A Primer on Economic Feasibility Analysis

Short Lecture Notes for Training of Nominated Members of the National Climate Change Committee (The Gambia)

by

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A Primer on Economic Feasibility Analysis

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Course Outline

1. What is Economic Feasibility Analysis?
2. What are indicators/indices of economic feasibility used for?
3. How is Economic Feasibility Measured?
4. Summary
5. Examples and Exercises

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Economic Feasibility Analysis (1)

Economics is the study of how scarce resources are allocated among competing uses (i.e. scarcity makes choice unavoidable)
A decision is said to be economically rational when use of the resources yields benefits that exceed the opportunity cost of using those resources
Economic feasibility of an action implies that the benefits of such action (i.e. programme/project) will exceed costs over the period of its implementation, and/or unit programme/project costs meet sector-specific standards (i.e. benchmarks)

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Economic Feasibility Analysis (2)

Economic Feasibility Analysis (EFA) refers to procedures/analytical methods used to demonstrate justification or otherwise of a particular action/policy

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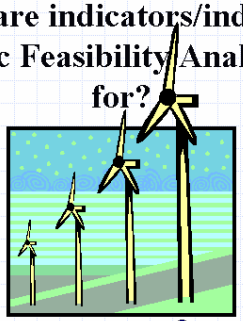
What are indicators/indices of Economic Feasibility Analysis used for?



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Usefulness of Economic Feasibility Analysis

Economic Feasibility Analysis (EFA) metrics provide owners and major stakeholders (e.g. public agencies, private firms, individual entrepreneurs, lending institutions, a.o.) with decision-shaping information on the merit of specific actions and alternatives

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Application of economic feasibility metrics

Decision-support and making
- Screening/ranking of alternatives
- Input to multi-criterion decision-making

Economy-wide applications
- Public/Private Investment
- Natural Resource Management
- Environmental Management
- Infrastructure Development
- Project/Policy Analysis

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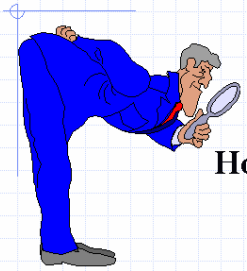

How is Economic Feasibility Measured?

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EFA methodology (1)

EFA methodology is **case-dependent**

Case 1: Benefits are specified

When two or more alternatives have roughly equivalent benefits, the problem is to compare the costs incurred in generating benefits under the different alternatives. This is the domain of Cost-Effectiveness Analysis (CEA) which tries to identify least-cost alternatives of achieving a given objective. Comparisons between alternatives may be in in nonmonetary units.

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EFA methodology (2)

Case 2: Costs are specified

When two or more alternatives have roughly equivalent costs, comparing benefits generated under the different alternatives. (e.g. a public agency authorises a budget for improvement of nutritional status of target group through livestock vs. aquaculture production), is conceptually similar to CEA

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EFA methodology (3)

Case 3: Alternatives have different benefits and costs

This is the general case and calls for Benefit-Cost Analysis (BCA). The case for BCA is particularly strong when benefits and costs can be quantified and assigned monetary values

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Evaluation of benefits and costs (1)

When quantifiable in monetary terms, Benefits and Costs are evaluated using **market prices** of relevant goods and services

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Evaluation of benefits and costs (2)

Costs include those necessary to implement action such as investment costs, operation and maintenance expenses, other direct and associated costs that are needed for successful implementation of an action/policy

Benefits are positive outcomes of the action consistent with previously stated objectives.

In contrast to Costs, Benefits are not always identifiable, or measurable.

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Cost/price distortion and correction (1)

Causes of price distortion

- Market failures (violation of conditions of perfect competition – lack of information, domination/monopoly, entry barriers, etc.)
- Government intervention (subsidies, tariffs/taxes, price controls, fixing wages, public investment)

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Cost/price distortion and correction (2)

Price correction

- Shadow pricing

Shadow prices taken from international market (labour, foreign exchange, commodities, discount rate) considered as being closest to conditions of "perfect competition"

- Inflation adjustment

Use of relative inflation factor

Analysts work with constant costs (valid if inflationary effects on Benefits and Costs similar)

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Cash Flow Statement

This is the basic EFA tool

Comprises of inflow/benefit and outflow/cost streams arranged on rows, and corresponding time periods in columns

Example

	Year									
t	1	2	3	4	5	6	7	8	9	10
B(t)	0	0	50	50	50	50	50	50	50	50
C(t)	150	100	50	0	0	0	0	0	0	0
B(t) – C(t)	-150	-100	0	50	50	50	50	50	50	50

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Standard EFA metrics

$$NPV = \sum_{t=1}^{t=n} w(t)\left[B(t) - C(t)\right] \quad \text{in which} \quad w(t) = \frac{1}{(1+r)^t}$$

$$IRR = r: \quad \sum_{t=1}^{t=n} w(t)B(t) = \sum_{t=1}^{t=n} w(t)C(t)$$

$$\frac{B}{C} = \frac{\sum_{t=1}^{t=n} w(t)B(t)}{\sum_{t=1}^{t=n} w(t)C(t)}$$

NPV is Net Present Value (Net Present Worth), IRR is the Internal Rate of Return, B/C is the benefit-cost ratio, $B(t)$ and $C(t)$ are benefit and cost streams over project life/horizon, t is time, r is the discount/interest rate, and $w(t)$ is a time-variable discounting factor

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Interpretation of standard EFA metrics

NPV > 0	Action/Project economically justified
NPV < 0	Action/Project not economically justified. Other criteria/imperatives needed to proceed with implementation
IRR > OCC	Action/Project economically justified OCC = Opportunity Cost of Capital
B/C > 1	Action/Project economically justified (Converse is also true)

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Other EFA metrics

$$RRI = \frac{\overline{B} - \overline{C}}{I_{t=1}} \cdot 100\%$$

RRI is Rate of Return on Investment, $\overline{B}$ and $\overline{C}$ are average annual undiscounted benefits and costs, $I_{t=1}$ is initial investment cost

$$PBP = t: \sum_{t=1}^{t=n} [B(t) - C(t)] = 0$$

PBP is **Payback Period**, roughly equivalent to the time it takes for cumulative cashflow to become positive

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Example of NPV, IRR, B/C computation (1)

Step 1: Establish Benefit and Cost Streams

	Year									
t	1	2	3	4	5	6	7	8	9	10
B(t)	0	0	50	50	50	50	50	50	50	50
C(t)	150	100	50	0	0	0	0	0	0	0

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Example of NPV, IRR, B/C computation (2)

Step 2: Compute discounting factor (Interest Rate = 10% p.a.)

	Year									
t	1	2	3	4	5	6	7	8	9	10
w(t)	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386
B(t)	0	0	50	50	50	50	50	50	50	50
C(t)	150	100	50	0	0	0	0	0	0	0

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Example of NPV, IRR, B/C computation (3)

Step 3: Compute discounted Benefits and Costs

	Year									
t	1	2	3	4	5	6	7	8	9	10
w(t)	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386
B(t)	0	0	50	50	50	50	50	50	50	50
C(t)	150	100	50	0	0	0	0	0	0	0
w(t)B(t)	0.0	0.0	37.6	34.2	31.0	28.2	25.7	23.3	21.2	19.3
w(t)C(t)	136.4	82.6	37.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Example of NPV, IRR, B/C computation (4)

Step 4: Compute NPV and B/C

	Year										
t	1	2	3	4	5	6	7	8	9	10	Σ
w(t)	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386	
B(t)	0	0	50	50	50	50	50	50	50	50	
C(t)	150	100	50	0	0	0	0	0	0	0	
w(t)B(t)	0.0	0.0	37.6	34.2	31.0	28.2	25.7	23.3	21.2	19.3	220.45
w(t)C(t)	136.4	82.6	37.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	256.57

$$NPV = \sum_{t=1}^{t=n} w(t)[B(t) - C(t)] = 220.45 - 256.57 = -36.12$$

$$\frac{B}{C} = \frac{\sum_{t=1}^{t=n} w(t)B(t)}{\sum_{t=1}^{t=n} w(t)C(t)} = 220.45/256.57 = 0.86$$

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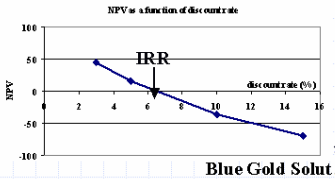
Example of NPV, IRR, B/C computation (5)

Step 5: Redo discounting with different Interest Rates to find IRR

	Year									
t	1	2	3	4	5	6	7	8	9	10
w(t)	0.940	0.885	0.832	0.782	0.736	0.692	0.651	0.612	0.576	0.541
B(t)	0	0	50	50	50	50	50	50	50	50
C(t)	150	100	50	0	0	0	0	0	0	0
										Σ
w(t)B(t)	0.0	0.0	41.6	39.1	36.8	34.6	32.5	30.6	28.8	27.1	271.12
w(t)C(t)	141.1	88.5	41.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	271.12



$$\sum_{t=1}^{t=n} w(t)B(t) = \sum_{t=1}^{t=n} w(t)C(t)$$

at r =6.33%

Thus, IRR = 6.33%

Example of RRI and PBP computation

	Year										
t	1	2	3	4	5	6	7	8	9	10	
											Σ
B(t)	0	0	50	50	50	50	50	50	50	50	400
C(t)	150	100	50	0	0	0	0	0	0	0	300
B(t) – C(t)	-150	-100	0	50	50	50	50	50	50	50	
Σ[B(t) – C(t)]	-150	-250	-250	-200	-150	-100	-50	0	50	100	

PBP = 8 years

$$RRI = \frac{(400/10) - (300/10)}{150} \cdot 100\%$$

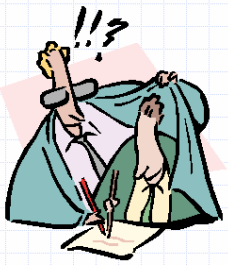
= 6.6%

Relevance and limitations of EFA metrics

	Measures	Limitations
NPV	Impact,Absolute return on investment	Discount rate used may be debatable
IRR	Efficiency of investment	Does not measure absolute size of return, Discount rate used may be debatable
B/C	Efficiency of investment	Does not measure absolute size of return, Discount rate used may be debatable
PBP	Impact of investment, Time span to recover expenditure	Does not consider benefits and cost after PBP

Major conceptual issues

- Time period of BCA
- Discounting and Discount rate
- Baseline for Analysis
- Alternatives
- Limitations of the BCA method



Time period of BCA (1)

The Problem

There is frequently no clear basis for determining the appropriate time period for analysis

The intent of a regulatory/corrective/adaptive action is usually to correct a current problem for good, but it is often necessary and appropriate to limit that time period to a finite time period.

Project components may have different life cycles

All things being equal, results of BCA are sensitive to the time period of analysis

Time period of BCA (2)

Guidelines

The time period must allow the Analyst to capture any specific identified changes expected to occur over time.

In particular, the period of analysis should be at least as long as the payout period for funds borrowed to pay for the project, but should not exceed the economic life of the project

Once discounted future benefits or costs become negligible, little is gained by extending the analysis further into the future

Discounting

Discounting is the process by which time streams of benefits and costs of a particular action are projected to the present, and placed on a comparable basis

A decision to discount future benefits involves implicit acceptance of certain political and economic philosophies (i.e. dominant paradigm)

When discounting is used, the future benefits (of regulation, adaptation, etc.) decline in comparison to the present costs

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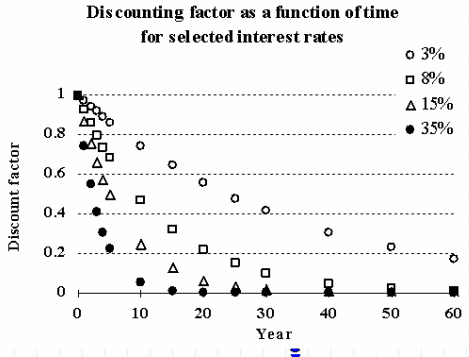
Discounting factor $w(t) = \frac{1}{(1+r)^t}$



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Discount/Interest Rate

Discount rates essentially reflect:

- Cost of borrowing on open market
- Cost of borrowing set by law

Sector-specific rates of return on capital can be obtained from lending institutions and secondary data sources, such as Commercial Banks, Chamber of Commerce, etc.

3 percent as the most reflective of risk-free lending, or concessionary loans

8 to 10 percent rate traditionally used in EFA featuring use of private cost of capital in public projects

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Baseline for Analysis (1)

The Analyst starts an EFA with a projection of what the situation would look like if a specific action/policy is not implemented

The expected **situation without the action/policy is referred to as the baseline**, or reference case

To develop the baseline, the Analyst relies on simple/complex preliminary analyses, surveys, literature review (e.g. stage-damage curve for flooding), forecasts of economic activity, technological innovation and uptake, regulatory action and development in related sectors (LULUC), etc.

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Baseline for Analysis (2)

These projections are also known as **scenarios**.

To be **consistent across sectors/systems**, scenario development requires the Analyst to take a broad perspective of the problem at hand. The Analyst should at the very least clearly describe assumptions underlying the specification of the baseline, and the reasons why the chosen scenario is appropriate

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Alternatives (1)

Perception of a problem, technological preferences/bias, and other noneconomic criteria may provide the Analyst with a menu of options to tackle the issues at hand

Different choices/options are referred to as alternatives (e.g. beach nourishment vs. seawalls to counter coastal erosion, crop selection vs. irrigation to increase productivity)

An EFA should include at least one alternative to the proposed action/policy

If alternatives **are difficult to generate** due to the nature of problem, the **baseline (i.e. "do nothing") then becomes the only alternative**

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Alternatives (2)

Alternatives should have similar objectives and the same time frame for meaningful comparison

An alternative with highest benefit or lowest unit cost preferred to others

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Comparison of two Alternatives (1)

Description

An investor has the choice of allocating GMD100,000 or GMD200,000 to a poultry farming project. In the first scenario (Project A), the investment is made in Year 1 of a 10-year cycle. The larger investment going to Project B is split over two years. Both projects are expected to start generating benefits from Year 3 onwards. The relevant rate of interest is 8% per annum. What further lessons and conclusions do you draw from the project data shown in next two slides?

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Comparison of two Alternatives (2)

Project A

t	1	2	3	4	5	6	7	8	9	10	
	Year										
w(t)	0.926	0.857	0.794	0.735	0.681	0.630	0.583	0.540	0.500	0.463	
B(t)	0	0	20	20	20	20	20	20	20	20	
C(t)	100	0	0	0	0	0	0	0	0	0	
w(t).B(t)	0.00	0.00	15.88	14.70	13.61	12.60	11.67	10.81	10.00	9.26	98.54
w(t).C(t)	92.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	92.59
										NPV	5.94
										B/C	1.06

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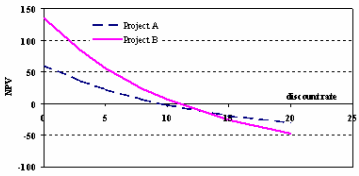
Comparison of two Alternatives (3)

Project B

t	1	2	3	4	5	6	7	8	9	10	
	Year										
w(t)	0.926	0.857	0.794	0.735	0.681	0.630	0.583	0.540	0.500	0.463	
B(t)	0	0	20	45	45	45	45	45	45	45	
C(t)	100	100	0	0	0	0	0	0	0	0	
w(t).B(t)	0.00	0.00	15.88	33.08	30.63	28.36	26.26	24.31	22.51	20.84	201.86
w(t).C(t)	92.59	85.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	178.33
										NPV	23.53
										B/C	1.13



Project B consistently preferable if the market rate of interest is lower than 10.7%. Neither project is economically justifiable above this rate

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From Financial to Economic Analysis

Financial Analysis evaluates Benefits and Costs from an investor (i.e business/private sector) perspective

Economic Analysis evaluates Benefits and Costs from a the point of view of society

Discount/interest rates in Economic Analyses usually different/lower

Payments to government (e.g. taxes) accounted for in Financial Analyses, are eliminated, whilst externalities are included in Economic Analyses

EFA indices computed under new conditions give an ENPV, EIRR, EB/C, where the leading letter "E" shows the results refer to an Economic Analysis

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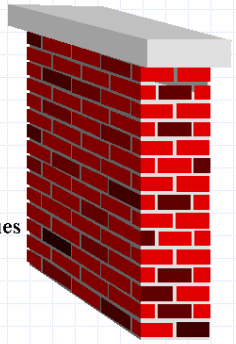
Limitations of the BCA method



Non-monetised/market values

Theoretical validity

Ethical legitimacy

Uncertainties

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Non-monetised/market values (1)

- Some benefits of an action/policy are not tradable in the market place, making their integration in traditional BCA look like adding 'sheep' and 'goats'
- Protecting the environment saves lives, and thus benefits include quantification and value of human life
- Environmental benefits disproportionately fall in category of nonmarket environmental benefits

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Non-monetised/market values (2)

Nonmarket environmental benefits include:

User value: Environmental/Eco-asset directly used by people (e.g., fishing in river, recreational activities)

Option value: This prominent when people intend to make use of Environmental/Eco-asset some day in the future. Irreversible effects/impacts (e.g. destruction of virgin forest) or its disappearance would preclude use in the future.

Existence value: This reflects the value people assign to aspects of the natural environment they care about even when there is no direct use (spiritual, ethical, etc., values of conservation)

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Theoretical validity

- BCA assumes that the utility one person derives from one unit of currency (e.g. €1 is the same as that of another. This is obviously flawed because utility is a function of income, €1 for a poor person is totally different to €1 for a millionaire
- Serious flaws in model of positive time preference, and discounting of future values

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Ethical legitimacy

- The BCA assumption that the present worth more than future has serious implications for the inter-generational equity (IGE) dimension of an action/policy
- BCA is not concerned with sustainable use of environmental resources (which could be source of livelihood and lifelines for future generations)
- BCA is not concerned either about the distribution of losses and gains emanating from an action/policy

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Uncertainties

- Uncertainty refers to the confidence with which EFA results can be accepted
- Uncertainty can result from any number of factors, including insufficient data, an incomplete understanding of the physical or economic process under study, model specification and parameters, etc.

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Overcoming some limitations of the BCA method

- Monetary valuation
- Alternative discounting
- Uncertainty Analysis

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Monetary valuation

Monetary valuation is about measuring people's preferences, which is different from measuring the intrinsic value of the environment

Categories of monetary valuation

- Conventional market price approach
- Household production function approach
- Hedonic price methods
- Experimental markets

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Conventional market price approaches

There are two market price approaches

Dose-response

Takes the physical, environmental, and ecological links between CC (dose) and the impacts (response) and value these at a market or shadow price (e.g. cost resulting form CC impairment of production/economic, regulation/environmental, information, aesthetic functions of wetlands)

Replacement cost

Ascertains the damage done and then estimates the cost of restoring the environment to its original state (e.g. restoring natural resources capital of renewable resources)

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Household production function methods

Avertive expenditure

Limited to cases where households spend money to avert environmental /CC hazards (e.g. environmental tax, expenditure on commodities which are substitutes or complements for an environmental characteristic, investment in aquaculture)

Travel Cost Method (TCM)

Generally limited to the valuation of (mainly recreational) site characteristics and to valuation of time. Uses data on voluntary expenditures on travel to visit a park or recreation area

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Hedonic price methods

Reveals willingness-to-pay (WTP) for environmental, health, safety, and community qualities

House price approach

Applicable only to environmental attributes which are likely to be capitalised into the price of housing and/or land

Wage risk premia

Valuation of morbidity and mortality risks in occupations. Also used in dose-response relationship)

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Experimental markets

Contingency Valuation Method (CVM)

Modern CVM studies work like a referendum

Use of survey questionnaires to elicit hypothetical WTP questions (one of few ways to measure existence and passive use values)

Iterative bidding

Ask predetermined number of randomly selected people whether they would be willing to pay $X in taxes to protect the environmental amenity in the way described, or
What are you willing to pay for X or to prevent Y?, or what are you willing to accept to tolerate A or to forgo B?

Econometric analyses to determine mean WTP

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Extension of Standard BCA with CVM Results

$$NPV = \sum_{t=1}^{t=n} w(t)\left[B(t) - C(t)\right] \pm a_n B_*$$

in which

$$w(t) = \frac{1}{(1+r)^t} \quad , \text{ and } \quad a_n = \frac{(1+r)^n - 1}{r(1+r)^n}$$

a_n is the present worth of annuity factor, B_* is willingness-to-pay (WTP) or willingness-to-accept (WTA) compensation. All other variables preserve their previous meanings

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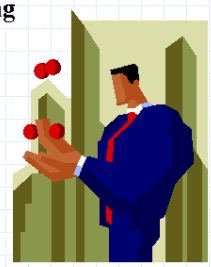
Alternative discounting methods

Separate time discounting of benefits and costs

Hyperbolic discounting

Zero and negative time preference



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Uncertainty Analysis (1)

There are five basic methods for handling uncertainty and making an EFA more transparent:

Delphi methods: Use input from a group of experts to characterise the likelihood of specific outcomes

Meta-analysis : Combines data or results from a number of different studies to estimate a more general model or to characterise the range or distribution of key input variables

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Uncertainty Analysis (2)

Other methods of uncertainty analysis include:

Scenario analysis: Estimates a range of possible futures, such as worst-case and best-case scenarios, in addition to the most likely scenario

Sensitivity analysis: Investigates the influence of assumptions made about key input variables and conducting the analysis over a range of plausible values (e.g. discount rate), on EFA results

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Uncertainty Analysis (3)

Monte Carlo method: Simulates a statistical distribution of EFA indices by randomly drawing from the probability distributions of input variables and repeating the analysis numerous times

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Summary

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Points to remember (1)

Economic feasibility Analysis (EFA) represents a systematic approach to policy/programme/project evaluation, screening, and prioritisation in a manner that ensures efficient and cost-effective allocation of resources

EFA indicators are valuable decision-support tools for investment and development planning in the public and private sector

EFA is operationalised through Cost-Effectiveness Analysis (CEA) and Benefit-Cost Analysis (BCA)

Benefits of an action/policy (unlike Costs) are not always identifiable, or quantifiable

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Points to remember (2)

- BCA is applicable when benefits of an action/policy are quantifiable and measurable (directly/indirectly) in monetary terms
- CEA is more appropriate when benefits are expressed in physical units, or cannot be quantified
- Important limitations of EFA include the assumption, taken for granted, of positive time preference, strategic biases in CVM (the only method for evaluating option and existence values)

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Suggested reading

European Commission, 1997. Financial and Economic Analysis of Development Projects (A Manual). Office for official publications of the European Communities. Luxemburg. 375p.

Leach, D. J.m 1982. Economic and Financial Studies for Engineers.Ellis Horwood Publishers. Chichester, 259p.

Meier, G.M., 1989. Project Appraisal in Leading Issues in Economic Development, 5th Edition, Oxford University Press, Oxford, pp467 – 510.

Keeny, R. L., and Raiffa H., 1993. Decisions with multiple objectives: Preferences and value tradeoffs. Cambridge University Press. Cambridge. 569p.

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Some useful web pages

- http://www.dec.ctu.edu.vn/ebooks/envreval/troleofm.html
- http://www.ecosystemvaluation.org/hedonic_pricing.htm
- http://www.eldis.org/static/DOC13358.htm
- http://www.fao.org/docrep/x5325E/x5325e0c.htm
- http://www.colorado.edu/Economics/CEA/cea-wkpapers.htm
- http://www.buseco.monash.edu.au/research/publications.php

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Examples and Exercises

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Instructor-led exercise

- Baseline scenario (esp. LULUC)
- Fisheries (aquaculture, business as usual)
- Livestock (cattle breeding, poultry farming, business- as usual)
- Human health (vector control, vaccination, business-as usual)
- Agriculture (fertilisation, irrigation)

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Group-work exercises

- Forestry
- Coast zone and wetlands
- Energy
- Water Resources

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