

Assessing Externalities

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Lecture 8
Turbo Section
Elements of Economic Analysis II
Fall 2011

Introduction

Last class, we concluded that information is key

- Assessing externalities requires collecting right info
- This typically comes from several different sources:
 - ① Some is scientific, technical, etc.: usually best by expertise
 - ② Some information is subjective, held by affected individuals
 - Problematic for policy: given incentive to reveal
- Today we'll see how to combine, trade-offs between
 - ① Benefit-cost analysis as encompassing framework
 - ② Role of technical studies and value of life and health
 - ③ Example: Stern Review of Economics of Climate Change
 - ④ Types of useful subjective and private information
 - ⑤ Contingent valuation approaches: a naïve first pass
 - ⑥ The Vickrey-Clarke-Groves mechanism
 - ⑦ VCG problems and trade-offs of assessing externalities

Benefit-cost analysis and policy evaluation

Benefit-cost analysis is common paradigm for policy evaluation

- Supported by economists, lines up well with economics
- Emphasizes importance of trade-offs, pro's and con's
- Applied to a wide range of decisions:
 - Instituting regulations, building public projects
 - For us: externalities, cap levels, damages
 - Here evaluation to determine harms, optimal level
- Analyses involve many different dimensions:
 - 1 Direct harms on economic resources
 - Gauge amount of destruction, market value of this
 - 2 Limits on utilization of existing resources
 - Requires assessing market value of different uses
 - 3 Effects on human life and health: more soon
 - 4 Intangible harms on subjectively-valued resources
 - Inherent (from ethical theory) or derived (from individuals)

Tying technical and engineering studies to economics

Crucial element in evaluating is technical

- What physical harms, benefits actually follow
- Typically requires detailed knowledge of (among others)
 - 1 Physics:
 - What are chances of nuclear reactor spilling over?
 - 2 Chemistry:
 - How much SO_2 causes how much acid rain?
 - 3 Epidemiology:
 - How much does vaccination reduce others infections?
- But all this useless without economic back-end:
 - 1 How much should we value land lost to Fukushima?
 - 2 How valuable are crops destroyed by acid rain?
 - 3 How much are lives, health ruined by disease worth?

⇒ Every study combines economics, science

Leading example: the value of human life and health

Perhaps most famous economic input is value of human life

- This is quite controversial as some say “life is invaluable”
- But if this were true, no one would drive a car
 - To choose what is worth investing in, need standard
- Clearly, people make trade-offs that risk their lives often
- How much they will pay to reduce risks depends on income
 - Wealth have more to spend, more to lose
 - Marginal utility of money declines, but of life constant
- ⇒ Rich person’s life “worth more” than a poor person’s
 - May seem unjust, but just one more thing money buys
 - Redistribute, if you want, but don’t distort trade-offs
- Thus three categories must be measured:
 - 1 Value of life (statistical, per unit probability)
 - 2 Value of other types of injuries, diseases
 - 3 Income elasticity (to extrapolate): about .6 – .8

Approaches to measuring value of statistical life

Usual approach to measuring is:

- 1 Assume value is on life, state, not how it happens
 - Crucial assumption, basis of all numbers
 - Problematic if injury process painful, degrading
- 2 Look for cases where people make trade-offs
 - Deciding whether to take dangerous work (like mining)
 - Deciding how safe of a car to purchase
- 3 Price difference measures willingness-to-pay of...
 - *Marginal person just indifferent between two choices*
- 4 Assume everyone cares same amount as marginal

Obviously problematic in many ways but...

- This is about all we have; even rough rules out crazy things
 - Some programs cost orders of magnitude more or less
- Also surveys, but equally problematic (see below)

Estimates of statistical value of life

Author (Year)	Sample	Risk Variable	Mean Risk	Nonfatal Risk Incl?	Workers' Comp Incl?	Avg Income Level (1990 U.S. \$)	Implicit Value of Life (\$ million)	Implicit Value of Life for Air Travelers (\$ million)
R. S. Smith (1974)	Industry data: Census of Manufacturers, U.S. Census, Employment and Earnings	Bureau of Labor Statistics (BLS)	NA	Yes	No	22,640	7.2	11.0
Thaler & Rosen (1976)	Survey of Economic Opportunity	Society of Actuaries	0.001	No	No	27,034	0.8	1.0
R. S. Smith (1976)	Current Population Survey (CPS), 1967, 1973	BLS	0.0001	Yes, not signif.	No	NA	4.6	NA
Viscusi (1978a, 1979)	Survey of Working Conditions, 1969-1970 (SWC)	BLS, subjective risk of job (SWC)	0.0001	Yes, signif.	No	24,834	4.1	5.7
Charles Brown (1980)	National Longitudinal Survey of Young Men 1966-71, 1973	Society of Actuaries	0.002	No	No	NA	1.5	NA
Viscusi (1981)	Panel Study of Income Dynamics, 1976	BLS	0.0001	Yes, signif.	No	17,640	6.5	12.8
Craig Olson (1981)	CPS 1978	BLS	0.0001	Yes, signif.	No	NA	5.2	NA
Alan Marin & George Psacharopoulos (1982)	U.K. Office of Population Censuses and Surveys, 1977	Occupational Mortality U.K.	0.0001	No	No	11,287	2.8	8.1
Richard Arnold & Len Nichols (1983)	U.S. Census	Society of Actuaries	0.001	No	Yes	NA	0.9	NA
Richard Butler (1983)	S.C. Workers' Compensation Data 1940-69	S.C. Workers' Compensation Claims Data	0.00005	No	Yes	NA	1.1	NA
J. Paul Leigh & Roger Folsom (1984)	Panel Study of Income Dynamics, 1974; Quality of Employment Survey (QES) 1977	BLS	0.0001	Yes	No	27,693, 28,734	9.7 10.3	11.0 11.7
V. Kerry Smith and Carol Gilbert (1984)	CPS 1978	BLS	NA	No	No	NA	0.7	NA
Alan Dillingham (1985)	QES 1977	BLS; Constructed by author	0.000008, 0.00014	No	No	20,848	2.5-5.3, 0.9	4.2-8.8, 1.5

Stern Review goals

Perhaps most ambitious BCA of all time was *Stern Review*

- Commissioned by British government, with others
- Goal: evaluate economic B's and C's of climate change
- Many stages?
 - 1 Determine largest sources of greenhouse gases?
 - Methane from animals, carbon from energy, deforestation
 - 2 Determine effects of gases on global climate?
 - Use large-scale climate models, filled with uncertainty
 - ⇒ *Distribution* of conditional outcomes
 - 3 Determine economic effects of changes?
 - Disasters, productivity of farm land, direct harms
 - 4 Determine extent to which adaptation mitigates?
 - Helpful, but institutions lack; Dust Bowl study
 - 5 Similar for other impacts?
 - Salinification of oceans, ecosystems, etc.

Externality and optimal level calculations

Corresponding to Cap and Trade v. Tax, two approaches?

- 1 Marginal harm from carbon, given business as usual
 - Benefits: no estimates of technology costs needed
 - Thus simpler, less assumptions needed
 - Drawbacks: effects highly non-linear
 - Large effects catastrophic, mild not too bad
 - Most harm comes from catastrophic effects
 - Estimate: \$85 per tonne
- 2 Socially optimal level of carbon
 - Advantages: deals with non-linearity
 - Drawbacks: requires understanding technology better
 - Estimate: optimal to stabilize at 450-550 ppm

Most helpful because illustrates how hard this is!

- Example: geo-engineering eliminates catastrophes?

What's missing from the Stern Review?

Stern Review focuses on “hard” economic costs; leaves out

- 1 Do people like being warmer, cooler, rain, etc.?
 - Sounds frivolous, but CA v. Chicago real estate
- 2 How much do people care about animals?
 - Potential to cause massive extinctions
- 3 Value on civilizations, cities destroyed
 - We put a lot of value on culture preservation, etc.
- 4 Private knowledge about agriculture, mitigation innovations

All of these share that science, expertise not enough

- True for broad class of cases:
 - 1 Subjective existence values (environment or culture)
 - Can be assigned by expert, but some prefer via individuals
 - 2 Personally/privately valued property, consumption
 - 3 Local information about technology, impacts

Contingent valuation surveys

When such information *genuinely important* try to elicit

- Careful that not just opinions, guesses, etc.
- Goal is information, not “individual’s value defines”
- For example, inherent value of cultures:
 - Do these come from how individuals or “society” values?
 - Which one determines if individuals or anthropologist better
- When we do need information, why not ask?
 - Simple, traditional approach has long history
 - Called *contingent valuation*; done via surveys
 - 1 Describe different situations
 - 2 Ask individuals how much they’d pay for one over other
 - 3 Impute this as true willingness to pay
 - Most commonly used as for environmental issues
 - Also used for value of creating transport, public goods

Practical examples of surveys and related approaches

Classic examples of contingent valuation?

- 1 Payment for preserving visibility at Grand Canyon
- 2 Preserving seals and whales in ocean
- 3 Avoiding logging in national forests
- 4 Value of bird killed by Exxon Valdez
- 5 Value of preserving languages of indigenous cultures
- 6 Value of new building in a city

Commissioned by regulatory agencies, courts

- Benefit-cost analysis for externalities, regulations, actions
- Also used to assess damages from oil spills, etc.

These are formal, money-based surveys, but informal too:

- Surveys of public opinions often influence politicians
- Not exactly the same as contingent valuation...binary
- But have some significant similarities, impacts

Traditional criticism of contingent valuation

Such surveys are in low repute among economists; why?

- 1 People don't take these seriously
 - How would you take a question like this?
- 2 People answer wrong question: overall evaluation
 - What we want is harm/WTP of *that individual personally*
 - Most people make casual, overall social evaluation
- 3 People don't have any idea, information, experience
 - Takes a lot of reflection to determine value for these things
- 4 People's answers motivated by "warm glow"
 - Many feel good about thinking they value these things
 - This may be main cause of their answers
- 5 Responses highly inconsistent, apparently irrational
 - Depend on order, grouping, etc: how to interpret?
- 6 No incentives to get things right, no experience

Strategic problem: why contingent valuation can't work

Actually, much worse than this; what are incentives?

- Depends on what survey is used for
 - ① What if no one takes survey seriously?
 - Then no incentives, but why take survey in first place?
 - Probably true right now, in which case pure waste
 - ② Survey has major impact on public policy?
 - In this case, large incentives!
 - If you want preservation, report huge number
 - If you want no preservation, report \$0

⇒ Never a real incentive to report truthfully

- Great example from Haiti in *The Economist*
 - After quake, reporter asked if people got supplies
 - Everyone said no, but later saw people had!
 - Only way to make sure aid keeps flow is to lie

Eliciting information: the incentive problem

⇒ If we want to take seriously, need to consider *incentives*

- Suppose know private net benefits $B(q)$ of activity
 - We want to determine socially optimal amount q^*
 - Each individual knows harm to them of activity $h_i(q)$
 - Total harm is $H(q) \equiv \sum_{i=1}^N h_i(q)$
 - q^* , optimal cap, maximizes $B(q) - H(q)$
 - How can we get people to tell truth about harms?
 - One approach pushes question back another layer
 - My reporting $h_i = \hat{h}$ is an action, like others
 - If I pay externalities of action, I will do what is best
 - What are *externalities* of my reporting \hat{h} v. 0?
 - If 0, then q^* maximizes $B(q) - \sum_{j \neq i} h_j(q)$, call q_{-i}^*
 - With \hat{h} , q^* maximizes $B(q) - \sum_{j \neq i} h_j(q) - \hat{h}(q)$, call \hat{q}^*
- ⇒ Externality is $B(q_{-i}^*) - B(\hat{q}^*) + \sum_{j \neq i} h_j(q_{-i}^*) - \sum_{j \neq i} h_j(\hat{q}^*)$

The Vickrey-Clarke-Groves Mechanism

The *Vickrey-Clarke-Groves Mechanism* asks people to pay this

The Vickrey-Clark-Groves (VCG) Mechanism

- 1 Everyone reports h_i
- 2 Cap is set at q^* maximizing $B(q) - H(q)$
- 3 Each individual pays
 $B(q_{-i}^*) - B(\hat{q}^*) + \sum_{j \neq i} h_j(q_{-i}^*) - \sum_{j \neq i} h_j(\hat{q}^*)$
- 4 May receive (make) other payment independent of h_i

Two important notes:

- 1 Individuals need not report full h_i , only their information
 - Truthful in interest, but need not know everything
- 2 Externalities *paid to state not those who are harmed*
 - Otherwise, incentive to lie to make harm (look) bigger

Graphical illustration of VCG

Practical applications of VCG

Most common use of VCG is *second-price auction*?

- Suppose everyone bids for for some object
- If winner pays bid of second-highest, that is his externality
 - Externality created is that the other guy doesn't get it
- Note that you want to bid your value v_i
 - 1 Conditional on winning/lose, doesn't affect payment
 - 2 Never want to bid lower and lose: could have won below v_i
 - 3 Never want to bid higher and win: would have paid above v_i
- Multi-unit (package) auctions sometimes use
- Also course selection: artificial currency for classes
- Many proposals to use, but very uncommon in practice
- Example is land assembly: alternative to eminent domain
 - Offer made, values reported, sale if offer above values
 - Pay for vetoing assembly: $o > \sum_{j \neq i} v_j$ but $o < \sum_{j \neq i} v_j + v_i$

Why VCG isn't used more often?

The VCG mechanism is elegant (lovely) but rare (lonely); why?

- 1 What to do with the leftover money?
 - Payments *must go to government not individuals*
 - Maybe this is fine if only a few people are affected
 - But many externalities affect large numbers
 - In this case, government can't use money
 - This effectively ruins efficiency and always redistributes
- 2 Collusion
 - Even worse, two people ruin everything
 - Two extreme changes outcome with externality
 - Thus just two colluders can cause terrible trouble
- 3 De-merger problem
 - Even worse if one person can pretend to be two!
 - Then even one person can ruin system

⇒ In practice, VCG is a disaster

The source of VCG's problems

Why does VCG go so badly wrong?

- All the problems are basically the same
 - Under VCG, others' say externality you cause
 - Yet they are incentivized only to get outcome right
 - 1 Can't give them payments, or they'd want to lie
 - 2 If you collude with them, overwhelm their incentives

⇒ What we need is either:

- 1 Some objective information somewhere down the line
 - 2 To make people "prove" others exert externalities on them
- These are actually closely related
 - If one person is going to pay for saying another did wrong...
 - Then need to know about what other might do
 - So we need to bring back objective information
 - We may be able to determine *expected externality*

Is VCG necessary? Expected externalities are enough

In fact, a famous theorem shows that:

- If a system is efficient, then anyone changing decision...
- Must pay average externality caused by that change
 - VCG does because everyone pays their exact externality
 - But don't need this
 - Enough that individuals pay *their expected externality*
- If this is not based on others' information then:
 - 1 You can give money back, no problem
 - 2 No more collusion issues
- More places use expected, less collusion, more given back
 - Sometimes, expected externality doesn't require too much
 - Example: first-price, sealed-bid auction
 - Incentive to bid best guess of next highest value
 - In other circumstances, examples like this

Combining expertise and private information

Summing up, no solution is perfect:

1 Scientific and technical studies

- Advantage: good incentives, incorporates expertise
- Disadvantage: leaves out subjective, private information

2 Contingent valuation surveys

- Advantage: tries elicit private information
- Disadvantage: incentives misaligned, not serious

3 VCG mechanism

- Advantage: simple, powerful, robust individual incentives
- Disadvantage: practical problems, collective incentives

4 Expected externality mechanism

- Advantage: Much more practically useful, when feasible
- Disadvantage: not always obvious how to make work

⇒ Practice should be flexible, combine approaches

- And be open to less clean alternatives, like voting