



Trade &
Investment

ESA

The Economic Society
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Cost Benefit Analysis Forum

Issues & Challenges

Dr Peter Abelson

Applied Economics P/L | NSW Treasury
paper presented at One-Day Conference on Cost-Benefit Analysis,
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Aims of Presentation

- To provide overview of CBA
- To advocate for CBA
- To identify various issues
 - Technical
 - Normative / ethical
 - Political economy / practical
- To place these in context of workshop discussions.

CBA in Outline

- CBA attempts to estimate total benefits and costs of policies, projects or programs
- Benefits are any increases in human well-being; costs are reductions in well-being
- Includes market and non-market goods to all members of society that count
- Values benefits and costs in dollars based on individuals' own valuations
- Aggregates these benefits and costs to total benefit and cost.

Applications of cost-benefit analysis

Economic infrastructure	Social programs	Recurrent expenditure	Regulations
Transport: Roads, railways, ports and airports	Health care Hospitals Mental health facilities	Public health programs Subsidies for medicines	Food and drug safety regulations
Utilities: Water supply, Power	Education	Efficient class sizes	Deregulation of airlines, taxis
Communications: National broadband	Early childhood programs	Allocation of VET places	Urban planning
Environment: Renewable energy	Investment in emergency services	Location of government offices	Environmental regulations

CBA, Efficiency and Social Welfare

- CBA is a measure of efficiency of resource use
- Estimates net social benefit: $NSB = \sum B_i - \sum C_i$
- B and C are usually estimated using willingness to pay (WTP) measures (but see more below).
- If $\sum B_i > \sum C_i \rightarrow$ project is described as “efficient”.
- Public policy objective: to maximise welfare of society (W):
 - $W = f(u_1, u_2, \dots, u_n)$, where u = welfare of each individual $1 \dots n$.
- Does $NSB = W$?
- CBA maximises W only under restrictive assumptions about individual and social welfare – for later discussion.

Official Guidelines

CBA is widely recommended:

See:

- World Bank, 1996
- OECD, 1997
- US EPA, 2000
- Australian Department of Finance and Administration, 2006
- NSW Treasury, 2007
- Australian Office of Best Practice Regulation, 2010.

Some critical issues in CBA

1. Are the valuation principles acceptable?
2. Are estimated (quantity) impacts sufficiently accurate?
3. Given valuation principles, are valuations of benefits and costs sufficiently accurate?
4. How are valuations of benefits and costs aggregated and compared? (SWFs / equity)?
5. How to deal with impacts over time (discount rates)?
6. How should we deal with uncertainty?

Political economy issues (PM session Stream B)

- How to deal with stated government objectives?
- Poor base cases and/ or poor options.
- Variations in agency and jurisdiction parameter variations.
- How to persuade decision makers to use CBA?
- How to make CBA reports public?

General Primacy of NPV Rule

- Net present value
 - $PV = w_1 B_1 + w_2 B_2 = B_1/(1+r) + B_2/(1+r)^2$
 - $NPV = PV(B) - PV(K+C)$
- Internal rate of return
 - $\sum_t K_t/(1+i)^t = \sum_t (B-C)_t/(1+i)^t$
 - Or i that makes $NPV = 0$
- Benefit-cost ratio
 - $PV(B-C)/PV(K)$
- $B =$ benefits, $C =$ recurrent costs, $K =$ capital cost, $r =$ selected discount rate, $t =$ time (year), $i =$ internal rate of return (IRR)

Biases with IRR and BCR

- If $NPV > 0$ then $i > r$ and $BCR > 1$ and vice versa.
- But NPV, IRR and BCR may rank projects differently.
- IRR and BCR favour small projects and projects with early returns (see next slides).
- NPV is unbiased and correct but poor indicator of risk.

Project Outcomes

Table 1.3 Project outcomes with the IRR and NPV criteria (\$m)

<i>Project</i>	<i>Year 1</i>	<i>Year 2</i>	<i>Year 3</i>	<i>IRR</i>	<i>NPV</i>
	<i>Capital</i>	<i>Net benefit</i>	<i>Net benefit</i>	<i>(%)</i>	<i>7% discount rate</i>
A	-100	120	0	20.0	12.1
B	-100	0	135	16.2	17.9
C	-50	0	70	18.3	10.4

Extra bias with incorrect BCR (C in denominator)

- Suppose efficient project: $(B - C) / K > 1$
- Then $(B - C) / K > B / (K + C)$
- Wrong formula \rightarrow return is underestimated

- Suppose inefficient project: $(B - C) / K < 1$
- Then $(B - C) / K < B / (K + C)$
- Wrong formula \rightarrow return is overestimated

NPV and BCR

If agency capital is constrained (i.e. the marginal return on its capital > return elsewhere), the agency should select projects with highest PV per unit of constrained capital (i.e. highest BCR) until capital is exhausted. This maximises the return surplus (and NPV) from scarce capital.

Box 1.2 NPV versus BCR criterion

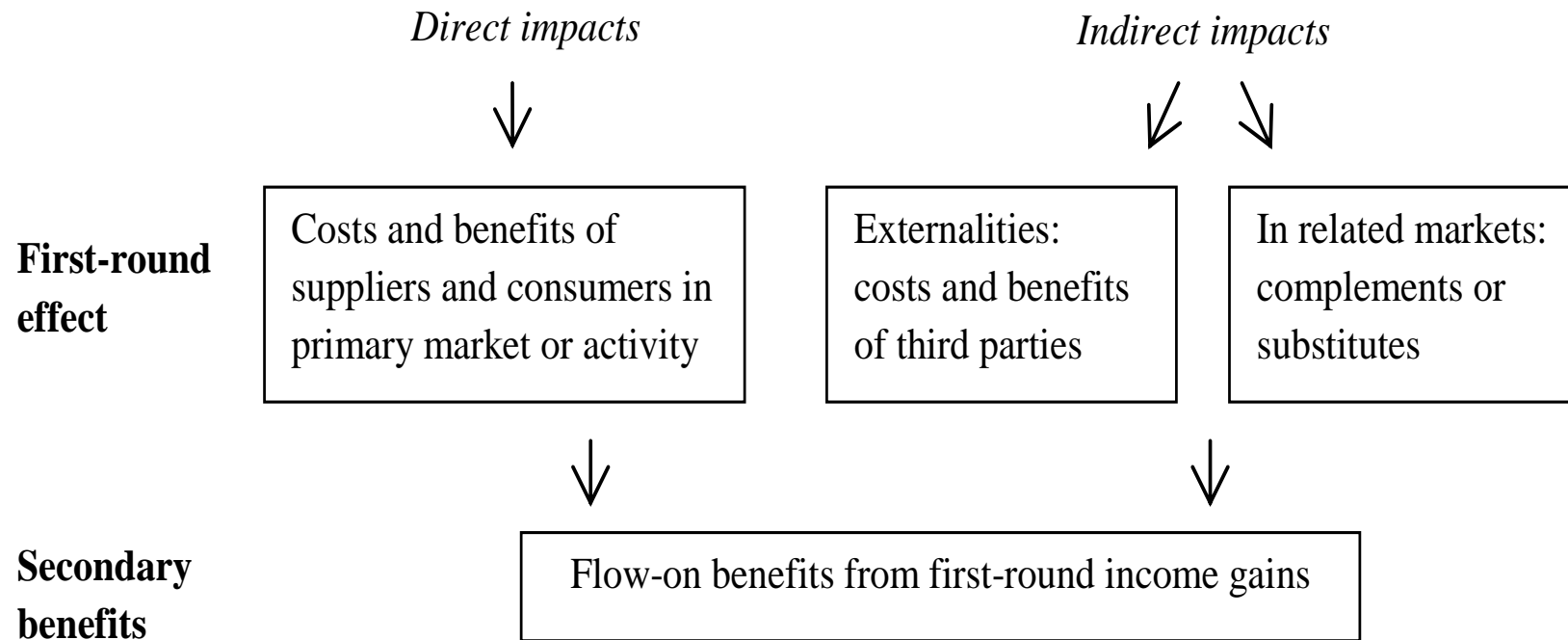
Suppose that three projects (*A*, *B* and *C*) have capital costs and benefits as shown below. If the projects are mutually exclusive and the opportunity cost of capital is say 7%, selection of *A* would maximise NPV. Compared with say *B*, *A* has an incremental cost of \$20m and generates incremental benefits of \$35m. However, if the agency has a capital constraint of \$50m and *B* and *C* are not mutually exclusive, the agency would maximise NPV from the \$50m by selecting *B* and *C* instead of *A*.

<i>Project</i>	<i>Capital cost</i> <i>(K) (\$m)</i>	<i>Discounted net benefits</i> <i>(B-C @7%, \$m)</i>	<i>NPV</i> <i>B - C - K (\$m)</i>	<i>BC ratio</i> <i>(B-C)/K</i>
A	50	105	55	2.10
B	30	70	40	2.33
C	20	50	30	2.50

Evaluation criteria: conclusions

- If several options, option with highest NPV is most efficient strategy.
- Governments should only do projects with +ve NPV.
 - Do not spend \$10.0m to get \$9.0m benefit.
- IRR can be useful indicator of risk.
- BCR (correctly defined) has role with constrained capital.

Scope of evaluation: classifying impacts



Three general valuation principles

1. The value of a good is maximum amount that someone (individual or firm) is WTP to pay for it and be no worse off than before.
2. Loss of a good or property right is *sometimes* valued at the minimum amount that someone is willing to accept (WTA) and be just as well off as before.
3. The cost of using a resource (factor of production) is its opportunity cost (OC) – its value in highest alternative use .

Notes:

- These reflect Compensation Variation (CV) principle; see more discussion below.
- Relationship between WTP and OC.

Valuation principles (cont.)

- Principles apply to market and non-market goods.
- Indirect impacts are valued with similar principles and methods as direct impacts.
- Benefits are gains in consumption of various kinds; costs are (value of) consumption foregone.

Basic valuation assumption

- Individuals are rational and well-informed
- Behavioural economics suggests this may not be sound assumption
- Extreme cases: social intervention in dysfunctional families or individuals with mental health problems
- How important are assumptions of rational and informed behaviours? Do these assumptions affect use of CBA?

Valuation principles: property rights

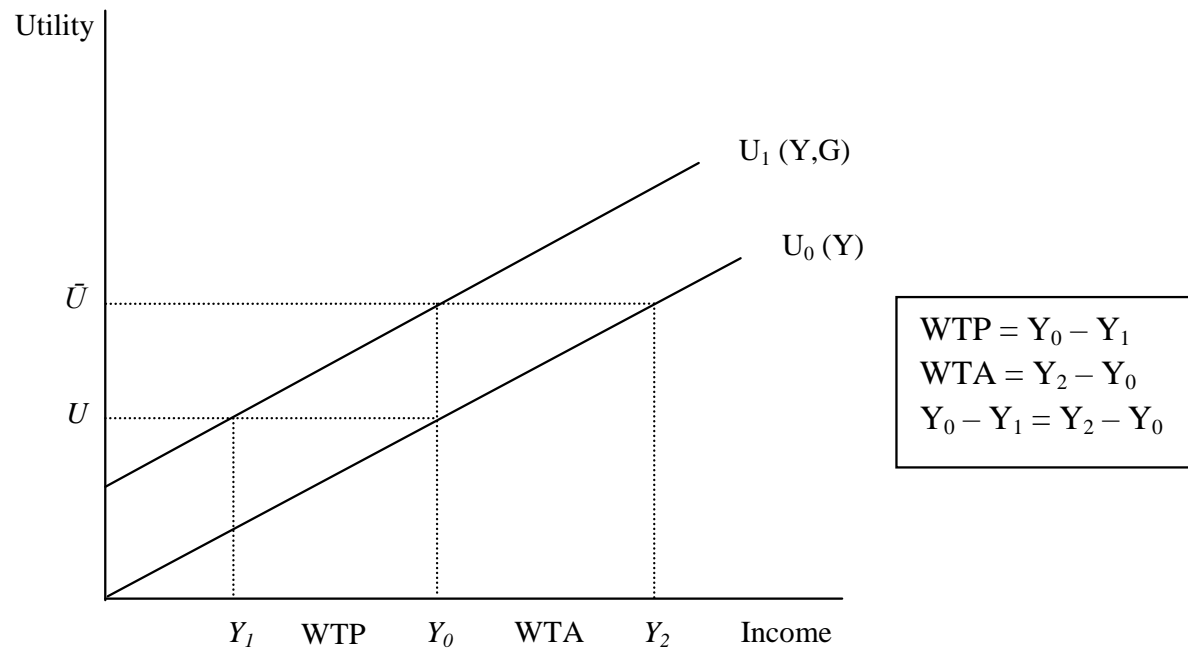
Compensating and equivalent variations

- CV: property rights are status quo. EV: households have right to a change.
- CV value of a good is **maximum** amount someone is WTP for it and be as well off with the good as without it.
- CV for loss of a good is **minimum** amount someone is *willing to accept* (WTA) as compensation and be no worse off than before.
- EV value of a good is **minimum** amount someone is WTA and be as well off without the new good as he/she would be with it (i.e. at *new* utility level).
- EV for a loss is **maximum** amount that an individual is WTP, given that the change has occurred, in order not *to* have the change.

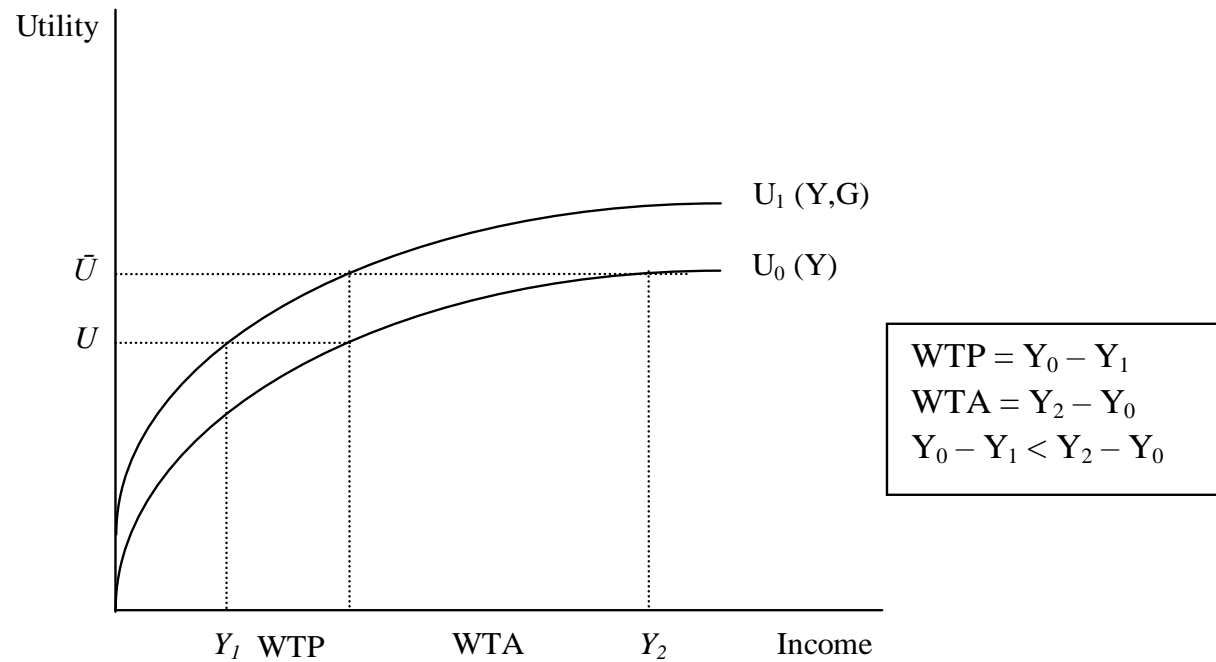
Example of CV and EV

- Suppose government proposes level 6 hospital services in a regional centre.
- With CV, we estimate what people are WTP for these services. If $\sum WTP >$ cost of services, services should be provided.
- Now suppose population in region is entitled to the services. EV principles apply. We estimate what people are WTA as compensation for not having the services. If cost of services $< \sum WTA$, services should be provided.
- $CV = EV$ if marginal utility of income is constant or change is very small.
- $CV \neq EV$ when MU of income falls and changes are large.

WTP and WTA with linear utility functions



WTP and WTA with non-linear utility functions



Choice of valuation principle

- CV is most common principle, reflecting the status quo.
- Valuing goods: WTP is used generally.
 - Note consumer surplus is often used to value price reductions.
- Valuing losses: no standard practice, though with CV, WTA would be appropriate.
- A right to a beneficial change, EV (WTA) measure (compensation for not having it) may be appropriate but is rarely used.
- Questions
 - Do CV and EV differences matter? When?
 - If so, how do we decide on valuation principle?

Estimating costs

- Use of shadow prices where applicable
- Suppose
 - Project costs \$100m
 - Includes labour cost of \$60m, with opportunity cost of \$40m
 - Benefits of \$90m.
- $\text{NSB} = \text{benefits} - \text{real costs} = 90\text{m} - \$80\text{m} = \$10\text{m}$
 $= \text{labour gains} - \text{project loss} = \$20\text{m} - \$10\text{m} = \$10\text{m}.$
- **NB: CBA allows for benefits to workforce. Do not double count employment gains!**
- But suppose project is financed by taxation, should excess burden of taxation be included as a cost?

Estimating WTP

- Market prices, other revealed preference methods and stated preference methods
- Other revealed preference methods:
 - hedonic price and wage analyses,
 - travel cost analysis,
 - defensive behaviours ex-ante or ex-post.
- SP methods needed because many non-market goods or goods cannot be valued from behaviour.

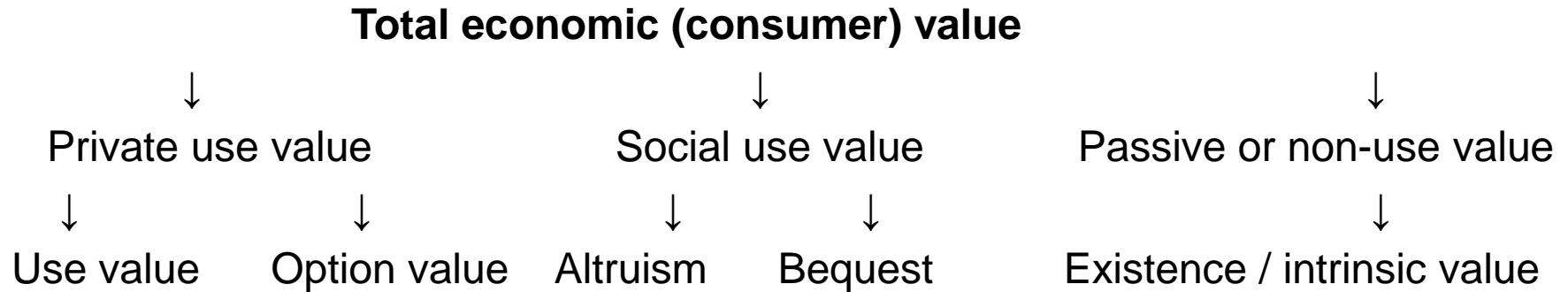
Some issues in RP analysis (PM session, Stream A)

- Literature suggests RP methods are quite robust.
- Is behaviour rational and well-informed?
 - e.g. understanding probabilities – VOSL
 - what is workshop's level of confidence in revealed preference methods?
- How to update parameter values?

Some issues in SP analysis (PM session, Stream A)

- Unfamiliar goods
- Information bias
 - \$2 a week or \$100 a year
- Embedding and scope
- Strategic bias
- Can SP value subjective well-being?
- When can we have confidence in SP results? How can SP results be validated?

Special case of passive (non-use) values



- Should we value passive (non-use) benefits?
- If so how?

Related markets: treatment of complements and substitutes

General principle

- If related market is competitive, $P = MC$, no need to include any impacts;
- If related market is distorted, $P \neq MC$, surpluses gained or lost should be accounted for

But how to decide?

- Policies that encourage in-bound tourism
- Investments, e.g. roads, that switch expenditure from one area to another.

Secondary effects (multipliers)

- Secondary effects: flow-on benefits from spending income gains that have already been counted.
- Arguments against including secondary benefits in CBA.
 - With full employment, additional expenditure cannot increase local output.
 - Aggregate demand depends on fiscal and monetary policy, not on project surpluses.
 - Expenditures on alternative projects also have multiplier effects. If $C > B$, then $MC > MB$, where M is the multiplier.
- But if unemployment varies by region and labour is not mobile, spending in one area may have more flow-on impact than spending in another one. Thus secondary benefits may occasionally have efficiency effects as well as distributional ones.
- **Conclusion:** multipliers are rarely accepted in CBA studies.
- Is this a correct conclusion?

Use of multi-sector economic models

- I-O models – no opportunity cost.
- CGE models allow for related markets and include opportunity cost
 - But general focus on output (e.g. GDP), not welfare
 - Sensitive to input assumptions and not transparent
- Should we make more use of multi-sector economic models?

CBA and social welfare (equity)

- NPV is efficiency measure
- Social welfare $W = f(u_1, u_2, \dots, u_n)$
- If marginal \$ has = marginal utility to each individual and SWF is additive, efficiency = welfare.
- But this very unlikely.
- What are the implications?

The case for efficiency

- If NPV criterion is applied generally, efficient projects are adopted and more people are better off than if government adopts less efficient / inefficient projects.
- Efficiency maximises aggregate wealth and provides overall capability to assist less well-off (and compensate losers).
- Distributional objectives generally achieved more cost-effectively by fiscal (tax-transfer) instruments than by individual projects.
- Conclusion: government should adopt efficiency strategy and deal with equity separately through fiscal measures or other compensation programs.

Case for including distributional effects

- Above approach requires faith in the political process.
- Reasons for considering distributional effects of policies are:
 - Losers are often not compensated. Some projects with positive NPVs may benefit the rich *and* hurt less well-off.
 - Fiscal policies (tax/transfers) may not produce a fair outcome.
 - WTP values are based on existing distribution of incomes. WTP measures may bias projects toward higher-income households, esp. when goods are free.
 - Individuals often place high value on loss of rights. Adopting WTA compensation values is of little use if compensation does not occur.

Aggregate welfare: integrating efficiency and equity

- An integrated approach involves using weights, with WTP (or WTA) amounts weighted according to their social importance.
- E.g. a weight = 2.0 for someone with half average income and weight = 0.5 for someone twice average income.
- Weighting recognises welfare differences between individuals and attempts to provide a way to deal with these differences.
- UK Green Paper advocates weights

Integrating efficiency and equity

- Problems with use of weights in evaluations
 - Equity weights are normative decisions
 - Technical information cannot provide the weights
 - No generally acceptable set of weights available
 - Equity weights can produce confusing results.
 - Very difficult to achieve consistent project comparisons.
- Major exceptions:
 - Equity weighting for key non-market goods, such as value of life or leisure travel time savings where average values often employed
- When, if ever should weights be used in CBA?

Dual track: efficiency and equity

- CBA presents NPV and separate information on distributional effects. Government makes policy determination.
- Describing distributional effects can be complex and require data not in CBA.
 - Selection of social groups is a value judgement
 - Distribution of project surpluses depends on forecast prices.
 - Producer surpluses may accrue to owners of capital, managers or other employees.
 - Ideally government revenues and costs should be attributed to households.
 - Transfer payments affect distribution of costs and benefits
 - Secondary benefits can also have distributional effects.
- Poor distributional studies can be positively misleading.
- When should distributional analyses be provided?

Rates of return and discount rates

- Discount rates have large effect on present values of future benefits and costs – see next slide.
- Key issue is whether to require projects to exceed rate of return on alternative projects (the social opportunity cost – SOC) or to discount using a private or social time preference rate (PTPR or STPR) .
- $SOC > PTPR$ or $STPR$ because SOC is gross pre-tax rate of return.

Effects of discount rates

Table 6.1 **Impacts of discount rates**

Years	Discount factor = $(1 / 1+r)^t$ where t is the number of years			
	0%	1%	3%	7%
0	1	1	1	1
5	1	0.95	0.86	0.71
20	1	0.82	0.55	0.26
50	1	0.61	0.23	0.03

Time preference v rate of return on capital

- Following standard valuation principles, future consumption benefits would be discounted by PTPR or STPR.
- *But consumption foregone would also be discounted by PTPR or STPR.*
- This dilemma can be resolved by:
 - estimating a shadow price for capital which reflects SOC and
 - discounting all future benefits with a consumer rate of discount.
 - This is shown in Table 6.2 (next slide)
- Although technically attractive, this approach is rarely employed because it is complex and unnecessary as use of SOC gives generally similar results (and ensures efficient projects).

PTPR or SOC

Table 6.2 Comparison of the shadow price of capital method and standard discounting method (\$m)

Evaluation method		Years										NPV ^a	
		1	2	3	4	5	6	7	8	9	10	@7%	@3%
Cost	=benefit foregone	0	-7	-7	-7	-7	-7	-7	-7	-7	-107	-100.00	-131.14
Benefit		0	4	4	5	5	5	6	6	6	106	87.58	116.87
Net benefit		0	-3	-3	-2	-2	-2	-1	-1	-1	-1	-12.42	-14.68
Net benefit	Shadow price (a)	-131	4	4	5	5	5	6	6	6	106	-43.57	-14.68
Net benefit	Standard method	-100	4	4	5	5	5	6	6	6	106	-12.42	16.87

(a) All costs and benefits discounted to year (i.e. year one is not discounted).

PTPR v SOC (cont)

- If all capital expenditure is foregone investment, using SOC discount rate generally produces same outcome for project efficiency as using a shadow price of capital + PTPR.
- Accordingly, most public agencies recommend a (risk-free) SOC rate of discount be used for discounting public projects.
- Time preference rates could apply if discounting or comparing pure consumption streams.
 - E.g. Valuing life years.

Discount rates: conclusions

- For public projects, a risk-free SOC is generally preferred with occasional exceptions:
 - Privately funded finance at risk-adjusted rate
 - Comparing pure consumption streams at a consumer rate of discount.
- Some agencies recommend a lower time preference discount rate and sometimes a declining rate.
- There is little discussion how to determine SOC. Probably most common approach is risk-free corporate bond rate.
- When should a time preference discount rate be used?
- How should SOC or PTPR (or STPR) be decided?

Introducing uncertainty: PM session Stream A

- Where possible, economists quantify all major impacts of projects. There are advantages of even approximate quantification.
- If impacts are highly uncertain, they may not be quantified. Poor quantification can discredit rest of the work. Such impacts should be listed in a CBA.
- For quantified impacts, next slide shows the kind of choice that may be required.
- Should economists (CBA) provide estimated mean NPV with sensitivity tests? Should we try to estimate complete distributions more often?
- If we provide full distribution, what, if anything, can we (economists) advise about this trade-off between means and variances?

Nature of risk

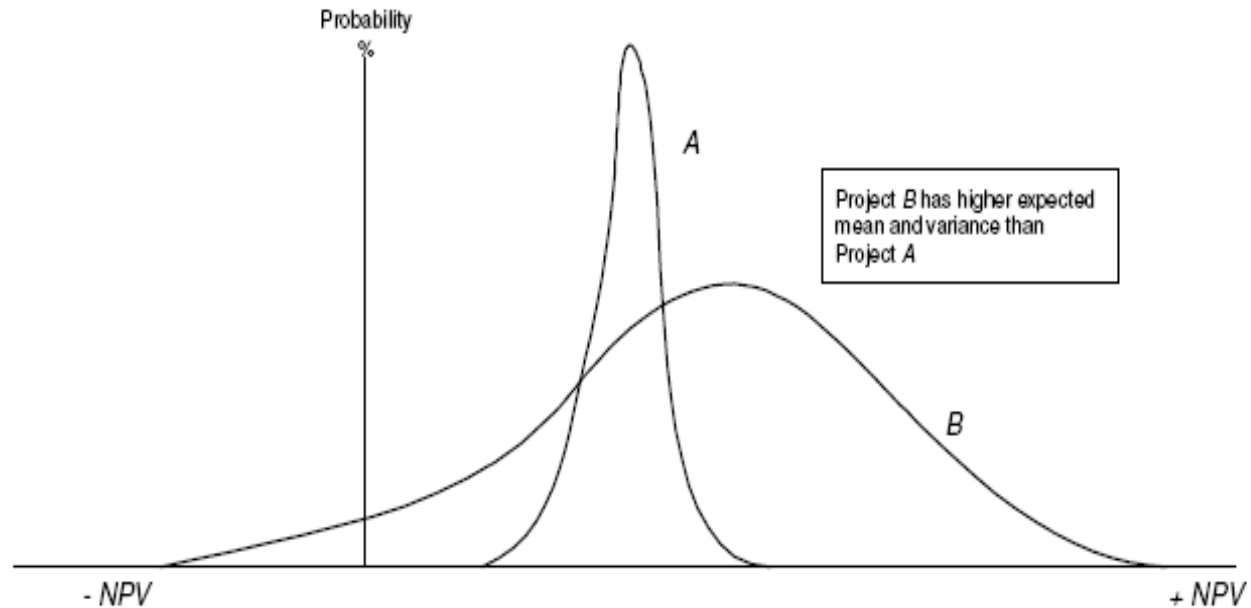


Figure 7.1 Forecast probability distributions for two projects

CBA: Conclusions

- CBA is most comprehensive form of economic evaluation and recommended by most government agencies.
- CBA is concerned with welfare.
- CBA is based on principles of value but these do involve value judgements about property rights.
- CBA has reasonable practical capacity to estimate costs and benefits.
- CBA can go wrong especially if forecasts are wrong.
- Determining preferred efficiency/equity outcome and amount of risk are ultimately political issues.

Other political economy issues

- How do we ensure they're done independently and objectively?
- Dealing with political objectives, e.g. educational or environmental targets.
- Establishing a reasonable base case and options.
- How to communicate more effectively with non-economist policy makers?
- How to increase the use of CBA?
- How to make more CBA reports public?

Who will give us the answers?

- It may be too much to expect that all these issues, many longstanding, will be resolved at this meeting.
- But we have many distinguished speakers and other participants at this workshop who will, I am sure, provide many answers.
- The final panel of the day will also come back to many of these issues.
- And perhaps the Economics Society may circulate a summary of the ideas that emerge from the day.

Questions?

Morning Tea

10.30am – 11.00am



Break