

Benefit-Cost Analysis of Mitigation: A Review of the State of the Art

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Abstract

- Many proponents of disaster mitigation claim that it offers potential benefits in terms of saved lives and property far exceeding its costs. To provide evidence for this, and to justify the use of public funds, agencies involved in mitigation can use benefit cost analysis. Such analysis, if well done, offers a testable, defensible means of evaluating and comparing projects, it helps decision makers choose between mitigation projects, and provides a means to assess the way we spend public funds. In this critical overview of key elements and latest developments in benefit cost analysis, I emphasize the pragmatic choices that one can make according to good practice in project evaluation.

Introduction

- The largest share of disaster expenditures is on response, relief and recovery.
- Disaster mitigation is about 10% of total disaster expenditures in the US.
- Despite massive expenditures on insurance in the US, individuals and authorities would rather react to disasters than anticipate and mitigate them.

Mitigation vs. Avoidance and Preparedness

- Traditional distinction made between mitigation (reducing impact of disaster,) avoidance (eliminating some impacts of disaster,) and preparedness (reducing costs of responding to disaster,) is somewhat arbitrary and unhelpful.
- Mitigation is any action taken before a disaster to reduce subsequent losses.

Mitigation is an Investment

- Mitigation is like saving, or investing, since it involves committing present resources (and consequently lower present consumption) in order to reduce losses, or increase available resources, in the future.
- Therefore we must determine the present value of the expected future net benefits from mitigation.
- Benefit-Cost Analysis (BCA) is an appropriate tool to calculate this.

Valuing Mitigation is Informative

- Using BCA to determine the value of mitigation is necessary to
 - Place a dollar value on net benefits.
 - Identify and quantify gains and losses
 - Justify and defend expenditures in a tight fiscal environment.
 - Compare mitigation activities and rank alternatives.

Mitigation is an Investment

- Most costs are present and known.
- Benefits occur in the future and are uncertain.
- We should apply the same thinking about mitigation as we would about any investment.
- Leads to a focus on present value of future net benefits.

Theoretical Basis of BCA

- Most programs have benefits and costs.
- Calculate net benefits (gainers – losers.)
- Is compensation necessary for losers?
- Measurement a large problem.

Theory I – Net Benefits

- Nearly every project will create benefits and costs
 - Benefits: increases in well-being for some
 - Costs: decreases in well-being for some
- Gainers and losers not always the same people.
- Transfers are netted-out and do not contribute to net benefits.
- Accounting method somewhat arbitrary since a cost is a negative benefit. Aim for consistency.

Theory II - Compensation

- Strictly BCA does not require losses from project to be compensated.
- Politically compensation may be required, or desired.
- Project should be evaluated with compensation if there is a reasonable expectation it will actually occur.

Theory III - Measurement

- Benefits measured as willingness to pay
 - What would someone give up (measured in equivalent \$) in order to receive that benefit?
 - Market bid prices directly measure this*.
- Costs measured as opportunity costs
 - What is the value of the resources used in project in their best alternative use?
 - Market ask prices directly measure this*.
- *But not always: alternatives to market prices exist to measure value.

What about Cost-Effectiveness?

- A sub-set of BCA
- Measures costs of producing a particular level, or change, of a specific benefit. (eg reducing one life lost.)
- Most applicable when benefits are not easily measured or monetized, but avoids the hard choices implicit in real-world decisions.

Benefit-Cost Analysis

- The procedure:
 - Decide on standing (who's benefits and costs)
 - Catalog impacts and select measures
 - Predict impacts over life of project
 - Monetize all measures
 - Discount to obtain present values
 - Sum discounted benefits and costs
 - Undertake sensitivity analysis

Remember!

- Evaluating a mitigation program involves calculating losses avoided (a counterfactual.)
- Generally the analyst measures the losses (and gains if any) that would have occurred without mitigation, and those with mitigation, then calculate the differences.
- Since most projects are forward-looking, both losses without, and those with mitigation, involve uncertainty, making the task all the more difficult.

Issues I - Standing

- Those suffering potential direct impacts:
 - Such as loss of housing, property and injury.
- Those suffering potential indirect impacts:
 - Business disruption (work, shopping)
 - Caution, fear, suspicion
 - Historical, cultural values
 - Environmental impacts (health effects, also natural resources)
- Pragmatism: those closest (physically, temporally, economically) should be identified and measured first.
- Transfers net out, unless we treat beneficiaries differently to contributors.
 - Then we must do social-welfare weighted BCA.

Issues II – Monetizing impacts

Alternative methods to monetize, depending on availability of data, and characteristics of markets.

- Market prices
 - Most appropriate when analyst is reasonably certain prices reflect true values (no market failure present.)
- Shadow prices
 - Usually calculated by using a model of the relevant economic system (Input-Output, Linear Programming, General Equilibrium, HAZUS are examples.)
- Opportunity costs
 - Used when direct value measure is unavailable, but a comparable alternative is.

Issues II – Monetizing (cont.)

Indirect methods

- Revealed preference (based on observed behavior)
 - Travel cost (values of related, complementary activities)
 - Hedonic (values implicit in observed prices, usually housing)
- Stated preference (based on intended behavior)
 - Choice modeling (bundles of characteristics, including price, are ranked and analyzed)
 - Contingent Valuation (a given change in quantity is offered at various prices, and usually presented as a referendum)
- All methods involved quite sophisticated statistical modeling and estimation. All are controversial and relatively expensive to undertake carefully.

Issues III – All impacts?

- Direct and indirect impacts
 - Must go beyond insured values as insurance markets are notoriously incomplete.
 - Sample data may be used to determine “factors” to impute indirect impacts from direct.
- Market and non-market values
 - Many goods and services are not traded explicitly, so non-market values must be imputed.
- Use and non-use (existence) values
 - Considerable evidence that people value to option, and existence of items even if they do not directly use them (e.g. preserving the flow of the Colorado River through the Grand Canyon.)
- Pragmatism: Limits on resources available to do study means impacts must be prioritized. Some impacts will be left unmeasured.

Other Issues

- Uncertainty
 - Uncertainty arises from many sources:
 - Measurement error
 - Uncertain timing and severity of hazard
 - Uncertain losses from hazard
 - Uncertain impact/effectiveness of mitigation
 - Sophisticated methods exist to account for uncertainty, but each with extensive data or computational needs. Uncertainty cannot be dealt with simply.

Other Issues (cont.)

- Discounting
 - Futures net benefits should be expressed in current dollars to reflect alternative opportunities and account for time preference.
 - OMB A-94 regularly publishes the government discount rates (serves as reference.)
 - Care should be taken to use matching rate: real rate for real dollar measures (most common,) nominal for nominal.
 - Alternative discount rates should be used in sensitivity analysis.

Other Issues (cont.)

- Sensitivity analysis
 - Not the same thing as dealing with uncertainty. Should be treated separately.
 - All major assumptions and key factors (such as discount rate) should be subject to sensitivity analysis.
 - Extreme sensitivity suggests problems with analysis or measurement.

Beyond Benefit Cost

- BCA must be seen as an input to a larger decision process.
- Decision is physical, economic, political, social, emotional.
- BCA is better than nothing, but badly done BCA is misleading at best, dishonest at worst.

Further Reading

- Adler, Matthew D. and Eric A Posner: 2001, *Cost Benefit Analysis: Legal, Economic and Philosophical Perspectives* University of Chicago Press, Chicago
- Boardman, Anthony E., David H. Greenberg, Aidan, R. Vining and David L. Weimer: 2001, *Cost-Benefit Analysis*, 2nd Ed. Prentice Hall, New Jersey
- Layard, R. and Glaister, S. 1994 *Cost-Benefit Analysis* Cambridge University Press, Oxford
- Zerbe, Richard O. and Dwight D. Dively: 1994, *Benefit-Cost Analysis in theory and practice* Harper Collins College Publishers, New York