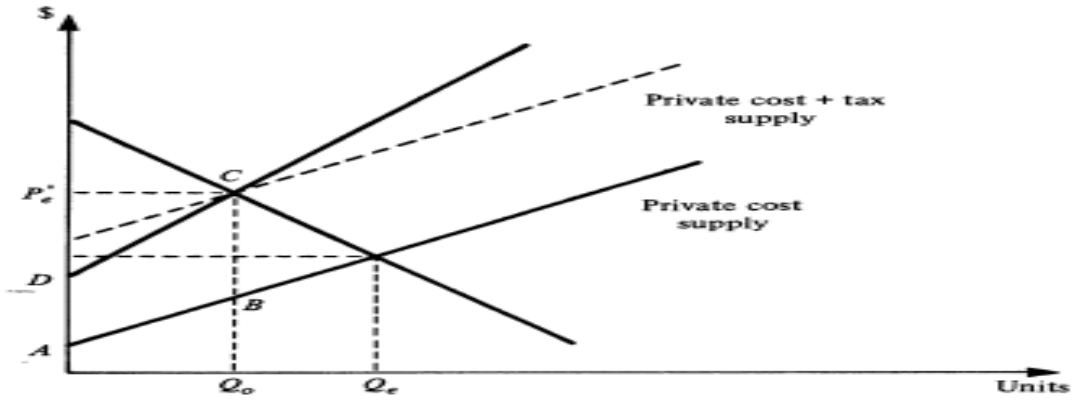


Fig. 2

Note the informational requirements – taxes may not be that practical !

The paper river: A demonstration of externalities

- *What could be changed in order to make Firm A take into account no 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?*

Optional readings:

Cherry, Kroll, Shogren, Environmental Economics, Experimental Methods

Introduction

- Environmental economists quickly adopted the methods of the newly emerging area of experimental economics in the 1970s and 1980s (out of pragmatism?) < >
- "Today, we have come full circle, and 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. For example, Cason & Plott (1996) examined in a laboratory experiment the incentives for sellers in new emission trading mechanisms proposed by the US Environmental Protection Agency." (p. 2)
- 63 researchers … < >
- "The one common thread through all four discussion chapters is the call for more *context*. Experimental economists traditionally use 'context-free' settings and instructions in their experiments to make the experiment as general and applicable as possible, and 'it is an accepted practice in economics experiments to strip away a lot of social context that is not an essential part of the theories being tested.' (Holt 2006, p. 13)" (p. 3)
- "What other themes do the non-experimentalists address? … < > 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.' < >." (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)

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

- economists working on empirical approaches to measuring the value of non-market 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 1970;s 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 stated preference methods. The emergence of the notion of non-use values provided a second and perhaps more compelling motive for developing stated preference approaches. … for example the existence of a fragile ecosystem is part of the real income of many individuals but does not contribute to the area under the demand curve for the resource. This came to be called existence value later. Pure public goods [common 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. There is no better example than the damages from the Exxon Valdez oil spill." (p. 2)
- "Stated preference studies now make up a large proportion of valuation research. This is not simply for the original reasons – the inability to observe some actions an the need to measure existence values – but the growing recognition that econometric problems compromise many preference studies. … [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. [see lecture 11] The NOAA Blue Ribbon Panel identified both of these issues as problems for the use of contingent valuation in damage assessment." (pp. 2 – 3)

Use of Experimental Methods

(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

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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

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- Testing theoretical predictions at relatively low cost (economic theory)
- Help to generate the data which are difficult to be obtained from "the field" (e.g. firms' or
- Estimation of a cost that the firm which produces pollution should internalize so that the (socially) more efficient outcome can be achieved
  -> ENVIRONMENTAL ECONOMICS

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Sources of the data (or, types of experimental approaches) (L&L, Harrison and List 2004)

- Naturally occurring data (identification assumptions) – selection into treatment is not up to researcher (e.g. ex-post examination of ERT, pollution regulation)
- Controlled data - selection into treatment is up to researcher (e.g. drug vs. placebo)
    - Field experiments -
        - Artefactual - departure from laboratory experiments; use "non-standard" subjects, or experimental participants from the market of interest, subjects understand that they are participating in an experiment
        - Framed - same as an artefactual field experiment but with field context
        - Natural - same as a framed field experiment but in the natural environment (where the subjects naturally undertake such tasks); the subjects do not know that they are participants in an experiment
    - Lab experiments (in laboratory setting, often using student subjects, randomization to identify the treatment effect)

A. Natural experiments = Quasi-experimental approaches (G&G)

SELECTION BIAS:

The researcher also compares the outcomes between the treatment and the control group. The difference is that 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

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MEASUREMENT ERRORS:

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B. Controlled Experimends (Field and Lab)

Use **RANDOMIZATION** to avoid the problem of **SELECTION BIAS** -> **Randomized experiments**

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The use of randomized experiments in economics is growing rapidly.

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.

Numerous contingent valuation and experimental studies have reported discrepancies between WTP and WTA measures of value. (These measures are obviously connected to property rights about which more in a couple of weeks – Lecture 5 March 19 (JK) on Coasian solution to the externality problem.)

Surveying forty-five such studies, John H. Horowitz and Kenneth E. McDonnell (JEEM 2002) find that the median ratio of average WTA an WTP is 2.6 (mean 7.17).

This evidence of, seemingly, a systematic asymmetry between individuals attitudes to gain and losses relative to some reference point, has until recently been widely accepted.

Relevant references:

Knetsch (AER 1989), The Endowment Effect and Evidence of Nonreversible Indifference Curves.

Kahneman, Knetsch, Thaler (JPE 1990), Experimental Tests of the Endowment Effect and the Coase Theorem.

Plott, Zeiler (AER 2005), The Willingness to Pay-Willingness to Accept Gap, the „Endowment Effect“, Subject Misconceptions, and Experimental Procedures for Eliciting Valuations

Plott, Zeiler (AER 2007), Exchange Asymmetries Incorrectly Interpreted as Evidence of Endowment Effect Theory and Prospect Theory?

Isoni, Loomes, Sugden (2009), The Willingness to Pay-Willingness to Accept Gap, the „Endowment Effect“, Subject Misconceptions, and Experimental Procedures for Eliciting Valuations: Replication and Reassessment.

List (Econometrica 2004), Neoclassical Theory Versus Prospect Theory: Evidence from the Marketplace

List, Neoclassical Theory Versus Prospect Theory: Evidence from the Marketplace (Econometrica 72.2, 615 - 625)

What’s the behavioral pattern called endowment effect?

And why are endowment effect and prospect theory synonyms? (See fn 2)

What would be a typical study showing the endowment effect? (Knetsch 1989)

- Most CU students keep what they were given (mugs, chocolate, etc.)

What's the experimental design?

- How many treatments are there exactly? (12)
- What were the two goods „traded" in each of these treatments?
  (coffee mugs, chocolate bars; in pre-sample seemed of about equal interest to similar subject pool.)

- Where, and how exactly, were the first four treatments run? (p. 617)
  (floor of a sportscard show in a large Southern city, monitor approached individuals asking to fill out questionnaire, then offered a „gift" [note – List used a form of „asset legitimacy", treatment, exit interview.)

- Where, and how exactly, were the second four treatments run? (p. 618)
  (same as before but ... with different subjects.)

Theoretical predictions? (p. 619)

- the proportion of subjects who trade mug for choco should be equal to
  1 – proportion of subjects who trade choco for mugs (Neoclassical)

- Subjects in both and neither treatments will opt for mug (choco) more often than subjects that initially endowed with choco (mug)

Results

- See Table I
- See Table II

[Do the results reflect less market experience but the specific experience that sellers bring in? Do the results simply illustrate that a particular kind of person selects in seller roles?]

TABLE 1

SELECTED CHARACTERISTICS OF PARTICIPANTS

	Dealers Mean (Std. Dev.)	Nondealers Mean (Std. Dev.)	Nondealers Mean (Std. Dev.)
Trading intensity	11.81	4.94	6.88
	(10.9)	(6.58)	(6.39)
Yrs. of market experience	9.88	7.15	7.21
	(9.79)	(9.83)	(8.03)
Income	4.15	4.10	4.18
	(1.75)	(1.69)	(1.81)
Age	36.55	34.54	37.04
	(13.1)	(14.41)	(14.1)
Gender (% male)	.94	.85	.82
	(.24)	(.35)	(.39)
Education	3.54	3.44	3.54
	(1.40)	(1.33)	(1.54)
Sample Sizes:			
Private			
Treatment E_{candybar}	30	31	—
Treatment E_{both}	32	30	—
Treatment E_{neither}	35	33	—
Treatment E_{mug}	32	30	—
Public			
Treatment E_{candybar}	—	—	33
Treatment E_{both}	—	—	28
Treatment E_{neither}	—	—	29
Treatment E_{mug}	—	—	35

Notes: 1. Trading intensity represents the number of trades made in a typical month. 2. Yrs. of market experience denotes years that the subject has been active in the market. 3. Income denotes categorical variable (1–8): (1) Less than $10,000, (2) $10,000 to $19,999, (3) $20,000 to $29,999, (4) $30,000 to $39,999, (5) $40,000 to $49,999, (6) $50,000 to $74,999, (7) $75,000 to $99,999, (8) $100,000 or over. 4. Age denotes actual age in years. 5. Gender denotes categorical variable: 0 if female, 1 if male. 6. Education denotes categorical variable (1–6): (1) Eighth grade or less, (2) High School, (3) 2-Year College, (4) Other Post-High School, (5) 4-Year College, (6) Graduate School Education. 7. "Private" and "Public" sample sizes denote the number of subjects in Experiments 1A and 1B, respectively.

TABLE II

SUMMARY OF EXPERIMENTAL RAW DATA

	Number of Subjects Choosing Candy Bar	Number of Subjects Choosing Mug	Pearson χ^2
Panel A. Nondealers (Private)			
Treatment E_{candybar}	25 (81%)	6 (19%)	19.21 (3 df)
Treatment E_{both}	18 (60%)	12 (40%)	
Treatment E_{neither}	15 (45%)	18 (55%)	
Treatment E_{mug}	7 (23%)	23 (77%)	
Panel B. Nondealers (Public)			
Treatment E_{candybar}	29 (88%)	4 (12%)	34.79 (3 df)
Treatment E_{both}	16 (57%)	12 (43%)	
Treatment E_{neither}	17 (59%)	12 (41%)	
Treatment E_{mug}	6 (17%)	29 (83%)	
Panel C. Dealers (Private)			
Treatment E_{candybar}	14 (47%)	16 (53%)	.54 (3 df)
Treatment E_{both}	14 (44%)	18 (56%)	
Treatment E_{neither}	18 (51%)	17 (49%)	
Treatment E_{mug}	14 (44%)	18 (56%)	

	Preferred Exchange	p-Value for Fisher's Exact Test
Panel D. Trading Rates		
Pooled nondealers ($n = 129$)	.18 (.38)	$< .01$
Inexperienced consumers (< 6 trades monthly; $n = 74$)	.08 (.27)	$< .01$
Experienced consumers (≥ 6 trades monthly; $n = 55$)	.31 (.47)	$< .01$
Intense consumers (≥ 12 trades monthly; $n = 16$)	.56 (.51)	.64
Pooled dealers ($n = 62$)	.48 (.50)	.80

Notes: 1. The Pearson chi-square tests in Panels A–C are distributed with 3 degrees of freedom and each have a null hypothesis of Hicksian preferences. 2. Data in Panel D are pooled from Treatments E_{candybar} and E_{mug}. For nondealers, data from "public" and "private" are pooled. Standard deviations are in parentheses. 3. Experienced consumers are those consumers who trade 6 or more times per month (6 is roughly the mean level of monthly trades). Intense consumers trade 12 or more times per month (12 is roughly the mean plus one standard deviation). 4. Fisher's exact test in Panel D has a null hypothesis of no endowment effect.

On to public good provision (in the lab)

"Linear Public Goods Experiments: A Meta-Analysis"

Author: Jennifer Zelmer
Experimental Economics, 6: 299–310 (2003)

Introduction

- **1st Fact:** EconLit tracks over 600 journals, as well as a wide range of books and dissertations (AEA, 1999).

✓ **1st Problem:** single experiments or studies in the social sciences rarely provide definitive answers to a research question (Wolf, 1986).

- **2nd Fact:** the literature about how different ***factors*** affect individuals' willingness to contribute to public goods has accumulated many data and results (sometimes conflicting) for more than two decades.

✓ **2nd Problem:** survey articles and qualitative reviews do not provide ***estimates*** of the ***effect size*** of factors based on the totality of evidence.

...these problems can be approached with the meta-analysis... 3

Introduction

- Meta-Analysis

definition: "the statistical analysis of a large collection of results from individual studies for the purpose of integrating the findings into a single, generalizable finding" (Plath 1992, as cited in Zelmer p. 300);

main steps:

1. Identifies a ***sample*** (as complete as possible) of studies pertaining to the same issue;
2. Describes features and results in a ***consistent quantitative way***;
3. Applies statistical techniques to ***aggregate*** the findings across studies and objectively ***examine the relationship*** between study characteristics and outcomes;
4. Concludes with a systematic and detailed description of the method used to integrate study results, ***ensuring replicability*** of the findings.

consideration:

applications of meta-analysis in economics continue to be relatively rare (van de Bergh et al., 1997; Croson and Marks, EE 2000, for provision point public good experiments; see various references of Zelmer to latter paper). 4

Study objective

- "The objective of this meta analysis is to ***synthesize*** the results of existing experimental evidence on the impact of a variety of [...] ***factors*** on the **extent of cooperation observed** in standard linear public goods experiments using the voluntary contribution mechanism" (p. 301)

Theoretical framework

Voluntary contributions to public goods

- What are **public goods**?

Commodities for which use of the good by one agent does not preclude its use by others (Pigou, 1932). (***non-rival***)

- Under what conditions are individuals more likely to voluntarily contribute to the provision of public goods?
- The game-theoretical framework in which the primary sources face this problem is the *voluntary contribution mechanism* in linear public goods environment (VCM).

Theoretical framework

Voluntary contributions to public goods

- Subjects are divided into groups and play the same game for a finite number of periods.
- Endowment for <u>each</u> period: w_i.
- w_i has to be divided between:
  - x_i = contribution to private account (constant return to him/herself only)
  - g_i = contribution to public good (benefits to all group)
- at the end of each period subjects (usually) learn:
  - the aggregate contribution to the public good;
  - their earnings for the period.

Theoretical framework

Voluntary contributions to public goods

- Individual *i*'s utility function: $u_i=\alpha x_i+\beta g_i \longrightarrow$ *maximize*
- Budget constraint: $w_i = x_i + g_i$
- Public good identity: $G = \sum_i g_i$

→ *under these three constraints*

- Non-negativity constraint: $g_i \geq 0$
- α and β *(m.p.c. return)* are constants;
- Subjects in finitely repeated games (i.e. one shot games) have a dominant strategy to contribute nothing to the public good;

⇓

- ***Nash-equilibrium*** is full free riding;
- ***Pareto-efficient*** outcome is for all subjects to contribute their entire endowment to the public good

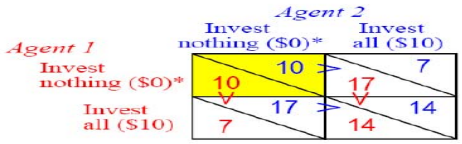
Theoretical framework

Voluntary contributions to public goods

An example…[1]

- 2x2 matrix game
- Number of subjects = 2
- w_i= 10; α = 1; β = 0.7;
- *only two actions are possible* for the subjects:
  - to contribute for all the endowment (invest all)
  - to contribute for nothing (invest nothing)

(Prisoner Dilemma)



[1] This example was taken from Saijo and Nakamura (1995), one of the articles used in the meta-analysis.

Methods

1. Searching

A search of the economics literature of *standard single-stage linear public goods in VCM*, was conducted using three sources: **EconLit**, Internet documents in Economics Access Service (**IDEAS**), and references cited in John Ledyard's (1995) survey of experimental research related to public goods.

• ***Four*** keyword searches: "public goods" and "experiment*", "voluntary contribution" and "experiment", "variable contribution" and "experiment" and "cooperation" and "experiment".

• ***Two*** subject heading searches were conducted using the ***JEL classification system***:

i. area H410 and keyword "experiment*"

ii. areas C900,C910,C920 and C990, and the keyword "public goods"

• Detected 349 potential primary sources.

Methods

27/349 = Is less than the 10% of the *primary sources*, obtained through the search phase!

2. Selection criteria

Titles and abstracts were screened using these ***inclusion criteria***:

1. unique ***reports*** of a laboratory experiment, observations gathered in a ***controlled environment;***
2. standard V.C.M. in a single-stage linear public goods environment, where ***β<1***;
3. reported ***group-level results*** for at least one of the outcome of interest;
4. Could be obtained through electronic access or libraries (at Toronto and York Universities) or *www*.

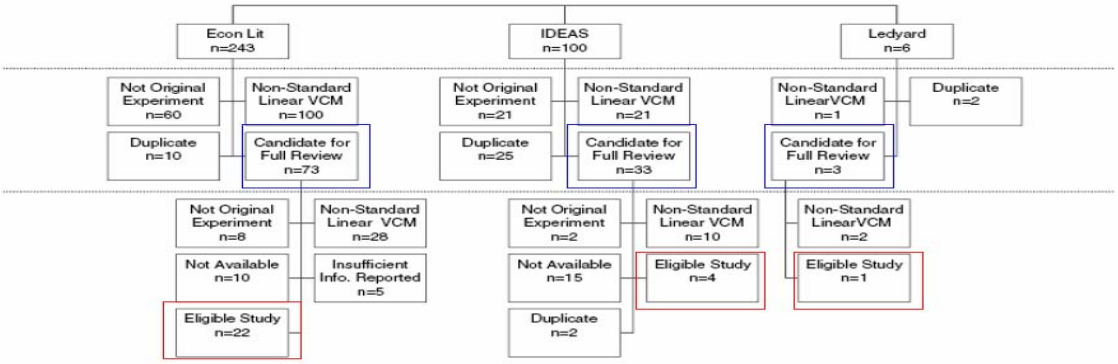
(where it was possible, potential relevant studies where retrieved for a more detailed evaluation = full review)

• 27 studies were included in the meta-analysis.

Methods

2. Selection criteria

Flow-chart of the search and review process.



Methods

2. Selection criteria

Final coverage of the meta-analysis:

- **711 distinct groups** (in experimental session with the same conditions)
- **7240 experimental periods** (together)
- **13 groups were excluded** due to missing data fir the dependent variable

Table 1. Selected parameters for experiments included in the meta-analysis.

Author(s)	Year of publication	# Periods	Group size	MPCR
Andreoni	1988	3–10	5	0.5
Andreoni	1995a	10	5	0.5
Andreoni	1995b	10	5	0.5
Asch, Gigliotti, and Polito	1993	5	8–12	0.3
Carson and Khan	1999	6–24	4	0.3
Croson	1996	10	4	0.5
Croson	2000	10	4	0.125
Dorsey	1992	10	4	0.3
Falkinger, Fehr, Gächter, and Winter-Ebmer	1999/2000[6]	10	4–16	0.1–0.4
Fehr and Gächter	1999/2000[6]	6–10	4	0.4
Fisher, Isaac, Shatzberg, and Walker	1995	10	4	0.3–0.75
Gächter, Fehr, and Kment	1996	10	4	0.4
Goeree, Holt, and Laury	1999/2002[6]	17	2–4	0.2–0.8
Harbaugh and Krause	2000	10	6	0.33–0.67
Isaac and Walker	1988a	10	4	0.003
Isaac and Walker	1988b	10	4–10	0.3–0.75
Isaac and Walker	1998	10	4	0.3
Isaac, Walker, and Thomas	1984	10	4–10	0.3–0.75
Isaac, Walker, and Williams	1994	10–60	4–100	0.03–0.75
Kesser and van Winden	1996/2000[6]	25	4	0.5
Laury, Walker, and Williams	1995	15–30	4	0.55
McCorkle and Watts	1996	1	49	0.04
Nowell and Tinkler	1994	13	4	0.3
Ockenfels and Weimann	1999	10	5	0.33
Saijo and Nakamura	1995	10	7	0.7
Weimann	1994	10	5	0.5
Wilson and Sell	1997	18	6	0.003

Methods

3. Validity assessment and data abstraction

- For the selected studies, author abstracted ***bibliographic details***, ***contextual information*** (for each experiment) and ***data*** on each session in the experiments, and put them in a Microsoft Access Database, in order to improve ***data reliability*** and to facilitate potential ***replication*** of data extraction and coding.

- For this procedure a pilot test was conducted using 7 experimental reports. Two experts (A. Muller and S. Mastelman) reviewed the *study selection criteria* and *abstraction protocols* prior to implementation.

Model adopted

Method: Meta-regression method, weighted least squares[2] of group level results.

Dependent variable: average efficiency of the group's contributions over the session.

Explanatory variables:

1. ***literature's relevant characteristics*** *of the public goods environment:*
   - m.p.c. return
   - group size
   - gender of subjects
   - extent of subject experience
   - extent of communication allowed to subjects
2. *variable describing* ***study design*** *and* ***experimental design****:*
   - cash or benefits?
   - fully computerized environment or not?
3. *dummy variable to track* ***quality problems*** *reported by the primary searches*
4. *dummy variables indicating* ***publication info*** *(published journal or w.paper?)*
5. *dummy variables for each* ***experiments****, where possible*

[2] in the weighted least squares (WLS) regression, each data point (set of value) potentially receives a different weight. The appropriate weight to assign is one which is proportional to how well the dependent variable is known or inversely proportional to the variability if the dependent variable.

Methods

3. Validity assessment and data abstraction

- **Comments on data abstraction:**

✓ ***type*** and ***extent*** of data reported in primary studies ***varied significantly***

✓ more reported information: ***m.p.c.***, ***group size***, ***fully computerize or not***;

✓ less reported information: ***nature of the subjects pool***, ***date and place*** of the experiment, ***average payments*** to subjects

✓ three variables were taken off the quantitative analysis because of inconsistent reporting: ***average payments to subjects*** as a proxy for salience rewards **(!!!)**, year of the experiment, methods use to randomize subjects to different treatment groups.

✓ for selected variables, standardized imputations were conducted according to the study protocol

Results

Quantitative data synthesis – Model adopted

Not reported data:

- results of analyses about the ***decay in efficiency over a session*** — Few primary studies included these data
- proportion of complete free riders

- parameter estimates and other information on the dummy variables of each experiment — To facilitate interpretation of results

Results

Quantitative data synthesis
Weighted least squares regression results
(adjusted r^2=0.6115)

Δ_+

Table 3. Weighted least squares results—Average contributions as a percent of the total endowment.

Variable	Estimate	Std error	*p*-value	sig
Intercept	−14.87	18.44	0.4207	
# Periods	−0.44	0.29	0.1376	
Friendship among subjects	1.50	7.05	0.8320	
Group size	0.15	0.09	0.0948	
Cash rewards	15.36	10.92	0.1605	
Fully computerized environment	1.10	5.72	0.8479	
Marginal per capita return	39.53	6.12	<.0001	**
Male subjects only	1.00	13.16	0.9395	
Female subjects only	8.00	12.60	0.5260	
Child subjects	44.85	22.49	0.0472	*
Heterogeneous MPCR	−0.54	12.65	0.9657	
Heterogeneous endowments	−14.51	7.10	0.0421	*
Experienced subjects	−6.15	2.55	0.0167	*
Communication allowed	40.46	4.16	<.0001	**
Punishment of subjects allowed	1.86	6.16	0.7637	
Economics training	6.05	5.87	0.3039	
Positive framing	19.30	7.90	0.0151	*
Optimum announced	−0.46	12.99	0.9716	
End of session announced	6.48	9.98	0.5168	
Quality problems identified	−5.55	6.95	0.4255	
Imperfect monitoring of group contributions	2.25	7.19	0.7550	
Beliefs re: others' behaviour solicited	−20.00	8.49	0.0193	*
Constant groups for session ("partners")	15.67	3.54	<.0001	**
Subjects from western europe	−0.55	10.14	0.9568	
Subjects from eastern europe	−10.78	11.20	0.3368	
Japanese subjects	−10.60	13.22	0.4232	
Published in journal	−6.28	15.24	0.6807	

Factors which (significantly) affect mean contributions to the public good in a ***positive*** way.

Results

Quantitative data synthesis
Weighted least squares regression results
(adjusted r^2=0.6115)

Δ_-

Table 3. Weighted least squares results—Average contributions as a percent of the total endowment.

Variable	Estimate	Std error	*p*-value	sig
Intercept	−14.87	18.44	0.4207	
# Periods	−0.44	0.29	0.1376	
Friendship among subjects	1.50	7.05	0.8320	
Group size	0.15	0.09	0.0948	
Cash rewards	15.36	10.92	0.1605	
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Subjects from western europe	−0.55	10.14	0.9568	
Subjects from eastern europe	−10.78	11.20	0.3368	
Japanese subjects	−10.60	13.22	0.4232	
Published in journal	−6.28	15.24	0.6807	

Factors which (significantly) affect mean contributions to the public good in a ***negative*** way.

Other results

Variables included in the meta-regression which have ***relatively little overall influence*** on the meta-analysis result (either positively or negatively).

Table 3. Weighted least squares results—Average contributions as a percent of the total endowment.

Variable	Estimate	Std error	*p*-value	sig
Intercept	−14.87	18.44	0.4207	
# Periods	−0.44	0.29	0.1376	
Friendship among subjects	1.50	7.05	0.8320	
Group size	0.15	0.09	0.0948	
Cash rewards	15.36	10.92	0.1605	
Fully computerized environment	1.10	5.72	0.8479	
Marginal per capita return	39.53	6.12	<.0001	**
Male subjects only	1.10	15.16	0.9395	
Female subjects only	8.00	12.60	0.5260	
Child subjects	44.85	22.49	0.0472	*
Heterogeneous MPCR	−0.54	12.65	0.9657	
Heterogeneous endowments	−14.51	7.10	0.0421	*
Experienced subjects	−6.15	2.55	0.0167	*
Communication allowed	40.46	4.16	<.0001	**
Punishment of subjects allowed	1.86	6.16	0.7637	
Economics training	6.05	5.87	0.3039	
Positive framing	19.30	7.90	0.0151	*
Optimum announced	−0.46	12.99	0.9716	
End of session announced	6.48	9.98	0.5168	
Quality problems identified	−5.55	6.95	0.4255	
Imperfect monitoring of group contributions	2.25	7.19	0.7550	
Beliefs re: others' behaviour solicited	−20.00	8.49	0.0193	*
Constant groups for session ("partners")	15.67	3.54	<.0001	**
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Subjects from eastern europe	−10.78	11.20	0.3368	
Japanese subjects	−10.60	13.22	0.4232	
Published in journal	−6.28	15.24	0.6807	

Discussion of the results

- **Results which support the Ledyard (1995) view:**
  - higher ***m.p.c*** returns → Δ_+;
  - allowing ***communication*** → Δ_+;
  - heterogeneous endowments → Δ_-;
  - ***group size*** and gender are → not significant;
  - ***experienced*** subject → Δ_-.

See Bosch-Domenech et al. (2002); possible explanations of the discrepancy:

- How is the term "trained" used?
- Different contexts?

→ to be discussed!

- **Results which do not support the Ledyard (1995) view:**
  - ***repetition*** → has not a significant effect[3] on decreasing contribution;
  - "***economic training***" → not significant in decreasing contribution[4];
  - relationship ***friendship/group***: maintaining the same group → Δ_+;
  - ***framing effect***: not yet studied by Ledyard (see Andreoni, 1995b) → Δ_+.

[3] a separate analysis showed that at least in those studies where data were reported, contributions declined sharply between the first and the last periods (non-linear relationship due to the end of the game).

[4] maybe due to the low levels of training among most subjects categorized as "economics-trained"

Discussion of the results

Meta-analysis also provided:

- **parameter estimates** for each variable → useful in developing hypotheses regarding the combined effect of different factors;
- **a priori power calculations**: as the likelihood on detecting a difference of a specified size if (it exists) and ***focusing experimenters on areas where experimental evidence is less strong***;

For the author, it is likely that meta-analysis will become more popular in economics; but this kind of analysis strongly depends on ***consistent*** and ***complete reporting*** of the methods and results of primary sources.

Many of the articles reviewed for this research ***do not include key information*** about experimental design and results. → Solution: to use existing guidelines (Palfrey and Porter, 1991).

Also increasing ***experimental data-sharing*** would be useful.

23

On with the show ☺

10 Can public goods experiments inform policy?

Interpreting results in the presence of confused subjects

Stephen J. Cotten, Paul J. Ferraro, and Christian A. Vossler

This is a chapter in the Cherry et al book discussed in L1.

- VCM (= voluntary contributions mechanism) is the cornerstone of experimental investigations on the private provision of public goods
- Standard experimental investigation places individuals in a context-free setting where the public good, which is non-rival and non-excludable in consumption, simply money
- Specifically, “tokens” have to be divided between a private and a public account
- Typically, parameterized/designed so that each player has a dominant strategy of not contributing (to the public account)
- In one-shot (single-round) VCM experiments, subjects contribute – contrary to the theoretical prediction – about 40% - 60 %
- In finitely-repeated VCM experiments, subjects contribute about the same initially but contributions then decline towards zero (but rarely ever zero)
- “Thus, there seem to be motives for contributing that outweigh the incentive to free ride” (CFV 194)

- Possible “motives”: “pure altruism”, “warm-glow” (also called, “impure altruism”), “conditional cooperation”, “confusion”
- “Confusion” describes individuals’ failure to identify (in the laboratory set-up) the dominant strategy of no contribution (a realistic concern, see Rydval, Ortmann, Ostatnicky, Three Simple Games and How to Solve Them, now forthcoming in Journal of Economic Behavior and Organization: http://www.cerge-ei.cz/pdf/wp/Wp347.pdf
- Findings:
    - Palfrey & Prisbey (AER 1997) - find warm-glow but no evidence of pure altruism
    - Goeree et al. (JPublE 2002) - find pure altruism but no warm-glow
    - Fischbacher et al. (EL 2001) – find conditional cooperation but no pure / impure altruism, as do Fischbacher & Gaechter (manuscript 2004)
    - etc. (contradictory gender effects, but see Ortmann & Tichy JEBO 1999)
    - apparent lack of correspondence between contributions behavior in experimental and naturally occurring settings (e.g., Laury & Taylor JEBO 2008)
- Could it be that these findings are the result of confusion that “confounds” the interpretation of behavior in public good experiments? (p. 195)
    - One new experiment, two old ones
    - Using the “virtual-player” method to sort out pro-social motives such as altruism …
- Finding:
    - “The level of confusion in all experiments is both substantial and troubling.” (p. 196)
    - “The experiments provide evidence that confusion is a confounding factor in investigations that discriminate among motives for public contributions, … “ (p. 196)
- Solutions:
    - Increase monetary rewards in VCM experiments ! (inadequate monetary rewards having been identified as potential cause of contributions provided out of confusion)
    - Make sure instructions are understandable ! (poorly prepared instructions having been identified as possible source of confusion)
    - Make sure, more generally, that subjects manage to identify the dominant strategy ! (the inability of subjects to decipher the dominant strategy having been identified as a possible source of confusion)
    - “Our results call into question the standard, “context-free” instructions used in public good games.” (p. 208)

In more detail:

- Andreoni (AER 1995) first to argue that (parts of) what looks like kindness in VCM experiments is really confusion. Andreoni finds that other-regarding behavior (kindness, altruism) and confusion are “equally important”
- Houser & Kurzban (AER 2oo2) did the same thing but they used a different set-up:
    - a “human condition” (the standard VCM game)
    - a “computer condition” (the standard VCM game, played by one human player and three non-human (or, “virtual”) players.
    - Each round, the aggregate computer contribution to the public good is three-quarters of the average contribution observed for that round in the human condition.
        - Basic idea: confusion and other=regarding behavior present in the human condition but not in the computer condition
        - Basic result: Confusion accounts for about 54 percent of contributions to all public good contributions.
- Ferraro et al. (JEBO 2003) and Ferraro & Vossler (manuscript 2005), with designs similar to Houser & Kurzban find that 54 and 52 percent contributions come from confused subjects.
- Palfrey & Prisbey (1997) find a similar result in their own experiment (not using virtual players) and estimate with their model that “well over half” of the contributions in the classic VCM experiments by Isaac et al. (Public Choice 1984) are attributable to error.
- Goeree et al. (JPublE 2002) find in their own experiment (not using virtual players) both a positive and significant effect on coefficients that correspond to (pure) altruism and decision error (confusion); no point estimate is given,
- Fischbacher & Gaechter (manuscript 2004) find in their own experiment (not using virtual players) that “at most 17.5% “ are contributed by confused subjects; they also argue that none of their subjects exhibits altruism or warm-glow (no subject stated they would contribute if other group members would not). In Fischbacher & Gaechter’s view, all non-confused subjects are “conditional cooperators”
- Summary: every study that looks for confusion finds that it plays a significant role in observed contributions.

- The virtual-player method has three (four, five) important features:
    - Virtual players (that are preprogrammed to execute decisions that are made by human players in otherwise identical treatments)
    - Split-sample design (where each participant is randomly assigned to play with humans or (human condition) with virtual players (computer condition)
    - A procedure that ensures that human participants understand how the non-human, virtual players behave.
    - Random assignment of subjects to the human condition or the computer condition – important assumption here that subjects are drawn from the same population.
    - "Twins" in multiple-round public goods games where the group contributions are announced after each round, so that history starts to play a role …

- Some graphs:

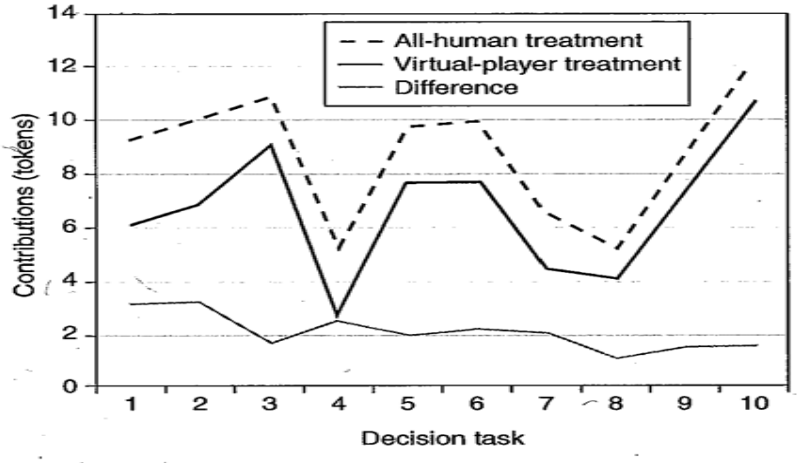


Figure 10.1 GHL application, comparison of all-human and virtual-player contributions.

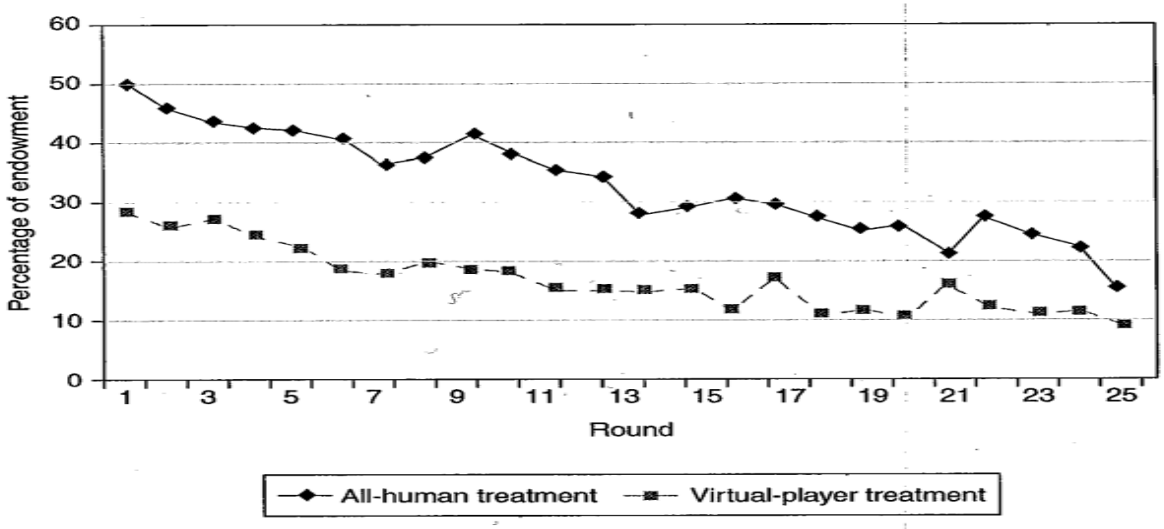


Figure 10.2 Ferraro and Vossler (2005) experiment, mean contributions.

Stern, The Rise and Fall of the Environmental Kuznets Curve (World Development 32.8, 2004, 1419 - 1439)

Yandle, Vijayaraghavan, Bhattarai, The Environmental Kuznets Curve: A Primer. A PERC Research Study May 2002, 24 pages

What the basic issue?

- Can economic growth be a (the?) means to *eventual* environmental improvement?

- Can have humankind “have our cake and eat it” (Rees 1990, p. 435, in Stern

- Does the following result (of an “inverted U-shaped function of income per capita”) generalize to other emissions?

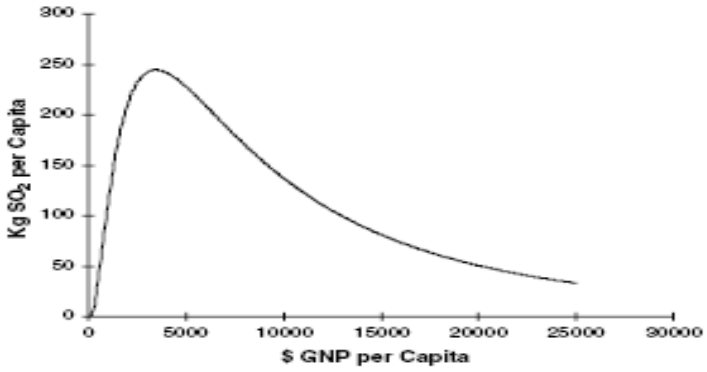


Figure 1. *Environmental Kuznets curve for sulfur emissions. Source: Panayotou (1993) and Stern, Common, and Barbier (1996).*

Sulfur

From Wikipedia, the free encyclopedia

Sulfur or **sulphur** (pronounced /ˈsʌlfɚ/, see spelling below) is the chemical element that has the atomic number 16. It is denoted with the symbol **S**. It is an abundant multivalent non-metal. Sulfur, in its native form, is a yellow crystalline solid. In nature, it can be found as the pure element and as sulfide and sulfate minerals. It is an essential element for life and is found in two amino acids, cysteine and methionine. Its commercial uses are primarily in fertilizers, but it is also widely used in black gunpowder, matches, insecticides and fungicides. Elemental sulfur crystals are commonly sought after by mineral collectors for their brightly colored polyhedron shapes. In nonscientific context it can also be referred to as *brimstone*.

Environmental impact

The burning of coal and/or petroleum by industry and power plants generates sulfur dioxide (SO_2), which reacts with atmospheric water and oxygen to produce sulfuric acid (H_2SO_4). This sulfuric acid is a component of acid rain, which lowers the pH of soil and freshwater bodies, sometimes resulting in substantial damage to the environment and chemical weathering of statues and structures. Fuel standards increasingly require sulfur to be extracted from fossil fuels to prevent the formation of acid rain. This extracted sulfur is then refined and represents a large portion of sulfur production. In coal fired power plants, the flue gases are sometimes purified. In more modern power plants that use syngas the sulfur is extracted before the gas is burned.

Kuznets (AER 1955) hypothesized that income inequality first rises and then falls with economic growth, hence the name *E*KC (Environmental Kuznets Curve).

Meadows, Meadows, Randers, & Behrens (1972) – "Club of Rome" study, dire predictions (economic growth is bad)

Grossman & Krueger (1991) - impact of NAFTA study, much more optimistic predictions (economic growth may be good); popularized by 1992 World Bank Development Report (IBRD 1992)

Prospect of sustainability while doing business as usual !!! (How nice !)

- currently, dispute over methodology and the reality of the EKC
    - "most of the EKC literature is econometrically weak" (Stern p. 1420) because it does not account properly for the statistical properties of the data used [serial dependence, stochastic trends] and issues of model adequacy [possibility of omitted variable bias]
    - "when we … use appropriate techniques, we find that the EKC does not exist" (Stern p. 1420)
        - "It seems that emissions of most pollutants and flows of waste are monotonically rising with income", with "income elasticity" being less than 1 and moderated also by other factors ("income-independent, time related effects [such as institutional quality] reduce environmental impacts in all countries at all levels of income" (Stern p. 1420)
        - In rapidly growing middle-income countries, scale effects tend to dominate time effects
            - ⇨ Pure growth, without change in the structure or technology of an economy, leads to more pollution and other negative environmental impacts (scale effects)
            - ⇨ As economies grow, output mix changes – from more pollution intensive to less pollution intensive industries --,

input mix changes, emission specific regulations might change and actually hasten output/input mixes, etc.
        - In wealthy countries, time effects can dominate scale effects (partially because growth is slower)

- currently, also a dispute over the appropriate mix of metrics /statistics and theory, as well as the facts
    - "many environmental economists take the EKC as a stylized fact that needs to be explained by theory." (Stern p. 1421)
    - "the EKC has never been shown to apply to all pollutants or environmental impacts and recent evidence." (Stern p. 1421)

- A number of theoretical models have been developed of how preferences and technology interact to result in different time paths of environmental quality. (Stern p. 1422)
- Most of these studies can generate an inverted U-shape curve of pollution intensity but … the assumptions made and the values given to particular parameters make all the difference whether indeed the EKC gets generated. (Stern p. 1422)
- "Many EKC studies have also been also been published that include additional explanatory variables, intended to model underlying or proximate factors such as 'political freedom' … or output structure … or trade … In general, the included variables turn out to be significant at traditional levels. … it is not clear what we can infer from this body of work [because of potential for omitted variable bias]. Given these problems, I do not review these studies systematically here." (Stern p. 1423)

- Turning point estimate differ widely (see Table 1, Stern p. 1425, here reproduced in parts only):

Table 1. *Sulfur EKC studies*

Authors	Turning point 1990 USD	Emissions or concentrations	PPP	Additional variables
Panayotou (1993)	$3,137	Emissions	No	–
Shafik (1994)	$4,379	Concentrations	Yes	Time trend, locational dummies
Torras and Boyce (1998)	$4,641	Concentrations	Yes	Income inequality, literacy, political and civil rights, urbanization, locational dummies
Grossman and Krueger (1991)	$4,272–5,965	Concentrations	No	Locational dummies, population density, trend
Panayotou (1997)	$5,965	Concentrations	No	Population density, policy variables
Cole, Rayner, and Bates (1997)	$8,232	Emissions	Yes	Country dummy, technology level
Selden and Song (1994)	$10,391–10,620	Emissions	Yes	Population density
Kaufmann, Davidsdottir, Garnham, and Pauly (1998)	$14,730	Concentrations	Yes	GDP/Area, steel exports/GDP
List and Gallet (1999)	$22,675	Emissions	N/A	–
Stern and Common (2001)	$101,166	Emissions	Yes	Time and country effects

Table 1
Water Pollution and Income

Pollutant	EKC Turning Point	
	1985 US$	2001 US$
Arsenic	$ 4,900	$ 8,000
Biological oxygen demand	7,600	12,500
Cadmium	5,000	8,200
Chemical oxygen demand	7,900	13,000
Dissolved oxygen	2,700	4,400
Fecal coliform	8,000	13,100
Nitrates	2,000	3,300
Lead	10,500	17,200
Smoke	6,200	10,200
Sulfur dioxide	4,100	6,700
Total coliform	3,000	4,900

Note: The values for 2001 U.S. dollars are approximate.
Source: Grossman and Krueger (1995).

[from Yandle et al.]

- "The only robust conclusions from the EKC literature appear to be that concentrations of pollutants may decline from middle income levels, while emissions tend to be monotonic in income. … " (Stern p. 1426)

- How about the feedback from environmental damage to economic production (typically assumed away by most EKC studies)?

- Could a EKC-type relationship, if it does indeed exist, be partly or largely be the results of the effects of trade on the distribution of polluting industries, as proposed by Arrow et al. (Science 1995) and Stern et al. (World Development 1996)? -> literature on pollution havens “There is no clear answers on the impact of trade on pollution from the empirical EKC literature.” (Stein 1427)

- But see this:

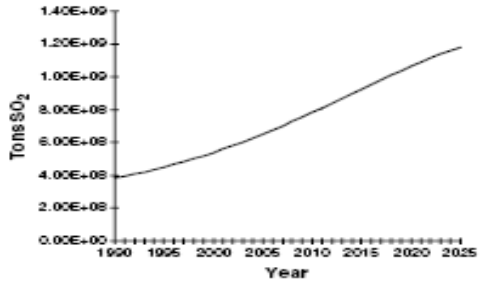


Figure 2. *Projected sulfur emissions. Source: Stern et al. (1996).*

- “It seems unlikely that the EKC is an adequate model of emissions or concentrations. I concur with Copeland and Taylor (JEL 2004), who state that: “Our review of both the theoretical and empirical work on the EKC leads us to be skeptical about the existence of a simple and predictable relationship between pollution and per capita income.” (Stern p. 1435)

- “The true form of the emissions-income relationship is likely a mix of two of the scenarios proposed by Dasgupta et al. (JEP 2002) illustrated in Figure 3. The overall shape is that of their ‘new toxics’ EKC – a monotonic increase of emissions and income. But over time this curve shifts down, which is analogous to their ‘revised EKC’ scenario. [innovations being adopted in high-income countries, and with a short lag in the majority of poorer countries.]” (Stern p. 1435)

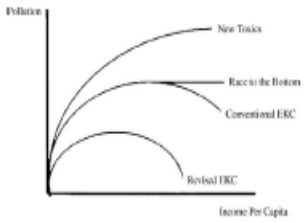
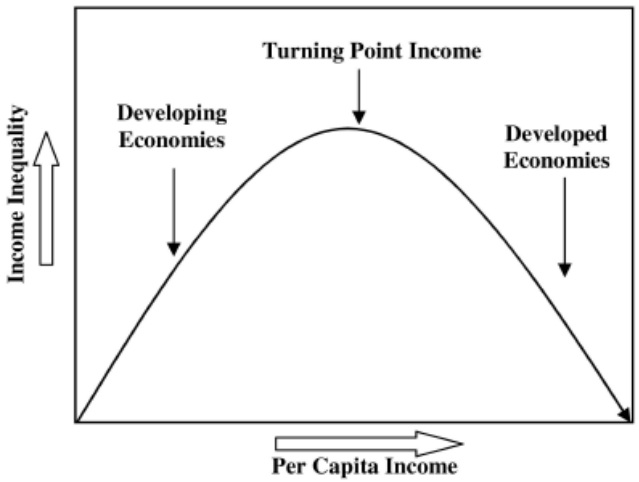


Figure 3. *Environmental Kuznets curve: alternative views. Source: Dasgupta et al. (2002) and Perman and Stern (2003).*

Does the degree of property rights and contract enforcement make a difference? (Yandle et al., p. 1)

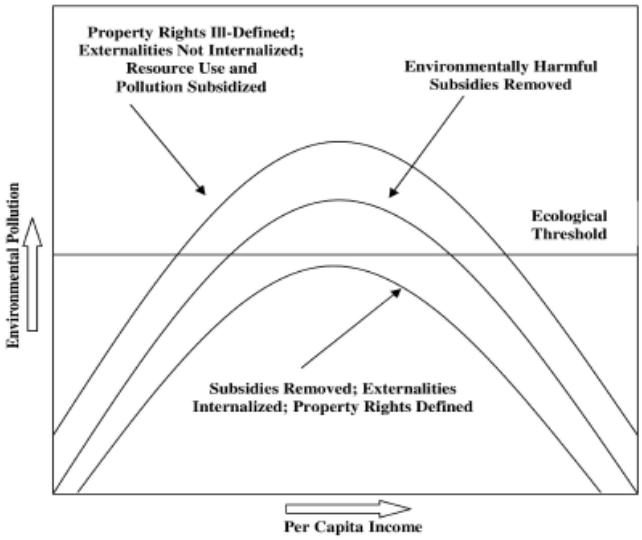
Figure 1
The Kuznets Curve



"The movement along an environmental Kuznets curve is also a movement through a well-known set of property right stations." (Yandle et al., p. 4)
"The search for meaningful environmental protection is a search for ways to enhance property rights and markets." (Yandle et a;., p. 18)

"Eventually, when most aspects of the environment are defined as property, the community moves rapidly in the race to improve environmental life. The pace of this progress is determined partly by the extent to which environmental assets are protected by private property rights. Thus, the EKC is a proxy or a property rights model that begins with a commons and ends with private property rights," (Yandle et al., p. 4)

Figure 3
Income-Environment Relationship under
Different Policy and Institutional Scenarios



Source: Panayotou (1997).

"Property rights enforcement leads to higher income levels, which in turn generate demand for environmental quality." (Yandle et al. P. 14)

"As this primer indicates, there is no single EKC relationship that fits all pollutants for all places and times. There are families of relationships, and in environmental change and income growth. The indicators for which the EKC relationship seems most plausible are local air pollutants …

… there is no evidence to support the EKC hypothesis for gases such as carbon dioxide, which cause no harm locally but may affect the global climate as they accumulate in the atmosphere. The very nature of the potential harm – impact on global climate – makes unilateral action fruitless. It is impossible for people in a single nation or community to make a difference in upper atmospheric conditions.

… The EKC evidence for water pollution is mixed. … In most cases, the income threshold for improving water quality is much lower than that for the air pollution improvement threshold.

The acceptance of the EKC hypothesis for select pollutants has important policy implications.
First, the relationship implies a certain inevitability of environmental degradation along a country's development path, especially during the take-off process of industrialization. Second, the normal EKC suggests that as the development process picks up … economic growth helps to undo the damage done in earlier years. … However, income growth [and related policies] without institutional reform is not likely to be enough. … Whether environmental quality improvements materialize or not, when and how, depends critically on government policies, social institutions and the completeness and functioning of markets. It is for this reason, among others, that Arrow et al. (Science 1995) emphasize the importance of getting the institutions right in rich and poor countries. … Torras & Boyce (Ecological Economics 1998) argue and show empirically, all else equal, when ordinary people have political power, civil rights as well as economic rights, air and water quality improves in richer and poorer countries." (Yandle et al. pp. 17 – 18)

[A little double auction experiment, to motivate the induced value theory used in Plott 1982:Buyer values were 10 and 6, seller values were 4 and 7; final price was 7 and resultant consumer and producer surplus were 3 each for the buyer and seller involved in the transaction.]