

# A Partial Review of Seven Jurisdictional Guidelines for Cost-Benefit Analysis

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## Abstract

This paper reviews seven contemporary jurisdictional guidelines to cost-benefit analysis (CBA) with respect to eight major cost-benefit issues drawing on the latest edition of the major CBA textbook (Boardman et al, 5E, 2018) for guidance, though not complete authority. The jurisdictions are Infrastructure Australia, NSW Treasury, Victorian Department of Treasury and Finance, UK Treasury, the European Commission, the US Environmental Protection Agency, and New Zealand Treasury. The eight major issues discussed are the issue of standing, core valuation principles, the scope of CBA with reference to potential additional economic benefits, changes in real values over time, allowance for the marginal excess tax burden, the choice of social discount rate, the use of benefit-cost ratios, and treatment of risk. While all the guidelines are quality guides to CBA, the paper finds that there is room for improved discussion and practice at various points in each of these guidelines.

## Acknowledgements

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## 1 Introduction: Issues and Approach

Cost-benefit analysis draws on some key principles of economics and is one of the most practical uses of economics. In 2018, Boardman et al. (henceforth Boardman) produced the fifth edition of their leading international textbook on cost-benefit analysis (CBA). In this paper, I examine whether seven jurisdictional guidelines for CBA are consistent with this major academic text and, where they are not consistent, whether the variation can be justified either in principle or on practical grounds, such as the need for consistency across CBA studies.

To do this, I selected eight major issues: (1) standing, (2) core valuation principles (compensating or equivalent variation) and possible applications of willingness to accept (WTA) values, (3) the scope of CBA studies, including secondary markets, additional economic benefits and multipliers, (4) changes in real values over time (5) the marginal excess tax burden (METB), (6) choice of the social discount rate, (7) use of benefit-cost ratios and (8) treatment of risk.

The seven guidelines reviewed are UK Treasury (2018), European Commission (2014), US Environmental Protection Agency (USEPA, 2014), New Zealand Treasury (2013) and three Australian guidelines: Infrastructure Australia (IA, 2018), NSW Treasury (2017), and Victorian Department of Treasury and

Finance (2013).<sup>1</sup> All these Guidelines have been produced in the last six years, in some cases as updated editions. The USEPA Guide is chosen as a major current US guide and based on official US Office of Management and Bureau guidelines (e.g., OMB, 2000, 2003).

Two further introductory remarks should be made. First, the Editor of the much cited “Green Book” (UK Treasury, 2018) pointed out to me (email, 5 June 2019) that this is intended as a “guide for public officials”, not as a “textbook on techniques such as CBA” which are to be found separately in “the academic arena”. This leads to the related issue whether a jurisdictional guide should provide complex advice. Introducing complex issues or quantification may discourage use of CBA and result in inconsistent reports. Where the differential effects of alternative approaches are minor, simpler explanation and requirements may be preferred. Supplementary explanation could be provided in annexes (or references).

The paper layout is straightforward. I discuss the eight issues in turn. In each case, I outline the major issue(s), describe the Boardman text position(s) and the relevant positions of the guidelines, and draw conclusions. Where there are differences, I provide some comments and, in some cases, judgments on the outcome. In some cases, this sides with the jurisdictional guidelines. While Boardman may be considered correct in principle, an alternative approach may be judged to be more practical. The final section concludes.

## **2 The Issue of Standing**

One of the first issues that a CBA Guide must advise on is “standing”: whose benefits and costs are to be included in a CBA?

Boardman (2018) notes that it is possible to take a global, national, provincial or local perspective and that the choice is contentious. The text concludes (p.40) that “analysts should ideally conduct CBA from the national perspective... Adopting the subnational perspective makes CBA a less valuable decision rule for public policy”. The text also recommends that, if “major impacts” spill over national borders, the CBA should be done from the global, as well as, national perspective.<sup>2</sup> And, further, analysts may conduct a parallel sub-national CBA in response to interests of narrower groups of stakeholders.

Table 1 summarises the jurisdictional positions on standing along with key page references in each guideline. Not surprisingly, the jurisdictions typically define standing in CBA studies from their own perspective. Thus, the UK, USEPA, MZ and IA guidelines define standing from a national perspective. This reflects the area over which they have authority and/or “the community of interest”. On the other hand, NSW explicitly recommends state standing (and notes cross border impacts) but does not mention national CBA. Drawing on author’s work in Victoria, Victorian CBAs are also based on the state (e.g. Applied Economics, 2007).

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<sup>1</sup> I should acknowledge providing inputs to NSW Treasury (2017) and peer reviewing the Victorian (2013) guide.

<sup>2</sup> Boardman does not define “major impacts”.

**Table 1 Positions on Standing**

<b>Agency</b>	<b>Position summary</b>	<b>Page(s) (a)</b>
Boardman	National standing + global or sub-national if needed.	40
UK	National (no mention global). Sub-national is a distributional issue (Annex 3).	6, 20-2
EC	Local, regional, national, “even EU”. Wider standing essential with env. Impacts.	33
USEPA	National. Report beyond border effects separately. Cites OMB Circular A-4.	1-3
NZ	National. Government responsible to country. Especially present generation.	10
IA	National. “Australian community as a whole”; global not mentioned.	88
Victoria	“All welfare costs and benefits to society” (not defined). In practice state.	8
NSW	NSW state. Should consider inter-state impacts (Box 2.6). No mention national.	1
This paper	Standing as per jurisdiction + global or national if significant impacts.	

(a) In this and following tables, key pages are cited. The texts may include further references.

Moreover, there is little discussion in the guidelines of alternative standings. The UK, NZ and IA guidelines make no mention of global effects and NSW and Victoria do not mention national impacts. The USEPA (p.1-3) does note that effects beyond US borders should be reported separately. The EC is the major exception. It notes (p.33) that the community of interest may “even” be the EU and that “All projects must incorporate a wider perspective when dealing with environmental issues related to CO<sub>2</sub> and other greenhouse gas emissions with effects on climate change which are intrinsically non-local”.

Thus, generally the guidelines do not accord with Boardman views. The national guidelines ignore possible global impacts and the state guidelines ignore national outcomes.

This paper would make three points. Firstly, a value judgment, it is not acceptable for countries (or states) to conduct policies or projects that advantage them, but which significantly disadvantage other countries (or states). Thus, although the starting point may be the country or state, following Boardman, the guidelines should require a global or national CBA when there are significant external costs. These may be exceptional cases, but they should be recognized.

Secondly, and this applies more to states than to nations, it is not efficient to exclude external effects. For example, excluding often large central government grants to states implies that these grants have zero cost. On the other hand, reduced central government welfare payments (say with successful state training programs) would be treated as costs to state-based recipients, not as transfer payments. This approach could encourage widespread adoption of nationally inefficient projects.

Thirdly, all the guidelines implicitly assume that standing is easy to implement, i.e. that defining beneficiaries and losers from projects is a simple process. This is often far from the case. For example, profits of external (non-local) entities would be excluded from national and state-based CBAs.<sup>3</sup> Likewise, transport benefits accruing to non-local entities should be excluded from transport infrastructure projects. In a federal system, the treatment of central government revenue effects is complex. If the central government gains tax revenues from increased local resident earnings (or saves from lower social benefit payouts), what percentage returns to the state? And so on. However, these practical issues relating to standing are not discussed in jurisdictional CBA guides.

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<sup>3</sup> UK (2018, p.22) defines the beneficiaries as UK residents and UK personnel posted abroad.

Thus, this paper broadly agrees the Boardman approach. We should not do national projects that have a negative global NPV or state projects with a negative national NPV. However, the complex implications of standing are not spelled out in Boardman or in the guidelines. Our conclusion is that the issue of standing and how to apply the principle needs fuller discussion in most of the guidelines.

### 3 Core Valuation Principles

Turning to valuation principles, there are two core issues. (i) What is the underlying welfare starting position? And (ii), how to value individual losses from this position? The common starting position is the policy and welfare status quo, which is known as the “compensation variation” (CV) approach. Under this approach, benefits are valued at the maximum amounts that individuals are willing to pay (WTP) for them and losses valued at what individuals are willing to accept (WTA) as compensation and, in both cases, be as well off with the change as without it.

Alternatively, if a policy change is deemed to be the appropriate ethical or political starting point, the benefits are the amounts that individuals would be WTA as compensation for not having the policy and the costs are the amounts individuals are willing to pay for the policy, and be as well off without the policy as with it. This is known as the equivalent variation (EV) approach. With EV, the reference point is the individual’s level of utility with the change.

These principles and the implications for valuation are summarised in Table A.

Table A Summary of valuation principles and methods

Valuation principle	Reference point	Valuation method	
		For a good	For a loss
Compensating variation	Existing utility level	WTP	WTA
Equivalent variation	Utility with change	WTA	WTP

For example, suppose government is considering whether to provide high level hospital services in a regional centre. Under the CV approach, we would estimate whether the regional residents would be WTP for these additional services. If the collective WTP amount exceeded the cost, the services would be provided. Under the EV approach, we would estimate the WTA amounts that residents would accept instead of the services. The services would be provided if the total WTA amount exceeded the cost.

This issue is further complicated by the relationship between observed (Marshallian) demand curves and Hicksian demand curves. Observed demand curves allow for real income changes and substitution effects. Hicksian demand curves hold real income constant as and allow only for substitution effects as required by the CV approach. Thus, benefits as measured by consumer surplus from lower prices are greater with observed demand curves than with Hicksian demand curves.

Of course, these distinctions do not matter if the alternative measures produce similar results. CV and EV valuations are equal if the marginal utility of income is constant. However, when there are significant changes in income and consequently in the marginal utility of income, CV and EV valuations (and WTP and WTA values) are likely to differ.

In Chapter 3 on microeconomic foundations, Boardman concludes (p.75) that “under most circumstances, estimates of changes in consumer surplus, as measured by demand curves, can be used in CBA as reasonable approximations of individuals WTP to obtain or to avoid the effects of policy changes”. In an annex to the chapter, discussing CV and EV as well as CS, the text concludes (p. 80) that the income effects of price changes are usually small “and can be safely ignored in CBA” and that the Marshallian demand curves are reasonable approximation of WTP. However, they note in italics that this *may* cause a bias where income changes are significant as with large changes in housing or wage rates. They also note (p.81) the differences between CV and EV, but do not draw practical conclusions.

On the other hand, Boardman notes (p. 442) that while economic theory suggests that WTP values are close to WTA values for market goods, stated choice surveys suggest otherwise, in some cases eliciting WTA values up to five times WTP values. However, they note that this may be due to the lack of a budget constraint in WTA responses to surveys as well as to loss aversion. They conclude (p. 446) that it may sometimes be appropriate to include WTA values but with “social budget constraints to increase the likelihood that respondents will provide an economic response”.

Table 2 provides jurisdiction positions on the valuation principles. Standard CBA practice in these jurisdictions is to take the present situation (base case) as an appropriate starting point for policy evaluation. This embodies the CV principle. But these valuation principles receive little discussion in most guides. The UK Green Book (2018) does not discuss these issues. The NZ, Victorian and NSW guidelines do not mention EV but, by emphasizing that the base case is current policy, they imply the CV principle without using that conceptual language. NZ, Victoria and NSW mention WTA values, but do not provide any detail about their application, effectively minimising their use. The IA guide briefly mentions CV and EV approaches as well as possible use of WTA values, but without prescription.

**Table 2 Positions on Valuation Principles**

<b>Agency</b>	<b>Position summary</b>	<b>Page(s)</b>
Boardman	CV. Generally, observed (Marshallian) WTP values. WTA sometimes appropriate.	75, 446
UK	Chapter 6 discusses valuations. But core valuation principles nowhere discussed.	
EC	CV / EV discussed (p.321). CV and WTP recommended. WTA possible (323-3)	321, 309
USEPA	Recommends Marshallian WTP. Detailed CV / EV discussion. May be WTA. 7-8,9	A10-A12
NZ	CV implicit in do-nothing Base Case. WTA mentioned only in passing.	9, 17
IA	Both approaches described informally. WTA mentioned, not clearly prescribed.	84
Victoria	CV implicit. Base case = existing policy. WTA mentioned only briefly once (p.14).	6
NSW	CV implicit. WTP values (implicitly Marshallian). WTA mentioned; not specified.	32
This paper	Adopt explicit CV and explicit WTA. EV alternative should be explained.	

By contrast, the EC guide explicitly discusses the CV and EV principles and recommends CV and WTP values. It also notes that WTA values may be appropriate within the CV approach but does not provide guidance detail.

By even more contrast, the USEPA guide provides a thorough discussion of CV / EV choice. CV uses the utility level without environmental improvements; EV with improvements. With CV, to enact policy, WTP for improvement must offset business cost of improvement. With EV, policy is enacted if WTA values for not having the improvement exceed the costs of improvement. As USEPA points out (p. 7-7),

WTP is consistent with firms and individuals having the right to pollute. WTA is consistent with individuals having a right to a clean environment. It concludes (p.5-1) nevertheless that “The baseline of an economic analysis is a reference point that reflects the world without the proposed regulation”. And while it notes that direct valuation studies are not possible for non-market goods, it acknowledges (p. 1-12) that “most indirect valuation studies are based on Marshallian demand functions in practice, in the hope of keeping the associated error small”.

In effect, if not by explicit reasoning, the guidelines broadly follow the Boardman view that the starting valuation position is the CV view of the world and that benefits (consumer surpluses) can be valued using Marshallian demand curves or concepts to estimate WTP values. This is undoubtedly practical. However, the guidelines could be clearer about the value judgments underlying these valuation principles by reference, possibly in an annex, to compensating and equivalent variations and what these approaches imply about rights to health services, environmental goods and so on. These are important value judgements and clarity could help to reduce misunderstandings on these issues between economists and other disciplines, notably environmental or social disciplines.

A more practical issue is the omission in the guidelines of any guidance on possible application of WTA values in terms of contexts and magnitudes. Certainly, for small changes in income (say up to \$100) and most plausible forms of the utility function, differences between WTP and WTA amounts are likely to be minor and can be ignored. However, losses are often far higher than this, as with household disruptions from major transport infrastructure projects. Horowitz and McConnell (2002) found that WTA values are often as much as 10 times WTP values for some health and safety goods or services and are on average 7 times higher. Boardman also cites major differences between WTP and WTA values. While recognizing the practical issues in estimating WTA values, in our view, this is an area for more consideration.

#### **4 Project Scope: Additional Economic Benefits**

The scope of CBA evaluations is a critical issue. The wider the scope of possible benefits, the higher the net benefit of a policy or project. Additional economic benefits, beyond user benefits in the primary market, include an array of possibilities. These include impacts in related markets and second-round flow-on effects (multipliers). Disagreements on scope are at the heart of many disagreements about work and results in cost-benefit studies.

Moreover, discussion is often complicated by different uses of the terms “secondary”. Secondary may refer to impacts in related (secondary) markets or to second-round (flow-on) impacts from first-round benefits (multiplier effects). Figure 1 provides a simple diagram which distinguishes between indirect related market impacts and secondary flow-on multipliers.

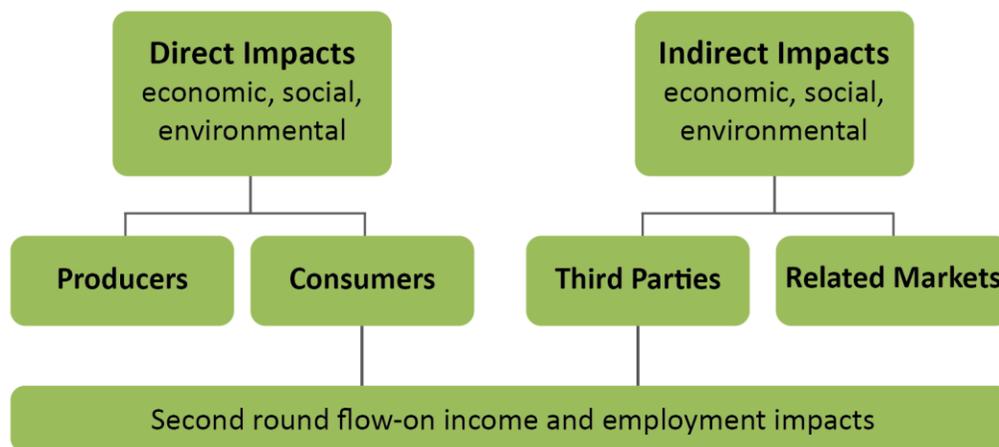
It follows that the main issues are (i) what are related markets and when to include benefits from them, and (ii) if, and when, to include second-round income effects (multiplier effects).<sup>4</sup> These may be thought

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<sup>4</sup> In the input-output literature, there are two distinct multiplier effects. **Type 1 multipliers** refer to increases in output (or incomes) associated with increased production due to an increase in demand on their suppliers and so on down the supply chain. **Type 2 multipliers** refer to increases in output, employment and incomes due to additional demand for goods and services arising from first-round increases in incomes.

of as supply-side and demand-side effects respectively. The related markets include possible benefits to suppliers of complementary inputs and possible losses to suppliers of substitute goods. In both cases, benefits and costs respectively arise from market distortions when prices depart from marginal costs. But some related market impacts, notably related to transport infrastructure, are associated with “wider economic benefits” notably agglomeration economies or place making benefits rather than specific impacts on complementary or substitute goods. These more general claims are controversial.

**Figure 1 First and second round effects of projects and policies**



Boardman (Chapter 7) describes how it is generally appropriate to include related market effects (described in the text as “secondary benefits”) when markets are non-competitive or distorted. This may also occur for infrastructure projects where prices don’t reflect costs (p. 173). The text does not discuss wider economic benefits. However, the text does not support including second-round (multiplier) flow-on effects in CBA, except for distributional analysis. In discussing project scope (p.9), the text warns: “It is often incorrect to include secondary, or “knock- on”, effects” meaning, it appears, multiplier effects.

Table 3 below provides a summary of jurisdictional positions on economic scope. There is virtually unanimous agreement that CBAs should not include demand-side multipliers. As expressed in the NZ guide (p.55) “CBA typically assumes that the increased activity from the project crowds out other activity. The total amount of activity in the economy does not change.” However, the guide (p.19) does note possible exception for multipliers when unemployment is significant.

The three guidelines that discuss effects in related distorted markets (NZ, NSW and EC) follow the Boardman principles. The other guides do not provide specific guidelines in these markets.

Greater differences emerge in considering wider economic benefits. These are discussed in the UK and Australian guidelines but not in the EU, USEPA or NZ guidelines. The UK Guide (p.44 and elsewhere) opens the door to significant productivity / agglomeration benefits related to infrastructure over and above users of infrastructure. This is reinforced in UK Treasury (2015), *Valuing infrastructure spend: Supplementary guidance to the Green Book*. The three Australian Guidelines cited here allow for possible wider economic benefits. However, noting the uncertainties about them, where they may exist, they should be included in sensitivity tests rather than in central results.

**Table 3 Positions on Project Scope: Additional Economic Benefits**

Agency	Position summary	Page(s)
Boardman	Allow when related markets are distorted. Do not use multipliers.	9, 173
UK	Indirect productivity benefits possible. Demand-based multipliers not be adopted.	44, 40
EC	Use shadow prices reflect indirect benefits. Don't double count related markets.	64
USEPA	Growth impacts not predictable (9-9). Don't double count pass-through effects.	8-4,5,6
NZ	Yes, if related markets distorted, but usually small. Do not use multipliers.	16, 19
IA	Significant extra economic benefits possible. <sup>a</sup> CGE / multipliers limited (pp. 83-4).	95, 110-1
Victoria	Scope not discussed. Wider economic benefits are possible. <sup>a</sup> Avoid multipliers.	20-1, 12
NSW	Allow for distorted related markets; exclude wider benefits <sup>a</sup> and multipliers	11, 63
This paper	Allow for market distortions in related markets (conservatively). No multipliers.	

(a) Should be included only as sensitivity test, not as part of central CBA result.

Thus, there is a fair degree of concordance between the Boardman positions on economic scope and the guidelines, with high agreement on the non-use of multipliers.<sup>5</sup> There is also a fair measure of agreement on treatment of impacts in related markets. However, the treatment of these issues could usefully be addressed more explicitly in several guidelines. The main difference is on inclusion of wider economic benefits which Boardman does not address, presumably implying unimportance, which the UK guideline supports as do the Australian guidelines more tentatively. The writer's view (detailed in Abelson, 2019) is that wider economic benefits should be treated very cautiously.

## 5 Changes in Real Values over Time

All CBAs include forecast values in constant prices. However, real (relative) values may change over time. For example, a resource, or environmental asset, may be expected to become scarcer or more plentiful over the life of a project, with relative values rising or falling accordingly over time.

Boardman (p.220) has a clear view on this. "Relative prices may change. Analysts should always consider this possibility, especially for long-lived projects. Fortunately, *there is no conceptual difficulty* in handling relative price changes" (my italics).

Table 4 shows jurisdictional positions on the treatment of real values over time. Only the NZ guide addresses the issue explicitly. The issue is discussed implicitly in the USEPA guide. It is not discussed in the the EC or UK guide or in any Australian guide.

The NZ guide accepts allowing for relative price changes in principle but recommends applying this with great caution because of difficulty in forecasting relative prices changes. It notes (p.18) that it may be possible to follow forward market signals (futures markets). The USEPA guide does not discuss the principle explicitly but notes the difficulty of forecasting technological changes and market responses.

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<sup>5</sup> Politicians may be concerned about the distribution of gains or losses from projects and accordingly in the distribution of secondary benefits (where they occur). Thus, these impacts may be considered in analyses of distributional effects.

**Table 4 Positions on Real Values over Time**

<b>Agency</b>	<b>Position summary</b>	<b>Page(s)</b>
Boardman	CBA should allow for changes in real values over time.	220
UK	Not discussed but note position on STPR (Table 6 below).	
EC	Not discussed	
USEPA	Not discussed directly. Hard to predicting tech. changes & varying responses.	5-7, A-9
NZ	Best assume constant but allow change if evidence (inc. value of life).	18, 32
IA	Not discussed	
Victoria	Not discussed	
NSW	Not discussed	
This paper	Assume constant. Introduce real changes if evidence in sensitivity tests.	

Although the UK guide does not discuss changes in relative values, it recommends using a lower social discount rate for life and health values (see Table 6 below). Thus, implicitly it is advocating an increasing value of life. The NZ guide also recommended that the value of statistical life (\$3.85m in 2013 prices) should be indexed to changes in average hourly earnings, presumably as WTP values would rise with income rather than with inflation, which would be changes in real terms. This writer has a problem with regarding future lives as more valuable than ours. This is also inconsistent with the equity approach that values life equally across all individuals (of standing) in standard CBA studies. It may also be noted that the USEPA value of statistical life rises with inflation (p. 7-8) which is constant in real terms

To conclude, we agree with Boardman that the issue of real (relative) values over time should be explicitly considered. For example, arguably the value of business travel time savings would rise with real earnings. But, as NZ and USEPA note, this is a complex forecasting matter. It is also important that, if changes in real values are adopted, they be adopted consistently and centrally and not by analysts on individual projects.

## **6 The Marginal Excess Tax Burden**

The issue here is the marginal cost of public funds (MCPF). Is MCPF simply cost expended or should it include an additional allowance for the marginal excess tax burden (METB) associated with distortions of labour supply, savings or consumption? And, if METB is included, what value should be allowed?

Boardman (pp. 69-73) recommends that METB should be included in CBA. Drawing on several estimates of METB in the US, the text estimates an average METB = 0.23 (23 cents in the dollar) for federal projects based on income tax financing. On the other hand, for local government projects financed by property tax, METB = 0.17.

Table 5 shows the positions of the jurisdictions on allowance for the marginal excess tax burden. **Four** of the seven jurisdictions do not discuss the issue, which implies no allowance for METB. NSW recommends not adopting a METB in the central case, but possibly including in sensitivity tests. Victoria recommends a low METB = 0.08 reflecting land tax, but no allowance when tax revenue is fixed or for Commonwealth grants or when revenue is funded by efficient user charges. In practice, in the writer's experience (extensive in NSW, limited in Victoria), METB is not applied in NSW or Victorian CBAs, including in sensitivity tests. This leaves NZ as an outlier recommending a METB = 0.20.

**Table 5 Positions on Marginal Excess Tax Burden**

<b>Agency</b>	<b>Position summary</b>	<b>Page(s)</b>
Boardman	Should allow for METB. In federal use METB = 0.23. Local government = 0.17.	69-73
UK	Not discussed	
EC	Not discussed	
USEPA	Not discussed	
NZ	Include at 20%	15-16
IA	Not discussed	
Victoria	Allow 8 cents per \$ marginal tax raised; not for fixed tax revenue or Comm. Grants.	49-51
NSW	Not in central case. May be included in sensitivity test downside.	61
This paper	Inclusion of METB not supported.	

So, where should we go from here? Follow Boardman, ignore METB or search for a compromise? In comprehensive guides, it is appropriate to recognize that the METB is a real cost. However, it does **not** follow that METB cost multipliers should be included in CBA studies for several reasons. First, taxes are generally fixed independently of projects. Thus, the cost of a project is the opportunity cost of the forgone project(s), not the marginal tax raised. As argued below, this should be recognised in the choice of social discount rate. Where tax is fixed, it is inappropriate to add METB.<sup>6</sup> Secondly, revenues may offset taxes, with net tax less than gross tax, and this would need to be accounted for, which would be challenging. Thirdly, and relatedly, including METB on a differential basis on a project by project basis would raise serious practical issues of consistency between projects.

## **7 The Social Discount Rate**

There are two main concepts of the social discount rate (SDR): the social opportunity cost of capital (SOC) and the social time preference rate (STPR). There are, in turn, two main versions of SOC: the return on investment (ROI) forgone in alternative projects (including market projects) or a weighted cost of capital (WCOC) reflecting the estimated proportions of investment and consumption foregone based on the sources of the project funding. ROI is forward looking. WCOC reflects how funds have been raised. The STPR values benefits and costs based on social values of consumption over time. This typically discounts future consumption as the marginal utility of consumption falls as incomes are expected to rise and may allow for pure time preference. The SOC based on ROI is typically around 6-7% p.a. while the STPR is usually around 2.5-3.5%. Hence this is a very consequential issue.

One way to resolve this dilemma is by using a shadow price of capital (SPC). A shadow price of capital is estimated by discounting the forecast returns on investment forgone by the STPR. The STPR is then applied in turn to the forecast project net benefits based on the estimated shadow price of the capital employed. Where the funds employed would otherwise have been fully invested, this gives similar outcomes (positive or negative) to the ROI approach.

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<sup>6</sup> In a perfect economy, where public funds are raised until the marginal rate of return on public projects equals the marginal return on private investments and both equal the optimal social time preference rate (discussed in Section 7), the METB should be accounted for. But this is not the economy most of us experience.

Boardman concludes (p. 260) that there is general agreement that the SPC approach is the appropriate one, but that this is not practical for various reasons including whether projects are funded from investment or consumption forgone. In lieu of this approach, they recommend what they call the “optimal growth rate method” which, in their account, means application of the STPR. They also recommend use of declining SDR over time. Thus (p.258), they recommend 3.5% SDR from year 0 to 50, and then declining rates over the next 50 and 100-year periods reaching 0% in year 300. They also recommend sensitivity testing with alternative discount rates.

Table 6 provides jurisdictional positions on the SDR. There is a sharp geographical divide. The northern jurisdictions (UK, EU and USEPA) follow Boardman in recommending a STPR. In the case of the USEPA, this reflects the impacts of environmental policy regulations, which the USEPA notes would affect consumption more than investment. The UK also recommends a declining rate in the long run. New Zealand and the Australian jurisdictions recommend a SOC discount rate. The NZ and NSW rates are based on the ROI approach. The Victorian SDR is apparently based on the WCOC approach (see Fernandez, 2019).

**Table 6 Positions on the Social Discount Rate**

Agency	Position summary	Page(s)
Boardman	SPC correct method, not practical. Recommends STPR = 3.5% + slow fall (p.258)	237-60
UK	STPR = 3.5 with 1.5 for life and health values. Decline after 30 years. (Annex A6)	103
EC	STPR. 5% for cohesion states and 3% for member states.	55
USEPA	SPC method. Or STPR (2.5% to 5%) based on foregone consumption.	6-8 to 6-20
NZ	SOC = 6% default = ROI approach. Varies with $\beta$ in CAPM / WACC.	34-36
IA	SOC implicit. 7% in line with other Australian practice.	
Victoria	Claim SOC. Recommends 7%, but 4% for hard to quantify benefits.	25
NSW	SOC = ROI = 7%	45
This paper	ROI based on return on alternative foregone: market WACC (inc. market risk)	

On the other hand, differently from Boardman but still following the STPR principle, the northern jurisdictions recommend different STPRs for different situations. The UK recommends that as life becomes more valuable, life and health should be discounted at lower rates. We disagreed with this approach in Section 5 above. On the other hand, the EC recommends higher STPR rates in countries where the expected rate of growth of incomes is higher. This is consistent with the standard Ramsey STPR formula where the STPR rises with higher forecast rates of economic growth and therefore less marginal value from future consumption.

Turning to the Australian and NZ guidelines, IA and NSW recommend that a central 7% SOC rate be applied (along with sensitivity tests for other rates). NZ and Victoria recommend central rates of 6% and 7% respectively, but that they should vary with circumstances. The NZ approach allows the rate to vary with the value of  $\beta$  (the correlation with market risk) in the CAPM component of the standard WACC model, with the recommended rate falling or rising with lower or higher  $\beta$ . The Victorian approach allows a lower SOC of 4% for “core public services” such as health and education where benefits are hard to monetise, in contrast with transport and housing where benefits are more quantifiable.

In conclusion, this paper agrees with Boardman on the principle of the SPC approach but also that this approach is not practical for general use. Given this, as argued in Abelson and Dalton (2018), this writer

recommends a SOC discount rate based on the forward-looking ROI principle rather than on the backward looking WCOC. Selecting projects with lower rates of return than the ROI is inefficient and does not optimise welfare growth. Selecting efficient projects with higher rates of return can benefit future generations as well as present ones. This paper is also cautious about adopting different SDRs for different projects based on assumptions about less or more covariance with market risks or with greater or less ease of monetising benefits. These assumptions are hard to verify and implement and could cause more distortions than they would resolve.

## 8 Benefit-Cost Ratios

Discussions of benefit-cost ratios (BCRs) are complicated by the lack of a clear single definition. The common (standard) definition is:

$$BCR = PV(B) / PV(I+C) \quad (1)$$

where PV is present value, *B* is benefits, *I* is capital investment and *C* is all other costs. An alternative, less common, definition is:

$$BCR = PV(B-C) / PV(I) \quad (2)$$

The Boardman text (pp. 34-5) does not formally identify the BCR but implies Equation (1) and does not discuss Equation (2). However, the text has a clear position on standard Equation 1. After noting that the BCR has been proposed as an alternative decision rule, the text states (p.15): “This is one area where there is a right answer and wrong answers. The appropriate criterion to use is the NPV rule ...The other rules (including the IRR) sometimes give incorrect answers; the NPV rule does not.” The text points out that (i) the NPV criterion is generally preferred way to rank projects because the BCR is biased towards small projects and (ii) the BCR may be manipulated by classifying some costs as negative benefits (classification issue). They conclude (p. 35): “We recommend that analysts avoid using benefit-cost ratios to rank policies and rely instead on net benefits”.

Table 7 summarises the jurisdictional positions on benefit-cost ratios. All jurisdictions cite or imply the standard BCR as in Equation (1). Victoria is the only jurisdiction to cite Equation 2.

IA gives a further possible option as  $BCR = NPV/I$ . However, this is not a further option as

$$NPV/I = PV(B-C-I)/PV(I) = PV(B - C)/PV(I) - 1 \quad (3)$$

i.e. This equals BCR in Equation (2) – 1. This form of BCR is redundant when Equation 2 is employed.

**Table 7 Positions on the Benefit-Cost Ratios**

Agency	Position summary	Pages
Boardman	NPV appropriate. $BCR = PV(B)/PV(I+C)$ should not be used. Do not discuss other.	34-5
UK	Standard $BCR = PV(B)/PV(I+C)$ cited as an option - no qualifications.	32
EC	Standard BCR; cites bias / classification issues. Suggests OK if budget constraint.	335, 65
USEPA	Cites standard BCR; notes ranking issue; not proposed in summary template.	xi; 11-8
NZ	$BCR = PV(B)/PV(I+C)$ provides understanding. But ranks projects incorrectly.	14, 37-8
IA	Supports standard $BCR = PV(B)/PV(I+C)$ Use $NPVI = NPV/I$ if budget constraint.	104-5
Victoria	$BCR = PV(B)/PV(I+C)$ biases rankings. $BCR = PV(B-C)/PV(I)$ yes, when capital limited.	30-1
NSW	Adopts $BCR = PV(B) / PV(I+C)$ with no qualifications.	18-9
This paper	Agree Boardman with Victorian addition (or IA equivalent).	

As shown in Table 7, the jurisdictions take various approaches. Several jurisdictions (EC, USEPA, NZ and Victoria) cite bias and / or classification errors in the (standard) Equation (1). But they reach different conclusions. EC suggest that Equation (1) is satisfactory when there are budget constraints. USEPA excludes the BCR from its proposed reporting template. NZ says Equation 1 provides useful intuitive understanding of outcomes, despite ranking problems. Only Victoria recommends Equation 2 with capital constraints. On the other hand, the UK and NSW guides support use of BCR in Equation 1 without qualifications.

Given the clear Boardman views and the contrasting muddled set of jurisdictional recommendations, where does this reviewer stand? Well, first, we agree fully with Boardman’s criticisms of Equation 1 as biased towards small projects and subject to manipulation due to treatment of costs as negative benefits in the numerator or as costs in denominator.<sup>7</sup>

However, the BCR as per Equation (2) is relevant to decision making under capital constraints when the return on an agency's marginal projects exceeds the return elsewhere. In this case, the agency should select projects in order of their present value per unit of constrained capital until the capital is exhausted. Box 1 illustrates how the BCR ranks smaller projects more favourably than the NPV criterion but also how Equation 2 maximises NPV under a budget constraint (here a simple first year constraint).

**Box 1 NPV versus BCR criterion**

Suppose three projects (A, B and C) have capital costs in year 1 and discounted benefits as shown below. 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 independent (one does not exclude the other), the agency would maximise NPV from the \$50m capital by selecting B and C instead of A.

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

Thus Equation 2 is appropriate when ranking projects subject to capital constraint. Arguably, the constraint could include ongoing recurrent, as well as capital, government expenditure. In this case, government recurrent expenditures would also be below the line and other costs above.

**9 Treatment of Risk and Uncertainty**

There are numerous issues regarding the treatment of risk and uncertainty. Here, we discuss two. One is how to represent the distributions of the costs and benefits in a CBA? The second is whether to allow

<sup>7</sup> It can also be shown that when NPV is positive, compared with Equation 2, use of the popular Equation 1 always reduces the BCR closer to 1. On the other hand, when NPV is negative, Equation 1 always raises BCR closer to 1.

for option values? An option value is the difference between the expected use value and the total WTP for an asset or service. Thus,

$$\text{WTP} = \text{EUV} + \text{OV} = \text{OP} \quad (4)$$

where EUV is expected use value, OV is option value and OP is known as the option price.<sup>8</sup> Note, importantly that, as shown by Freeman (1984), while option value is generally positive when individuals are risk averse, it can be negative when individuals are uncertain about future income.

The discussion of option values is sometimes complicated by two other option concepts: “quasi-option values” and “real options”. Quasi-option value is the value of information that can be gained by more time or study (Pearce et al., 2006). The value is the benefit from deferring and improving a project decision. This needs to be weighed against the costs of deferment. A real option arises through variations in the time or mode of project delivery, such as staging the various components of a project. Morton-Cox (2018) provides a helpful discussion of real options.

Boardman devotes two chapters to the two topics we have identified. Chapter 11 discusses expected values (EVs). Chapter 12 discusses option values. Chapter 11 concludes (p.298) that the expected value analysis is the appropriate way to deal with an uncertain range of costs of benefits. Implicitly, this is a risk neutral approach.

The text notes conceptual support for the use of option prices at several points. “Economists now generally consider option price ... to be the theoretically correct measure of willingness to pay in circumstances of uncertainty or risk” (p.315). “The conceptually correct way to value a policy involving risks is to sum the ex-ante amounts that individuals ... would be willing to pay for it” (p. 316). “Option price is the conceptually correct measure of benefits” (p. 324).

However, Boardman also states: “In practice analysts usually do not convert net benefits to certainty equivalents or option prices. Specifically, they use expected values rather than option prices because the former can be estimated from observable behavior, while the latter requires contingent valuation surveys” (p.263 endnote 6). “In practice economists typically estimate the benefits using EV estimates” (p. 315). “Unfortunately, confidently signing, let alone quantifying option price is often not possible”.

Table 8 provides jurisdictional positions on the use of expected values and option values (or prices). As a generalization, most of the guidelines discuss treatment of risk and uncertainty at some length, with various discussions of the nature of risks, contingencies, appraisal optimism (especially in UK guide), sensitivity tests, the use of real option analysis, and identifying and managing of risk. However, there is limited discussion of the use of expected values and virtually none on option values.

The only guides to explicitly discuss and recommend use of EVs are the EC and NSW guides. The IA guide recommends EV for costs but allows use of P50 if distribution is not available (which is questionable with typical skewed cost distributions). It does not discuss how to deal with distributions across benefits. The NZ guide implicitly (but very briefly) recommends EVs. The Victorian Guide describes Monte Carlo analysis without mentioning EVs. The other two guides do not mention EVs.

The EC is the only guide to mention option values but does not discuss them in any detail.

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<sup>8</sup> The option price is sometimes described as the ‘certainty equivalent’.

**Table 8 Positions on Uncertainty and Risk<sup>a</sup>**

<b>Agency</b>	<b>Position summary</b>	<b>Pages</b>
Boardman	Should use EVs. Option prices / values conceptually correct, but not practical.	298, 332
UK	No discussion EVs or option values Discusses risk management inc. optimism bias.	89-98
EC	Recommends EVs and ENPV. Option values flagged, but not discussed (pp.323-4)	71-2,337-40
USEPA	V. little discussion (regs. focus); ideally show probabilities; describe uncertainties.	11-9
NZ	EV only implicit para 131. Mainly other concepts (e.g. real options) discussed.	28-32
IA	EV preferred for cost. Can use P50. EV for benefits and option price not discussed	100-101
Victoria	No discussion EVs or option values. Discusses real options & Monte Carlo analysis.	33-6
NSW	Recommends EVs. Option values not discussed. Discusses real options.	49-51
This paper	Paper agrees Boardman position.	

(a) Focus in this table: expected values and option values, not sensitivity tests and risk management.

Turning to our concluding thoughts. First, we agree with Boardman that CBA should generally be based on expected values (and expected net present values, ENPVs). This risk neutral approach is efficient and appropriate for most public policy and project decisions. Occasionally, when projects have a large impact on a community, government may choose a safer project with a lower ENPV. This should be an explicit approach in CBA guides along with guides on how to treat issues like contingency costs. In some cases, contingencies are allowances for project features that cannot be fully designed or forecast in advance and should be part of EV. In other cases, contingencies are really P90 forecasts.<sup>9</sup>

Option values are more complex. In effect, option values are included in WTP (option) prices obtained from stated preference surveys. They are not included in values obtained from market prices or other revealed preference valuation methods. The usual implicit assumption is that where these differences exist, they are likely to be small and can be ignored. This paper cannot provide any better approach.

## 10 Conclusions

This paper has reviewed how seven major jurisdictional CBA guidelines deal with eight CBA issues: (i) standing, (ii) valuation principles, (iii) scope of the CBA, (iv) real values over time, (v) the marginal excess tax burden, (vi) the social discount rate, (vii) benefit-cost ratios and (viii) treatment of risk and uncertainty. In several cases (i, ii, vii and viii), there were two main issues. The most recent Boardman text is used as a guide to appropriate jurisdictional positions, though not as a bible.

In this review, we found that the guidelines did not deal with these issues in many cases. This applies to (CV/EV) valuation principles and application of WTA values, elements of project scope, dealing with real values over time, the marginal excess tax burden, the preferred alternative form of the BCR, and the use of expected values under uncertainty.

Turning to the eight sets of issues, the review found that:

- I. The application of standing generally needs more discussion. The paper also expressed concern about undertaking national projects with a negative global NPV and state projects with a negative national NPV.

<sup>9</sup> The UK Guide discusses contingencies and appraisal optimism at length but does not make this important distinction between the nature of different contingencies.

- II. The guidelines should provide more guidance on when (if ever) WTA values should be adopted and how they should be estimated.
- III. Most guidelines should give more guidance on the inclusion or otherwise of secondary benefits in related markets and how these impacts should be valued.
- IV. Changes in real (relative) values over time should be discussed but considered cautiously. If changes in real values are adopted, they should be adopted consistently with central guidance.
- V. The guidelines should recognize the possible METB but not recommend inclusion.
- VI. The SOC discount rate based on ROI principle should be adopted.
- VII. The guidelines should explain but not recommend the widely used standard BCR. Under capital constraints, the alternative BCR with only capital (and perhaps government net recurrent costs) in the denominator is useful.
- VIII. The guidelines should give clearer guidance on the use of expected values, including expected net present values, in CBA.

CBA is increasingly accepted as an instrument for guiding public policymaking.<sup>10</sup> All seven guidelines reviewed provide high quality, readable and practical guidance. It is a challenge to provide accessible advice to a wide audience, to ensure consistency in applications and to cover complex technical issues. This may be achieved by providing a basic guide to CBA and discussing more complex issues in annexes. Thus, there are various ways in which the points made in this review may be incorporated into the jurisdictional guidelines. However, it is hoped that they will not be ignored.

## References

- Abelson, P. and T. Dalton, 2018, "Selecting a social discount rate for Australia", *Australian Economic Review*, 51, 1, 52-67.
- Abelson, P., 2019, "The Wider Economic Benefits of Transport: A Review", Working Paper ITLS-WP-19-11, Institute of Transport and Logistic Studies, University of Sydney.
- Applied Economics, 2007, *Commissioned Study A. Cost-benefit analysis (of Formula 1 Grand Prix)*, in Victorian Auditor-General, 2007, *State Investment in Major Events*, Victorian Printer, Melbourne.
- Boardman A.E., Greenberg, D.H., Vining, A.R. and D.L. Weimer, 2018, 5th ed., *Cost-Benefit Analysis, Concepts and Practice*, Pearson, New York.
- Commonwealth Department of Finance, 2006, *Handbook of Cost-Benefit Analysis*.
- European Commission, 2014, *Guide to Benefit-Cost Analysis of Investment Projects*.
- Fernandez, R., 2019, "Review of discount rates used in economic evaluations", *Victoria's Economic Bulletin*, Vol 3, 24-32.
- Freeman, A. M., 1984, "The Sign and Size of Option Value", *Land Economics*, 60, 1, 1-13.
- Horowitz, J., and K. McConnell, 2002, 'A Review of WTA/WTP Studies', *Journal of Environmental Economics and Management*, 44, 426-447.

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<sup>10</sup> One reviewer observed that there is also a counter trend against use of CBA.

Infrastructure Australia, 2018, *Assessment Framework*. Section D3, *Conducting Economic Appraisals*, pp. 79-120. Economic appraisals are identified as CBA studies. "The form of economic appraisal required in an Australian business case for an infrastructure project is typically a CBA." p. 88.

Morton-Cox, L., 2018, "Uncertainty and the Value of Real Options in Infrastructure Decision Making", *Victoria's Economic Bulletin*, Vol.2, 44-56.

New Zealand Treasury, 2015, *Guide to Social Cost-Benefit Analysis*.

NSW Treasury, 2017, *Guide to Cost-Benefit Analysis*, TPP 17-03, NSW Treasury, Sydney.

OMB, 2000, *Guidelines to Standardise Measures of Costs and Benefits and the Format of Accounting Statements*, M-00-08, Washington, US.

OMB, 2003, Circular, A-4, *Regulatory Analysis*, Washington, US.

Pearce, D., Atkinson, G. and S. Mouranto, 2006, *Cost-Benefit Analysis and the Environment: Recent Developments*, OECD, Paris.

UK Treasury, 2018, *The Green Book: Appraisal and Evaluation in Central Government*, HMSO, London.

UK Treasury 2015, *Valuing infrastructure spend: Supplementary guidance to the Green Book*

US Environmental Protection Agency, 2010 (updated 2014), *Guidelines for Preparing Economic Analyses*, UCEPA, Washington.

Victorian Department of Treasury and Finance, 2013, *Economic Evaluation for Business Cases: Technical Guidelines*.