

Master of Science in Sustainability Management

Cost Benefit Analysis - PS5020

3 Credits

Instructor: Satyajit Bose

Course Overview

Cost-Benefit Analysis (CBA) is a policy assessment method that quantifies the value of policy consequences (usually called impacts) in monetary terms to all members of society. The purpose of a CBA is to help effective social decision making through efficient allocation of society's resources when markets fail. When markets fail and resources are used inefficiently, CBA can be used to clarify which of the potential alternative programs, policies or projects (including the status quo) is the most efficient.

The course introduces practitioners of environmental science and sustainability management to the techniques of preparing a CBA, including microeconomic foundations, valuation methods, discounting, the impact of uncertainty and optionality, and distributional consequences. The course provides a basic introduction to revealed preference, contingent valuation and benefits transfer method of valuing environmental impacts.

The use and interpretation of CBA in specific cases is critically evaluated, with a detailed examination of alternative approaches. Worked examples and case studies are integral to each topic. Although the techniques of CBA are generally associated with social decision-making, we will examine case studies involving both social and private decisions.

in the course. Those who have not had such preparation will need to work hard to absorb the theoretical concepts along with the applications. However, it is not uncommon for students with little economics preparation to excel in a course on CBA. In the absence of any economics preparation, it is useful to have some mathematical fluency. If you are concerned about your level of mathematics preparation, you are strongly encouraged to attend the Math Camp provided before the start of the Fall semester.

Learning Objectives

By the end of the course, you will be able to:

- Demonstrate an understanding of theoretical concepts that are foundational to CBA, including: consumer surplus, producer surplus, discounting and present value, uncertainty and expected value theory, option value, revealed preference, contingent valuation and shadow pricing.
- Demonstrate an understanding of quantitative techniques/skills necessary to compute consumer and producer surplus, present values, expected values, option values and shadow prices and perform supplementary analyses such as distributional impact assessments or Monte Carlo analyses.
- Conceive, plan and implement a CBA.
- Articulate why a particular CBA may be faulty or inappropriate for a specific policy choice. Interpret any economic argument employing the logic of costs and benefits.
- Describe alternative techniques of decision-making which complement a CBA.
- Develop proficiency in the language of cost-benefit analysis, including the ability to structure a clear, concise and persuasive argument both verbally and in writing.

Course Activities and Assignments

Resources: Each week, before the lecture, you are required to review all readings. Understanding the foundational concepts presented in the texts is a critical pre-requisite to participation in the lecture.

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Problem Sets: Three times during the course, you will complete problem sets in small groups (minimum size 2, maximum size 4). The problem sets will consist of quantitative exercises and essays interpreting quantitative information. Each problem set will be graded on a categorical scale from check- to check+. A check will be equivalent to 85 out of 100. Problem sets will account for 21% of the final grade. Absent extenuating circumstances, problem sets will be graded by the TA and returned to students approximately one week after they are due.

Attendance and Participation: Students will be required to:

Attend and contribute to class discussions. Contributing means enhancing the quality of the class experience for yourself and others. It involves making relevant, useful and non-obvious comments, or posing pertinent questions, in clear and succinct language;

Be prepared to give 2 minute answers to impromptu questions regarding the readings in the lectures.

The attendance and participation grade will account for 7% of the final grade.

4-minute Class Presentation: Each student will present in a previously assigned class on a current affairs topic that she feels is related to concepts from CBA. Class presentations will begin in the third week. The presenter must post a reading (an article, website or other material) to the discussion board with a 2-3 paragraph introduction to her talk 1 week before the presentation. The presenter must use slides (a maximum of 5) to aid her presentation. The presentation may not exceed 4 minutes. The presentation must outline the key points in the article/reading, include the presenter's own views and the relationship to CBA.

The discussion board post and presentation will account for 7% of the final grade.

In-Class Quiz: There will be an in-class quiz with simple quantitative exercises similar to the group problem sets. The in class quiz is to be completed individually (i.e. not in groups) during part of a class. Performance on the in class quiz will count for 8% of the final grade.

Midterm: Halfway through the course, you will take a take-home midterm consisting of short quantitative exercises using Excel, computation of CBA-related ratios and essays setting up a CBA or otherwise interpreting data. The midterm exam will be graded on a numeric scale from 1 to 100 and account for 27% of the final grade.

Term Project: A position paper, accompanying cost-benefit analysis spreadsheet and an oral presentation arguing for a specific decision regarding a narrow aspect of sustainability for a business, a government agency or a country will be prepared in groups assigned by the instructor based on stated topic preference. You will choose from a list of topics distributed in the third week of class, prepare your report throughout the semester, and present it to your peers during the last few weeks of the course. The position paper, accompanying spreadsheet and oral presentation will be graded on a letter grade scale from F to A+ and will constitute 30% of the final grade.

Evaluation/Grading

Your final course grade will be computed using a weighted index of numeric grades that combine performance under problem sets, attendance and participation, midterm exam, analyst report, CBA spreadsheet and oral presentation. The weighted index will be scaled into a letter grade scale from F to A+ based on an expectation that a class representative of the population of Columbia masters students will receive a median grade of B+ or A-.

Group Problem Sets 21%
In class Quiz 8%
Take-home Midterm 27%
Term Project 30%
In class Presentation 7%
Participation & Attendance 7%

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Course Policies

Attendance

Regular attendance in lectures is required. Students are expected to have done the readings for each session prior to the lecture.

Participation

Participation in all lectures and project activities is required. We expect your contributions to enhance the quality of the class experience for yourself and others. This involves making relevant, useful and non-obvious comments, or posing pertinent questions, in clear and succinct language. During the lectures, come prepared to answer impromptu questions about the readings and course assignments.

Attendance at office hours is optional, but strongly recommended for those striving to fully understand core concepts.

Late work

All assignments must be submitted on the published due dates. In the absence of well-documented extenuating circumstances, I will deduct 10 points from the assignment grade score for each day that you are late in submission.

School Policies

Copyright Policy

Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity

Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at <http://sps.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community-standards>. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: <http://health.columbia.edu/services/ods/support>.

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Course Schedule/Course Calendar

Session 1: Foundations of CBA

In our first week of the course, we will examine the economic framework which underlies cost-benefit analysis (CBA). We will outline the basic steps of a CBA and consider the relationship between CBA and efficient resource allocation. We introduce the concepts of Pareto efficiency, opportunity cost and willingness-to-pay and consider the interaction between CBA as a decision-making tool and democratic approaches to choose. We consider the limitations of CBA and identify situations when it would be an inappropriate tool.

Learning objectives:

- By the end of this unit, you will be able to:
- Explain in broad overview a number of key issues surrounding the use of cost-benefit analysis in decision-making.
- Explain the concepts of Pareto efficiency, opportunity cost and willingness-to-pay (WTP).
- Compute the net benefits and benefit-cost ratio, given total monetary benefits and costs of a project.

Readings: The assigned readings this week provide you with a broad overview of some of the foundational concepts critical to understanding CBA. Arrow, Cropper et al. will furnish you with the classic economist's arguments for the use of cost-benefit analysis in policy decisions. Chapters 1 & 2 in the Boardman et al. textbook introduce CBA and outline its conceptual foundations. The article by Brandenburger & Stuart provides a framework for the usage of 'willingness-to-pay' and 'opportunity cost' in a business context. We will use this framework for describing CBA in a corporate social responsibility context.

- Arrow, K.J., M.L. Cropper, et al. "Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation (<http://www.jstor.org.ezproxy.cul.columbia.edu/stable/pdfplus/2889625.pdf>) ." *Science*. 272(April 12, 1996):221-222.
- Chapters 1-2 in *Cost-Benefit Analysis: Concepts and Practice* by Boardman et al.
- Brandenburger, A.H. & H.W. Stuart Jr. "Value-based Business Strategy (<http://onlinelibrary.wiley.com.ezproxy.cul.columbia.edu/doi/10.1111/j.1430-9134.1996.00005.x/pdf>) " *Journal of Economics and Management Strategy* 5:5-24. 1996.

Session 2: Social Surplus

This week we will review the major concepts of microeconomic theory as they apply to the measurement of social costs and benefits. We will examine demand and supply functions and introduce the concepts of consumer surplus, producer surplus and government surplus. We will conduct a deeper examination of the interaction between WTP as a driver of action, and other motivators of action, such as democratic choice.

Learning objectives:

- By the end of this unit, you will be able to:
- Explain why changes in social surplus are the appropriate measure for evaluating benefits of projects in monetary terms.
- Compute consumer, producer and government surplus, given demand and supply curves. Demonstrate the use of WTP in the context of a well-studied example of the mechanics of bribery and corruption.

Readings: WTP, and demand curves provide the quantitative foundation for valuing environmental goods and services in the absence of markets. They allow us to assign monetary values to environmental goods which do not have observable prices. The assigned readings this week introduce you to demand and supply curves and how they are used to compute consumer surplus. The Boardman reading this week builds a complex framework using some relatively dense concepts. After reading the Boardman

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et al. textbook, check to make sure that you understand the concepts of demand and supply curves and their relationship to allocative efficiency. Keep in mind the concept of willingness-to-pay. Then read the McMillan & Zoido paper and ask yourself how WTP-based methods might interact with democratic decision-making processes in an imperfect world. McMillan & Zoido's research introduces the concept of 'revealed preference,' which we will investigate further for environmental valuation in Session 8.

- Read Chapter 3 in Boardman et al.
- McMillan, J. & Zoido, P. "How to Subvert Democracy: Montesinos in Peru. (<http://dx.doi.org.ezproxy.cul.columbia.edu/10.1257/0895330042632690>)" *Journal of Economic Perspectives* 18, 4 pp 69-92. 2004.

Session 3: Computing Net Benefits

In CBA, costs and benefits are based on the concept of WTP. Benefits are the sum of the maximum amounts that people would be willing to pay for a policy outcome, and costs are the sum of the opportunity costs of the resources required by the policy.

Learning objectives:

By the end of this unit, you will be able to:

- Estimate the change in social surplus caused by a policy intervention.
- Explain how the computation of social surplus is affected by market distortions such as monopoly or the presence of positive or negative externalities.
- Explain the salience of the marginal excess tax burden for projects that are financed from tax revenues.

Readings:

The assigned readings this week outline how to estimate the change in social surplus in the primary market affected by a policy intervention. Chapter 4 in the Boardman et al. textbook provide roadmaps for measuring changes in social surplus in primary markets. Chapter 4 examines primary markets: both the simple case of efficient (or undistorted) markets and the more complex case of markets distorted by monopoly, information asymmetry or externalities. In situations where prices observed in the market do not reflect the social value of a good accurately or where prices do not exist (e.g., for public goods), a process called shadow pricing is used.

Shadow prices are prices which have been adjusted or estimated so that they come as close as possible to measuring the social value of the good in question. The article by Loomis provides a classic overview and context for the measurement of the nonmarket value of environmental amenities (i.e. shadow prices). This reading should modulate your assessment of how these techniques end up being used in the real world.

- Read Chapter 4 in Boardman et al.
- John Loomis. "Economic Values without Prices: The Importance of Nonmarket Values and Valuation for Informing Public Policy Debates." *Choices*. 3rd Quarter 2005.

Session 4: Computing Net Benefits

Previous Session Continued.

Session 5: Discounting

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All decisions have significant consequences which are felt over time. These future impacts must be translated into present values in any cost-benefit analysis. This unit outlines how to compute the net present value of a project, assuming a given social discount rate and also discusses different methods of choosing an appropriate discount rate.

Learning objectives:

- By the end of this unit, you will be able to:
- Compute the present and future values of any cash flows, given a discount rate,
- Compare projects with different timeframes,
- Understand how to incorporate inflation and select horizon values in cost-benefit analyses, Describe and support alternative methods of choosing an appropriate discount rate.

Readings: Please read the Goulder & Stavins article first. This will give you an overview of discounting and how it is used in environmental cost-benefit analysis. Then read the chapters in the Boardman et al. text.

- Chapter 6 describes how to compute the net present value of a project, assuming a given discount rate. Chapter 10 outlines alternative rationales for choosing the appropriate discount rate.
- Goulder, L.H. & R.N. Stavins. "An Eye on the Future." (<http://www.nature.com.ezproxy.cul.columbia.edu/nature/journal/v419/n6908/pdf/419673a.pdf>) " Nature 419:673-674. Oct 2002.
- Read Chapters 6 and 10 in Boardman et al. Cost-Benefit Analysis: Concepts and Practice.

Recommended:

- Bazelon C. & K. Smetters. "Discounting inside the Washington DC Beltway" (<http://pubs.aeaweb.org.ezproxy.cul.columbia.edu/doi/pdfplus/10.1257/jep.13.4.213>) ." Journal of Economic Perspectives 13(4): 213-228. 1999.
- Johnson L.T. & C. Hope. "The Social Cost of Carbon in US Regulatory Impact Analysis" (<http://link.springer.com.ezproxy.cul.columbia.edu/article/10.1007/s13412-012-0087-7>) ." Journal of Environmental Studies and Sciences. 2(3):205-221

Session 6: Uncertainty

Since uncertainty is pervasive, rational decision-making must incorporate probabilities of outcomes rather than actual outcomes. It is not enough to make decisions based on expected (or mean) outcomes: good decisions must account for the underlying variability in outcomes. This week, we learn about expected value analysis and sensitivity analysis, methods of incorporating the range of possible outcomes into the optimal decision. We also consider the value of information and quasi-option analysis, which are techniques for rationally deferring decisions until salient information is acquired or revealed.

Learning objectives:

By the end of this unit, you will be able to:

- Calculate the expected value of net benefits, given a range of outcomes and associated probabilities, Design and carry out appropriately informative sensitivity analyses,
- Describe how a Monte Carlo analysis would be carried out for any specific CBA.

Readings:

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- Chapter 7 in the Boardman et al. text will provide you with a concise and directed exposition of the impact of uncertainty on CBA, including sections on expected value analysis, sensitivity analysis and the value of information. The treatment in that text is dense and while you may find it sufficient, it may be helpful to read
- Chapter 18 in the Kolstad text for a more general outline of the impact of risk and uncertainty on environmental decision-making.
- Read pages 167-187 and pages 196-199 in Chapter 7 in Boardman et al.
- Read the first chapter on Monte Carlo analysis in business analytics and decision-making in Jonathan Pinder's Introduction to Business Analytics using Simulation (Academic Press, 2017) .

Recommended Readings:

- Kolstad, C.D. Chapter 18 (<http://vizedhtmlcontent.next.ecollege.com/CurrentCourse/KolstandCh18.pdf>) in Environmental Economics. 2nd edition.
- EPA's guidance on the use of Monte Carlo in risk assessment "Guiding Principles for Monte Carlo Analysis" EPA/630/R-97/001 March 1997 (attached).

Session 7: Optionality

We introduce and distinguish the two concepts of expected social surplus and option price. The expected social surplus is just the mean social surplus probability-weighted across all outcomes. The option price incorporates the monetary value of risk reduction which consumers are willing to pay to choose a project that reduces the variability of outcomes. Differentiating these two concepts facilitate the valuation of projects which reduce or pools risks. Without these concepts, it is impossible to conduct a proper CBA of any risk-reducing project.

We extend the analysis of uncertainty to quantify the value of information acquisition. We ask when it is worth investing in information to partially reduce uncertainty? We go beyond measuring merely the chance of being wrong and outline methods for determining the cost of being wrong.

Learning objectives:

By the end of this unit, you will be able to:

- Distinguish between expected social surplus and option price, Explain the value of real options analysis to decision-making.
- Outline a method for determining the most important drivers of uncertainty in a decision problem.

Readings: The Copeland & Antikarov reading provides a practitioner's introduction to the value of options thinking in the context of decision-making and outlines the situations in which real options analysis is productive. Chapter 8 in the Boardman et al. text provides a technical exposition of the concepts of expected social surplus and option price, and builds the framework within which the value of a risk-reducing project is measured.

- Copeland & Antikarov. Chapter 1 in Real Options: A Practitioner's Guide (see below).
- Read Chapter 8 in Cost-Benefit Analysis: Concepts and Practice.

Readings: The section on value of information the Boardman text provides a conceptual introduction to the value of information using theoretical decision tree analysis. The chapter from Douglas Hubbard's book provides a practitioner's summary of the value of information acquisition.

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- Read Chapter 7, pages 187-195. in Cost-Benefit Analysis: Concepts and Practice.
- Read Chapter 7 entitled "Quantifying the Value of Information," in How To Measure Anything: Finding the Value of Intangibles in Business by Douglas W. Hubbard. (attached).

Session 8: Revealed Preference

We can compute the change in social surplus in actual markets by directly estimating demand and supply curves in markets where this is feasible. In situations where markets for certain "goods" such as pollution or human life do not exist, we must use alternative methods to value social surplus. This week we examine what are known as revealed preference methods of valuation, which include the hedonic pricing method, the travel cost method and the defensive expenditures method. These methods attempt to infer the value of goods which do not trade in the market from the observed behaviour of stakeholders in related markets.

Learning objectives:

By the end of this unit, you will be able to:

- Perform a simplified direct estimation of a demand curve and use the estimate to compute to compute consumer surplus.
- Outline and assess various methods of revealed preference valuation.

Readings: Chapter 13 in the Boardman et al. text describes methods of valuing the impact of on social surplus using direct estimation of demand curves. Chapter 14 extends the analysis to situations where markets for certain "goods" such as pollution or human life do not exist. This chapter provides an introduction what are known as revealed preference methods of valuation, which include the hedonic pricing method, the travel cost method and the defensive expenditures method. Timothy Haab has a layperson's introduction to the concepts of revealed preference valuation.

- Read Chapters 13-14 in Cost-Benefit Analysis: Concepts and Practice.
- Kolstad, C.D. Chapter 7 in Environmental Economics. 2nd edition (see file below).
- Haab, Timothy. "What's the Value of a Clean Beach? (<https://www.greenbiz.com/article/whats-value-clean-beach-heres-how-economists-do-numbers>) " GreenBiz.

Session 9: In-Class Quiz & Take Home Exam

There will be an in-class quiz.

Following the lecture, there will be a Take Home Exam

Review everything we have done to date in preparation for the midterm exam.

Plan to take a take-home examination from Friday, Mar 29 from 6:00pm to Wednesday, Apr 3 at 5:00 pm.

Session 10: Stated Preference

In situations where the value of an environmental amenity does not lead to a behavioural trace amongst consumers, revealed preference methods of valuation are not feasible. For components of value such as existence value, contingent valuation (CV) is the only method of estimating MWTP. Contingent valuation uses carefully structured surveys to elicit the values that stakeholders place on amenities. We provide an overview of CV surveys, review criticisms of CV, and consider the strengths and weaknesses of the most commonly used CV methods.

Learning objectives:

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By the end of this unit, you will be able to:

- Provide an overview of contingent valuation (CV) surveys, review and counter criticisms of CV, and outline the strengths and weaknesses of the most commonly used CV methods,
- Critique the survey design of any specific CV survey.

Readings: Chapter 9 in the Boardman et al text describes sources of passive use values for natural resources such as option value and existence value. These are primarily the categories of value for which we use CV surveys, which are described in Chapter 15.

- Read Chapters 9 and 15 in Cost-Benefit Analysis: Concepts and Practice.

It would not be cost-effective to estimate shadow prices from scratch each time that CBA needs to be performed. This week we review the existing estimates of shadow prices and outline methods to construct a bespoke estimate for each CBA application. We review a number of shadow prices including the value of a statistical life, the value of a life year, the cost of crashes and the cost of injuries, the cost of crime, the value of time, the value of recreational activities, the value of nature, the value of water and water quality, the cost of noise, and the cost of air pollution.

Learning objectives: By the end of this unit, you will be able to:

- List the range of shadow prices for which previously constructed estimates are readily available, Adjust the available estimates to compute a first approximation of net benefits in a specific CBA.

Readings: Chapter 16 in the Boardman et al. text provides an overview of shadow prices for a number of 'goods' including value of a statistical life, the cost of crime, the value of time, recreation and nature. The article by Ashenfelter focuses on methods and challenges of estimating the shadow price of life, a key building block for the measurement of social surplus in projects which change mortality risks.

- Read Chapter 16 in Cost-Benefit Analysis: Concepts and Practice.
- Ashenfelter, O. (2002) "Measuring the Value of a Statistical Life: Problems and Prospects (<http://www.jstor.org.ezproxy.cul.columbia.edu/stable/3590409>) ." Economic Journal Oct 2002.
- Richardson, L., et al. (2015). "The role of benefit transfer in ecosystem service valuation ." Ecological Economics 115: 51-58.
- McComb, G. et al. (2006) "International Valuation Databases: Overview, methods and operational issues (<http://ejournals.ebsco.com.ezproxy.cul.columbia.edu/Direct.asp?AccessToken=95X5JIX8XXRUEZE4Q9DJEKPJQIKM8Q41J&Show=Object>) ." Ecological Economics 60.
- De Groot, R. et al. (2012) "Global estimates of the value of ecosystems and their services in monetary units" Ecosystem Services 1: 50-61.

Session 11: Benefits Transfer

It would not be cost-effective to estimate shadow prices from scratch each time that CBA needs to be performed. This week we review the existing estimates of shadow prices and outline methods to construct a bespoke estimate for each CBA application. We review a number of shadow prices including the value of a statistical life, the value of a life year, the cost of crashes and the cost of injuries, the cost of crime, the value of time, the value of recreational activities, the value of nature, the value of water and water quality, the cost of noise, and the cost of air pollution.

Learning objectives

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By the end of this unit, you will be able to:

- List the range of shadow prices for which previously constructed estimates are readily available, Adjust the available estimates to compute a first approximation of net benefits in a specific CBA.

Readings: Chapter 16 in the Boardman et al. text provides an overview of shadow prices for a number of 'goods' including value of a statistical life, the cost of crime, the value of time, recreation and nature. The article by Ashenfelter focuses on methods and challenges of estimating the shadow price of life, a key building block for the measurement of social surplus in projects which change mortality risks.

- Read Chapter 16 in Cost-Benefit Analysis: Concepts and Practice.
- Ashenfelter, O. (2002) "Measuring the Value of a Statistical Life: Problems and Prospects (<http://www.jstor.org.ezproxy.cul.columbia.edu/stable/3590409>) ." Economic Journal Oct 2002.
- Richardson, L., et al. (2015). "The role of benefit transfer in ecosystem service valuation ." Ecological Economics 115: 51-58.
- McComb, G. et al. (2006) "International Valuation Databases: Overview, methods and operational issues (<http://ejournals.ebsco.com.ezproxy.cul.columbia.edu/Direct.asp?AccessToken=95X5JIX8XXRUEZE4Q9DJEKPJQIKM8Q41J&Show=Object>) ." Ecological Economics 60.

Session 12: Case Studies & Critique of CBA

Case Study

Case Studies – ARC Tunnel and Chinese Biodiversity

This week we will discuss two case studies: the costs and benefits of preserving biodiversity within Chinese nature reserves and the canceled ARC tunnel project to build an additional rail link under the Hudson River. Please review the readings for both cases. The second case includes the actual pro- and con- reports prepared by your colleagues who took the class in a previous year. These are good examples of projects with both vocal supporters and opponents.

Learning objectives:

- By the end of this unit, you will be able to:
- Outline the costs and benefits of the projects in the case studies,
- Describe specific valuation techniques which apply to the measurement of social surplus in these cases,
- Critique arguments for and against the projects.

Readings

Case Study: Chinese Biodiversity

- Ma, B., Zhao, Z. et al. "Household costs and benefits of biodiversity conservation: case study of Sichuan giant panda reserves in China (<https://link-springer-com.ezproxy.cul.columbia.edu/content/pdf/10.1007%2Fs10668-017-9959-z.pdf>) ." Environment, Development & Sustainability. Vol 20 (4) 1665-1686. 2018.
- Case Study: ARC Tunnel
- The two opposing reports by former students will give you an outline of the arguments. The additional assigned readings will provide examples of source documents you will be using for your own project reports.
- Price D., D. Prioleau, M. Pernalet & S. Rosner. "Access to the Region's Core: Cost Benefit Analysis Project Report in favor of the ARC Project" 24 December 2012.
- Barry M., D. Carille, S. Cook. "Cost Benefit Analysis for Access to the Region's Core" 24 December 2012.

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- U.S. Government Accountability Office. "Potential Impacts and Cost Estimates for the Cancelled Hudson River Tunnel Project" March 2012. See attached report.
- Magyar, Mark J. "ARC: The 21st Century Tunnel that Wasn't (<http://www.njspotlight.com/stories/10/1008/0153/>) ." NJ Spotlight. October 8, 2010.

Cost-benefit analysis as a decision-making tool has its shortcomings and critics. Many of its shortcomings can be addressed by supplemental analyses such as multigoal analysis, cost-effectiveness analysis, distributionally weighted analysis or sustainability assessment models. These supplementary methods also have their own shortcomings. We review the most trenchant critiques of CBA and its foundations.

Learning objectives: By the end of this unit, you will be able to:

- Provide a reasoned and substantiated argument for when CBA is advisable, when it must be supplemented by other analyses and when it is not useful.

Readings: Chapters 18 and 19 in the Boardman et al. text outline two supplemental analyses (cost effectiveness and distributionally weighted CBA). Chapter 20 identifies sources of error and evaluates the accuracy of CBA. Boardman et al. are proponents of CBA and consider the method to have correctable shortcomings. The articles by Kelman and Bebbington et al. present more fundamental critiques of CBA. Kelman questions our ability to effectively measure the value of environmental amenities while Bebbington et al. compare CBA to sustainability assessment models, a method outside the CBA framework.

- Read Chapters 18-20 in *Cost-Benefit Analysis: Concepts and Practice*.
- Kelman, S. "Cost-Benefit Analysis: An Ethical Critique (with Replies)." in *Economics of the Environment: Selected Readings*. Fourth Edition. R.N. Stavins, ed. (2000). Ch 15.
- Bebbington, J., J. Brown & B. Frame. "Accounting Technologies and Sustainability Assessment Models (<http://www.sciencedirect.com.ezproxy.cul.columbia.edu/science/article/pii/S0921800906005544>) ." *Ecological Economics* 61(2007) pp224-236.

Session 13: Student Presentations

Term Project Presentations:

Session 14: Student Presentations

Term Project Presentations