Undergraduate Public Finance:
Cost Benefit Analysis

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Economics is often referred to as **the dismal science**.

"In modern discourse, the term can refer to the fact that economics invariably involves the study of scarcity, conflict, and trade-offs, leading to conclusions and policy recommendations that may highlight limitations and negative aspects of human behavior and societal organization."

(Source: *Wikipedia*)

Cost-Benefit Analysis

This expression is not a misnomer.

At the heart of economics is the wish to quantify the trade-offs associated with public projects and policies.

To do so, economists rely on cost-benefit analysis.

Cost-benefit analysis: The comparison of costs and benefits of public goods projects to decide if they should be undertaken.

A Difficult Task

Quantifying the costs and benefits of projects is often a complex endeavor...

- How do we translate theoretical concepts into real numbers?
  - e.g., the sum of marginal rates of substitution = social marginal benefit
- Requires value judgments about what society cares about
- Requires credible public policy evaluation (“causal” estimates)
- Most benefits are in the future, but most costs are in the present

A Concrete Example

Consider the case of a highway. Cost includes wages and materials.

What if, without this highway project, half of the workers on the project would be unemployed?

How can the government take into account that it is not only paying wages but also providing a new job opportunity for these workers?

What is the value of the time saved for commuters due to reduced traffic jams?

And what is the value to society of the reduced number of deaths if the highway is improved?

TABLE 8-1

Cost-Benefit Analysis of Highway Construction Project

		Quantity	Price/Value	Total
Costs	Asphalt	1 million bags		
	Labor	1 million hours		
	Maintenance	$10 million/year		
			First-year cost:	
			Total cost over time:	
Benefits	Driving time saved	500,000 hours/year		
	Lives saved	5 lives/year		
			First-year benefit:	
			Total benefit over time:	
			Benefit over time minus cost over time:	

Let's start with measuring costs...

Measuring Current Costs

Cash-flow accounting: Accounting method that calculates costs solely by adding up what the government pays for inputs to a project, and calculates benefits solely by adding up income or government revenues generated by the project.

Opportunity cost: The social marginal cost of any resource is the value of that resource in its next best use.

Perfect vs. Imperfect Markets

As a general rule, economic costs are only those costs associated with diverting the resource from its next best use.

If labor market is perfectly competitive the social economic cost of an hour of labor used is the market wage

If labor market is imperfect and wages are above the efficient level, then the social marginal cost is calculated as the next best wage the worker could get if he/she is not employed in the provision of the public good

Imperfect Markets (Our Example)

Suppose that the minimum wage of construction workers is \$15/hour.

The market wage is \$10/hour for all other workers.

The opportunity cost of this project is the next best alternative for the construction workers who join the project, which is the \$10 they could have earned elsewhere. The cost is:

$$\$10/\text{hour} \times (1 \text{ mill hours}) = \$10 \text{ million}$$

Of the \$15 million actually paid, \$5 million is transfer of rents from government to workers and is not counted as a true economic cost of the project.

Measuring Future Costs

Present discounted value (PDV): A dollar next year is worth $1 + r$ times less than a dollar now because the dollar could earn r in interest if invested.

Maintenance cost of F in perpetuity as PDV of

$$\sum_{t=1}^{\infty} \frac{F}{(1+r)^t} = \frac{F}{1+r} + \frac{F}{(1+r)^2} + \frac{F}{(1+r)^3} + ... = \frac{F}{r} \qquad (1)$$

Longrun Social Discounting

Social discount rate: The appropriate value of r for computing PDV for social investments.

Two reasons for discounting \$1 in the future relative to \$1 today:

1) Absolute discounting: people prefer \$1 now than \$1 in one year

However, on ethical grounds, it is unclear why we should discount future generations relative to the current generation (extinction risk?)

2) Economic growth makes future generations richer so \$1 extra means less for them than for us.

In an ideal world, those two effects are embodied in interest rate r, so we just need to take the current r to discount

Longrun Social Discounting

The problem is that we don't know how growth (and hence r) is going to evolve over the next 100 years!

If the economy collapses due to global warming, future people will be poor and we don't want to discount

A simple example:

Zero growth: 50% probability: $r = 0\%$: \$1 in 100 years = \$1 now

Normal growth: 50% probability: $r = 3\%$: \$1 in 100 year = \$.052 now

\$1 in 100 years worth on average now: $.5 \cdot \$1 + .5\$ \cdot .052 = \$.552$

Implied discount rate $\bar{r}$ such $(1 + \bar{r})^{-100} = .552 \Rightarrow \bar{r} = .6\%$

$\Rightarrow$ We should use low discounting for distant future is there is a chance that growth will stop (Weitzman 1998)

TABLE 8-2

Cost-Benefit Analysis of Highway Construction Project

		Quantity	Price/Value	Total
Costs	Asphalt	1 million bags	$100/bag	$100 million
	Labor	1 million hours	$10/hour	$10 million
	Maintenance	$10 million/year	7% discount rate	$143 million
			First-year cost:	**$110 million**
			Total cost over time:	**$253 million**
Benefits	Driving time saved	500,000 hours/year		
	Lives saved	5 lives/year		
			First-year benefit:	
			Total benefit over time:	
			Benefit over time minus cost over time:	

Now that we've covered costs let's turn to benefits...

Market-Based Measures to Value Time

If individuals optimize their labor supply decisions, the value of hourly wages equals the value of one extra hour of leisure they must give up.

This theoretical proposition runs into some problems in practice:

1) Individuals may be unable to trade off leisure and hours of work freely.

e.g., jobs usually come with hours restrictions (40-hour work week)

2) Not all hours have the same value. One hour sitting in traffic is worse than losing one hour of leisure

⇒ The value of reducing traffic is higher than the time saved!

Survey-Based Measures to Value Time

Contingent valuation: Eliciting individuals' willingness to pay (WTP) for an option they are not currently choosing or do not have access to.

The method is particularly useful when no market price exists, but we still need a monetary value for cost–benefit analysis.

Some examples:

- How should we value saving endangered species?
- What is the value of keeping the Arctic pristine?

The Problems of Contingent Valuation

The structure of contingent valuation surveys can lead to widely varying responses (Diamond and Hausman)

Main issues:

1) **Dishonest answers**: People don't have to pay, so they can easily exaggerate the value. If they do have to pay, I let you guess...

2) **Isolation of issues**: Different value for sum of single issues or issues asked in combination.

3) **Order of issues**: Asking about an issue first or second changes its reported value.

4) **The "embedding effect"**: Asking about different location sites or variances in the scope of the project does not affect answers.

On a deeper level, we can only make rational allocation decisions by looking at all the issues simultaneously: allocate a (fixed) budget among all causes.

→ With the big picture in mind, the trade-offs become much more apparent!

Asking people cause by cause does not make sense for evaluating the benefits of public policy decisions...

The government is best placed to make this allocation.

Using Revealed Preference to Value Time

Revealed preference: Letting the actions of individuals reveal their valuation (also called the *hedonic* approach)

Market prices potentially reveal preference: If people are willing to pay P for something, then it is worth at least P to them.

⇒ By far the preferred approach of economists

e.g., How much do commuters value reductions in commuting time?

Price differences between houses close and far from downtown might reflect the value of commuting time.

Valuing people's time is already better than discussing ice creams and cookies, but we are now going to discuss a very thorny yet policy-relevant problem: valuing people's lives.

Valuing Saved Lives

Valuing human lives is the single most difficult issue in cost-benefit analysis and raises (many) ethical issues

However, virtually any government expenditure has some odds of saving a life (e.g., making roads safer, health care, etc.)

Scarcity of resources means we cannot afford to pursue all projects

⇒ In some cases, we need to be able to place some value on a statistical human life

Contrast between a statistical life (fewer deaths in accidents) and a real life (one specific person at risk)

⇒ If it is possible to set a value on a statistical life, it is not on a real life.

Application: The General Motors Scandal

Some General Motors pickup trucks produced between 1973 and 1987 had a dangerous, side-mounted gas tank.

1993: Consumer groups demanded GM recall 5 models of cars.

Recall would cost \$1 billion and would save at most 32 lives. Using these estimates, the cost per life saved by the recall would have been \$1 billion/32 = \$31.25 million.

GM agreed with the government to invest instead \$50 million to support education programs about seat belts and drunk driving, to buy 200,000 child seats for low-income families, and undertake research into burn and trauma treatment

Estimated that child seat alone saved 50 lives>cost per life saved= \$1million instead of \$31 million

How can we value saved lives?

Lifetime Wages: Life's value is the present discounted value of the lifetime stream of earnings.

Contingent Valuation: Ask individuals what their lives are worth.

Revealed Preferences: Estimate the extra cost consumers pay for a product that reduces the risk of death by a quantifiable amount.

Valuing Saved Lives

We can value life by estimating how much individuals are willing to pay for something that reduces their odds of dying.

Compensating differentials: Additional (or reduced) wage payments to workers to compensate them for the negative (or positive) amenities of a job, such as increased risk of mortality (or a nicer location).

e.g., bonus of $10K needed to recruit soldiers during Afghanistan-Irak wars (relative to peacetime). Afghanistan-Irak wars carries an extra 1/1000 odd of dying $\Rightarrow$ Value of life would be $10K/.001=$10m

In the US, a statistical life is valued at 9.6 million dollars.

A Note of Caution

The revealed preference approach has (many) limitations:

- Requires people to be rational
- Assumes perfect information
- Measures the value of life for the marginal person willing to take this additional risk (may not represent average preferences in society)
- In general, the price is not the value of a thing. Our societies just haven't found a better metric.

  e.g., in a market for slaves, human lives also have a price

For a deeper discussion, see this lecture by Michael Sandel.

TABLE 8-3

Cost per Life Saved of Various Regulations

Regulation concerning . . .	Year	Agency	Cost per Life Saved (millions, in 2015 dollars)
Childproof lighters	1993	CPSC	$0.13
Food labeling	1993	FDA	0.5
Reflective devices for heavy trucks	1999	NHTSA	1.2
Children's sleepwear flammability	1973	CPSC	2.9
Rear/up/shoulder seatbelts in cars	1989	NHTSA	5.9
Asbestos	1972	OSHA	7.4
VALUE OF STATISTICAL LIFE			**9.6**
Benzene	1987	OSHA	29.0
Asbestos ban	1989	EPA	102.8
Solid waste disposal facilities	1991	EPA	131.9
Cattle feed	1979	FDA	224.1

Data from: Morrall (2003), Table 2, updated to 2015 dollars.

Trading-off time saved and value of life: speeding limits

Speeding limits reduce traffic fatalities but increase travel time

Ashenfelter and Greenstone JPE'04 analyze speed limits:

In 1987, the federal government allowed states to raise the speed limit from 55 mph to 65 mph in rural highways ⇒ 21 states adopted higher speed limit

The 65 mph limit increased speeds by approximately 3.5%, and increased fatality rates by roughly 35% ⇒ 125,000 hours of travel time were saved per lost life

Valuing the time saved at the average hourly wage implies that adopting states were willing to accept risks that resulted in a savings of $1.54 million (1997$) per fatality

⇒ Those states were valuing a life saved at $1.54 million at most

TABLE 8-4

Cost-Benefit Analysis of Highway Construction Project

		Quantity	Price/Value	Total
Costs	Asphalt	1 million bags	$100/bag	$100 million
	Labor	1 million hours	$10/hour	$10 million
	Maintenance	$10 million/year	7% discount rate	$143 million
			First-year cost:	**$110 million**
			Total cost over time (7% discount rate):	**$253 million**
Benefits	Driving time saved	500,000 hours/year	$22.70/hour	$11.4 million
	Lives saved	5 lives/year	$9.6 million/life	$48 million
			First-year benefit:	**$59.4 million**
			Total benefit over time (7% discount rate):	**$848.6 million**
			Benefit over time minus cost over time:	**$595.6 million**

Other Issues in Cost Benefit Analysis

Common Counting Mistakes: When analyzing costs and benefits, a number of common mistakes arise, such as:

- Counting secondary benefits (e.g., more commerce activity around new highway comes at the expense of other places)
- Counting labor as a benefit (e.g., labor is a cost, jobs created means those workers do not produce something else)
- Double-counting benefits (e.g., rise in house values due to reduced commuting time)

Distributional Concerns: The costs and benefits of a public project do not necessarily accrue to the same individuals.

Uncertainty: The costs and benefits of public projects are often highly uncertain.

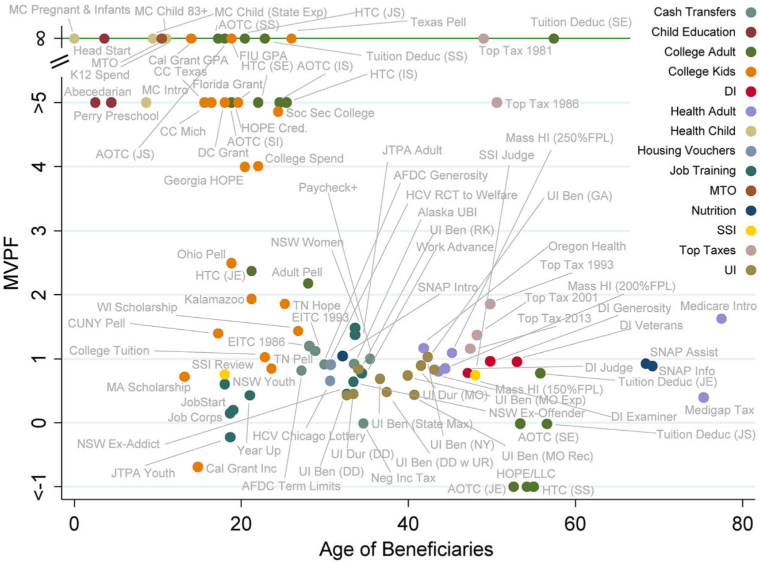
Modern Cost Benefit Analysis

Currently, many economists rely on the Marginal Value of Public Funds:

$$MVPF_j = \frac{\sum_i WTP_i^j}{G_j} = \frac{WTP^j}{Net\ Cost}.$$

Represents the amount of welfare that can be delivered to policy beneficiaries per dollar of government spending on the policy

⇒ It measures the "bang per buck" of public policy interventions



See the website Policy Impacts for other, detailed real-life examples.

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