Economic Policy Analysis: Lecture 3

Externalities

Camille Landais

Stanford University

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Outline

Externalities and Deadweight Loss

Solutions to Externalities

Empirical Estimation of Externalities

Internalities

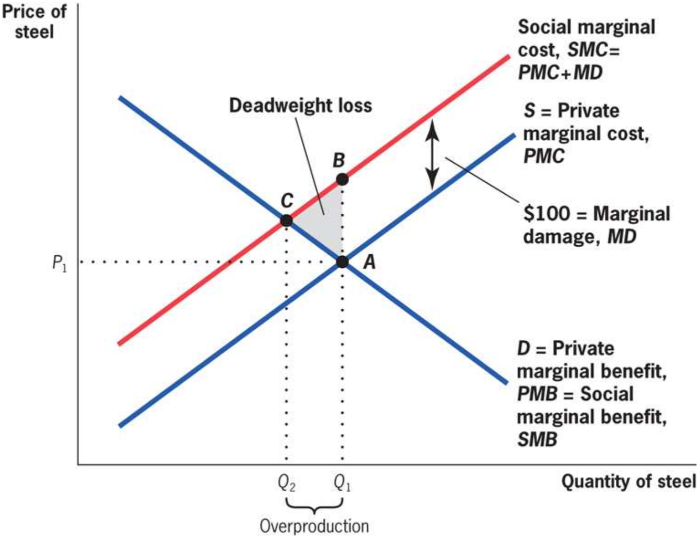
Examples of Externalities

- The key issue at the heart of climate change is one of the canonical forms of market failure
- **Externalities** arise whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so
- Examples Include:
  1. carbon emissions
  2. noise pollution
  3. flu vaccinations
  4. scientific research

Examples of Externalities

- The classic case involves **negative production externalities**
- Consider a steel plant that produces a by-product called sludge
- These plants typically dump the sludge into nearby rivers
- This harms many parties downstream, including fishers, recreational users and the like
- The fundamental problem is the difference between the **private marginal cost** of steel production and the **social marginal cost**

Figure 1: Negative Externality and Deadweight Loss



Examples of Externalities

- As opposed to the competitive equilibrium presented earlier, this market outcome results in overproduction of steel
- Alternatively, we have behavior that produces positive externalities
- Here, the mismatch is between private marginal benefits and social marginal benefits
- Consider the case flu vaccination

A Simple Model of Externalities

- Firms produce x units of steel using $c(x)$ units of a numeraire good y
- Steel production also produces river pollution: $D(x) = x$
- Consumers have quasi-linear utility:

$$U = u(x) + y - sD(x)$$

  s is the marginal damage of pollution
- Importantly, Consumers take level of pollution as given $D(x) = \overline{x}$ when maximizing U subject to budget constraint:

$$Z = px + y$$

  where p is the price of steel
- Firms maximize profits: $\pi = px - c(x)$

Walrasian Equilibrium

- Firm maximizes profits and does not internalize pollution cost:

$$p = c'(x)$$

- Individuals maximize utility taking pollution as given:

$$p = u'(x)$$

- Private marginal benefits and private marginal cost are equal in equilibrium

$$u'(x) = c'(x)$$

First-best: social optimum

Walrasian equilibrium is not social optimum

- Social welfare = profits + utility

$$\begin{aligned} W &= U + \pi = u(x) + y - sD(x) + px - c(x) \\ &= u(x) + Z - sx - c(x) \end{aligned}$$

- Perturbation argument: let's say I change quantities x of Δx from Walrasian equilibrium

$$\begin{aligned} dW &= u'(x)\Delta x - s\Delta x - c'(x)\Delta x \\ &= -s\Delta x \;\; > 0 \text{ if } \Delta x < 0 \end{aligned}$$

- x is overproduced in equilibrium compared to optimal situation

Outline

Remedies to Externalities

- Private solutions:
  1. Coasian bargaining solution
- Public solutions:
  1. Pigouvian corrective taxation
  2. Regulation
  3. Permits (cap-and-trade)

Coasian Bargaining

- Externalities emerge because property rights are not well defined.

  $\Rightarrow$ Establish property rights to create markets for pollution.
- Example: pollution in a river.
  - If consumer owns river, in competitive equilibrium, firms pay marginal cost of pollution for every unit of pollution emitted.
  - Marginal cost of production is now $c(x) + s$, leading to 1st best.
- Symmetric solution when firm owns river.
- Assignment of property rights affects distribution but not efficiency

Limits to Coasian Bargaining

- Cost of bargaining
  - Ex: air pollution $\Rightarrow$ would require millions of agents to coordinate and bargain
  - To reduce transactions costs, need an association to represent agents: This association is the government
- Asymmetric information:
  - competitive equilibrium can break down
  - Often hard to identify precise source of damage
    E.g. atmospheric pollution very diffuse, marginal damages unclear

Public Sector Solutions to Externalities

- In the absence of Coasian negotiation, the government may be fit to intervene in cases of externalities
- The types of public solutions to externalities include
  1. Corrective Taxation (Pigouvian Taxes)
  2. Subsidies
  3. Regulation
- These methods vary in their relative efficiency

Pigouvian Taxation

- Impose tax t equal to marginal damage of pollution: $t = s$
- Restores Pareto efficiency and maximizes social welfare
- Practical limitations:
  - Must know marginal damage function to set tax level t
  - Difficult to measure the marginal damage in practice

Regulation

- Must reduce pollution to set level or face legal sanctions.
- Same outcome as Pigouvian taxation
- Advantages:
  1. Ease of enforcement
  2. Salience, political expedience
- Disadvantages:
  1. Dynamics: no incentive to innovate
  2. Allocative inefficiency with heterogeneity in cost of pollution reduction

Figure 2: Command and Control

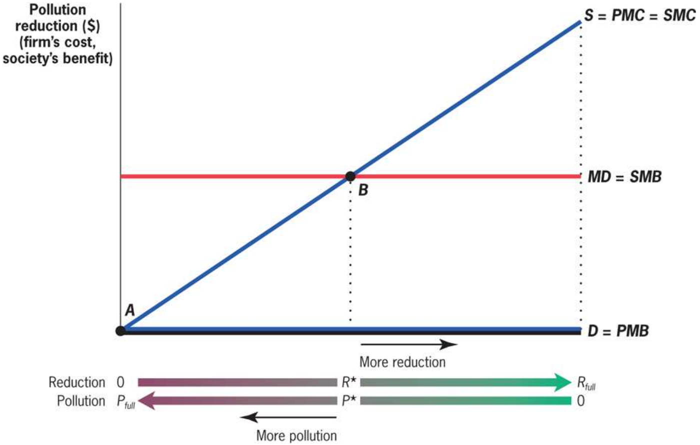
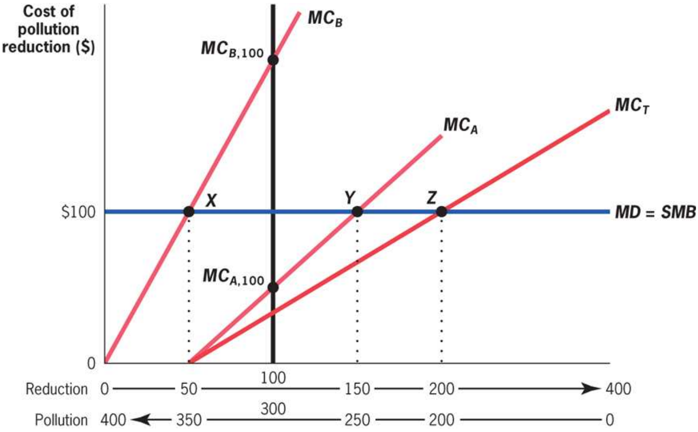


Figure 3: Allocative Inefficiency with Heterogeneous Costs



Permits

- Cap total amount of pollution and allow firms to trade permits to pollute
- Address disadvantages of regulation using an auction-based permit system
- Hybrid of regulation and Coasian solution. In eq., firms with highest MC of reducing pollution will buy permits; those that can easily reduce pollution will do so.
- If total number of permits is set to achieve the social optimum, both allocative and productive efficiency will be achieved
- Also have dynamic incentives to innovate because each firm is bearing a marginal cost of pollution

Efficiency of Public Solutions

Weitzmann (1974): price, quantity and uncertainty

- Social Marginal Benefit (SMB) of depollution is more or less steeply decreasing (global warming vs nuclear leakage)
- Cost of depollution is uncertain
- Should gvt use tax or regulation?
- If SMB is fastly decreasing, quantity is a better instrument
- If SMB is flatter, price instrument is better
- Intuition:
  - Quantity regulations ensure the level of environmental protection but at variable costs to firms
  - Price regulations ensure minimization of the cost to firms but at variable level of environmental protection

Figure 4: Uncertainty & Solution to Externality

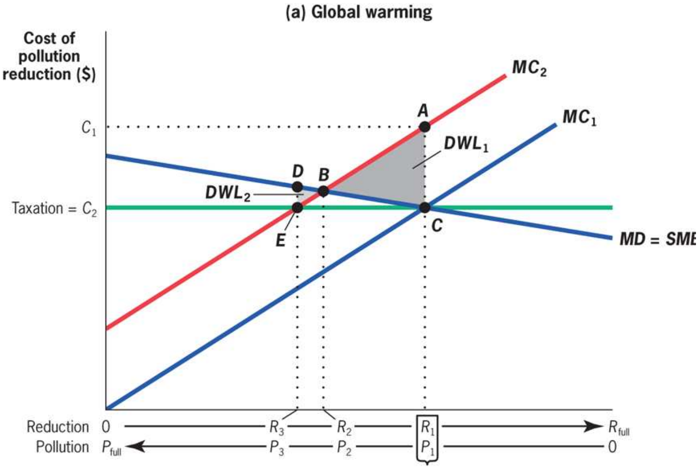
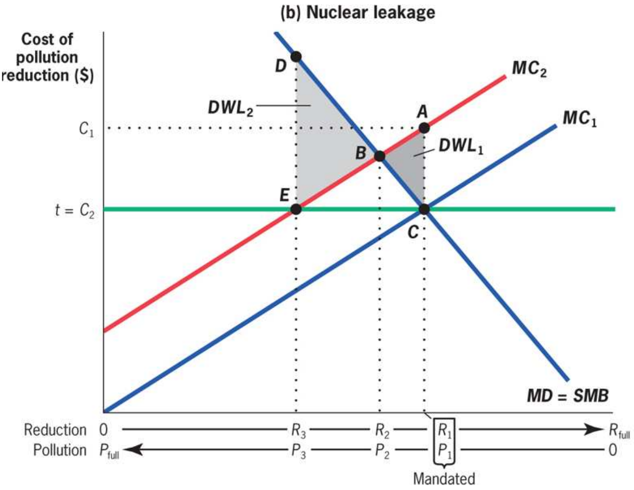


Figure 5: Uncertainty & Solution to Externality



Externalities and Optimal Tax Policy

- Sandmo 1975: optimal second-best taxation
- Double dividend discussion

Outline

Criminal Externalities

Do violent movies increase criminal behaviors?

- Lab experiments: sharp increase in aggressive behavior immediately after the media exposure, compared to a control group exposed to nonviolent clips.
- What about in the field? Dahl & DellaVigna QJE 2009
- Use exogeneous variations in theater attendance for violent movies
- Look at effect on violent crimes
- **Self selection** and **incapacitation** $\rightarrow$ In the sort-run, violent crimes *decrease*!
- Long-run effects impossible to identify

Figure 6: Dahl & DellaVigna QJE 2009

TABLE V
ROBUSTNESS

Specification:	Instrumental variables regressions						OLS reg.	Poisson reg.
Dep. var.:	Log (number of violent crimes in day t in time window)							No. of assaults
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Effects in morning and afternoon (6 A.M.–6 P.M.)								
Audience of strongly violent movies (millions of people in day t)	−0.0037 (0.0046)	−0.0046 (0.0045)	0.0005 (0.0039)	0.0005 (0.0037)	−0.0075 (0.0056)	−0.0047 (0.0044)	−0.0096 (0.0035)***	−0.0081 (0.0029)***
Audience of mildly violent movies (millions of people in day t)	−0.003 (0.0041)	−0.0046 (0.0042)	−0.0006 (0.0033)	−0.0006 (0.0033)	−0.0028 (0.0039)	−0.003 (0.0040)	−0.0088 (0.0027)***	−0.0102 (0.0023)***
Audience of nonviolent movies (millions of people in day t)	0.0003 (0.0041)	−0.0012 (0.0042)	−0.0012 (0.0035)	−0.0012 (0.0034)	−0.0013 (0.0044)	0 (0.0039)	−0.0079 (0.0028)***	−0.0098 (0.0023)***
B. Effects in the evening (6 P.M.–12 A.M.)								
Audience of strongly violent movies (millions of people in day t)	−0.013 (0.0049)***	−0.0158 (0.0048)***	−0.0144 (0.0046)***	−0.0144 (0.0044)***	−0.0139 (0.0063)**	−0.0153 (0.0044)***	−0.0099 (0.0037)***	−0.0081 (0.0030)***
Audience of mildly violent movies (millions of people in day t)	−0.0109 (0.0040)***	−0.0107 (0.0042)**	−0.0165 (0.0035)***	−0.0165 (0.0032)***	−0.0109 (0.0039)***	−0.0119 (0.0038)***	−0.0065 (0.0029)**	−0.0075 (0.0023)***
Audience of nonviolent movies (millions of people in day t)	−0.0063 (0.0043)	−0.0062 (0.0044)	−0.0098 (0.0040)**	−0.0098 (0.0036)***	−0.008 (0.0042)*	−0.0069 (0.0040)*	−0.0026 (0.0030)	−0.003 (0.0024)
C. Effects in the night (12 A.M.–6 A.M.)								
Audience of strongly violent movies (millions of people in day t)	−0.0192 (0.0060)***	−0.0202 (0.0059)***	−0.0206 (0.0054)***	−0.0206 (0.0055)***	−0.0252 (0.0068)***	−0.0211 (0.0066)***	−0.0098 (0.0052)*	−0.0133 (0.0035)***

Pollution Externalities

How much do air pollution affect prevalence of respiratory illness?

- Optimizing individuals compensate for predicted increase in pollution levels by reducing exposure $\Rightarrow$ Underestimation of potential health costs of air pollution when **avoidance behaviors** not taken into account
- Moretti & Neidell JHR 2010
- Use daily variations in ozone levels due to boat arrivals in two major LA ports.
- IV estimates (controlling for avoidance) much larger than OLS

Figure 7: Moretti & Neidell JHR 2010

Table 3. OLS and IV regression results for effect of ozone on respiratory illnesses

	1 OLS	2 IV	3 IV
A. First stage			
boat traffic / 100,000		4.608**	4.409**
		[0.029]	[0.044]
boat traffic / 100,000)*distance		-0.198**	-0.181**
		[0.001]	[0.003]
(boat traffic / 100,000)*distance^2)*1000			-0.293**
			[0.048]
B. Second stage			
8-hour ozone	0.113**	0.454**	0.442**
	[0.023]	[0.162]	[0.162]
Wu-Hausman F test (1,1927109)		4.820	4.485
P-value		0.028	0.034
percent effect	1.16%	4.66%	4.54%

Notes: * significant at 5%, ** significant at 1%. N=1,927,187 in all regressions. Robust standard erros clustered by date in brackets. Dependent variable is number of respiratory related hospital admissions per day, zip code, and age category. All regressions include independent variables from Table 1 (except boat arrivals and departures), age dummies, year-month dummies, day of week dummies, cubic day trend, and zip code fixed effects. 'percent effect' % change in dependent variables from .01 ppm increase in ozone (=(ozone coefficient/100)/(mean of dependent variable from Table 1)).

Contingent Valuations

Ask people directly about their willingness-to-pay.

- Cost of designing and conducting survey
- General issues with survey data (Diamond & Hausman (1994))
  - Non Commitment Bias
  - Framing
  - Embedding effects
- Strategic responses

Capitalization

Capitalization: net present value of an asset is the sum of the discounted flow of future benefits attached to holding this asset. If anything affects this flow of future benefits, it's going to be capitalized in the value of the asset.

Idea= use housing market to assess WTP for amenities. Look how pollution, schools, crime affect utility of individuals through evolution of housing prices

- Pollution: Chay & Greenstone (2005)
- Crime: Linden & Rockoff (2008)

Air Quality

- Chay & Greenstone estimate willingness to pay for air quality using capitalization approach
- Identification strategy look at how house prices change in response to presumably exogenous variations in air quality because of structure of the implementation of the Clean Air Act
- Instrumental Variable approach: counties which did not attain standards of the CCA at certain point in time experienced greater reduction in TSP

Figure 8: Chay & Greenstone JPE 2005

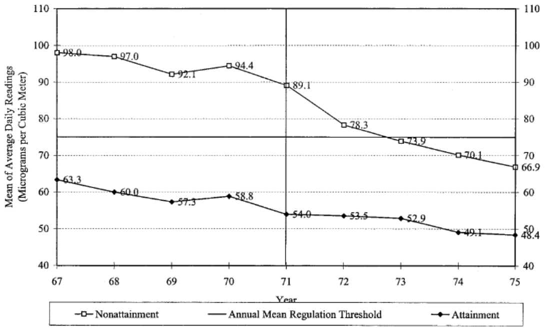


FIG. 2.—1967–75 trends in TSPs concentrations, by 1972 attainment status. The data points are derived from the 228 counties that were continuously monitored in this period. The 116 attainment counties had a 1970 population of approximately 25.8 million people, whereas about 63.4 million people lived in the 112 nonattainment counties in the same year. Each data point is the unweighted mean across all counties in the relevant regulatory category.

Figure 9: Chay & Greenstone JPE 2005

TABLE 5
INSTRUMENTAL VARIABLES ESTIMATES OF THE EFFECT OF 1970–80 CHANGES IN TSPs POLLUTION ON CHANGES IN LOG HOUSING VALUES

	(1)	(2)	(3)	(4)
	A. TSPs Nonattainment in 1975 or 1976			
Mean TSPs (1/100)	−.362	−.213	−.266	−.202
	(.152)	(.096)	(.104)	(.090)
Sample size	988	983	983	983
	B. TSPs Nonattainment in 1975			
Mean TSPs (1/100)	−.350	−.204	−.228	−.129
	(.150)	(.099)	(.102)	(.084)
Sample size	975	968	968	968
	C. TSPs Nonattainment in 1970, 1971, or 1972			
Mean TSPs (1/100)	.072	−.032	−.050	−.073
	(.058)	(.042)	(.041)	(.035)
Sample size	988	983	983	983
County Data Book covariates	no	yes	yes	yes
Flexible form of county covariates	no	no	yes	yes
Region fixed effects	no	no	no	yes

NOTE.—See the notes to previous tables. The coefficients are estimated using 2SLS. The first row of panels A–C indicates which instrument is used. From panels A to C, the instruments are an indicator equal to one if the county was nonattainment for TSPs in either 1975 or 1976, an indicator equal to one if the county was nonattainment for TSPs in 1975, and an indicator that equals one if the county was nonattainment for TSPs in either 1970, 1971, or 1972, respectively. Standard errors (in parentheses) are estimated using the Eicker-White formula to correct for heteroskedasticity.

Cost of Crime

- Rockoff & Linden (2008) estimate costs of crime using capitalization approach
- Identification strategy look at how house prices change when a registered sex offender moves into a neighborhood
- Data: public records on offenders addresses and property values in North Carolina

Figure 10: Linden & Rockoff 2008

Note: X marks the center of the offender's exact location. The surrounding circle marks all parcels within one-quarter of a mile. Neighborhoods are distinguished by shades of gray. Parcels within a neighborhood are usually, but not necessarily, contiguous.

Figure 11: Linden & Rockoff 2008

Note: Results from local polynomial regressions (bandwidth=90 days) of sale price on days before/after offender arrival.

Figure 12: Linden & Rockoff 2008

Note: Results from local polynomial regressions (bandwidth=90 days) of sale price on days before/after offender arrival.

Figure 13: Linden & Rockoff 2008

Table 6: Estimated Victimization Costs from Department of Justice Study

Type of Crime	Cost ($2004)
Sexual Offenses	
Rape and Sexual Assault	$113,732
Violent Crimes	
Murder/Manslaughter	$3,843,363
Assault	$31,374
Robbery	$10,458
Kidnapping	$43,140
Non-violent Crimes	
Burglary	$2,092
Larceny	$523
Motor Vehicle Theft	$5,229

Note: These cost estimates are taken from tables 2 and 4 in Miller et al. (1996). Their cost estimates are given in 1993 dollars. We adjust these for inflation using the 1993 and 2004 annual CPI for all urban consumers. Victimization costs for kidnapping are not listed in their study and we therefore set equal to the cost of

Figure 14: Linden & Rockoff 2008

Table 7: Estimated Victimization Cost of a Sexual Offense
Using Housing Market Impact and Objective Data on Crimes Against Neighbors

Assumptions in Calculation	Estimated Victimization Cost
Baseline Assumptions	$1,176,000
Lower Risk Aversion (λ=1)	$2,031,100
Higher Risk Aversion (λ=3)	$839,000
Fewer Neighbors (60)	$1,016,100
More Neighbors (180)	$1,259,000
Fewer Offenses by Neighbors (100% of NCVS)	$2,353,000
More Offenses by Neighbors (300% of NCVS)	$588,100
Systematic Overestimation of Risk: Housholds Neglect to Realize that Risk is Spread Among Neighbors	$66,700

Note: Baseline assumptions are as follows: (1) utility function with constant absolute risk aversion equal to 2, (2) lifetime wealth equals $1.575 million, (3) housing market discount equals $4,750, (4) neighborhood risk is spread among 120 neighbors, (5) the fraction of crimes committed against neighbors is 200% of the reported rates in the NCVS.

Outline

Internalities: Addiction Behaviors

- Internal costs of smoking cigarettes dwarf the external costs
- Is Pigouvian taxation relevant?
- Highly sensitive to positive model of addiction
- Challenge: difficult to determine which model is right empirically

Becker & Murphy (1988)

- Show that addictive goods can be modeled in perfectly rational framework
- Dynamic model with habit formation
- Current consumption of the addictive good decreases long-run utility but increases marginal utility of consumption tomorrow
- If discount rate high enough, rationally choose to become addicted.
- Implication: no reason for special taxes on these goods; set taxes according to Ramsey rules.

Gruber & Koszegi (2004)

- Hyperbolic discounting preferences for smokers

$$U_0 = u(c_0) + \beta \sum_{t \geq 1} \gamma^t u(c_t) \text{ with } \beta \leq 1$$

$$U_0 = u(c_1) + \beta \sum_{t \geq 2} \gamma^t u(c_t)$$

- Planner maximizes U_0 with $\beta = 1$ (true utility).
- Individuals overconsume c: fail to take full account of harm to future selves.
- Taxes reduce demand for each self can partly correct the internality. Calibration implies corrective tax should be very large.