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A framework approach to harmonisation

It is clear from discussions with government agencies in the Australian and New Zealand jurisdictions (except the Northern Territory) that all is not well in the area of economic evaluation. A survey of members of the Economic Society of Australia and the New Zealand Government Economics Network (Chapter 2) confirmed this impression. It is equally clear (Chapter 3) that any attempt to harmonise variable or parameter values to promote consistency and credibility in cost-benefit analysis (CBA) studies would be fraught with methodological and perhaps political difficulties.

Most academic texts implicitly also recognise that uniformity in approach is neither desirable nor practicable. They proceed instead on the basis of a general step-wise framework for conducting a CBA study. The 10 steps presented below are a typical presentational approach, although the number of steps, names and descriptions differ between texts.

1. specify the objective of the analysis
2. define 'standing' and scope
3. establish the base case: establishing a reference point
4. predict the effects of the policy or project over its life cycle
5. estimate the economic value of the costs and benefits
6. adjust costs and benefits for risk

7. calculate the net present value (NPV) of the costs and benefits
8. conduct sensitivity analysis
9. determine distributional consequences and distributional weighting of costs and benefits
10. arrive at a conclusion or recommendations for the CBA.

The framework is composed of a series of sequential processes. For example, clear specification of the objective of the proposed policy or project as the first step ensures that subsequent steps are executed with reference to it, so that the study remains internally consistent. The second step establishes the perspective from which costs and benefits are estimated. It ensures that a local government study, for example, does not include costs or benefits that are incurred or reaped only at a national level. The final steps are contingent on the results determined in the intervening analysis and provide the information that is typically required by decision-makers.

One advantage of systematising a CBA study in this way is that it helps clarify where different parts of the analysis fit within the overall picture. Complex studies may include detailed, and hence lengthy, sections that estimate components of variables, so it may not always be clear why or how a particular part relates to other sections of the study, or to the final result.

Because consultants and other analysts tend to approach CBA studies from unique perspectives — depending on the key estimation issues involved — reports can be idiosyncratic, following no particular order, and perhaps devoting considerable space to esoteric issues of particular interest to the problem at hand. Reading such reports, even if they are technically rigorous, is time-consuming, even for experienced users of CBA analyses, because it is necessary to identify the key components and to check for internal consistency.

Preparation, presentation and comprehension of CBA studies could be facilitated if a harmonised framework such as the one above were adopted by the various jurisdictions. Consistency in the order of the presentation of the steps would need to be maintained in order to maximise transparency for readers searching for specific information about a study.

Implementation of a harmonised framework need not require a formal agreement between all of the jurisdictions. Adoption of a framework — along the lines of that outlined in this chapter — by a central agency in one of the larger jurisdictions, the Office of Best Practice Regulation, or the Productivity Commission, would encourage others to follow over time.

Improved access to completed CBA studies undertaken by the Commonwealth Government would also assist in fostering increased harmonisation of approach. In this regard, amendment of section 47C(3)(a) of the *Freedom of Information Act 1982* to specifically include the social sciences would be an important first step.

Recommendations

- A common approach be adopted by the various jurisdictions in presenting the results of CBA studies, using a harmonised framework, such as proposed in the 10 steps outlined above.
- In the absence of a formal inter-jurisdictional agreement, consideration should be given by one of the central agencies to an informal leadership role by adopting a framework along the lines outlined in this chapter.
- Section 47C(3)(a) of the *Freedom of Information Act 1982* should be amended to specifically include the social sciences.

4.1 Specify the objective of the analysis

Clarity of objective is self-evidently essential in ensuring that each step in a CBA study is consistent with preceding and successive steps. In particular, it is important that alternative approaches or projects are formulated in a way that is consistent with the desired outcomes of decision-makers. An example might be the implementation of preventative health programs as an alternative to constructing a new hospital in order to address the policy objective of reducing the effect of some debilitating medical condition on the community.

4.1.1 Constraints

An informed approach to identifying realistic alternatives also requires an elicitation of legal, physical, geographic, informational, political and other constraints that could limit achievement of the policy objective. A key feature of the CBA should, therefore, be a specific enumeration and examination of the constraints that may influence achievement of the desired outcome.

4.1.2 Cataloguing alternative projects

All potential alternative projects should be listed at the outset so as to avoid 'first selection' bias. In the words of NSW Treasury (2007, p. 3), 'the economic appraisal should not be a "business case" which simply promotes a preferred approach'.¹ The list should not be limited to a single approach, such as construction of infrastructure or regulation of an activity. Market- or price-based solutions, delayed or staged implementation, and use of a real options approach, should also be considered. For example, a program to encourage people to increase their level of active exercise may be an effective alternative to a proposal to build a dedicated facility to treat obesity or diabetes.

For practical reasons, the full list of alternative projects will need pruning if the CBA is to be conducted within time and resource constraints. In doing so, however, transparency requires that reasons should be given for the rejection of projects that are not shortlisted. In some circumstances, it may also be possible to conduct a 'back of the envelope' or 'rapid CBA' appraisal of the major benefits and costs to assist in the filtering process with the detailed CBA conducted for the key proposals. For complex decisions, each proposal may deserve a standalone CBA to detail the process and results. In those situations, it is necessary to ensure different CBAs use consistent assumptions and unit value in the assessment and an overall CBA report is prepared to summarise all individual analyses.

¹ If a decision has already been taken by government that a specific project should be undertaken, then a cost-effectiveness analysis may be more appropriate than proceeding with a CBA. A government decision to proceed is presumably based on its perceived benefits. Implementation is then largely a matter of lowest cost, or value for money.

4.1.3 The role of the analyst in choosing alternatives for appraisal

Rather surprisingly, CBA textbooks rarely discuss the issue of selecting alternative projects to include in an appraisal. In practice, an analyst may be asked to evaluate only one project against a base case, but may also be aware of other potentially viable alternatives. If the commissioning agency rules out comparisons of the proposed project with potential alternatives, the analyst may face a moral dilemma. Sugden & Williams (1978, p. 231) examine some of the issues involved, but are unequivocal about the stance to be taken by the analyst:

The analyst has a dual role to play in relation to the set of alternatives to be compared. He may offer advice at this initial stage, seeking to ensure that important and practicable policy options are not ignored. Here the roles of decision-maker and analyst overlap a good deal. And at the end of the analysis, the analyst should do his best to ensure that his findings are not misinterpreted, or read as implying more than they really do. If important alternatives have not been considered in the study, intellectual honesty requires that the analyst points this out. It is possible that the decision-maker may suppress these, and perhaps other significant qualifications when presenting the analyst's work in support of his decision. This puts the analyst in a difficult position but we believe that the analyst has the professional duty to set the record straight, for otherwise analysis in general is brought into disrepute. If in the special circumstances this is impossible, then it becomes a matter of conscience for the analyst whether he can continue working for that client, and whether he should dissuade other analysts from so doing.

Table 2.4 reveals that more than half the respondents considered that CBAs are not conducted independently and objectively, are used to justify rather than inform, and are not undertaken for important decisions. Requiring CBAs to record explicitly why apparently feasible alternative projects have not been included in an analysis is desirable in maintaining credibility, even if decision-makers do not release this information.

4.1.4 Strategic merit tests

Transport agency guidelines in the various jurisdictions generally specify the conduct of a 'strategic merit test' in an early stage of a project. For example, Transport for NSW (previously the Road Transport Authority) (2013, p. 72) states that:

Strategic merit testing is a technique used to check if the proposed project aligns with the economic, environmental and social objectives, policies and strategies of the government. This qualitative project appraisal tool used during the strategic planning phase includes a series of questions which try to identify the contribution of the proposed project to the government's objectives, policies and strategies.

On one reading, this advice is not much different to the point made above that constraints, including those of a political nature, should be taken into account in identifying a realistic set of alternative projects. On the other hand, a less sympathetic interpretation might lead one to conclude that there is a considerable risk of bias posed by such 'strategic merit testing', with analysts second-guessing ministers as to what alternative projects might in fact be acceptable to the government. Government policy is not always set in stone, and may change during the course of an electoral cycle, especially if changeable budget constraints dictate a reconsideration of earlier priorities. From this perspective, a full listing of projects that satisfy the government's primary objective is a desirable element of all CBA studies.

A broader, more informative approach to the use of a 'strategic merit test' might be to compare government priorities in all sectors of society — perhaps by applying a rapid CBA assessment — to gauge the relative merit of using scarce resources in the transport sector compared to expenditure on health or education or defence. This may not be practical, however, and may pre-empt government consideration of the merits of broader alternatives. In some cases, governments may have decided formally or informally that they will proceed with a project or program long before a CBA is commissioned.

The national guidelines issued by the Australian Transport Council (2006, Part 3, p. 16) are rather circumspect, acknowledging the subjective nature of decisions made by government. Nevertheless, the risk remains that an unsophisticated approach that considers 'strategic

merit’ can result in a biased selection of project alternatives. This may especially be the case for inexperienced officials who commission a tendentious CBA study by a commercial consultant.

4.1.5 Peer review

Studies of complex projects can involve difficult issues of a methodological or conceptual nature. In order to ensure a defensible result, it is sometimes the practice to engage a peer body or analyst to review the study to reassure decision-makers or the public of its fidelity. The concept is analogous to the gateway process employed in large government procurement programs.

In general, CBA studies are time-consuming, and may be expensive. There is, therefore, merit in engaging a peer reviewer early in the process, to provide critique and feedback throughout the study, rather than at the end when there may be a reluctance to redress any apparent shortcomings. In doing so, however, it would be prudent to maintain a degree of independence for the reviewer, perhaps with greater use of academics who are not reliant on government agencies for continued work.

4.1.6 Recommendations

A CBA should record explicitly:

- the objective of the proposed project or policy
- a full list of alternative projects and policy initiatives that could be used to achieve the objective, including market-based alternatives to construction of infrastructure or its expansion
- reasons for not including any of the feasible alternative projects in the CBA analysis
- a process of objective and independent peer review be instituted at an early stage of the analysis for all government-funded studies.

4.2 Define ‘standing’ and scope

Many CBA studies fail to define explicitly the perspective from which costs and benefits are to be included or excluded.

Specification at the outset of the perspective or 'standing' to be taken in an analysis is a key determinant of subsequent steps, especially the inclusion or exclusion of particular benefits or costs. For example, if the analyst or decision-maker decides to conduct the analysis from the standpoint of the city of Auckland, then benefits accruing to residents of Wellington or Dunedin, or costs imposed on them, should not be counted.

The Capital Metro Agency (2014) business case for Canberra's proposed light rail system does not explicitly define standing. It implies in several parts (e.g. p. 69) that a key objective is 'facilitating economic growth for the ACT [Australian Capital Territory]', including job creation. It is therefore unsurprising that the study wrongly includes as a benefit additional tax revenue from an assumed larger workforce (Table 28, p. 102), even though income tax is levied and largely retained by the federal government rather than the ACT. Further, the study does not reveal how much of the additional employed labour is likely to be sourced from residents of the ACT, rather than from neighbouring commuter towns like Queanbeyan, Goulburn or Yass, which are located in New South Wales.

Omission of the critical step of defining standing in a CBA is difficult to condone. However, Whittington and MacRae (1986) argue that:

The practice of equating standing with citizenship worked reasonably well in most early applications of cost-benefit analysis. For instance, in the appraisal of water resources development projects, it served to broaden the focus of the analysis from the immediate beneficiaries for a project (often limited to a small district or region) to include other citizens who would have to pay the cost of what typically turned out to be porkbarrel projects. Neither the costs nor the benefits commonly spilled over national boundaries. Though the techniques of cost-benefit analysis were often misused, the thrust of the analysis should theoretically have detected narrowly conceived projects that were designed to serve only a few who would gain something at the expense of the majority, who would lose more. The issue of standing may also have been neglected in the literature because economists felt they had little expertise that could be brought to bear on the question. Thus, following Mishan, they attempted to calculate the willingness to pay for 'each person in the defined community', leaving the determination of the 'defined community' to the political process.

The issue of standing was the subject of debate in the early 1990s, primarily by Trumbull (1990), Whittington and MacRae (1990) and Zerbe (1991) in response to an article by Whittington and MacRae (1986). Despite some unresolved contentious issues, Boardman et al. (2011, ch. 2) reflect contemporary thinking in suggesting that standing in CBA should be from a national perspective as a default position, and be based on prevailing social norms and preferences, and legal rights.

Ethical conundrums can bedevil attempts at satisfactory approaches to defining standing. Some examples include the interests of aborted fetuses, the rights of prisoners incarcerated near a noisy airport, treatment of non-human hominids, local pollution that affects neighbouring countries, or non-participation of children in vaccination programs if their parents object.

4.2.1 Standing and the value of statistical life

The human capital approach essentially posits that society values a (statistical) life on the basis of the value of the wages that the deceased could have been expected to earn in their remaining lifetime as measured by their life expectancy at a particular age.

Most Australian road and rail agencies — New South Wales being an exception — have for many years used the human capital approach to value statistical life, or the hybrid approach employed by the Australian Bureau of Infrastructure, Transport and Regional Economics (2009). In New Zealand, the Ministry for Transport specifies the value of statistical life (VOSL), and the same value is used by New Zealand Treasury and other departments and agencies. The New Zealand VOSL has been based on the willingness to pay (WTP) approach since 1990, when it replaced the human capital approach.

One well-known disadvantage of the human capital approach is that the lives of pensioners who no longer earn a wage should theoretically be valued at zero, or worse. If a life is lost, it could be argued that society loses the value of that person's production (as measured by their wage), but that society will also save the resources that would have been consumed by the individual in their remaining lifetime. However, Prest and Turvey (1965, p. 722–23) point out that this issue of consumption forgone poses a conundrum for the analyst:

Ignoring non-materialistic considerations like the grief of family and friends, the loss to society of a decedent is typically taken to be the wealth that the person would have accumulated, plus taxes that would have been paid, minus any transfer payments that he or she would have received. An adjustment sometimes made to this 'value of life' approach is to subtract the value of the resources that would have been consumed by the individual because they can be used by society for other purposes, and are therefore a social 'gain'. But this presupposes that society is defined as it exists *after* the person's death. That is, standing is defined implicitly to exclude the statistically deceased individual.

Prest and Turvey (1965) argue that an alternative perspective might be to consider society as including all current residents or citizens, including those who will die in the future. Imagine these residents considering a proposed safety project and discussing the cost to society of future deaths of residents. Members of this discussion group would still see themselves as part of society into the future. For them individually, the loss due to death would include the consumption that they would forgo. Since they are still part of society, the disbenefit of their loss of consumption into the future would conceptually also represent a loss to society. From this perspective, the private loss of consumption by a prospective decedent should be counted as a social *loss*, rather than an offsetting 'gain'.

4.2.2 Standing and wider economic impacts in transport analysis

The 1980s saw the beginnings of a debate about the broader effects of transport infrastructure improvements on the economy, in addition to the conventional CBA methods employed by transport economists. Analysts and agencies in the United Kingdom began to characterise such effects as 'wider economic benefits', an inappropriate term given that they relate mainly to changes in gross domestic product due to public investment in infrastructure. Appendix 3 examines the issues in more detail.

Recent work, reviewed by Laird and Mackie (2010), has revealed a failing by earlier studies to take into account the standing or 'prism' from which the analysis was conducted. Increased productivity due to infrastructure investment was found to be mainly due to the relocation of the most productive people to larger cities. At a national level, the

additional productivity effect due to people relocating would simply be redistributive, with a particular area gaining what another loses, and therefore with no net increase. Local government, on the other hand, could be expected to include any increased productivity in its assessment of an infrastructure project.

The wider economic impacts (WEI) estimated in various sub-national studies were in general comparatively large compared to conventional estimates of net social benefits of transport and other infrastructure projects (Laird & Mackie, 2010). Failure to consider the implications of choice of 'standing' therefore risks significant bias in decision-making about the effect of infrastructure investment on the economy as a whole.

4.2.3 Practice in the jurisdictions

Despite its obvious importance in the aggregation of costs and benefits, the treatment of standing is largely absent from Australian Government manuals for CBA. Even the Australian Government Department of Finance and Administration (2006) handbook on CBA does not deal explicitly with the concept of standing.

Evaluation guidelines issued by the SA Department of Treasury and Finance (2014, p. 31) refer in passing to the need to assess costs and benefits that impact upon the 'state economy and broader community'. A NSW Government Department of Infrastructure & Planning (2012) guideline for the use of CBA in mining and coal seam gas proposals states that costs and benefits should be aggregated 'over the whole community', but without specifying the extent of the community. The Victorian Department of Treasury and Finance (Government of Victoria, 2014) guide to CBA in regulation indicates that impacts on different groups and governments should be identified, but does not deal explicitly with the issue of standing.

In contrast, a European Commission (2008) guide to CBA devotes about half a page to the need to establish standing as part of the socio-economic context and scope of the analysis. A draft CBA guide issued by the Treasury Board of Canada Secretariat (1998), also devoted space to the issue of standing, but the oft-cited HM Treasury (2003) Green Book does not cover the topic. New Zealand Treasury (2005, p. 11) stated its expectation that a CBA would be undertaken from a national

perspective, but the revised guide that was issued in July 2015 (New Zealand Treasury, 2015) is more equivocal, citing only some examples of the difficulties involved in defining standing.

Officials interviewed in the various Australian states invariably responded that standing was based on a purely state perspective. Somewhat incongruously, no distinction is made between state residents and visitors from other states or abroad, for example, in estimating the benefits of a faster transport link between a capital city airport and the central business district. The reason generally given was that no data are available to distinguish between different users of infrastructure.

Practice in the various Australian jurisdictions is thus consistent with the Austroads (Rockcliffe et al., 2012, Part 2, p. 8) suggestion that standing should include 'all affected persons', including foreigners, because 'few data sources distinguish the residency of affected persons'. One rationale given for not addressing this contradiction is that governments generally wish to promote tourism, so that the practice of including non-residents is not inconsistent with the overall strategic objectives of the government.² It is difficult to believe, however, that no adjustment is possible on the basis of available statistics produced by the Australian Government agency Tourism Research Australia.

Counting benefits to non-residents of a particular state when standing is taken as being confined to the residents of that state means that the benefits of the project will be overstated. In the health sector, however, interstate agreements about mutual hospital treatment may make it difficult to justify excluding consideration of project benefits to non-residents, even if 'standing' has been specified as being limited to one state alone.

On the face of it, there appears to be little justification for persisting with a narrow state-based approach to standing when benefits to non-residents are being counted. However, several jurisdictions intimated

² This argument is redolent of the use of apologetics to defend a position that may otherwise be logically flawed. If the government wishes to promote tourism, it should do so directly with a specific project or program, subject to justification through a CBA. Inclusion of benefits to tourists in an infrastructure project is a blunt instrument that may have no significant causal relationships to the number of tourists in the country.

in interviews that their governments would not be keen to take into account any externalities that local projects might impose on another state. For example differences in waste disposal fees between states has been seen at least one state accepting a neighbouring state's waste, but any externalities that might be imposed were not taken into account in an evaluation by the sending state. While not presented by interlocutors as a justification for taking a state-only perspective, political reality is that the issue of potential externalities would seem to be a pertinent disincentive to changing the current practice of purely state-based standing.

4.2.4 Recommendations

The need to clearly define standing at the outset of an analysis is important, but it would be inappropriate to offer prescriptive guidelines for areas that involve ethical issues.

Nevertheless, a degree harmonisation of approaches is desirable to promote greater consistency and transparency in economic evaluation. In particular:

- Explicit specification of 'standing' should be provided in all CBA studies. Where more than one perspective is adopted (e.g. to provide additional information requested by decision-makers), results should be shown separately for each specification.
- Adoption of a national perspective for all CBA studies should be the default position. Studies should clearly identify the parties whose benefits and costs are included, as well as those who are specifically excluded from the analysis.
- Consideration should be given to adopting a convention that all residents of Australia, not just citizens, be granted standing in a CBA study.

4.3 Establish the base case: Establishing a reference point

Calculation of additional benefits and additional costs requires an initial or reference case from which to measure the changes induced by implementation of a project or policy. This reference case is

often termed the 'base case' in CBA studies, but is also variously depicted as the 'before project situation', 'status quo option', 'do nothing' option, 'business as usual' and 'do the minimum' option. The latter two terms probably best express the underlying concept of a counterfactual situation that would exist if the project or policy were not implemented. In general, all alternative projects specified in Section 4.2 above should be evaluated against the same base case.

A realistic base case does not assume that past behaviour will be replicated infinitely into the future. It recognises that life goes on, even if a particular project or policy is not implemented. Populations may grow or diminish and age profiles will shift, traffic densities may increase, land-use patterns will change, and similar but smaller projects may be implemented.

Nevertheless, political constraints sometimes require use of a base case different to the 'business as usual' or 'do the minimum' scenarios. For example an analysis of the National Broadband Network (NBN) by the Australian Department of Communications (2014, Vol. II, p. 9) eschewed the use of continued rollout of the NBN as being 'clearly not realistic', because the incoming government had explicitly decided not to continue it. The base case adopted was continued rollout, but without any further government subsidy of the operation.

4.3.1 The period of the base case

Establishing the period of the base case — the time of its beginning and the time of its end — determines which, and how many, costs and benefits are counted. Where only one project is analysed, the base case and project periods may coincide naturally, although long-lived projects may require the inclusion of residual or 'horizon' values in order to justify choice of matching periods. If more than one alternative project is analysed and the project life cycles do not coincide, resort to equivalent annual values (s. 5.2), or similar techniques, may be required.

4.3.2 Recommendations

The importance of the base case as a reference point for estimating additional costs and benefits suggests that there would be merit in harmonising the following procedural principles:

- listing and explanation of all assumptions made in choosing or developing the base case scenario
- as a default option, use official sources for key variables employed in projections
- justification for use of estimates that are not based on official sources
- specification and justification of the time period selected for the base case
- where relevant, ensuring consistency of base case assumptions with those used in projections of impacts of the project or policy.

4.4 Predict the effects of the policy or project over its life cycle

The additional benefits and costs of a project are measured in terms of the difference of the effects induced by the implementation of a project, compared to the counterfactual of a base case. In simple terms, the project that generates the highest level of net benefit relative to the common base case is to be preferred.

Even if an analyst is experienced and knowledgeable, there is some likelihood that they may not fully identify all the impacts of a project, particularly if there is novelty in the case being examined. Prudence suggests a wide-ranging consultative process by the analyst, including particularly with operators (the people with the spanners) and those directly affected by the project, in order to avoid bias due to omitted impacts.

Unless the analyst provides readers of the study with information about who has been consulted, however, it is difficult for a decision-maker to form a judgement about the rigour of the results. Overcoming this asymmetry of information is relatively straightforward if the analyst provides a list of those consulted. The same is true of published sources that may have been relied on. A 'belts and braces' approach also requires the analyst to provide reasons for *not* consulting relevant people or sources of information.

Transparency and accountability also require that the identified impacts are presented by the analyst to allow peer reviewers and decision-makers to identify omissions from the analysis. In short-listing the impacts for which economic values are to be estimated, the analyst should provide cogent reasons for all exclusions.

4.4.1 The period of analysis of the project(s)

The period of time chosen for analysis of a project and its alternatives determines the types and number of costs and benefits that are aggregated over time, just as for the base case. Transparency is therefore critical, but is rarely observed in practice. Textbooks are also silent in this area, despite the fact that manipulation of results can be more easily achieved than fiddling with the more obvious aspects of a CBA, such as the discount rate.

The Canberra light rail project is a case in point. Economic analysis conducted by Capital Metro Agency (2014, Table 19) used a 30-year period beginning in 2016, despite positing an ‘operating term of 20 years’. Because the analysis begins from construction in 2016, it excludes significant set-up costs.³ It has been argued informally by Capital Metro that exclusion of preliminary costs accords with accounting standards because the formal Cabinet decision to proceed with the light rail project was not made until after contracts were let for preliminary engineering work and the agency had been established. In effect, the project period has been broken up into separate stages in a way that excludes preliminary project costs.

Where government procurement guidelines set limits to expenditure in the absence of a formal request for tender process, there may be a temptation to break procurement projects up into separate stages that all fall below the limit. To preclude this, guidelines typically require bundling of staged costs to ensure a full accounting of the total costs involved. The *Commonwealth Procurement Guidelines* (2005, s. 8.10), for example, contain the following safeguard clause:

Where a procurement is to be conducted in multiple parts with contracts awarded either at the same time or over a period of time,

³ Specific figures are not readily available, but *Canberra Times* (6 August 2014, p. 2) reported that \$30 million had been budgeted over two years from July 2013, including \$9.8 million for consultancies and \$2.3 million for staff and administration costs.

with one or more suppliers, the estimated value of the property or services being procured must include the estimated total maximum value of all of the contracts.

Employment of a similar approach in harmonising the analytical framework for CBA should be considered to ensure a 'true and fair' view of proposals as a whole. By the same token, all costs relevant to implementation of a government decision to proceed with a project or program should also be included: these may include items such as post-implementation reviews, *in media res* and ex post reviews, auditor investigations, and reports to ministers or parliament.

4.4.2 Transfer payments

Pensions, subsidies to businesses, taxes and unemployment benefits are examples of transfer payments. They redistribute resources or wealth without affecting the overall well-being of society (assuming, for example, that the marginal utility of income is constant). The person providing the payment does not directly receive any goods or services in return for the payment.

Because transfer payments are not considered to affect the overall well-being of society, they are typically treated as being neither a cost nor a benefit. For this reason, it is not uncommon for transfer payments to be ignored in a CBA. Nevertheless, it is useful to identify such transfers at an early stage of the analysis because they are relevant to any discussion of distributional consequences at a later stage of the CBA.

4.4.3 Duality in costs and benefits

There is often an element of duality in CBA. Duck hunters, for example, may welcome the construction of a dam, but campers may regret the loss of trees and land.

An increase in house rents (a change in price) that does not reflect a change in costs involves greater expenditure by the person renting the house. But the tenant's increased expenditure is exactly offset by the additional revenue to the landlord. Such pecuniary effects cancel each other out, so their inclusion in a CBA is effectively superfluous. Nevertheless, there is merit in including them when compiling a list of

project impacts, both to demonstrate comprehensiveness, and because they can provide useful information to decision-makers about the distributional outcomes of a project.

Some proponents of transport infrastructure favour the automatic inclusion of WEIs (Appendix 3) in project appraisals. A review of the WEI literature, however, found no reference to the need to also estimate the corresponding deadweight loss (Appendix 7) of a project. This is despite the fact that projects that can be expected to generate significant WEIs are also likely to require significant amounts of government expenditure, suggesting at least some degree of deadweight loss due to government borrowing or increased taxation. Some WEI studies do refer to potential negative effects of agglomeration, such as increased traffic congestion, but with no further investigation of the strength of such offsetting effects.

The Capital Metro Agency (2014) analysis of the Canberra light rail project includes as a benefit the WEI of the light rail, amounting to about 20 per cent of total estimated benefits. These so-called agglomeration benefits are largely calculated on the basis of the effect of government expenditure on the supply of labour. However, there is no countervailing inclusion of the marginal excess tax burden (METB) effects on disposable income, and hence transactions, or on the supply of labour. Costs have therefore been underestimated.

It is important to not only list all the positive and the negative effects that might be expected to arise from a project, but also to justify why some are not rigorously investigated. It need hardly be pointed out that failure to do so invites risk of bias.

4.4.4 Causality

Demonstration of causality is not a common aspect of CBA studies, despite its analytical importance. Methodological harmonisation requires, at the very least, an attempt to demonstrate causation, rather than relying on statistical correlations alone. Transport safety interventions, in particular, require an understanding of the possible range of impacts, rather than relying on experience in other countries.

On the basis of a survey of American regulatory impact statements, a conference paper by Johnston (2015) argued that:

epidemiological evidence alone is highly unreliable as a measure of actual health impacts. This point is made with a detailed analysis of estimates of the impact of fine particulates on excess mortality. The data show that particulates have their biggest impact on cardiovascular mortality among the elderly in the winter months. However, the medical literature reveals a variety of mechanisms that account for the heightened risk of death from cardiovascular causes among the elderly during the winter, and these mechanisms do not involve exposure to elevated levels of fine particulates. If researchers look statistically at only one particular factor — fine particulates — while ignoring others, then estimates are subject to omitted variables bias. A better approach is to look first to identify potential causal mechanisms so that all potential factors are controlled for in statistical studies ...

The cases of WEIs and the METB provide another example. A key qualification in the estimation of WEIs is that the direction of causality needs to be demonstrated for the relationship between effective density and productivity. It is also important to demonstrate that the relationship has not been overestimated because explanatory variables have been omitted. In the case of the estimated deadweight social loss due to increased taxation used to fund a project, a prior condition is the need to demonstrate that the expenditure can be attributed to increased taxes rather than borrowing or a countervailing reduction in expenditure elsewhere in the budget. Automatic inclusion of either effect without appropriate supporting evidence would likely result in a biased estimate of net benefits.

4.4.5 Primary and secondary markets

In listing the expected impacts of projects, it is useful to distinguish as far as possible between primary and secondary markets.

There are no firm rules for such distinctions, but the primary market can usually be divined from the objective of the CBA study. Textbooks such as Boardman et al. (2011) provide guidance on the circumstances in which impacts in secondary markets should be included in the appraisal. WEIs are an example of secondary market benefits, although not all the effects are suitable for inclusion in a CBA. Productivity effects on GDP, for example, are not commensurable with social surplus estimates in a CBA.

4.4.6 Recommendations

The following are worthwhile conventions for analysts compiling a catalogue of expected project impacts:

- provision of a comprehensive list of impacts and an explanation of all assumptions made in predicting impacts
- provision of a list of persons and sources consulted to identify project impacts
- provision of evidence-based justification of causality for all impacts identified
- cogent explanations for excluding impacts that have not been short-listed
- all costs and benefits, including the costs of preliminary analyses or administrative preparation, should be attributed to the project, even where the project is implemented in stages that may appear to be separate projects
- inclusion of all relevant implementation costs, including post-implementation and final ex post review on completion of the project or program
- identification and/or valuation of major transfer payments that are significant enough to include in a distributional analysis
- require the use of official sources for key variables employed in the base case
- explanation of reasons for use of estimates not based on official sources
- ensure consistency of time period used with that of the base case
- where relevant, ensure consistency of project impact assumptions with those used in the base case.

4.5 Estimate the economic value of the costs and benefits

Identification of the costs and benefits of the base case and those of the projects being assessed, needs to be followed by the estimation of their economic values. Costs are valued as opportunity costs, and benefits are valued in terms of social surplus. Boardman et al. (2011)

define the social surplus as consisting of consumer surplus, producer (i.e. factor) surplus, government surplus and externalities, but other categories could also be used.

Various methods are used to estimate WTP in order to estimate various aspects of social surplus. Commonly used approaches include econometric estimation where data are available, travel cost methods, market analogies, contingent valuation surveys, choice modelling, and hedonic pricing (Boardman et al., 2011; Campbell & Brown, 2003). Each of these methods has advantages and disadvantages, so that the analyst needs to choose the one best suited to the project at hand.

4.5.1 Harmonisation of variable values

The transport sector has a predilection for standardised variable values. Austroads, for example, has for many years provided detailed values, most recently in Tan et al. (2012). Similarly, the New Zealand Transport Agency provides evaluation methodologies and benefit parameter values in its *Economic Evaluation Manual*, which is updated annually. The European Commission (2008) guide to CBA also contains detailed instructions and variable values for use in a variety of major projects as part of its cohesion policy, the objective of which is to reduce regional socio-economic disparities.

Whether Australian agencies should adopt harmonised values for key variables is open to question. To ensure consistency and comparability between different projects, there may be some justification for harmonising the value of a variable such as the VOSL, because it is used by two different sectors, transport and health. There may also be a similar rationale for harmonising key variables, such as the value of time, because it is used across different transport modes in road and rail projects, and because larger projects may be federally funded so that their merits should desirably be fully comparable.

One drawback of adopting a set of standardised or harmonised statistics is that they need to be updated regularly. Updating requires not only resources for continued research, but also agreement on methodology. For example, the WTP for a reduction in the risk of premature death due to road crashes in New Zealand in 1991 was estimated at NZD2 million by Miller and Guria (1991) using the contingent valuation method (CVM). This figure has been used since for transport appraisals

in New Zealand, but it has been indexed using the ordinary time wage rate. As Guria (2010) points out, this method is flawed because indexation by price inflation should have been used instead.

A further complication may arise in the case of choosing a single default value for a variable, such as the VOSL. A stated preference estimate of a road crash VOSL may differ from one estimated for death due to a plane disaster or terminal cancer, because the risk or contextual factors may be perceived differently.

Sanderson et al. (2007) report on research within Business Economics Research Limited, which was commissioned by the NZ Fire Service Commission to establish 'a technically robust and defensible fire-related ... VOSL for use in Regulatory Impact Statements'. Because of the age of the 1991 car crash estimate, the preferred method of Sanderson et al. (2007) was to estimate the relativity between the fire VOSL and the road VOSL as a reflection of the current preferences of the NZ population. It was argued that a stand-alone estimate may not have been strictly comparable with one carried out some 15 years earlier. Their study found that the value of an additional life saved from fire was perceived to fall in the range of 57 to 66 per cent of the road VOSL.⁴

However, Guria (2010) notes that an Organisation for Economic Cooperation and Development (OECD) study shows that people's willingness to pay for a reduction in the risk of death in a house fire is greater than that for transport accidents. He concludes that:

To make sure government funds are used to best effect, the VOSLs need to be right. This would best be achieved by developing an appropriate and common methodology for estimating VOSLs for different risks in different areas and establishing the relativities between them.

Clough et al. (2015) also consider that a transport VOSL could be a benchmark for other risk areas, with appropriate adjustment if the value relativity between different risks is appropriately estimated. They further argue, however, that because VOSL is affected by base

⁴ The key question asked in the survey was: 'Suppose the Government could increase funding to safety programmes, which would result in 20 accidental deaths being averted per year. How many of these would you prefer to be saved from reduced car accidents, and from reduced residential fire accidents?' Respondents indicated on average that 12.4 of the 20 lives saved should be from car crashes and 7.6 from residential fire accidents.

risk and income of the affected population, a VOSL is not likely to be the same in transport as in other risk domains, such as workplace safety or health interventions. They therefore recommend that separate VOSLs should ideally be determined for each domain, reflecting its own particular risk characteristics.

4.5.2 Harmonisation of methodology

The VOSL can be estimated in a number of ways, but the two major contenders in Australia and New Zealand are the human capital approach and the stated preference (either choice modelling or the CVM) approach. The human capital method is an ex post present value of identifiable costs, such as earnings forgone, over a standard period (typically 40 years) representing an average working life, hospital care, and property damage. It therefore excludes retirees and non-working-age children. Further, it does not include family grief or pain and suffering, although the Bureau of Infrastructure, Transport and Regional Economics (BITREs) (2009) 'hybrid model' seeks to incorporate such effects. Conceptually preferable to the human capital approach, stated preference methods include all tangible and intangible effects by eliciting people's average, ex ante WTP to reduce the risk of death, based on econometric analysis of survey information.

The methodology used to estimate transport VOSL differs among jurisdictions. Transport NSW employs the WTP approach, as do the New Zealand Ministry of Transport and the New Zealand Transport Agency. Other jurisdictions use the human capital estimate established by BITRE, adjusted for property costs, earlier funerals, and pain and suffering of relatives. Queensland Transport and Main Roads uses the human capital approach, except for safety-related projects (e.g. the Black Spots program) where a WTP figure is used.

Reflecting general agreement among its members that the WTP approach is the most appropriate method for determining VOSL and crash costs, Austroads (Naude et al., 2014) produced a scoping study that explored the process for implementing a WTP study across Australia. It recommended a national WTP survey that 'would provide a set of robust values for the country, based on a sound and consistent

methodology' every 8–10 years with regular updating bi-annually. The cost of a national study was estimated at about \$1 million at 2012 prices.⁵

Use of CBA in the health sector is comparatively rare. Both clinical and pharmaceutical studies rely on measures such as quality adjusted life years (QALY) and disability adjusted life years (DALY). A QALY combines changes in life expectancy with a composite 'quality of life' index of changes in health states as the result of a treatment. For example, a treatment may extend a person's life expectancy, but, at the same time, reduce their quality of life for the remainder of their life, perhaps because of unpleasant side effects induced by the treatment. Treatment costs are compared to the change in a QALY or DALY in so-called cost-utility analysis, a form of cost-effectiveness analysis that does *not*, however, involve the economic concept of utility (Drummond et al., 1997).

Stated preference methods could be used to estimate people's willingness to pay for changes in risk of death or injury for specific illnesses and treatments. Unless relativities between the different conditions could be established, however, a large number of expensive studies would be required.

Abelson (2012, ch. 32) outlines an alternative approach. An estimated VOSL can be transformed into an annuity over some assumed life span such as 40 years. The equal annual amounts,⁶ termed the value of a life year (VLY), can be multiplied by a relevant QALY index number to provide a proxy annual estimate of people's willingness to pay for a specific treatment. Clough et al. (2015), however, argue that VLY should be estimated directly, based on survey results, rather than simply annualising the VOSL. The study also recommends investigating whether VLY varies with different levels of quality of life arising from an injury.

5 By way of comparison, the BITRE (2009) estimate, based on the human capital approach, involved four project staff, plus various contributions from another eight departmental officers. Assuming that the study took about two years, the saving in staffing costs had BITRE not undertaken its theoretically questionable approach, could have funded a national WTP study.

6 An annuity 'spreads' a given amount (like the value of life, VOSL) over a given number of years (assumed here as 40 years) so that the value is equal in each of the 40 years.

Given the readily available possibilities, it is only fair to ask why the health sector does not turn to CBA, rather than continuing its use of cost-effectiveness methods. One health sector official interviewed for this publication pointed out that the reason for the inertia is that the current system is based on a balance of incentives among the various vested interests. Large pharma-companies, government officials, and the medical profession are unwilling to change because their current profits, processes and invested knowledge are all geared to the current system. Any change would require authoritative intervention by an entity with an overriding interest in economic efficiency.

4.5.3 Optimism bias

Flyvbjerg (2009), and his earlier work on optimism bias, is well known. Nevertheless, the problem of underestimation of infrastructure costs is enduring. The Capital Metro Agency (2014, Table 1) business case for the proposed Canberra light rail estimated construction costs at less than \$600 million in nominal terms, excluding a contingency of \$173 million and an 'escalation' provision of \$65 million. However, *Canberra Times* (20 July 2015, p. 1) reported that a government letter to an agent engaged to promote the project with international financiers put the cost at \$900 million. No explanation for the difference in estimates is publicly available. Moreover, the letter is reported to have been issued two months before publication of the business case,

The issue of cost underestimation is not an easy one to resolve, mainly because of the difficulty of quantifying, *ex ante*, what the extent of any potential optimism bias might be. The same is true of overestimates of patronage for Sydney's Lane Cove and Cross City tunnels and the Clem Jones tunnel in Brisbane.

But it is at least arguable that, for project cases for large infrastructure projects in particular, author-analysts should be required to explain why they do not consider their work to have significantly underestimated costs or overestimated benefits. For example, a range of similar projects could be cited, with an analysis of any cost blowouts and how the project being proposed will safeguard against similar occurrences. Risk analysis using the Monte Carlo technique should also be used, perhaps with a suitably skewed probability distribution for expected construction costs.

Capital Metro Agency (2014, s. 5.1.2) stated that it used a 'cost estimation firm with deep, recent Australian light rail experience to calculate a non-risk adjusted base cost estimate'. The contingency provision estimate was based on workshopped consideration of risk and likely distributions (s. 5.2.1), with Monte Carlo analysis used to determine confidence levels in a range of cost estimates. This is a useful contribution, but fuller disclosure would have been preferable.

Full disclosure of the identity of experts undertaking estimates of costs and benefits is desirable from both a procurement perspective and from that of a CBA. Over time, it would become readily apparent whether particular experts are prone to optimism bias, especially if ex post CBAs are carried out. Inveterately over-optimistic analysts could be avoided by agencies that commission CBA studies: market pressure would eventually reduce any tendency towards optimism bias among consultants. Further, procurement officers and ministers would be less likely to be placed in the invidious position of having to seek additional funds because of underestimated costs, or criticism of unsuccessful projects.

4.5.4 Replicability

Whatever approach is taken to harmonising values used in CBA, it is important that full information be provided, possibly in detailed appendixes, on the sources of data and the methodology used to derive estimates of variables. The amount of detail provided should be sufficient to allow other researchers to replicate the estimates of economic values used in the study.

4.5.5 Recommendations

Harmonisation could involve the adoption of a set of conventions, including the following:

- provision of explicit justification for the timeframe used for analysis
- explanation of reason(s) for selecting a particular method of estimating benefits, rather than feasible alternative method(s)
- ensure replicability of results by making data publicly available (e.g. online), or providing specific references to sources used
- as a default option, use of official or authoritative sources for variables employed in projections

- comprehensive tabulation of all costs and benefits, including those that are attributable to the project but are incurred outside the period of analysis
- consideration of greater use of stated preference methods on a national basis to permit estimation of benefits on a comparable basis
- recording of all variables that it is not possible or practicable to quantify
- providing a statement explaining measures taken to minimise potential optimism bias in estimating infrastructure construction costs or predicted benefits, possibly by comparison with projects that have been completed in similar circumstances, but also including the identity of the author of the estimates.

4.6 Adjust costs and benefits for risk

Risk is commonly understood to be either a negative event outcome, or its combination with the consequence of the negative outcome. Wikipedia expresses the concept as the potential of losing something of value. Standards Australia and Standards New Zealand (2009) define risk as the ‘effect of uncertainty on objectives’, with ‘effect [defined as] a deviation from the expected — positive and/or negative’, although earlier formulations had been framed primarily in negative terms only.

Common usage of the term ‘risk’ implies a solely negative connotation, involving an adverse outcome for an event. For example, it is normal to speak of the risk of rain spoiling a picnic. In context, this vernacular use of the term ‘risk’ is valid and has a specific, generally accepted meaning.

Financial analysts and economists, however, envisage risk as meaning that an event can have either a negative or a positive outcome compared to an expectation. In the case of the picnic, the weather forecast may suggest a dry but cloudy day, which, in the absence of other information, is the accepted expectation. The economic concept of risk in this case could involve a negative outcome like rain, or a positive outcome like sunshine rather than cloud. In other words, the outcome could be either better or worse than expected.

In CBA, the concept of risk is generally associated with the statistical measure of variance — the degree of deviation from an expected value like the mean — a unit that can include both positive and negative deviations. For example, a road project may be designed to reduce travel times but a construction flaw may result in the need to impose a low speed limit for safety reasons. The outcome would be higher than expected travel times. Alternatively, a design improvement during construction may reduce the length of the road, or permit smoother traffic flows, so that travel times are reduced below their expected value. Estimation of probabilities of various possibilities could be used to construct a probability function that would allow calculation of its variance. The expected benefit of the road (in this case travel time) can then be calculated in probability-adjusted terms using a technique like Monte Carlo analysis (see Appendix 6).

Economists have generally accepted the distinction between risk and uncertainty put forward by Knight in 1921 (2009, p. 121). In the case of risk, ‘the distribution of the outcome in a group of instances is known (either through calculation a priori, or from statistics of past experience)’. Risk is therefore often characterised as the calculable variation — positive or negative — around a point of central tendency of a probability distribution. By contrast, the probability of uncertain events is, by definition, not known or measurable.

A traditional, but increasingly infrequent, means of allowing for risk in CBA has been to adjust the discount factor by some additional amount. A major disadvantage of doing so is the implicit assumption that the level of risk increases exponentially each year over the period of analysis, and that it applies equally to all costs and benefits. Loading discount rates is also potentially open to manipulation of the results of NPV calculations. An alternative is to use a risk-free discount rate after converting all costs and benefits into ‘certainty equivalents’, but this is generally considered impractical because people’s utility functions are not known.

Where probabilities of occurrence of costs and benefits are known or can be estimated, they can be expressed as expected values: the aggregated values of all possible outcomes weighted by their corresponding probabilities. A drawback of the expected value approach is that it is an average that is unlikely to reflect an actual outcome. For example, the likelihood of rain may be a probability-

weighted average of rain in different parts of a given area (e.g. 70 per cent), but the actual outcome can only be that it rains (100 per cent probability) or does not (0 per cent) in any particular spot.

Decision trees can be used to model different possible outcomes and their corresponding probabilities. This ‘decision theory’ approach has the advantage of being able to take into account varying circumstances over different time periods. Because costs and benefits are adjusted for risk through the application of probabilities, discounting takes place using a risk-free discount rate to avoid double counting the effect of risk. However, decision trees are based on expected values, and suffer from the disadvantage of not providing information about the variance associated with their calculated result.

Most modern texts express a preference for the Monte Carlo approach for incorporating risk into estimates of NPVs. Its advantage is that it permits simultaneous variation in multiple variables, yielding a probability distribution of NPV values rather than a single point estimate. A drawback is that the application of Monte Carlo analysis requires knowledge of — or assumptions about — the probability distributions of the variables involved. Nevertheless, the use of the Monte Carlo method is growing in large corporations and among government agencies.

4.6.1 Provision for contingencies

Infrastructure projects often make provision for ‘escalation’ and for ‘contingencies’, but details are not always provided. Escalation amounts may refer to price increases for inputs, but disclosure of their exact nature would be desirable to remove any ambiguity in the analysis.

Disclosure is also desirable where ‘contingency’ amounts are incorporated into costs. The rationale and the method of estimating the contingency is important if it is intended to serve as a proxy for risk analysis. Explicit explanations of the derivation of contingency amounts can help to reduce or avoid estimates based on arbitrary assumptions.

4.6.2 Sensitivity analysis

Some analysts confuse sensitivity analysis with risk analysis. Risk analysis involves the application of probabilities to estimates of costs and benefits. Sensitivity analysis does not involve the use of probabilities, and is limited to testing the effect of a specific change in value of a cost or benefit on the calculated NPV. Sensitivity analysis should be carried out after adjustment of costs and benefits for risk.

4.6.3 Recommendations

Harmonisation could involve the adoption of conventions such as the following:

- risk analysis should, in principle, be undertaken for all CBA studies
- where risk analysis is not used, an explicit explanation should be provided of the reasons for the omission
- Monte Carlo analysis is preferred, provided that relevant probability functions can be specified with sufficient confidence
- the rationale and estimation method for cost 'contingencies' and 'escalation' factors should be disclosed fully
- if the Monte Carlo technique is employed as part of risk analysis, details should be provided regarding the derivation and rationale for the probability functions used.

4.7 Calculate the net present value of the costs and benefits

Calculation of the NPV in a CBA is ultimately a straightforward, mechanical exercise in arithmetic. The basic formula contains four variables: costs and benefits in each time period, the discount rate, and the time period over which discounting takes place. Each of these variables is potentially subject to mis-estimation or to deliberate manipulation. Nevertheless, attention in the last few years has focused almost exclusively on the discount rate.

4.7.1 Discount rates

It is not the intention here to review the numerous approaches advocated for the determination of discount rates. The technical literature is voluminous, but some of the more accessible sources include Zhuang et al. (2007), Portney and Weyant (1999), Boardman et al. (2011), Pearce et al. (2006) and Harrison (2009). Appendix A.4 reviews some of the values used: Australian and New Zealand government agencies appear to have an unexplained preference for a real discount rate of about 7 per cent per annum.

Discount rates are not unimportant in calculating NPVs, especially over long time periods. However, the effect of differences even between rates such as 7 and 4 per cent per annum can be swamped by the uncertainties inherent in estimating future costs and benefits. The question therefore arises whether government agencies should simply adopt a common rate of discount to ensure consistency and comparability between the NPVs for different projects, or whether the search for the holy grail of an ideal rate should continue.

There is an arguable case for harmonising the methodology for setting common discount rates, should that be considered desirable by the various jurisdictions. A lower 'consumption' rate may be considered appropriate for projects in the health or environment sectors if benefits are generally consumed at the time that they accrue (and so cannot be reinvested) and resources used do not have significant opportunity costs. However, if the capital expended on the project represents forgone investment opportunities that would have provided a stream of benefits that could have been reinvested in perpetuity, then the 'producer' (social opportunity cost of capital, or 'investment') discount rate should be preferred (Pearce & Nash, 1981, s. 9.7.1; Abelson, 2012, ch. 8; Department of Finance and Administration, 2006, ch. 5). Central agencies in Australian jurisdictions have generally adopted the 'producer' rate.

Shirking the chore of specifying a discount rate a priori by using the artifice of sensitivity analysis is puzzling.⁷ If discount rates reflect social time preferences and opportunity costs, then they are better treated as parameters than variables in CBA (but not necessarily so in financial or investment analysis). It is in any case obvious from the NPV formula that different discount rates will affect the final value of the NPV, so the point of testing NPV for sensitivity to different discount rates is not entirely clear.

Further, plugging in arbitrarily selected higher and lower values of a discount rate cannot edify the decision-maker as to which rate is the more appropriate. The decision-maker is simply left to choose between several differing NPV values without a clear decision rule.

4.7.2 Real and nominal values

Whether NPV is calculated in real or nominal values is immaterial, provided that all the variables in the formula are expressed in the same dimensions. There is, however, a case for presentational consistency in any particular study.

In its business case for the proposed Canberra light rail project, Capital Metro Agency (2014) flips between the use of real and nominal values; for example, tables 1, 18 and 38. The lack of transparency complicates comprehension of the analysis, and leaves the reader wondering if the findings have not been compromised somewhere by a mistake involving the inconsistent use of variable values.

For the sake of both transparency and confidence in the findings of CBA studies, jurisdictions should agree that studies must be expressed entirely in either nominal or in real terms. This requirement would not preclude the presentation of results in both forms in order to suit the

7 The Department of Finance and Administration (2006, p. 187) handbook condones the application of sensitivity analysis to discount rates. Boardman et al. (2011, ch. 7) is more circumspect, drawing attention to the conceptual problem of 'mixing uncertainty about predicted effects with uncertainty about how we value those effects' and suggesting that the discount rate be treated as a fixed value. Sugden and Williams (1978, p. 226) indicate that if an analysis is found to be sensitive to the discount rate, then 'the decision-maker will be obliged to commit himself to some statement about the social MTPR [marginal time preference rate], even if only implicitly'.

needs of a particular audience. An implicit condition, however, would be the inclusion in the study of an exposition of the methodology used to derive the expected rate of inflation for future time periods.

4.7.3 Recommendations

To enhance transparency — and hence comprehension — as well as reducing the scope for potential manipulation of results, it would be desirable for jurisdictions to consider harmonisation in the following areas:

- prior to commencement of the analysis, specification of a single social discount rate to be used in the CBA
- adoption of a common discount rate, at least within jurisdictions
- consistency within a CBA study in terms of use of either real or nominal values
- if real values are used, derivation of the expected future rate of inflation for each period should be explained.

4.8 Conduct sensitivity analysis

It is far from unusual for CBA studies to contain a section on sensitivity analysis that consists simply of tables or statements reporting the effect on NPV calculations of some variation in the magnitude or range of all the variables. In such cases, the effort involved in estimating the effect on NPV is entirely nugatory. While tables of sensitivity testing may help pad out a report, and perhaps give the impression of analytical input, the lack of interpretative commentary leaves the analysis incomplete.

Lack of clarity about testing for sensitivity may be a factor in the absence of interpretative analysis of its implications. A confounding fact is that sensitivity analysis is often discussed in textbooks in the context of risk analysis, despite the fact that risk analysis is based on probabilities, while sensitivity analysis is not. The nature and purposes of the two are distinct.

At the simplest level, sensitivity analysis is used to determine whether NPV changes significantly when changes are made in variables used to calculate that NPV. Its ultimate purpose is to identify variables

that strongly influence NPV and to check their estimated values for robustness or accuracy. In other words, if NPV is shown to be sensitive to changes in a particular variable, it provides a signal to the analyst to check the robustness of the estimates being used for that variable and possibly also the adequacy of risk analysis.

Some judgement is required as to which variables should be tested. Where a CBA includes, say, 17 variables and the sensitivity analysis considers the most plausible value as well as one level that is higher and one that is lower, the number of combinations will be 3^{17} , yielding over 129 million results. As a first step, then, variables in whose estimation the analyst has confidence, or which are obviously unlikely to influence NPV significantly could be excluded from sensitivity testing to increase tractability.

General practice is to vary the expected or most plausible value by a certain percentage, both up and down. However, this may lead to inconsistent results. A 5 per cent variation in a cost of \$50 million per annum, for example, will affect NPV differently to a 5 per cent variation in an annual wage rate of \$100,000. The two variables should be tested on the same basis, perhaps by varying the expected value for each by one standard deviation (Perkins, 1994, s. 15.7.2). In many cases, however, relevant probability distributions may not be known for key variables.

Partial sensitivity analysis involves testing the influence on NPV by changing one variable at a time. This is the most common approach, and may involve testing 'best' and 'worst' case values for a variable. It is also possible, however, to change the value of more than one variable at the same time. Where this is done, care is required to ensure that the two variables are independent of each other. Negatively correlated variables, for example, could result in only a small effect on NPV, although their effect when altered separately may be quite large.

Sensitivity analysis can also be used to discover switching points (sometimes also called threshold, crossover or breakeven values) of variables (Sinden & Thampapillai, 1995, ch. 10). If the NPV has been calculated to be positive, for example, then a particular variable may be reduced (or increased) until the NPV falls to zero or switches to a negative amount. If decision-makers consider that it is plausible that the variable in question could in future reach such a switching

point, they may not proceed with the project, even if the calculated point NPV is ostensibly positive. Although it is inappropriate to vary social discount rates in sensitivity analysis, the switching point of zero NPV provided by the internal rate of return may be sought by a decision-maker.

4.8.1 Monte Carlo (risk) analysis and sensitivity analysis

Monte Carlo analysis involves random selection of values from the probability distributions of multiple variables at the same time. The result is the generation of a probability distribution of NPV values rather than a single point estimate. However, this simultaneous drawing of sample values from different variables' distributions is confused in some texts as representing multivariate sensitivity analysis. In fact, software programs such as Palisade's @RISK carry out a separate sensitivity analysis *after* completion of the Monte Carlo risk analysis. In the case of @RISK, the sensitivity test results are presented in the form of a tornado chart.

4.8.2 Recommendations

CBA reports should:

- focus sensitivity testing on key variables
- avoid treating social discount rates in CBA as variables to be subject to sensitivity testing
- interpret and analyse the results of sensitivity testing.

4.9 Determine distributional consequences and distributional weighting of costs and benefits

Distributional issues cause confusion and controversy. It is therefore desirable to clarify their role in CBA studies, to facilitate understanding and transparency of results.

A 'positive economics' approach is to examine the implications of a proposed project, including flows of transfer payments, by describing in detail the benefits and costs accruing to the main stakeholders. A normative approach seeks to influence the overall outcome of an analysis by adjusting the estimated benefits and costs in a manner that advantages specific stakeholders in society. Such 'distributional weighting' may involve multiplying benefits that accrue to low-income groups in society with weights greater than one, for example. Where this occurs, the calculated NPV will be increased, so that the project has a greater chance of being accepted.

4.9.1 Distributional consequences

Traditional texts such as Gramlich (1981), Mishan (1988) and Musgrave and Musgrave (1976) tended to address CBA issues from the perspective of society as a whole. If the benefits or gains to all members of society exceeded total opportunity costs, the project or policy was considered to be worthwhile overall. If the gainers in society also compensated the losers and were still left with net benefits, the situation was considered to satisfy the Pareto criterion that there be at least one winner and no losers. Under the so-called Hicks–Kaldor criterion, projects can also be considered to be overall socially beneficial where the *potential* exists for winners to compensate losers, even in the absence of *actual* compensatory transfers.

In order to determine whether it is possible in theory or in practice for the winners from a government project or policy to compensate the losers, it is essential to be able to identify the flow of benefits and costs between different sections of society. In theory, it would be possible to identify the gains and losses accruing to each member of society, but the identification of key groups is usually adequate for most policy considerations.

According to Lichfield et al. (1975, p. 78), a Planning Balance Sheet method was developed by Lichfield in the 1950s to identify the incidence of costs and benefits on various social groups in urban and regional planning proposals. This approach consisted of a conventional CBA, but with detailed accounting of costs and benefits by category of the social groups affected. Alexander (1978) applied the method

to a series of development proposals in the Blue Mountains, to the west of Sydney, with 18 categories of producers (mainly government agencies) and a similar number of consumer groups.

Krutilla (2005) adopted a similar disaggregated approach in promoting what he terms a 'Hicks–Kaldor tableau' for presenting the results of a CBA. Tables 4.1 and 4.2 are modified tableau presentations used by Krutilla (2005), illustrating three variants of a public project where labour is hired at a wage W to produce a good or service of benefit value B .

Table 4.1 represents a situation where labour is paid a wage of W by a private or government employer, but also incurs an opportunity cost (OC), perhaps due to loss of leisure time by previously unemployed persons. The wage itself is a transfer from the employer to labour, and nets out in the final column, and hence the overall calculation of net benefits created by the project. Nevertheless, the tableau format records the fact that a financial flow occurred due to the project, and was received by the labour sector. While the financial flow of wage payments does not affect the net social benefit in the simplified Table 4.1 scenario, the information contained is likely to be of interest to decision-makers, especially at the political level.

Table 4.1: Implementation of synthetic project, using labour

	Stakeholders in accounting domain			
	Project beneficiaries (consumers)	Project administrators (producers)	Labour (factor of production)	Net benefit
Benefit	B			B
Financial charge		-W	W	0
Economic cost			-OC	-OC
Net benefit	B	-W	W-OC	B-OC

Source: adapted from Krutilla (2005)

Tableau formats are flexible enough to reflect other features. Table 4.2, for example, indicates that local labour receives a wage as a windfall transfer, but the source of the wage is from an entity that has been excluded from the 'standing' of the project (perhaps a foreign government or investor). The net benefit from a 'local only' perspective is now $(B+W-OC)$.

Table 4.2: Synthetic project, assuming 'standing' is local only

	Stakeholders in accounting domain		
	Project beneficiaries (consumers)	Labour (factor of production)	Net benefit
Benefit	B		B
Financial charge		W	W
Economic cost		-OC	-OC
Net benefit	B	W-OC	B+W-OC

Source: adapted from Krutilla (2005)

Where the distributional consequences of a project are of interest to decision-makers, a tableau format can prove useful. In particular, a tableau can provide an indication of how much compensation may need to be offered to those opposed to a project because they will suffer some detriment. From a broader perspective, the tableau approach also promotes a degree of transparency that may not always be present in a conventional presentation of the efficiency effects of a government policy or project. A particular advantage of using a format that is useful to decision-makers because of the distributional information it contains, is that it would help promote the use of CBA.

Should jurisdictions find the tableau format useful, it could be considered as a standard feature to be used in CBA studies. However, two issues would need to be resolved:

- Greater levels of disaggregation are likely to involve greater analytical effort. It is not immediately obvious where the balance between cost and degree of detail might lie.
- Australian and New Zealand public servants have a duty to remain apolitical. Disaggregating CBA detail to the level of electorate boundaries may be unethical. Whether sufficient detail should be provided to allow ministers' offices to piece together the puzzle themselves is also an issue requiring careful resolution.

4.9.2 Distributional weighting of costs and benefits

Applying weights to the costs and benefits that affect different social groups is contentious at best.

In principle, adjustments to estimated costs and benefits accruing to particular social groups can be made on the basis of various criteria. For example, benefits from a road project that accrue to residents of a regional area may be increased by some factor because decision-makers consider that improved transport links between regional and urban areas are desirable, or that regional residents should be compensated with better transport links to make up for the disadvantage suffered due to isolation. Alternatively, low-income groups may be favoured by increasing the benefits attributable to them. Using choice modelling, Scarborough & Bennett (2008) estimate community distributional preferences favouring younger generations.

Pearce and Nash (1981, ch. 3) argue in favour of the use of distributive weights. Mishan (1988, ch. 30), on the other hand, argues that the use of such weights is ultimately subjective and arbitrary, as well as being a misplaced use of fiscal policy because income redistribution could be better achieved through general taxation policy.

Some safeguards can be adopted to promote transparency and reduce the degree of arbitrariness where decision-makers insist on the use of distributive weighting as part of a CBA.

- Justification for the use of weights, and for their value, should be established and recorded before commencement of the analysis, preferably certified by a high-level decision-maker.
- Because of the scope for potential manipulation of overall results, subsequent changes to the value of weights used should not be permitted.
- Two sets of results for the CBA should be presented: one with, and one without application of distributive weights.

4.9.3 Recommendations

- Jurisdictions should give consideration to the use of extended tableau formats to present the distributional consequences of CBA studies.
- Adoption of comprehensive tableau formats should be subject to safeguards that maintain the apolitical nature of public service advice.

- Justification for the use of weights, and for their value, should be established and recorded before commencement of the analysis.
- Because of the scope for potential manipulation of overall results, subsequent changes to the value of weights used should not be permitted.
- If distributional weights are used, then two sets of results for the CBA should be presented: one with, and one without application of weights.

4.10 Arrive at a conclusion or recommendations for the results of the CBA

It is not uncommon to read a CBA study where the executive summary or the concluding section asserts various findings, but where the claimed results are difficult to find in the body of the text or in the appendices. It is inefficient to search for greater detail, or for the evidence on which any conclusions are based.

In order to reduce search costs, conclusions or summaries of findings should be fully referenced to the section from which they have been sourced. For example, a calculated NPV should be referenced to a specific table or paragraph in Section 4.7 (in this publication), or to a relevant appendix. Some form of such referencing is important not only for transparency, but also to help ensure the internal consistency of the analysis.

An analytically complete study should also record sufficient data and calculations to allow reviewers to check the validity of the conclusions. Replicability is an important means of ensuring the credibility of the results.

More frequent publication of CBA studies would promote their credibility because both consultants and decision-makers would be faced with the 'sniff' or 'pub' test. During interviews a number of jurisdictions pointed out that publication would also assist long-term harmonisation because those commissioning CBA studies would have previous examples as models that could be followed. Commercial confidentiality is often claimed as a reason for not releasing CBA studies, but, given that project expenditure cannot occur without

parliamentary appropriation, much of the claimed commercially sensitive information may well be released into the public domain at some stage anyway.

4.10.1 Recommendations

Jurisdictions should consider harmonisation of the following aspects of the concluding or executive summary sections:

- All statements and assertions regarding findings should be referenced to tables or paragraphs in the body of the study, or to relevant appendices.
- Sufficient data should be provided in the body of the study, or in relevant appendices, to permit reviewers to replicate key findings.
- In the absence of genuine commercial or national security sensitivities, studies should be published in full to allow public scrutiny and to facilitate their use as models for evaluating other projects or policies.

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