

Basics of Economic Valuation: Cost-benefit and cost-effectiveness analysis

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Goals of the workshop

- This workshop introduces the economic perspective in evaluating public programs and policies.
- The emphasis is on measurement of value for money using costbenefit analysis (CBA), cost-effectiveness analysis (CEA) and, to some extent, cost-utility analysis (CUA).

Key themes

- Value for money
 - Results-Based Budgeting
 - Treasury Board Policy
- Foundations of economic valuation
- Measuring costs, Measuring outcomes
- CEA and CBA compared



Disclaimer

CBA and CEA are decision aids; they are not the decision. These methods can help organize decisions and the logic of analysis may reveal hidden benefits and hidden costs, but the outputs from this method are never the only input to a policy decision.

Any decision on a program, policy, or investment will always involve questions of ethics, intrinsic values, political considerations, etc., in addition to the economic calculus.

As always, the devil is in the details and the assumptions also bite.



Value for money (Treasury Board of Canada)

Relevance – Are we doing the right thing in the right way?

- Does the program addresses a demonstrable need?
- Is it within the scope of government capacity?
- Does it respond to citizens wishes?

Performance – Are we achieving value?

Economy: Are taxpayer resources well-utilized?
Efficiency: Are program *outputs* (services and products) achieved in an affordable manner?
Effectiveness: Are the costs of achieving program *outcomes* minimized?

Adapted from Treasury Board Secretariat of Canada http://www.tbs-sct.gc.ca/eval/ppt/dec06-001/vfmp-por_e.asp



 A comprehensive review of all Government of Alberta programs and services to assess whether programs and services are meeting intended objectives and being delivered in an efficient and effective manner.

Relevance

- Is this an appropriate line of business for the Government of Alberta to be in?
- Are there other areas of government who provide similar services to similar clientele? Are similar services offered by not- for-profits or the private sector?

Effectiveness and Efficiency

- Is the program operating effectively and efficiently? How is this being measured?
- If we are not achieving our desired outcomes, what are the critical factors causing this? How do we know?

Preference ore issues to be addressed in Federal evaluations (1)

- Relevance issues:
 - Issue 1 Continued need for the program: Assessment of the extent to which the program meets a demonstrable need and is responsive to the needs of Canadians.
 - Issue 2 Alignment with government priorities: Assessment of the linkages between program objectives and (i) federal government priorities and (ii) departmental strategic outcomes.
 - Issue 3 Alignment with federal roles and responsibilities: Assessment of the roles and responsibilities of the federal government in delivering the program.

Source: Treasury Board of Canada, Directive on the Evaluation Function (Annex A) April 2009



- Performance issues (effectiveness, efficiency, and economy)
 - Issue 4 Achievement of expected outcomes:
 - Assessment of progress toward expected outcomes (including immediate, intermediate, and ultimate outcomes) with reference to performance targets and program research, program design, including the linkage and contribution of outputs to outcomes.
 - Issue 5 Demonstration of efficiency and economy: Assessment of resource utilization in relation to the production of outputs and progress toward expected outcomes.

Source: Treasury Board of Canada, Directive on the Evaluation Function (Annex A) April 2009



Value for Money

Results-Based Budgeting

Performance/Cost Measurement

Program/Project Evaluation



Definition of government initiatives

- Social marketing to promote a goal (articulation of goal or intent; guidance on preferred behaviour)
- Expenditures on goods and services:
 - Direct resource commitments on goods (public housing, vaccination)
 - Direct resource commitments on services (consumer information, training)
 - Tax expenditures (tax deductions and credits awarded to citizens and businesses to behave, spend, invest)
 - Grants/contributions/contracts with third parties to perform services
- Legislation is a general framework for how citizens conduct themselves (smoking bans, Criminal Code) and requires political assent.
- **Regulation** modifies elements of legislation (changes to the speed limit) and can be completed by administrative fiat.



Performance is measured along the results chain



Results chain for a health screening program



Prairie Research Associates Logic Model – a sequence of results chains



Agri-environmental programming

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Business Process

(foundation for economy and efficiency)

Program Awards/Grants Process

- Questions of economy require business process maps
- These reveal the micro processes of transforming inputs into outputs through a sequence of activity steps
- For most public programs, the bulk of the costs are staff time costs.
- A first step in value for money (after creating the logic model) is to create activity steps for each "line" between an input and output.





Causal Logic National Child Benefit





Conventional Logic Model





Causal logic of the National Child Benefit (Federal program)



Outputs support the realization of outcomes in the context of an array of confounding factors

All outcomes and all confounding factors must be measured to isolate the causal chain

The prime defect of logic models for measuring effectiveness is poor specification of the causal "web" **PRA** Value for Money Requirements

- A logic model that details
 - All service lines
 - Business processes with processes/output performance measures
 - Theory of change a story of how outcomes arise from outputs
 - The link from immediate, to intermediate, and then to long term results (outcomes)
- Outcomes framed as benefits accruing to target beneficiaries
- "Costs" of outputs) must be available.



Cost comparison of alternate acquisition methods (benchmarking to outsourcing)

Process review to map the input-activity-output sequence

Management challenge

- Do not ask: "Is the program economical and efficient?"
- Do ask:
 - "What barriers/constraints exist to maximizing economy?"
 - "What evidence exists that can demonstrate that public resources have been assembled and used at least costs?"
 - "What could still be done increase efficiency?"



Assessing efficiency

- Simplest concept of the three "E's" (Many evaluations report on outputs and the measure of efficiency is the resource cost per unit output.
- Low-cost processes (inputs and activities) are economical and support the efficient production of outputs.
- Key differences between economy and efficiency:
 - *Economy* focuses on the costs of acquiring inputs and executing activities.
 - *Efficiency* calculates the costs of all processes (inputs and activities) to realize outputs.



- Many evaluations treat economy and efficiency as linked.
- In many cases, evaluations need only examine efficiency (cost per unit output):
 - Internal audits, if aligned with evaluations should handle the economy questions
 - When evidence suggests implementation challenges and delays, economy should be treated separately from efficiency.
 - In the case of a simple service, with a clear alternative delivery system, it is usually sufficient to address efficiency by benchmarking the existing delivery process to the alternative(s).
 - Horizontal initiatives, especially in response to new issues and involving different orders of government, usually require attention to issues of economy.

Issues in measuring economy and efficiency of horizontal initiatives

- Coalitions of departments, inter-government, government-HGO-Private Partners...)are ubiquitous.
- Touted to improve coordination and lower cost.
- Management styles:
 - one department/agency coordinates
 - a secretariat coordinates all partners
 - an agreement management committee with joint federalprovincial or interdepartmental chairs
 - Agency/Crown Corporation serves as general contractor
 - PPP (joint venture)
- The economy and efficiency of these initiatives depends on
 - Tracking all cost elements (especially) the process time needed to create and maintain the agreement
 - Identifying partner level contributions.



Economy and efficiency grants and contributions

Increasingly used as

- provincial/municipal governments have constitutional authority over designated public services
- provincial taxation capacity is limited and federal government often called in to level playing field





Foundations of economic valuation

- Cost concepts
- Measuring costs
- Time costs and costing time



Economic Cost Concepts

- Opportunity cost the cost of what is given up or the value of the next best option
 - The opportunity cost of taking this workshop is the loss in doing the next best alternative.
 - One of the opportunity costs of going to school is the income that is foregone.
 - The opportunity cost of mitigating climate change by subsidies for wind power technologies is the value of the alternative uses for the funds.
- Direct (tangible) costs the cost of resources (goods and services) expended on the program
- Variable costs costs that vary program activity (staff)
- Fixed costs cost that exist even without program activity (rent)
- **Indirect cost** the time spent by program participants in accessing a service (e.g., patient time spent in waiting when services are restricted)
- **Intangible costs** pain and suffering, morale (not usually included in a cost-effectiveness analysis)
- **Cost frames** individual, institutional, government, society

Financial statements do not represent economic cost

- Program budgets and typical accounting statements typically do not include all the costs associated with a project.
- FTE's only capture costs at the department level not the service line
- Most departmental program budgets exclude the cost of overheads, such as rent and utilities.
- Senior management time are often mot be included in the program's costs.
- Staff often work on multiple projects.
- Public accounting for capital costs may allocate the entire cost to one year, or amortize them, or may not include these costs at all.
- A program budget may be a small element of a departmental budget.



Approaches to costing

Components

- The intuitive approach
- Bottom-up costing
- Sum resources used in the delivery of the program
- Captures costs in certain specific project/program formats

Activity based Costing (ABC)

- Recognizes that labour costs are typically the largest cost category
- Attempts to assign a cost each service line
- Requires clear business processes and time-use data



Components approach to costing

Pojects need identified and localized costs:

- Identified costs means that all resources used are direct and tangible.
- Localized costs means that there are no charges pending, general overheads, or management costs that cannot be attributed to the program.
- Grants, contributions, and contracts to third parties are the most common examples.

Steps:

- Describe each intervention in terms of the resources needed
- Align the "contract" to the deliverable(s)
- Summarize resource use to the project/program (intervention)
- Create business processes to ensure that resource use aligns with deliverables



Example of cost-effectiveness analysis: programs to reduce truancy

Program funded as grant to school

- Costs Identified
- Costs Localized
- Qualitative information used to increase "validity" of the assessment

Got	Example – programs to reduce dropout rates							
Jain	relative Program	tothe	Dropouts Control	Dropout prevented	Cost per dropout prevented	Teacher opinion		
	Α	\$13,500	18	17	\$794			
	В	\$12,750	20	15	\$850	*++		
<u></u>	С	\$7,500	28	7	\$1 0 1	+		
Control Group	Control	0	35	0	- 12			
	Adapted from Levin & McEwan (2001)							

Tracking public sector resource use

- Public programs combine raw resources, infrastructure, and personnel to plan and deliver outputs.
- Wide variation exists in the types of inputs and activities used by public programs:
 - some are personnel intensive
 - others are capital intensive
 - some involve flow through transfers
 - some initiatives require coordination of many players and much of the resources are consumed in the process
- Standard financial statements of expenditure often offer little insight into the costs of individual processes and products.



Activity-based costing (ABC)

- Defects in standard components costing:
 - Inability to identify costs across service lines (programs) within a unit
 - Inclusion of many costs as indirect or overhead costs (not localized to the program)
 - No assignment of most costs (labour) to service lines (programs)
 - No insight into relative value of service lines
- **ABC** breaks down costs by service lines and activity in each service line.



Stages in ABC

- Create a process model and sub-models for the organization
- Identify the service lines and component activities
- Create time recording process for staff (who complete weekly reports on time spent in each activity/sub-activity area)
- Calculate total labour cost (time in an activity multiplied by wages) for each resource (staff person)
- Total the cost for each activity to derive a total cost for each service line
- Prorate indirect costs (rent and other overhead) by service line cost totals
- Sum to obtain cost for each service line



Basics of ABC





Example 1: ABC applied to legal aid

- Legal aid services are offered using three models:
 - staff model (lawyers and staff are employees of a government agency)
 - private lawyers provide the services under a tariff (contract)
 - mixed model
- Legal Aid Manitoba uses a mixed model:
 - comparing the cost-effectiveness of staff counsel versus private counsel requires an accurate costing
- It uses means tests to assess eligibility:
 - two levels of eligibility exists
 - full eligibility (very low income) will impose no costs on clients
 - partial eligibility (working poor) requires repayment of certain costs on a time payment plan
- Clients can choose private or staff counsel:
 - Private lawyers will submit invoices for their time according to a tariff schedule.
 - Processing costs (salaries and overhead) incurred by legal aid must be added to fees paid to lawyers.
 - The costs of staff counsel must also include all salaries and overhead.



Client Intake

Application/Intake (Private Bar)





Table 1: Major areas of activities for LAM					
	Activities related to:	Service line			
1.	Application Intake (Formal certificate applications – private and LAM)	Criminal adult	Criminal youth	Civil	
2.	Application Intake (Certificate equivalent, informal LAM cases)	Criminal adult	Criminal youth	Civil	
3.	Case Assignment Process (within LAM)	Criminal adult	Criminal youth	Civil	
4.	Duty Counsel (LAM) or Drop-in Centre	Criminal adult	Criminal youth	Civil	
5.	Case Conduct (LAM – informal cases, certificate equivalents and certificates)	Criminal adult	Criminal youth	Civil	
6.	Accounts Payable (Invoices by private bar – taxation)	Criminal adult	Criminal youth	Civil	
7.	Accounts Receivable (Clients on partial or full contribution, charge on land)	Criminal adult	Criminal youth	Civil	
8.	IT systems support (Use all service lines if time cannot be allotted between criminal adult, criminal youth, and civil cases)	Criminal	Criminal youth	Civil	All Service Lines
9.	Internal support – Not case related (Use all service lines if time cannot be allotted between criminal adult, criminal youth, and civil cases)	Criminal adult	Criminal youth	Civil	All Service Lines
10	. External relations – Not case related (Use all service lines if time cannot be allotted between criminal adult, criminal youth, and civil cases)	Criminal adult	Criminal youth	Civil	All Service Lines
Ac allo	tivities unusual for a typical day (Use all service lines if time cannot be otted between criminal adult, criminal youth, and civil cases)	Criminal adult	Criminal youth	Civil	All Service Lines



Tab	le 2: Activities related to application intake			
	Activities related to:	Time by service line		
1.A aı	oplication Intake (Formal certificate applications – private nd LAM)	Criminal adult	Crimin al youth	Civil
a.	Clarify application with the person that took the application (calling back to ask questions about application)		,	
a.	Determining eligibility and making eligibility decisions (gathering facts, meeting/interviewing applicants, consulting with senior management and/or intake officers, responding to applicant enquiries, computer searches, court registry, Internet, telephone advice)			
а.	Inform applicant of decision and respond to inquiries on decisions (issue certificate or amendment/issue rejection of application and appeals)			
a.	Review appeal			
a.	Monitoring/supervising staff			
a.	Review staff operations			
a.	Allocate workload			
a.	Correct mistakes			
a.	Office support for application intake (e.g., pulling files, filing, faxing, or photocopying)			


Example 3 – AAFC Advanced Payments Program

PRA ADVANCE PAYMENTS PROGRAM (APP ACTIVITY-BASED COSTING QUESTIONNAIRE This survey is being conducted as part of a program efficiency evaluation of the Advance Payments Program (APP). The purpose of the survey is to assist Agriculture and Agri-Food Canada in determining how staff resources are being used to administer the APP. This is not an exercise for analyzing the efficiency or productivity of individuals, and your identity will not be associated with your response The survey includes two sections: the first asks for basic information about your role in the APP and the second asks what percentage of your working time is spent on 13 different activities. All information you provide will be strictly confidential betwee you and PRA. You may complete the form electronically (click or type the appropriate response) or you may print it out and fill it in using pencil. Please email your completed form to blbik@ora.ca or fax it to 1-800-717-5456. SECTION 1: RESPONDENT INFORMATION What is your current role in the APP? (please check one only) O co Assistant director Ore Director Om Program manager On Program officer Oos Administrative/cierical O the Other (please specify) 2. When did you first start working in this position? _ month 3. In your current position, how many hours per week do you typically spend working on the APP Thinking of the past 12 months, has your role in the APP changed? O. Yes O₁₀ No SECTION 2: ACTIVITY TIME TRACKING This section asks you to record what percentage of working time you spent on 13 APP activities over the past week and over the last 12 months. Please read the entire set of activities listed and think about whether your responsibilities fail within them. Then, for each activity, please answer the following questions: 1. First, thinking of your ourrent position: a) During your last full week at work, what percentage of the week did you spend on each activity? b) During the past 12 months, what percentage of your time did you spend on each activity? 2. Next, thinking of your previous position (if applicable): a) During your last full wook at work, what percentage of the week did you spend on each activity? b) During the past 12 months, what percentage of your time did you spend on each activity? Please note that 100% of your time should be allocated to the activities listed. If you did not participate in the activity listed, please enter 0% Time spent per activity in Time spent per activity in CURRENT position PREVIOUS position Activity % of % of % of past 12 % of past 12 previous months months a. Meetings (management meetings, meetings with other b. Polloy and program design issues (beckground research, ad hoc king groups, working pape C. Ministerial documents/ATIP requests (briefing notes, letters from the Minister, "green" dockets)

 O. Performance and financial reporting (weekly status reports, RPP/DPR, service standards, progress reports, APPEDS)
Administrator applications (ensuring applications are complete, setting administrator IDs in APPEDS, reviewing committee activities,

 Other Interaction with administrators (responding to questions about program guidalines, resolving APPEDS issues)
Interect claims (requesting/inviewing Monthly Interest Claim Summaries, recording reports, calculating interest payments,

h. Defaults (requesting/reviewing Monthly Default Reports/Default During Production Period Reports, Default Working Group, Default

k. Stay of advance/default (forwarding requests to the Minister,

M. Human recourses (human resource planning, learning plans) Please specify any other APP activities you perform that are not

Recipient audits/compliance vicits (audit plans, administrator risk ratings, amenging third-party audits, reviewing results, preparing footonducing compliance visits, follow-up)

Awarenecc/promotional activities (trade shows, presentations)

 NON-EAPP ACTIVITED
What percentage of time did you spend on non-APP activities? (other program, special projects)
TOTAL AMOUNT OF TIME: "Each column should total 100%.

obtaining edvance rates, preparing AGAs)

Improvement Project, processing claims) Recoveries (sending files to recoveries, lisising with recoveries

personnel and administrators)

mitoring industry condition

already oovered in the above categories

authorizing payments)

Goal is to identify the costs of the program

Number of staff = 32

Questionnaire developed with the staff and management

Snail mail implementation – easy to use web-based survey

Senior management must communicate intent and value

Third party hosting is essential

CONFIDENTIAL WHEN COMPLETED

100%

100%

100%

100%



Measuring outcomes



Measuring outcomes: the bang

Three key concepts for measuring net impact (the bang):

- Counterfactuals form the philosophical base
- Gross versus net impacts net impact is the required measure
- Techniques to measure net impact
 - randomized trials (clinical, lab, field, and large social experiments)
 - multivariate (regression)
 - quasi-experimental (matching)
 - universal programs



Causal framework for policy design





The nature of random clinical trials

- Randomization into a treatment and control group (RCT) creates two groups that are statistically equivalent:
 - For any statistic (e.g., mean, variance) the two groups as a whole will return results that are the same (within bounds of statistical significance).
 - The test of statistical equivalence applies to *observable* and *unobservable* attributes.

• Manipulation of the treatment supports inferences about:

- effect of the treatment ("on"/"off" hypotheses)
- dose response (If one aspirin is good, 2 is better, what about 3?)



The random clinical trial - Donepezil





Randomization and statistical equivalence

- Randomization into a treatment and control group creates two groups that are *statistically equivalent*:
 - For any statistic (e.g., mean, variance) the two groups will return results that are the same (within bounds of statistical significance).
 - The test of statistical equivalence applies to observable and unobservable attributes.
- Changing a *single* condition for the treatment group while *maintaining everything else constant* for the treatment and control group yields an unambiguous test of causal (net) impact.

• Key challenges

- Side effects are often not detected in randomized trials because samples are small
- Single experiments are not generalizable many replications needed
- Most important, RCTs do not work in social settings

create program and comparison groups

- Many programs have people eligible for service, but elect not to participate.
 - Part 2 of the *Employment Insurance Act* specifies training programs for which current and past employment insurance beneficiaries may receive support.
 - Low-income families may or may not choose to participate in social assistance.
 - Some farmers choose not to participate in crop insurance, even with the government subsidy.
 - Some parents choose to home-school.
- Participants and non-participants differ in observable and non-observable ways.
- Quasi-experimental methods can attempt to statistically equate participants and non-participants.



- Universal programs admit all eligible participants.
- Not possible to identify a treatment and comparison group.
- Methods:
 - pre-post
 - limited treatment
 - parallel group
 - multivariate control
- Any method other than a randomized trial cannot identify net impacts; however, any contrast between the experience of program participants and non-participants offers more insight than no comparison.



Difference in Differences (DID)



Assume outcomes Y are measured for the program group P and comparison group C

Measurement occurs at time = a and time = b

Net impact is the gain in the Program Group (Gross Impact) relative to the gain in the comparison group (Comparison Change)

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Cost-effectiveness cost-benefit

Two requirements:

- Measure the "bang"
- Measure the "bucks"

Benefit - cost = "bang per buck" Cost - benefit = "buck per bang"

Cost-effectiveness analysis (CEA) – What is the cost of achieving specific outcomes arising from different interventions?

Cost-utility analysis (CUA) – What is the *perceived value* of the outcomes relative to their costs?

Cost-benefit analysis (CBA) – What is the value of all outcomes (social and private) in relation to all costs (social and private)?







	СВА	CEA	CUA
Scope	Global – multiple outcomes valued	Local – single output/outcome	Local – single output/outcome
Unit of measure for outcome	Money equivalent	Natural	Utility or perceived value of outcome
Timeframe	Extended	Immediate/short- term	Immediate/short- term
Primary decision purpose	Prospective	Retrospective	Retrospective
Application	Outcomes or impacts only	Activities- outputs-outcomes	Adjusted cost- effectiveness
Reference	No reference needed	At least one alternative	At least one alternative

Cost-effectiveness analysis

Outputs and outcomes must be strategic (and valid and reliable)

- Outputs and outcomes should reflect the core goals of the program:
 - An output/outcome selected for CEA should be selected to reflect the activity of a program. For this reason, outputs often replace outcomes in CEA because they are easier to measure.
- Outputs and outcomes must be strategic:
 - A single output/outcome, if used alone, must represent a central goal of the program.
- Variation in a strategic outcome should correlate with other results.
 - Increases in that output/outcome should also be correlated with other outcomes.



Cost-effectiveness analysis example – vaccination programs for employees

- Outputs include the numbers vaccinated.
- Outcomes include:
 - sick days
 - total number of employees affected
- The program with the *lowest cost per vaccination* is the most costeffective in terms of *outputs*.
- The program with the *lowest number of sick days* per dollar cost is the most cost-effective in terms of *outcomes*.
- Key assumption: Government offers three models to vaccinate its workforce
 - Primary care clinics
 - Pharmacies
 - Work place

The locale with the lowest cost per vaccinated employee is the most cost effective in terms of the immediate outcome of numbers vaccinated.



Cost-effectiveness analysis example – training interventions

A common goal for many training interventions is the return to work.

Typical examples of outcomes include:

- return to work for six months
- hours of work after the intervention
- number of trainees who become employed
- wages after training
- post-intervention employment insurance benefits avoided



Cost-effectiveness analysis example – early childhood development

- Early evaluations showed major gains in IQ and grade advancement as a result of early childhood interventions.
- Recent evidence suggests major benefits including:
 - higher levels of verbal, mathematical, and intellectual achievement (1–2 years)
 - greater success at school, including less grade retention and higher graduation rates (1–10 years)
 - higher employment and earnings (15 + years)
 - better health outcomes (1–10 years)
 - less welfare dependency (15 + years)
 - lower rates of crime (5–15 years)
 - greater government revenues and lower government expenditures (5–15 years)
 - intangibles (lower stress on parents)



Cost-benefit analysis rests on basic ideas in welfare economics

Welfare economics

The sub-discipline of economics that analyzes changes in the well-being of individuals/communities arising from changes in economic policy.

Assumptions

- Individuals have full information and are the best judges of their well-being, which is measured by willingness to pay or its proxy
- CBA is the empirical measurement of changes in well-being.
- Community or social welfare is the sum of the welfare of individual community members.



The main features of cost-benefit analysis

CBA—a decision-making framework to compare the welfare of stakeholders before and after an intervention.

- Sums the benefits and costs arising from an initiative
- Translates any change in individual welfare into a dollar amount; this can include benefits such as:
 - avoided harms (deaths from disease)
 - lost wages due to inability to work
 - value of time saved
 - value of extending life



Steps in a cost-benefit analysis

- Enumerate the stakeholders (individual, government, society)
- Enumerate the "stream" of costs and benefits
- Value all costs and benefits in a financial equivalent (intangibles)
- Compare costs and benefits over time



Enumerate stakeholders

- Including all impacts in a cost-benefit model often leads to double counting.
- *Primary effect* represents the first-round impact (costs and benefits of the change).
- Secondary effect is the induced impact arising from linked market transactions associated with the change.

Example: A new public transit system typically reduces the travel time (primary effect), which, in turn, increases the desirability (price and rent) of homes close to stations. The change in prices and rental costs of homes induced by changes to transit are a second-round impact and should not be included in the CBA. This would double count the benefits, which have already been measured by the reduction in travel time.



Enumeration and valuation of benefits and costs

Advantages of using money values of benefits and costs:

- All costs and benefits may be included in the calculation.
- A single project/initiative can be analyzed alone; projects where benefits exceed costs pass the CBA test.
- Sometimes primary outcomes cannot be measured, but secondary outcomes may be measurable.

Many are uncomfortable with the main steps in CBA:

- Translating intangible benefits and costs into money
- Comparing the changes in welfare among different groups
- Summing up individual benefits and costs seems to count welfare of some more than others (those with the greatest willingness/ability to pay)



The benefit cost structure

monetary value of net change to welfare of *all* outcomes for *all* stakeholders (\$) *over time*

CBA

Social cost (\$) (tangible and intangible) over time





Cost-utility analysis: toward subjective valuation of benefits using QALY and HRQL

CUA uses self-report data (e.g., surveys, focus groups) to measure quality of life and outcome (years of life after medical treatments).

- Many treatments do not restore perfect health.
- Subjective measures score perceived health out of 10: health-related quality of life (HRQL) and quality of life years (QALY).
- Therefore, if patients score their quality of life as .6 (60% of perfect health), then for one year the patient has .6 QALY, and outcomes are valued at 60%.

QALY for a patient compared to healthy person		
Year	Patient	Healthy
1	.7	1
2	.6	1
3	.5	1
4	.4	1
5	.3	1
Totaler tim	2.5	5



Example – Traffic congestion

Overpass: A new suburban subdivision is created beyond a main east/west transcontinental rail line. With 2,000 new households, new retail malls, and a main road linking north and south, traffic delays caused by rail traffic are substantial.

Option 1: Create an overpass at a cost of \$30 million Option 2: Impose restrictions on rail traffic

CBA compares the ratio of benefits to the costs for each option, as well as the "hidden" option of doing nothing.



Example – vaccination programs

Benefit

- reduced short-term cost due to illness
- reduced long-term cost for caring for the small number of catastrophic incidents
- averted loss of incomes for those who are disabled/dying
- averted costs of lost time at work and play

Cost

- vaccination program
- economic loss for the small number who experience adverse reactions to vaccine



Vaccination for measles (Axnick et al., 1969)

Figure 1. Economic cost and savings relationships



Axnick, N.W., Shavell, S.M., and Witte, J.J., (1969). Benefits Due to Immunization Against Measles, *Public Health Reports*, Vol. 84, No. 8.



Figure 2. Estimated measles incidence in the United States, 1963 through 1968





Table 1. Summary statement of savings due to immunization against measles

Type of savings	1963-65	1966-68	Total
Health and resource:			
Cases averted	1, 140, 000	8, 590, 000	9, 730, 000
Lives saved	114	859	973
Cases of retardation averted	380	2.864	3. 244
Hospital days saved	65,000	490, 000	555, 000
Workdays saved	189,000	1, 435, 000	1, 624, 000
Schooldays saved	3, 775, 000	28, 450, 000	32, 225, 000
Economie:			
Economic Lenefits	\$63, 192, 000	\$468, 351, 000	\$531, 543, 000
Cost of immunizing persons	43, 500, 000	64, 800, 000	108, 300, 000
Net economic savings	19, 692, 000	403, 551, 000	423, 243, 000

Table 2. Estimated health and resource costs due to measles and benefits due to immunization, United States, 1963 through 1968

Item	Without immunization	With immunization	Benefits due to immunization	
Incidence of acute cases	24, 000, 000	14, 270, 000	9, 730, 000	
Deaths	2,400	1, 427	973	
Cases of mental retardation	8,000	4,756	3, 244	
Patients hospitalized with encephalitis	24,000	14, 270	9,730	
Other hospitalized patients	1 268 000	71, 350 812, 000	48, 650	
Hospital days	4 013 000	2 380 000	1 694 000	
Schooldays	79, 487, 000	47, 262, 000	32, 225, 000	



Summary of measles CEA

The Axnick Measles Vaccination Study (1969)		
	Benefit (+) and Cost (-) (\$millions)	
Immunization costs (Year 1)	-\$108	
Immediate medical care averted (<i>discounted over</i> 20 years)	+\$77	
Long-term care of encephalitis cases averted (discounted over 20 years)	+\$201	
Economic loss averted (discounted over 20 years)	+\$253	
Net Benefit	+423	



Limits/challenges of cost-benefit analysis

- Defining the scope is always a problem. A narrow scope (just program recipients) ignores others such as those not eligible, whose exclusion may be a "disbenefit" (cost).
- Double counting is hard to avoid since taxes/subsidies always find their way into the costs/prices of private assets.
- Valuing underutilized resources requires adjustments to costs. Is the cost of labour less when unemployment is higher?
- Discounting costs and benefits over time require careful choice of interest rates.
- Politics distorts the structure of the CBA. Who and what is included is a judgment call.



Case study 1



Case study – Cost-effectiveness analysis of labour market training for single parents on social assistance



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Taking Charge! – a training program for single parents on social assistance

Taking Charge! (TC) was a pilot program jointly funded by Human Resources and Skills Development Canada and the Manitoba government. It focused on offering a range of supports for single parents on income assistance.

Key features:

- high level of support (e.g., daycare, counselling, basic education, volunteer experience, job placement)
- recruit income assistance (IA) clients
- employability assessments
- tailored training programs
- contracted service providers
- job placement



Measurement of outcomes

- Comparison groups
 - other training programs directed to similar clients
 - "control" group (social assistance recipients with no record of training)
- Multivariate model measured net impact
 - no statistical matching
 - difference in differences (DID) model



DID model of social assistance outcomes

- Reduction of SA benefits for TC (\$166) and comparison groups (\$118)
- The contribution of other participant attributes may be read in the equation
- Interventions coded with dummy variables
- Work expectations reflect whether the participant had been directed to participate or not

Difference of average income assistance paid and benefit reduction, pre- and post-intervention

	Change in IA paid		
Sample size		2526	
Constant	-166	**	
Group 1 (Taking Charge!)	-168	**	
Group 2 (comparison group)	-118	**	
Educ2	7	*	
Gender	91	**	
Age	0		
# Children 6–18	-1		
# Children < 6	79	**	
Status Indian	35	*	
Number of interventions	38	**	
Intervention 1 (work/job search)	-67	*	
Intervention 2 (trade skills)	-120	**	
Intervention 3 (tech/mgmt skills)	98	**	
Intervention 4 (lit./num)	34		
Intervention 5 (acad. upgrading)	-49		
Intervention 6 (job placement)	-17		
Work expectations	48	**	
Number of jobs before intervention	-19	**	
Total time on SA	63	**	Ī
Difference in unearned income	0		Ť
Difference in children <6 (pre and post)	31		
Duration of intervention	-0.2		
Adj. R ²		0.107	


Hazard model

- This uses a statistical technique (Kaplan-Meier) to estimate the time to leave SA.
- What always surprises is that the control group leaves at a high rate (25% per year in 1999).
- TC clients leave slowly because they receive SA benefits while in training.





"Cost-effectiveness" model

- This is a hybrid program, with analysis from the perspective of the government.
- It is technically a CEA, but since the benefits are avoided costs (reduced SA and taxes arising from incremental employment), the outcomes are naturally valued in \$.
- Basis for net impact comparison:
 - control group (SA clients who never took a program)
 - comparison group (participants in other training interventions)
 - program group (TC participants)



The benefit-cost framework						
	Costs		Benefits			
	A. Income assistance		E. Increased benefit reductions			
	payments during training		because of earned income			
+	B. Training allowances	+	F. Reduced income assistance			
	(books, special needs)		due to lower time on welfare			
+	C. Cost of training	+	G. Increased taxes from			
			employment earnings			
=	D. Total costs	=	H. Total benefits			



Benefit-cost results (see previous slide for interpretation of A, B, C, D, E, F, G, H)									
	Costs			Benefits					
Group	IA while in training	Training needs	Costs per client	Total	Reduced in benefits	Reduced time on IA	Taxes	Total	Benefit- cost ratio
	Α	В	C	D	E	F	G	Η	H/D
Taking Charge!	\$633	\$6	\$3,112	\$3,751	\$1,360	\$2,046	\$205	\$3,611	0.96
Comparison	\$267	\$55	\$1,341	\$1,663	\$1,136	\$4,550	\$181	\$5,867	3.53
Control		\$2	\$0	\$2	\$598	\$0	\$77	\$675	-

Key lessons:

- The outcome period was too short—a simulation exercise to project future benefits would have raised B/C ratios (prospective CEA).
- Current techniques would have used a matching model to align program and comparison groups better.
- Drop the comparison groups since they exhibit high selection biases (creaming and self-selection) that make for imprecise measures of net impact.



Case study 2



Case study – Estimating the cost-effectiveness of primary health care (Cancer screening and diabetes management)





Primary health care

The ultimate goal of primary health care is better health for all. The World Health Organization has identified five key elements to achieving that goal:

- reducing exclusion and social disparities in health (universal coverage reforms)
- organizing health services around people's needs and expectations (service delivery reforms)
- **integrating health** into all sectors (public policy reforms)
- pursuing collaborative models of policy dialogue (leadership reforms)
- increasing stakeholder participation

World Health Organization http://www.who.int/topics/primary_health_care/en/



Primary care

- Reduces the net costs to the payer (health insurance, government, and the individual) by avoiding entirely or intercepting disease at a more easily treatable stage
- Averts disease, yielding to economic benefits to individuals and society because of greater functional life expectancy and the consequent capacity to earn and play other productive roles
- Increases the quality of life, reducing treatment burden on patients and families, and extending the interaction of the patient with family and society

This CEA focuses on the first of these benefits.



Key cost-effectiveness analysis question for cancer screening

Does the short-term cost of increasing the uptake of screening for cancer in the general population result in health systems savings because cancers are detected at an earlier stage for a small number of people?

Maybe





- A Markov model creates a probability structure of disease outcomes over an extended period (50 years).
- This can be applied to many medical situations, vaccination, and primary health screening being the most common.
- The simplest screening/vaccination model uses binomial probabilities at each decision point (true-false probabilities).
- Presumably, the vaccination reduces the severity of getting the disease (P2 < P3)—by a lot.
- Also, cancer screening should detect cancers at an earlier stage.

PRA Prairie Research Associates Markov model of cancer screening



The figure gives a general overview of how a decision tree dealing with FOBT screening for colorectal cancer appears.

Each node () is a binary decision, determined by a simple "coin toss" (but with unequal probabilities).

Research Associates The decision tree of primary health cost-effective analysis: Markov model – Monte Carlo simulation



The P1, P2, and P3 values guide the patient through the tree.

The values of Pi come from incidence/prevalence data.

The bottom "cancer" or state are those who are diagnosed through symptoms and not screening. They are assumed to have more advanced stages of cancer and therefore are more costly to treat.



Cancer cost-effectiveness results (current trend screening versus Canadian Institute for Health Information screening)

	FOBT (colorectal cancer)	Mammography (breast cancer)	Pap test (cervical cancer)
Description	Cost per individual	Cost per individual	Cost per individual
Current trend cancer screening simulation over 25 years	\$1,360	\$2,047	\$283
Full screening simulation over 25 years	\$1,327	\$2,042	\$381
Difference	\$33	\$5	\$98
Count of simulated individuals	Total estimated savings or costs	Total estimated savings or costs	Total estimated savings or costs
Simulation across population	\$10,662,300	\$717,200	-\$40,904,000

In general, population-wide FOBT and mammograms are costeffective. Population-wide Pap tests are not.



Caution

- This analysis says nothing about the advisability of cancer screening for those at risk (mother/sister/aunt) or for those who have had cervical cancer—Pap tests are indicated in those *individual* cases.
- New therapies (HPV vaccine) may reduce the need for Pap tests.
- This model only examines the first three categories of cost savings/benefits associated with primary health screening.

PRASE-effectiveness analysis of diabetes management

- Diabetes is a disease of the small blood vessels induced by sugars binding to red blood cells.
- Morbidity and mortality arises from complications associated with the degeneration of small blood vessels and include:
 - neuropathies (ulcers of the extremities)
 - blindness
 - kidney failure
 - stroke
 - cardiovascular events (infarction and failure)



Model strategy

- Type II diabetes typically is late onset (adult) and induced by lifestyle choices and constraints.
- Pre-diabetes conditions, diagnosed by elevated fasting blood sugar, can be controlled by diet and exercise.
- Once diagnosed, the primary care strategy is to manage health risks associated with the disease:
 - hypertension control
 - lipid control
 - weight control (diet and exercise)
- The goal is to slow progression (there is no cure) to avoid the high cost of complications.



Diabetes management: Markov model (microvascular sequence)



- The complications are "co-occurring" morbidities.
- Patients can have one single event (heart attack), several (heart attack, stroke, and kidney failure), once or several times.
- Patients with one acute event cost the system less than someone that has several complications over a long period.

PRADetes management: Markov model (macrovascular sequence)



All permutations and combinations of micro and macrovascular complications need to be included in the model.



Results

Table 1: Diabetes cost-effectiveness results (70% control					
Description	Original simulation				
	Cost per individual				
70% diabetic control simulation over 40 years	\$20,003				
100% diabetic control simulation over 40 years	\$19,822				
Difference	\$181				
Count of simulated individuals	Total estimated cost avoidance				
Simulation of 5,841 individuals	\$1,057,221 savings				

An individual that maintains 70% control incurs \$181 additional cost over his/her lifetime compared to someone that maintains 100% control.

Across 5,841 individuals, this amounts to a treatment cost saving of \$1,057,221.

This analysis does **not** include the costs of rolling out a public health campaign to encourage/support people to engage in lifestyle changes to avert diabetes, or encourage/support people to maintain control once diagnosed.

No one has a clue what these are.



Cost-effectiveness analysis applied to primary health care

- Useful estimates that guide prospective CEA are possible.
- CEA rests on establishing model analogies (the decision tree model).
- Data to calibrate the models can be drawn from the literature and in the future will be supported by increasing availability of electronic medical records.
- The adage, an ounce of prevention is worth a pound of cure, needs to be taken with a grain of salt.



Planning evaluations to support value for money



Checklist for assessing economy

- Economy involves minimizing the use of resources to complete an activity.
- Specifically, economy refers to two core requirements
 - the acquisition of appropriate inputs (e.g., human resources, services, supplies) at the least cost and of the right quality
 - the effective organization of program resources to realize outputs.
- Economy asks whether managers have acquired, used, and organized resources to minimize the cost of activities



Checklist for assessing efficiency

- Select a few strategic outputs that logically link to outcomes
- Ensure that the selected outputs "span" the program
- Use activity based costing to compute the cost of the service line deliverables

Remember:

- Management is a source of insight and context. Management opinion is not reliable factual data
- Value-for-money and results-based budgeting will typically emphasize efficiency measures because net impact is too complex.



Checklist for cost-effectiveness analysis

- CEA is always much easier to design and execute than CBA.
- Ensure you have the information to complete a CEA before commissioning the study.
- Measure the CEA of each outcome and each service line
- Effective management always understands the direct costs of each service—consider implementing time recording for all human resources.
- Identify the immediate and intermediate outcomes of your service lines.
- Make sure these outcomes are:
 - central (meaningful measures of success)
 - consistent (move together)
 - comprehensive (capture the essence of the program)
- Analyze why you think your program "owns" these outcomes—attribution is critical.
- If you cannot draw a clear line between the outcomes and the outputs or your program, cost-effectiveness is not possible.



Selected readings

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