

Value for Money: Cost-benefit and cost-effectiveness analysis

Greg Mason

PRA Inc.

University of Manitoba

September 22, 2010

Presentation to the Saskatchewan Chapter of Canadian Evaluation Society

Disclaimer

Cost-benefit and cost-effectiveness analysis are decision aids; they are not the decision. These methods can help organize decisions and the logic of analysis may reveal both 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.

Goals of the workshop

- The economic perspective offers an important set of tools and perspectives in evaluating public programs and policies
- The main concepts involve cost-effectiveness and cost-benefit analysis
- Key themes:
 - Clear delineation of inputs, outputs and outcomes (logic models and results chain) supports
 - Net impact and attribution support for cost-effectiveness and cost-benefit analysis
 - Accurate costing along the results chain (activities, outputs, and outcomes) clarifies the use of public resources
 - Key differences exist in cost-effectiveness and cost-benefit analysis
 - Other important costing concepts (cost-minimization, cost-utility, etc.) play useful roles
 - Data challenges must be surmounted

Examples

- Challenges in assessing performance for grants and contributions programs
- Using activity based costing to overcome inadequate financial information (Legal aid services)
- Measuring cost-effectiveness
- Training (Retrospective an analysis)
 - Employment insurance (cost-effectiveness of training using a comparison group)
 - Social assistance (costs-effectiveness with multiple comparison groups)
 - Persons with disabilities (cost-effectiveness of training in the absence of a comparison group)
- Evaluating value for money in primary care programs
 - Vaccination of girls against HPV as a way to prevent eventual cervical cancer (prospective CBA)
 - Cancer screening (Prospective cost-effectiveness)
 - Diabetes management (Prospective cost effectiveness)
- Energy and climate change programs – measuring benefits over 100 years

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 cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and, to some extent, cost-utility analysis (CUA).
- The workshop will discuss
 - The measurement of net impact
 - Attribution of outcomes to the program
 - Accurate costing along the results chain (activities, outputs, and outcomes)
- Two examples will be presented in detail
 - Training single parents on social assistance (retrospective CBA)
 - Vaccination of girls against HPV as a way to prevent eventual cervical cancer (prospective CBA)

Morning: Overview of main concepts

- **Overview of main concepts**
- **Value for money – The Treasury Board Policy**
 - Rationale and relevance
 - Performance
 - Logic models and the results chain: outputs and outcomes
 - Defining economy, efficiency and effectiveness
- **Foundations of decision-making**
 - CEA (Cost-effectiveness analysis)
 - CBA (Cost-benefit analysis)
- **Measuring costs**
 - Direct and indirect costs
 - Challenges in aligning public sector cost statements with public sector resource use
 - Local and global cost (private and social costs)



Afternoon: Applications

Value for money

Core Issues to be addressed in 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

Core Issues to be addressed in Evaluations (2)

- **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 can be defined as:

- **Relevance – Are we doing the right thing in the right way?**
 - Program addresses a demonstrable need, is within the scope of government capacity, and responds 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

Relevance

Relevance (need) emerges in two ways:

- Consumers validate the demand for goods and services in the market place (*private goods*).
- Government determines needs that the public sector may legitimately provide (*government provision of private and public goods*).

- **Private and public goods**

- Private goods allow all the benefits/costs to be consumed (internalized) by the consumer.
- Public goods have external benefits and costs that cannot be internalized (i.e., externalities exist); there is no incentive for private provision.

- **Merit goods/services** are offered by government or charities based on ethical concepts (e.g., National Child Benefit).

Why does government exist?

Three main rationales for public sector action:

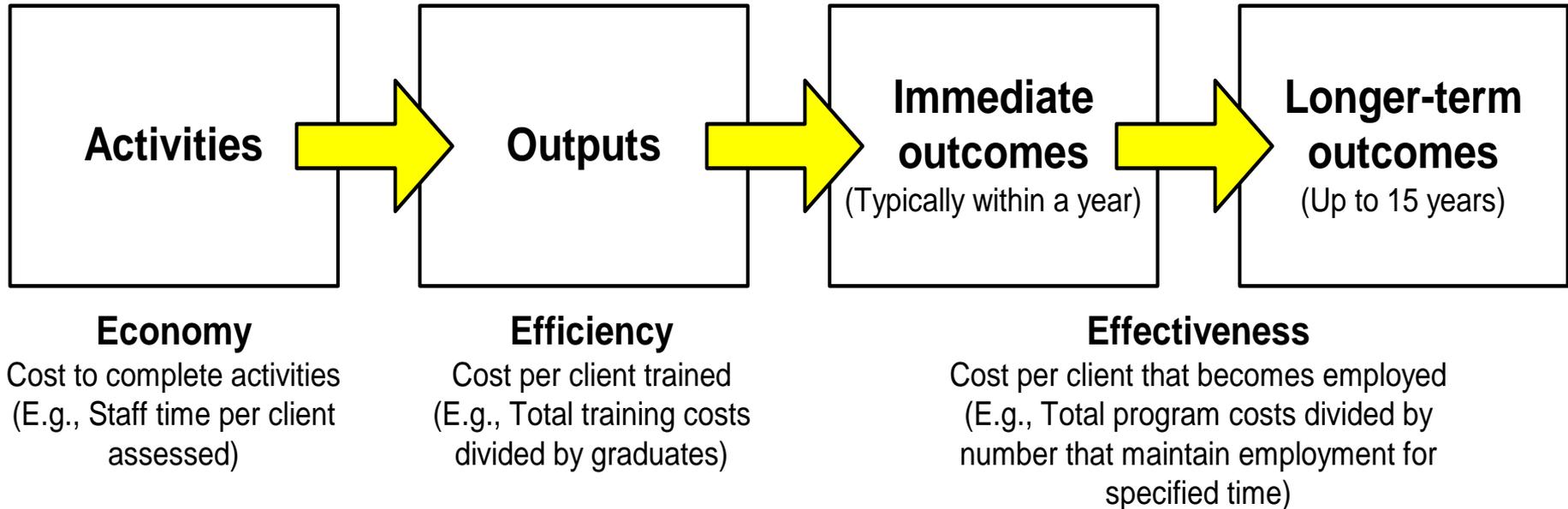
- Market failure (consumer ignorance of mortgages, pollution)
- Externalities (public goods and bads)
- Distributional unfairness (poverty)

- 1. Market failure** typically evokes a regulatory response (e.g., consumer education, fair lending laws, securities regulation).
- 2. Public goods** encourage government to supplement private sector provision of a good or services (e.g., subsidization of crop insurance, subsidization of vaccines, public education).
- 3. Distributional fairness** can result in regulatory, direct provision of a service, or direct cash transfer
 - Laws regarding usury, anti-discrimination legislation
 - Public housing
 - National child benefit, progressive tax, GST rebate for lower income households

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, etc.)
 - *Grants/contributions/contracts* to 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.

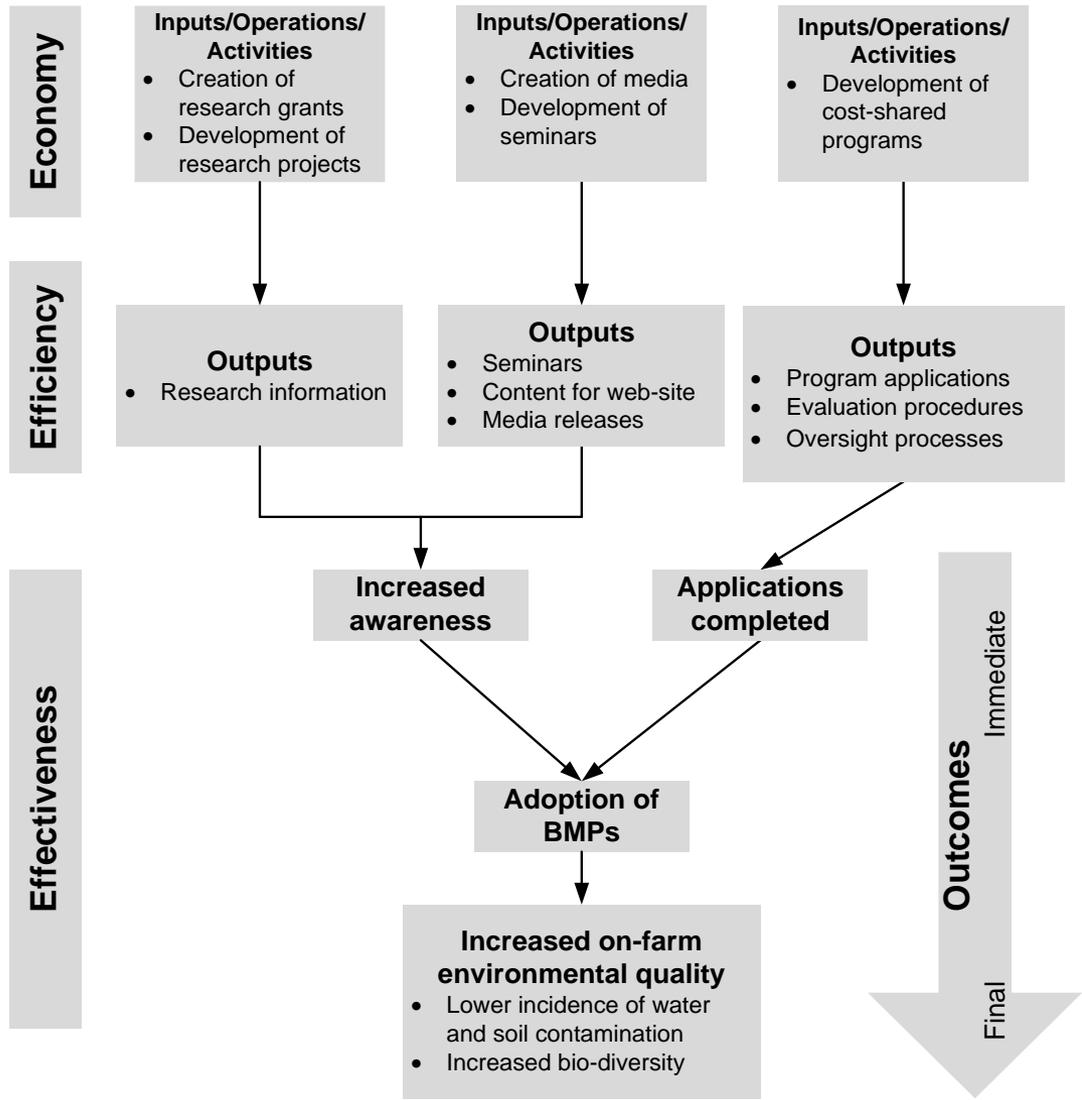
Performance is measured along the results chain





Agri-environmental Programming

Service lines →



A logic model anchors the results chain for each service line comprising a program

Foundations of public sector decision-making

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 – What is the cost of achieving specific outcomes arising from different interventions?

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

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

CBA, CEA, and CUA compared

CEA

Outcomes (outputs, inputs)
 (actual changes measured in natural units, not \$)

Cost of outcome (\$)

CUA

Subjective value of outcomes
 (subjective value of outcomes - adjusted natural units, not \$)

Cost of outcome (\$)

CBA

Monetary value of net change to welfare
 of **all** outcomes for **all** stakeholders (\$)

Social cost (\$) (tangible and intangible)

CBA, CEA, and CUA compared

	CBA	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
Time frame	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

CEA

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 cost-effectiveness analysis 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.

Measuring costs

Cost concepts

- **Opportunity cost** – the cost of what is given up
 - 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 other uses for the funds.
- **Direct costs** – the costs of goods and services expended on the program.
- **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 perspectives** – individual, institutional, government, society

Most budgets are inadequate for cost analysis

- Budgets and typical accounting statements typically do not include all the costs associated with a project.
- Most departmental program budgets exclude the cost of overheads, such as rent and utilities.
- Senior management costs may not 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 may not include these costs at all.
- A program budget may be a small element of a departmental budget.
- Two approaches to costing:
 - Components
 - Activity base

Components approach to costing

This can work for projects that have well identified and localized costs

- Identified costs means that no costs are unaccounted
- Localized costs means that there are no charges pending, general overheads, or management costs that cannot be attributed to the program

Steps:

- Describe each intervention in terms of the resources needed.
- Include only those that are relevant for the intervention to develop a marginal cost.
- Become very familiar with each intervention and how it operates.

Example of CEA: Programs to reduce truancy

Example – Programs to reduce dropout rates

Program	Total cost	Dropouts	Dropout prevented	Cost per dropout prevented	Teacher opinion
A	\$13,500	18	17	\$794	-
B	\$12,750	20	15	\$850	+++
C	\$7,500	28	7	\$1,071	+
Control	0	35	0	-	

Adapted from Levin & McEwan, 2001

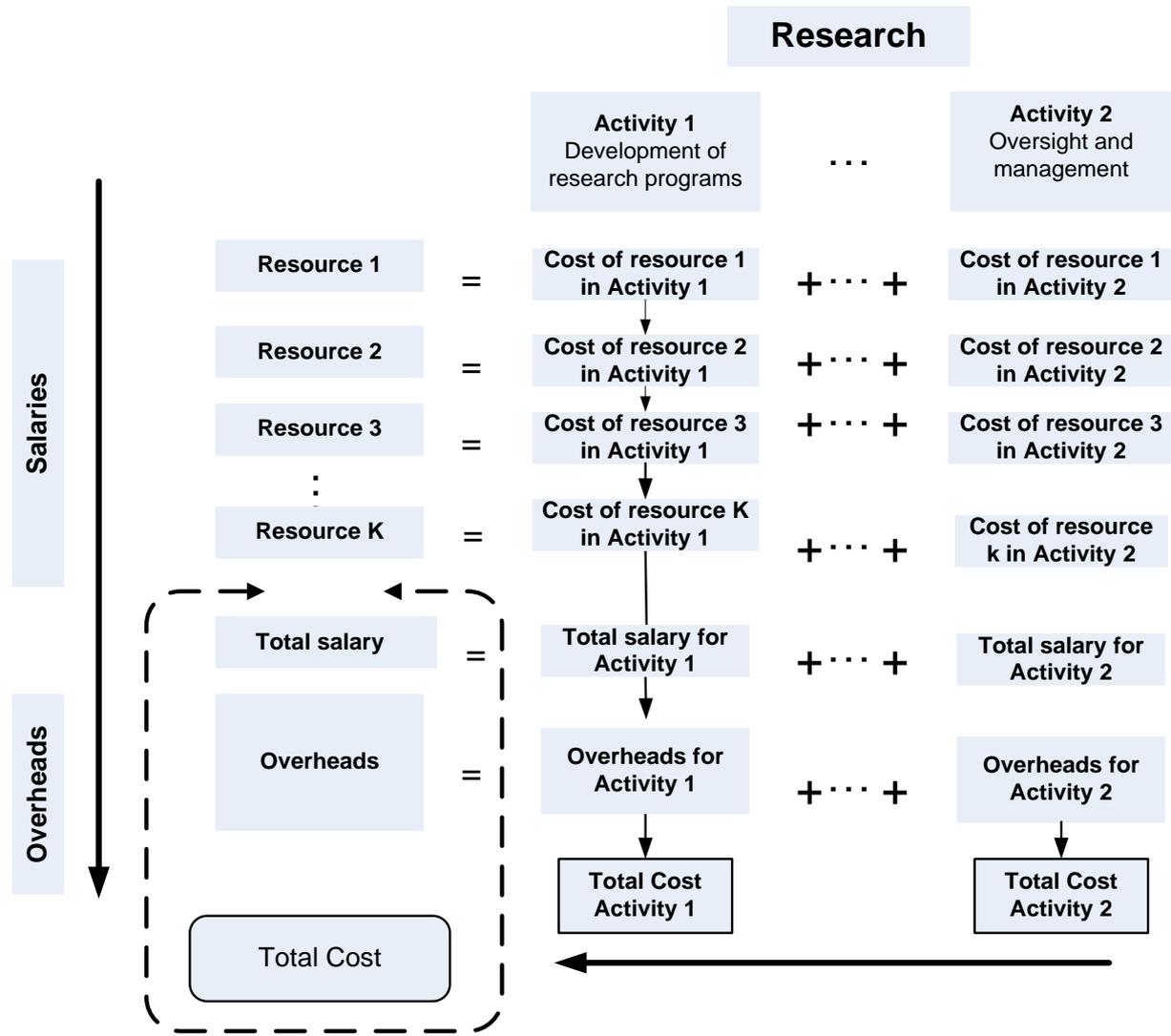
Activity-Based Costing (ABC)

- Defects in the standard components costing include:
 - 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 large blocks of variable (labour costs) to service lines (programs)
 - Cannot support the calculation of the marginal value of service lines.
- **Activity-based costing** breaks down costs by service lines and activity in each service line.
- It allocates labour across activities and then uses proportionality to distribute fixed/overhead costs among the activities.

Stages in ABC

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

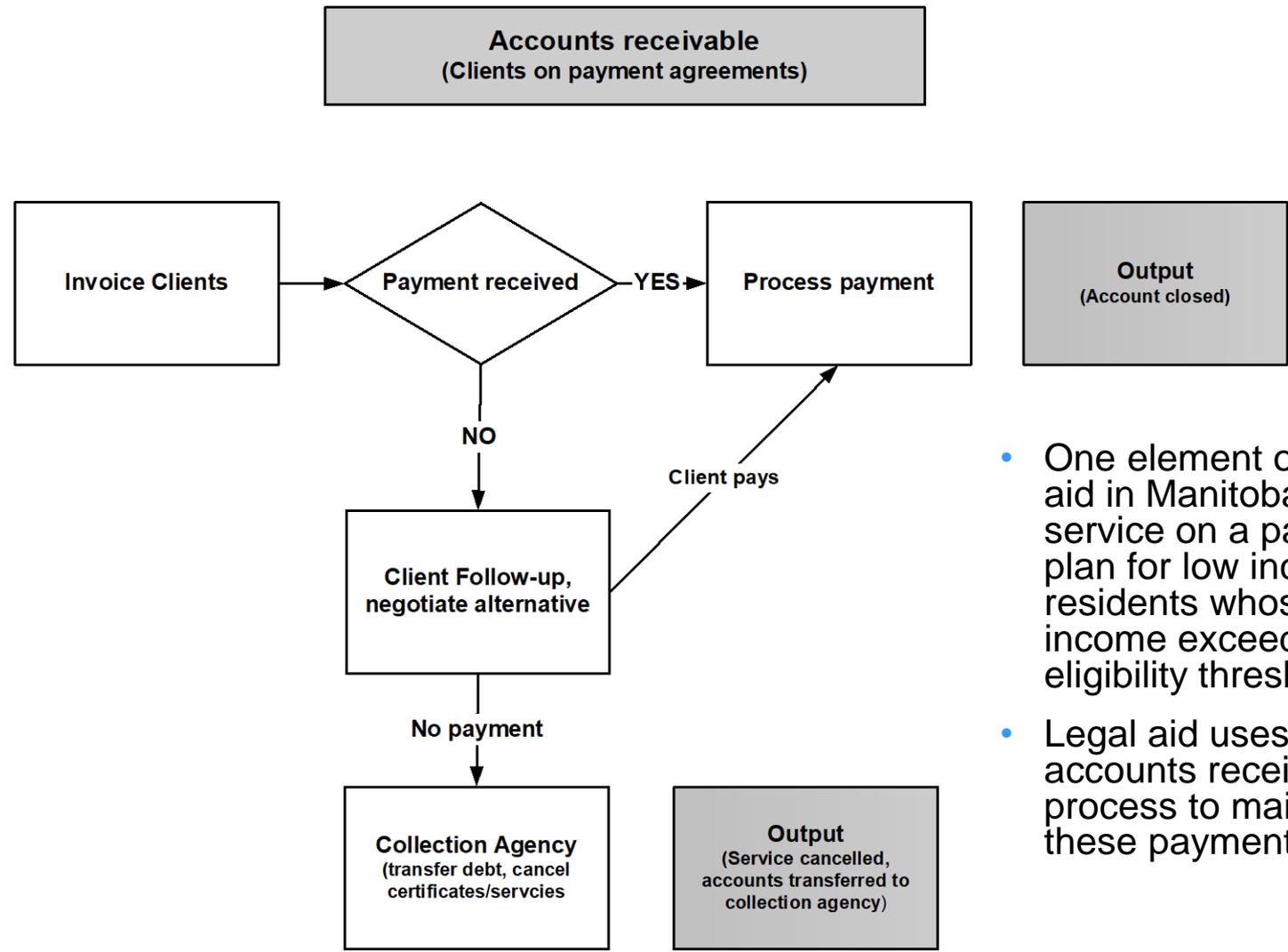
Decomposition of total costs by resource and activity



Case Study: 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
 - To the fees paid to lawyers, must be added processing costs (salaries and overhead) incurred by legal aid
 - The costs of staff counsel also must include all salaries and overhead)

Example: Process chart for legal aid service linte



- One element of legal aid in Manitoba offers service on a payment plan for low income residents whose income exceeds the eligibility threshold.
- Legal aid uses an accounts receivable process to maintain these payments.

Measuring outcomes

CEA 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 cost-effective 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: three programs are essentially similar. No program has a markedly different profile in terms of adverse impact, costs imposed on patient, etc.

CEA 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

CEA 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, “spread effects” to the peers of the child and parents) (?)

Example – Grants and contributions

- Increasingly used as federal approach to policy because:
 - Provincial/municipal governments have increasing constitutional authority over public services
 - Provincial fiscal capacity limited and federal government often called into level playing field
- The result is a policy where the federal government taxes and transfers funding to provinces and NGOs.
 - Federal departments are increasingly removed from the delivery point of services
 - Provincial governments may “roll” federal funding into existing programming, effectively removing the ability to measure net impact of federal expenditures.
 - Privacy is being used as a screen to limit access to end users
 - Advocacy organizations are used as third and fourth party delivery agents, which can raise potential issues of role conflict, if not out-right conflict of interest.



Potential approaches for Gs&Cs value for money assessment

	Advantages	Disadvantages
Ignore the problem (assess only federal component)	<ul style="list-style-type: none"> • Avoids delays and nasty confrontations 	<ul style="list-style-type: none"> • Incomplete evaluations (impact and delivery) • Eliminates the leverage effect • Limited accountability (financial but not value for money)
Move to contracts	<ul style="list-style-type: none"> • Assures delivery of program base on “verifiables” • Payment on proved performance 	<ul style="list-style-type: none"> • May result in limited capacity to deliver programs – adversely affects program delivery • Requires political will
Increased specification of performance measurement and data capture by delivery parties	<ul style="list-style-type: none"> • May increase data available for evaluation 	<ul style="list-style-type: none"> • Been there, done that
Make the evaluation truly joint – specialization of data collection and analysis to increase relevance to the third/fourth party	<ul style="list-style-type: none"> • Increases commitment to accountability and evaluation • Reduces evaluation burden on federal department 	<ul style="list-style-type: none"> • Requires pre-planning; departments often lack resources to implement the program, let alone evaluation processes.

Cost Utility Analysis: Using QALY and HRQL

CUA uses self-report data (surveys, focus groups, etc.) to measure the quality of 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
Total	2.5	5

From CEA to CBA

CBA 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.

Cost-benefit analysis 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 CBA

- Enumerate the stakeholders (individual, government, society)
- Enumerate the “stream” of costs and benefits
- Value all costs and benefits in a financial equivalent
- 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 rents of homes induced by changes to transit are a second round 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.

Valuation of benefits and costs

Advantages in 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 measureable.

However, 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).*

Time value of money

(Discounting)

The future value F of an amount P (\$100), saved for k years at an interest rate i of 10% is

$$F = \$100(1+i)^k = \$100*(1.1)^3 = \$100*1.33 = \$133$$

(assuming interest is paid on the last day of each year and the savings are deposited on the first day)

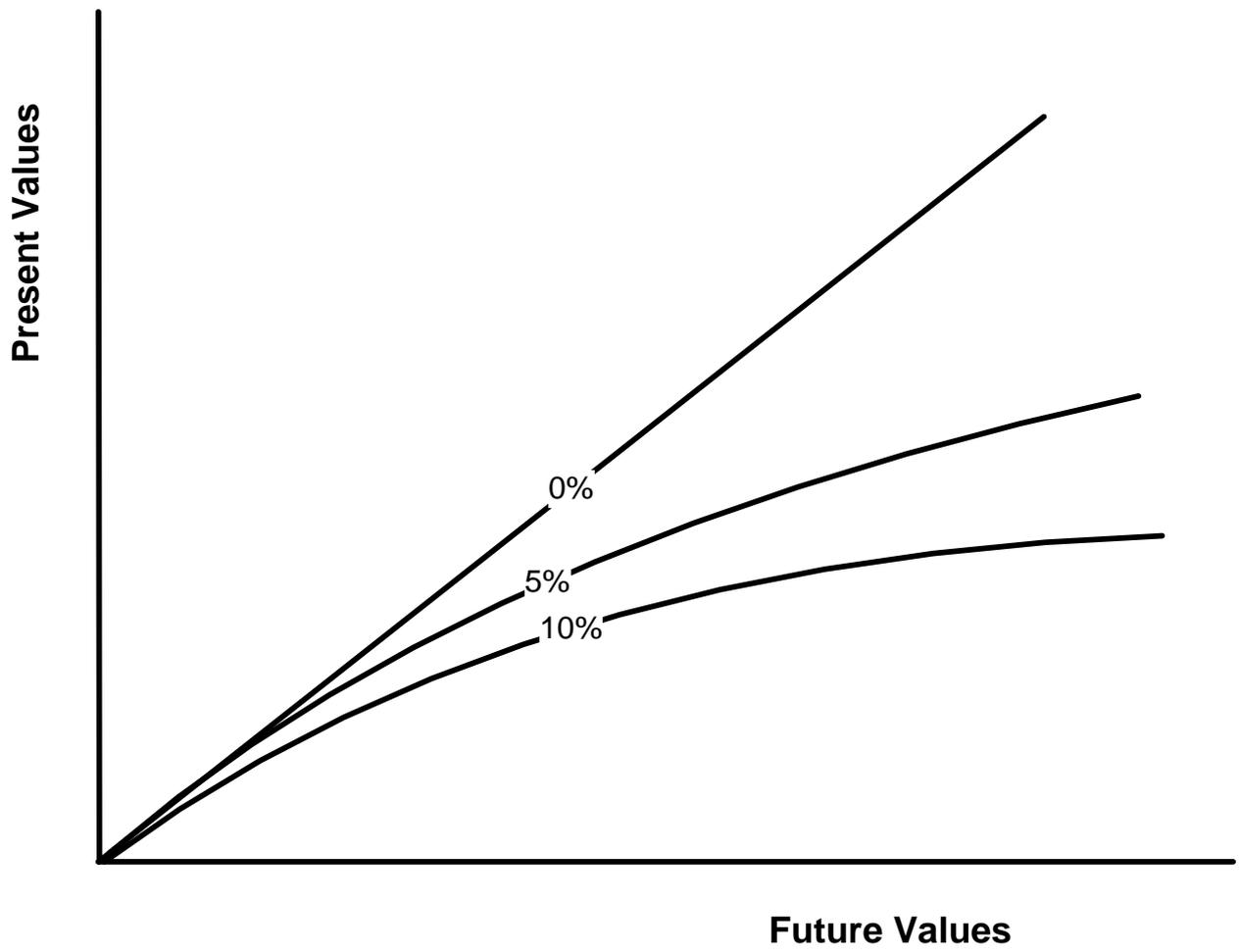
With prevailing interest rates of 10%, someone should be indifferent between receiving \$100 now or \$133 in 3 years.

The present value P of receiving \$133 in three years (assuming interest at 10%) is \$100.

The basic idea behind discounting is that we prefer present consumption to investing/saving for future consumption unless reward exists.

We need to be paid interest to defer present consumption.

The stream of future income



Estimating the value of intangibles

- **Intangibles include** life, peace and enjoyment, pollution (consumption)
- **Value of life** – direct measure
 - The typical method is to estimate the present value of the stream of future earnings
 - Basis for compensation awards
- **Indirect measure** (hedonic)
 - Useful for assessing social costs
 - The discounted value of land is a common reference process for external effects such as noise, odour, and contamination.

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**

$$BC \text{ Ratio} = \sum_{k=0}^n B_k / (1+i)^k / \sum_{k=0}^n C_k / (1+i)^k$$

$$Net \text{ Benefits} = \sum_{k=0}^n (B_k - C_k) / (1+i)^k$$

$$Net \text{ benefits} = (B_1 - C_1) / (1+i) + (B_2 - C_2) / (1+i)^2 + .. + (B_k - C_k) / (1+i)^k$$

Example 1 – 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 2 – 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

Limits/challenges of CBA

- 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 dis-benefit (cost).
- Double counting is hard to avoid since taxes/subsidies always find their way into the costs/prices of private assets.
- Valuing under-employed resources requires adjustments to costs — is the cost of labour less when unemployment is higher?
- Discounting costs and benefits over time requires careful choice of interest rates.

Advice to managers planning CEA/CBA

- CEA is always much easier to design and execute than CBA
- Ensure you have the information to complete a CEA before commissioning the study
- Effective management always understands the direct costs of each service – consider implementing a 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).
- Analyse why you think you “own” 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
- Measure the CEA of each outcome and each service line.
-

Afternoon

Complications in cost-benefit/cost effectiveness models

Example of CBA: Coquihalla Highway

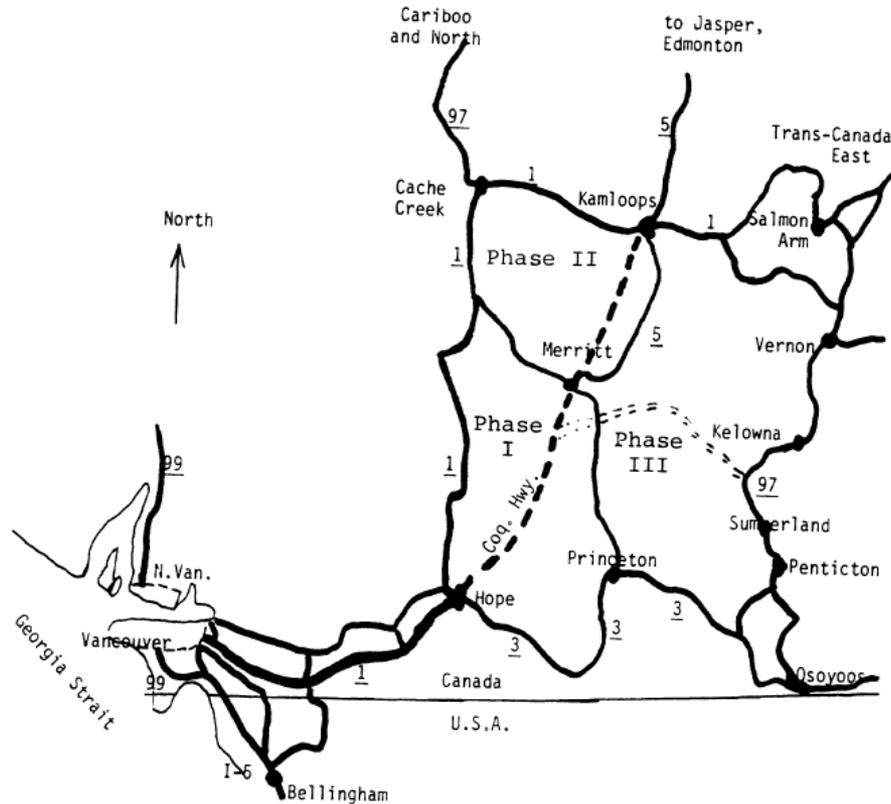


Figure 1. Map of Coquihalla highway and nearby routes.

Perspectives affect how CBA are interpreted

- **Analysts/economists** tend to have the most inclusive view and will try to include all costs.
- **Spenders** will tend to emphasize the benefits and try to monetize all possible advantages. They will use low interest rates.
- **Guardians** will emphasize the costs and try to limit spending. They will use high interest rates to limit the present value of future benefits.

Shadow pricing

- Opportunity cost of a resource, most often a variable factor such as labour, resources, or energy
- Distortions in the market exist, such as institutional practices, unionization, tariffs, and supply management, which cause the posted prices to diverge from the market prices.
- *"Shadow prices are prices indicating the intrinsic or true value of a factor or product in the sense of equilibrium prices. These prices may be different for different time periods as well as geo-graphically separate areas and various occupations. They may deviate from market prices."*

J Tinbergen

- Cost-benefit analysis adjusts the costs to reflect their true social value. This means using less than "posted" wages when unemployment is high, a situation which is common in underdeveloped areas (including certain parts of Canada).

Social discount rate

- The private discount rate (interest) shows an individual's time preference – that is, the rate at which they are willing to exchange present for future consumption.

e.g., If an individual is indifferent between receiving \$100 now and \$105 in a year, then his/her private discount rate is 5%.

- The social discount rate is the value that society attaches to present as opposed to future consumption.
- In a CBA, the second discount rate reflects the rate at which society exchanges present spending on present consumption, versus investing now and enjoying a larger future consumption.
- The social discount rate often is lower/higher than market interest to account for social benefits/costs not included in the analysis.

Sensitivity analysis

- A cost benefit model can become dependent on a range of assumptions
 - Social discount rate
 - Time horizon
 - Shadow wages and costs
 - Value of intangibles
- Sensitivity analysis systematically varies the components of the model to identify how the benefit cost ratio varies with changes in the assumptions of the analysis.

Summary: CEA, CUA, and CBA decision tools

- CBA/CEA provide information to assist a decision, but the ratios are not the decision.
- CUA can inject some subjective elements into a CEA, but it depends on credible (reliable and valid) valuation processes.
- CBA/CEA reflects the values of the analysts; it cannot discover new values or the values of participants.
- CBA/CEA rests on existing law and preferences — it must take these as a given.
- In most cases, evaluators will use CEA.

Measuring outcomes (Gross and net impact)

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

**Thought
experiments**

**Observational
studies**

**Empirical
experiments**

**Statistical
control and
natural
experiments**

Lab

Field

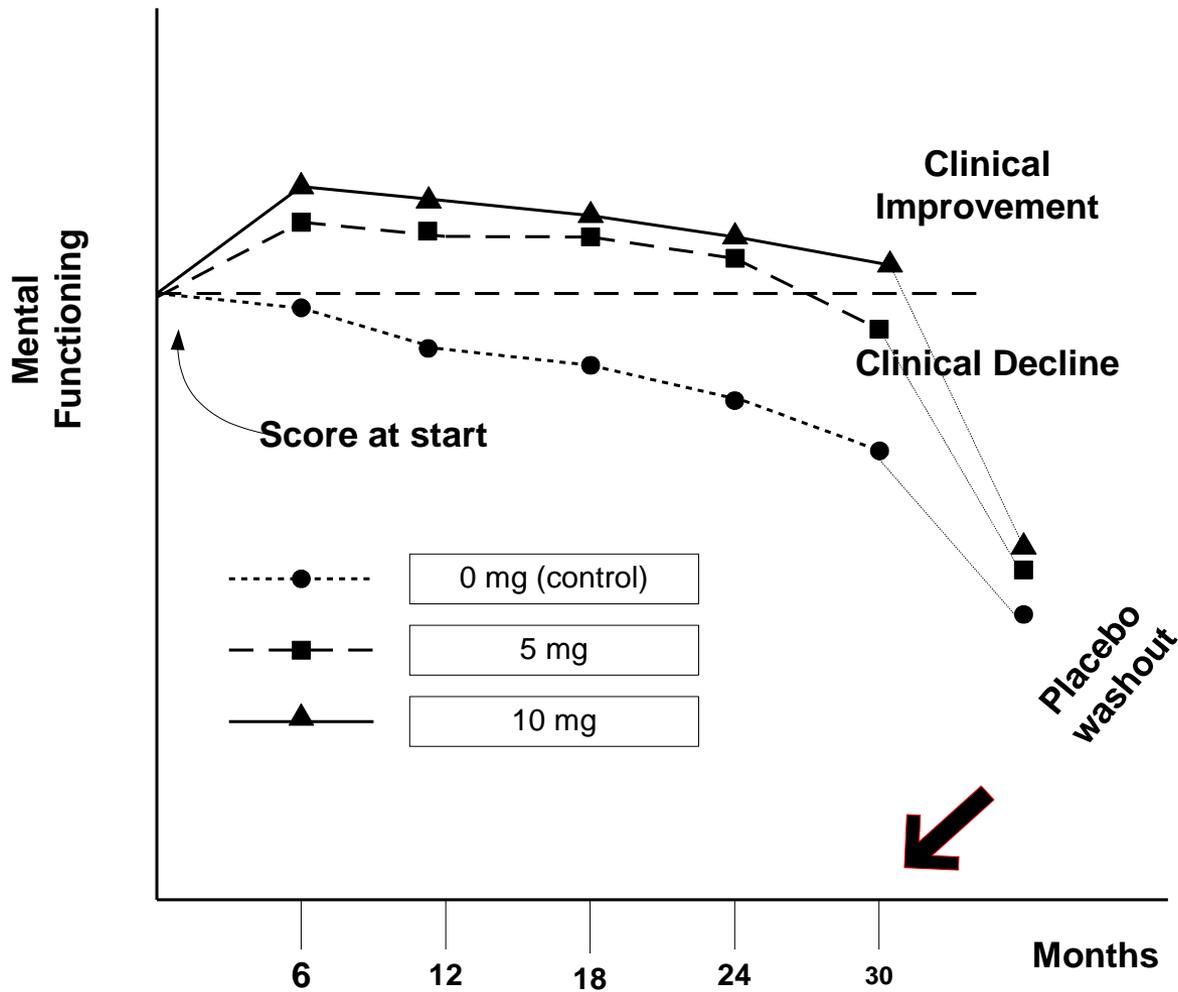
**Social
experiments**

**Quasi
Experiments**

The nature of random clinical trials

- **Randomization** into a **treatment** and **control** group creates two groups that are *statistically equivalent*:
 - For any statistic (mean, variance, etc.) 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
- **Key weakness** – Side effects are often not detected in randomized trials.

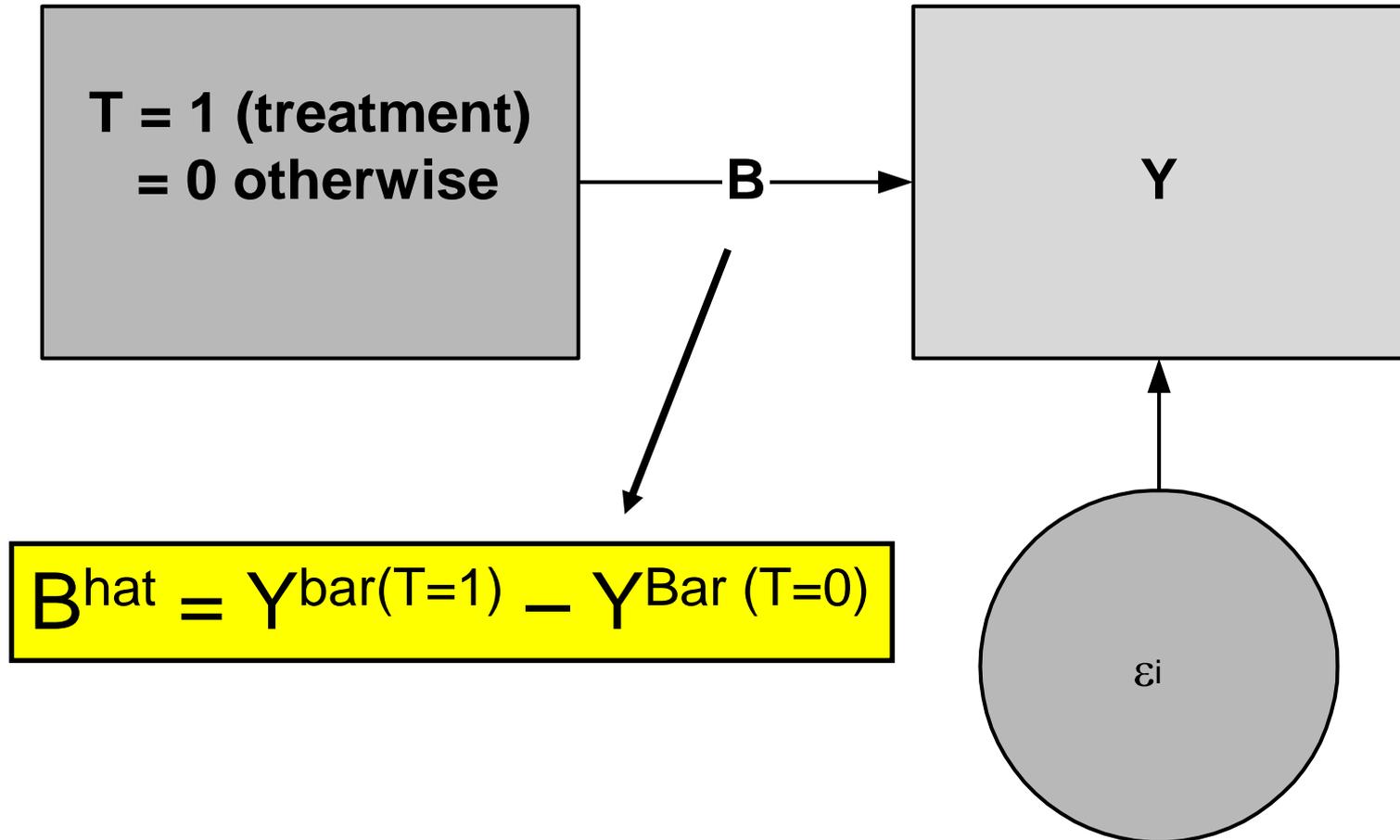
The random clinical trial - Donepezil



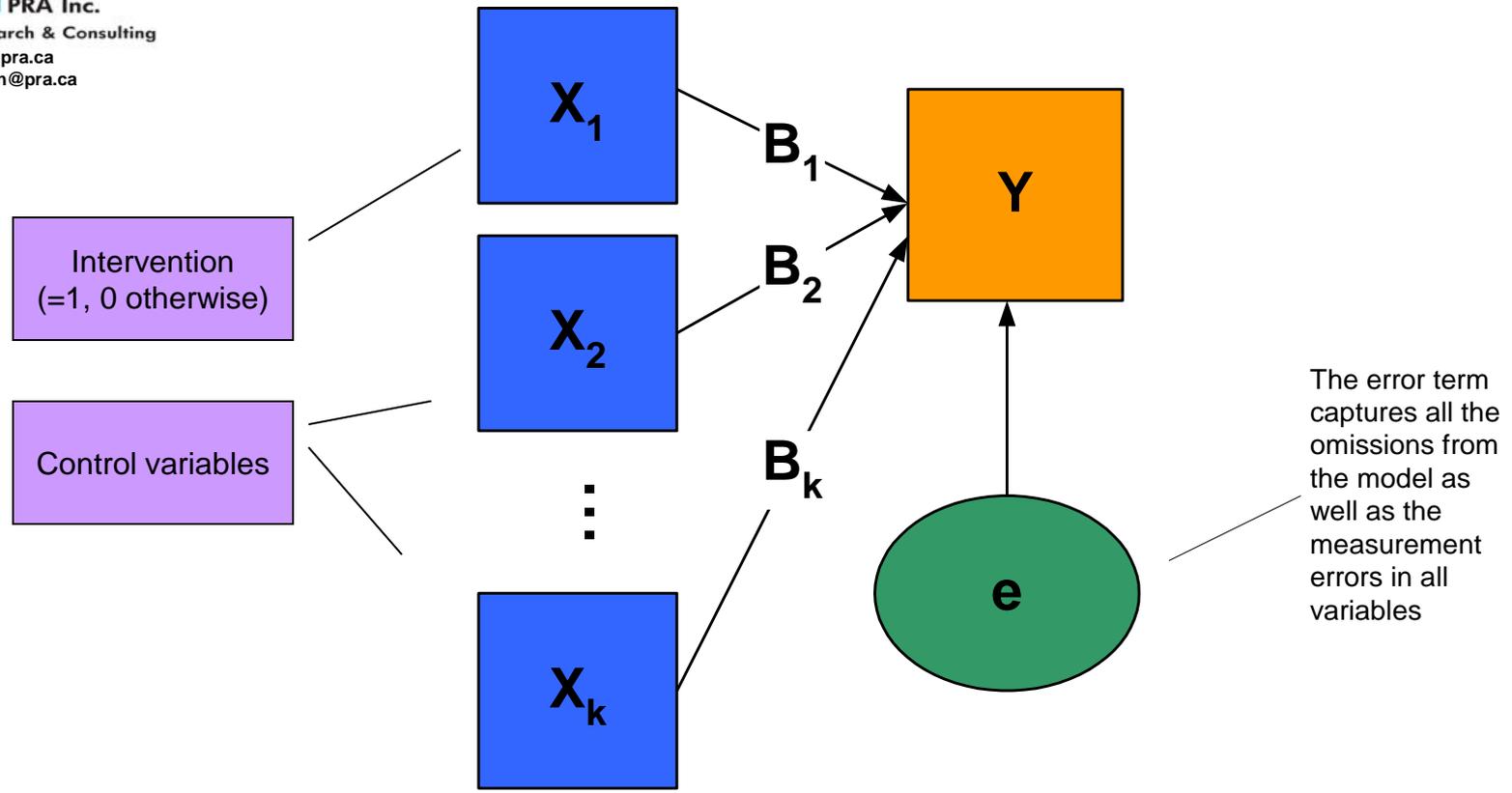
Using participants and non-participants to create program and comparison groups

- Many programs have those that are eligible for service, but who elect not to participate.
 - Part 2 of the EI Act specifies training programs for which current and past EI 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 the participants and non-participants.

The simple comparison group model



Visualizing regression



$$Y = B_1 X_1 + B_2 X_2 + \dots + B_k X_k + e$$

Measuring net impacts in universal programs

- Universal programs admit all eligible participants.
- This means that it is not possible to identify a treatment and comparison group.
- Methods
 - Pre-post
 - Parallel group
 - Limited treatment
- Any method other than a randomized trial cannot identify net impacts; however
 - Any method that contrasts the experience of program participants with some reference offers more insight than no comparison.

Client valuation of program relevance

Consumer choice and relevance

Formal CBA occurs where no market exists. Millions of consumers perform informal CBA every day.

The key idea is that, in the absence of a market for the program, it is possible to collect data that mimic market decisions. The willingness to pay for some public investment reflects its value (benefit).

The willingness to pay (WTP) to reach an outcome or the willingness to accept payment (WTA) are basic techniques of measuring relevance.

Example: Theoretically, the willingness to pay for a new overpass should equal the willingness to accept payment to tolerate delays from the trains.

Example: discrete choice methods for estimating labour supply

- A client survey, conducted as part of the National Child Benefit evaluations, randomly assigned social assistance respondents to three groups.
- Respondents in each group agreed or disagreed with a specific question: "Would you accept a job at \$Y per hour?" where Y varies with the group.
- The result is an experimentally determined reservation wage that measures the height of the welfare wall.
- Covariates show how the reservation wage/welfare wall varies with the attributes of the respondent.

Example: stated choice experiment in social policy preferences

- Focus group participants (NCB evaluation) rated various options for income and in-kind support.
- A stated choice experiment consists of a trial, or a series of trials, typically conducted as part of a focus group, in which the researcher makes purposeful changes to the attributes/levels of a policy package in order to observe and identify possible explanations for changes in the response variable.
- In the simplest form of analysis, the resulting data set is a regression model, where the valuations of packages become the dependent variables and the packages are coded using dummy variables.

Case study of a training program

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

Taking Charge! was a pilot program jointly funded by HRDC and the Manitoba government. It focused on offering a range of supports for single parents on income assistance.

Key features included:

- High level of support (e.g., daycare, counselling, basic education, volunteer experience, job placement)
- The program recruited Income Assistance (IA) clients, performed employability assessments, developed tailored training programs, contracted with service providers to deliver the training, and supported job placement.

DID Model of SA 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 reflects whether the participant had been directed to participate or not

	DIFFBENF		DIFFBNRD	
Sample Size	2526		2526	
Constant	-166	**	8	**
Group 1 (Taking Charge!)	-168	**	42	**
Group 2 (Comparison Group)	-118	**	45	**
Educ2	7	*	1	
Gender	91	**	-8	
Age	0		-1	
# Children 6-18	-1		17	**
# Children < 6	79	**	0	
Status Indian	35	*	-23	**
Number of Interventions	38	**	-7	
Intervention 1 (Work/Job Search)	-67	*	23	*
Intervention 2 (Trade Skills)	-120	**	29	**
Intervention 3 (Tech/Mgmt Skills)	98	**	-21	
Intervention 4 (Lit./Num)	34		-4	
Intervention 5 (Acad. Upgrading)	-49		-39	
Intervention 6 (Job Placement)	-17		37	**
Work Expectations	48	**	39	**
Number of Jobs Before Intervention	-19	**	1	
Total Time on SA	63	**	9	
Difference in Unearned Income	0		0	
Difference in Children <6 (Pre-Post)	31		-9	
Duration of Intervention	-0.2		0	
Adj. R ²	0.107		0.089	

Entries that are **bold and large** are statistically significant at the .05 level or lower (**) or the .10 Level (*). The other entries should be treated as equal to 0.

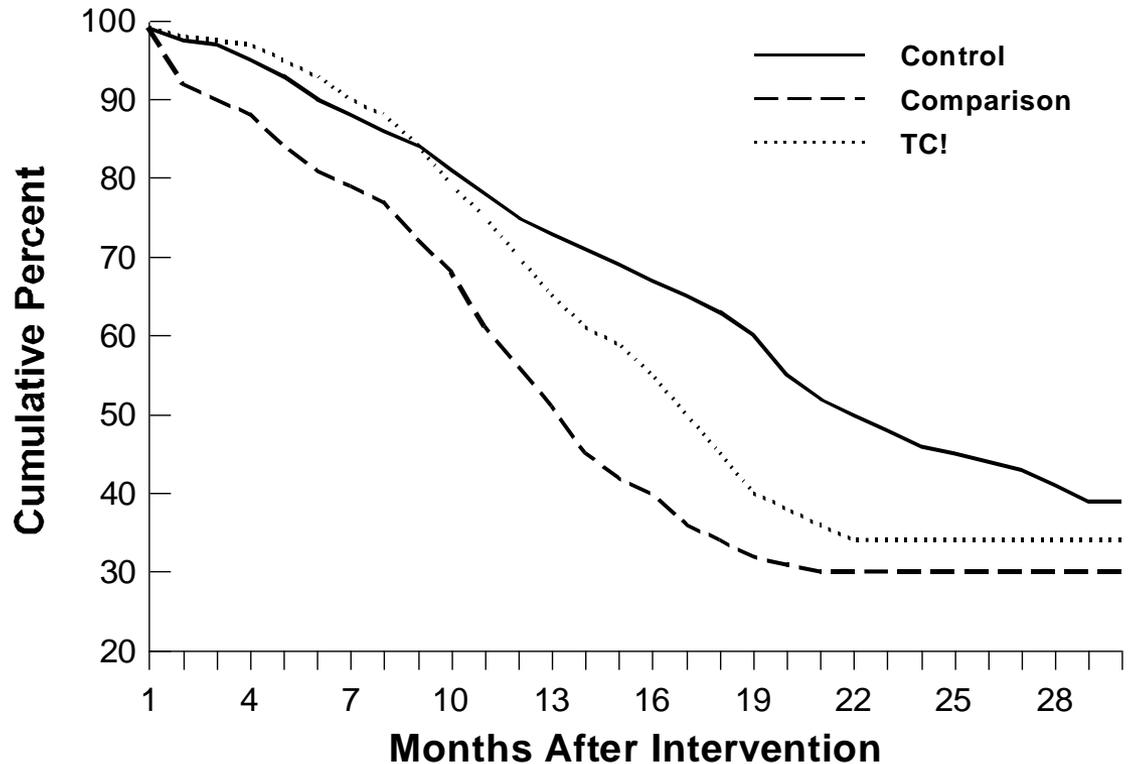
Hazard model

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.

Percentage on Social Assistance

(Months after intervention)



“Cost-benefit” model

- This is a hybrid program, with the analysis from the perspective of the government.
- It is technically a CEA, but since the benefits are avoided costs (reduced social assistance 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 (Taking Charge! participants)

Summary of post-intervention experience

Group	Percent remaining on assistance			Average time to come off assistance (months)
	3 months	6 months	9 months	
Treatment (Taking Charge!)	79%	71%	65%	20
Employment Connections	76%	63%	55%	14
Comparison	79%	67%	58%	16
Control	87%	82%	74%	23

The benefit-cost framework			
	Costs		Benefits
	A. Income assistance payments during training		E. Increased benefit reductions because of earned income
+	B. Training allowances (books, special needs)	+	F. Reduced income assistance 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)

Group	Costs				Benefits				Benefit-cost ratio	
	IA while in training	Training needs	Costs per client	Total	Reduced in benefits	Reduced time on IA	Taxes	Total		
	A	B	C	D	E	F	G	H	D/H	
Taking Charge!	\$633	\$6	\$3,112	\$3,751	\$1,360	\$2,046	\$205	\$3,611	0.96	0.51
Comparison	\$267	\$55	\$1,341	\$1,663	\$1,136	\$4,550	\$181	\$5,867	3.53	1.54
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
- Current techniques would have used a matching model to align program and comparison groups better
- Drop the reference groups since they exhibit high selection biases (creaming and self-selection)

Case Study: HPV Vaccination of School Age Girls (Grade 6)

HPV – Key facts

- HPV is a common virus with over 100 strains.
- It is responsible for a range of conditions, most importantly *the* cause of cervical cancer as well as a range of other conditions in women and to a lesser extent men.
- The virus is spread by sexual contact.
- The incidence of cervical and other cancers caused by HPV is low: compared to the other major cancers experienced by women, i.e., lung, breast, and colorectal.
- Women typically experience cervical cancer in their forties, fifties, and sixties.
- Early detection of cervical cancer uses a Pap smear, which is relatively inexpensive.
- Gardasil is a vaccine that protects against 4 of the many strains, two of which are believed to cause 70% of the cancers. It cost \$300 per injection
- It is unknown how long the vaccine remains effective and whether a booster shot is needed after 10 years.

Model Assumptions

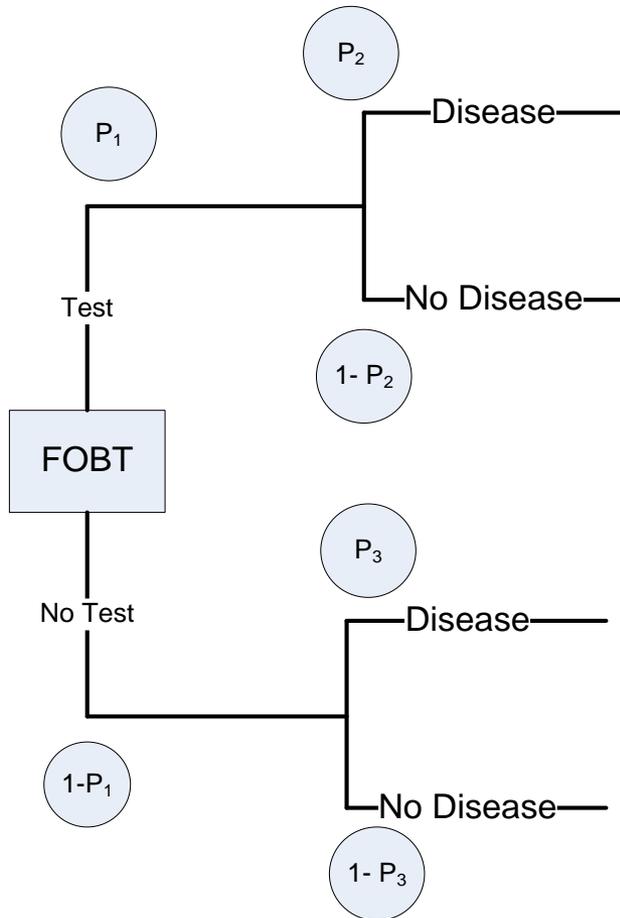
Simplistic Model

- Benefits are captured by discounted present value of wages that would have been maintained in the absence of premature death.
- By this standard, the program is not cost effective (discounted present value of preserved earnings is less than the opportunity cost of the vaccine cost).
- Cost of vaccine in 2008 ($22,000 \times 300$) = \$6.6 m and “benefits” at \$1.8m

Critique of simple model

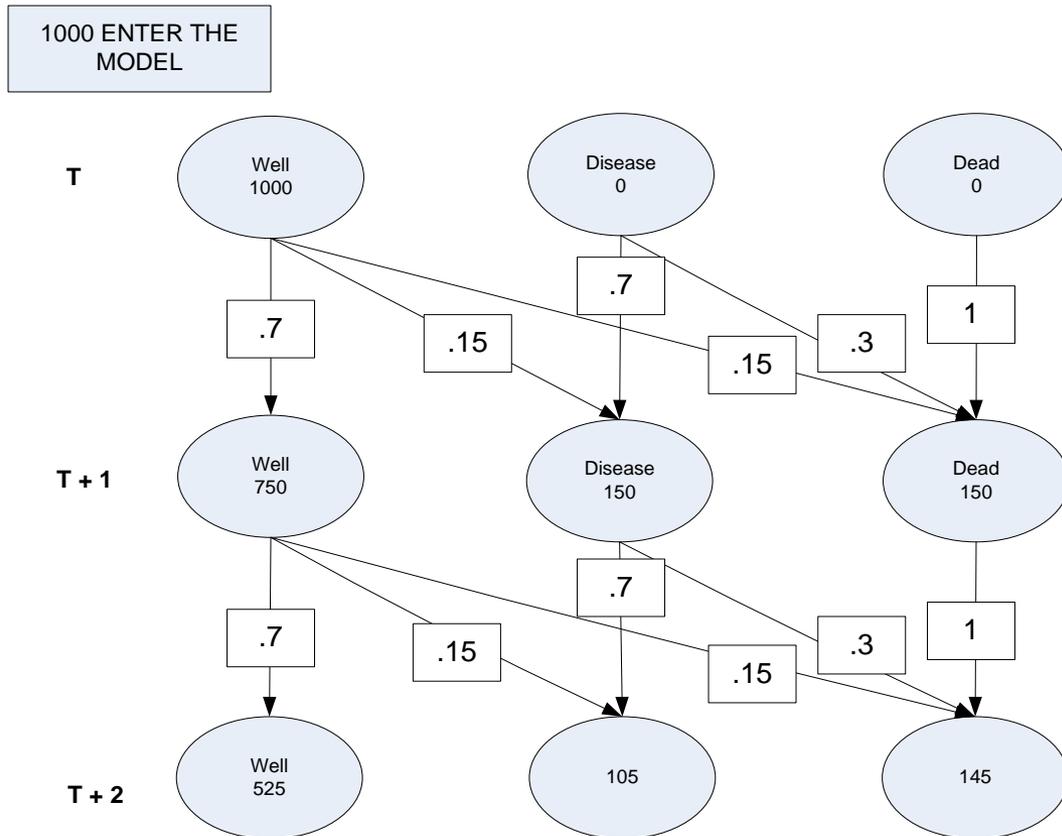
- Ignores the treatment costs of those who contract cervical cancer and who may or may not survive
- Does not include the costs incurred by caregivers
- Excludes the costs of experiencing the disease (pain and elimination of other than work experiences) and therefore undervalues the benefits.

Markov Modelling of CEA



- A Markov model creates a probability structure of disease outcomes over an extended period (50 years).
- The simplest vaccination model uses binomial probabilities at each decision point (true -false probabilities).
- Presumably the vaccination reduces the probability of getting the disease ($P_2 < P_3$) – by a lot.
- A CEA model of HPV vaccine usually assumes administration to a single age-cohort, and the follows this cohort for their lifetimes, under specific assumptions:
 - Effectiveness of the vaccine over time
 - Standardized QALY
 - Costs of treating those who fall ill

Monte Carlo Simulation



- Monte Carlo simulation assumes that the probabilities (P1, P2 and P3) are not static, but are draws from a distribution reflecting actual behaviour and disease uncertainties/
- It processes a large number base over time (T, T+1, T+2...)
- The progression cycle is assumed to be a year.
- Lit Review of studies -
 - Fawziah M, Cloutier K, Oteng B,1 Marra C and Ogilvie G Effectiveness and Cost Effectiveness of Human Papillomavirus Vaccine A Systematic Review: *Pharmacoeconomics* 2009; 27 (2): 127-147

Selected readings

- Boardman, A.E., Greenberg, D.H., Vining, A.R., & Weimer, D.L. (2010). *Cost benefit Analysis: concepts and practice*. Upper Saddleback River, N.J.: Pearson/Prentice Hall. (A standard reference)
- Just, R.E., Hueth, D.L. & Schmitz, A., (2004). *The Welfare Economics of Public Policy*. Cheltenham, UK: Edward Elgar. (An advanced graduate text)
- Levin, H.M. & McEwan, P.J. (2001). *Cost-effectiveness*. Thousand Oaks, CA: Sage Publications. (An accessible introduction)
- Treasury Board of Canada. (1998). *Benefit Cost Analysis Guide*. Retrieved April 7, 2003 from http://www.tbs-sct.gc.ca/fin/sigs/revolving_funds/bcag/bca2_e.asp?printable=True
- Weimer. D.L., & Vining, A.R. (2005). *Policy Analysis: concepts and practice*. Upper Saddle River, N.J.: Pearson/Prentice Hall. (A good text on policy analysis)