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Cost-benefit analysis: Then and now

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Abstract

This paper describes and analyses the evolution of cost-benefit analysis to the present day. The paper starts with a brief history of cost-benefit analysis to the early 1970s. By this time, the core principles of CBA had been established and applied to some major projects. But CBA was in its youth and not widely accepted. The paper then discusses these core principles of CBA and concludes that these are largely unchanged in the last 50 years. However, the paper also describes some major issues of principle that remain largely unresolved over the 50 years. Turning to the practice of CBA, the paper describes the huge increase (internationally) in the applications of CBA over the last 50 years. It also describes some of the major developments in CBA methods, especially valuation methods, and the quality of CBA work that have enabled these major new applications. Despite these developments, the paper finds that there remain some significant practical difficulties in the use of CBA, albeit some a function of the political environment in which CBA is applied. There is then a brief concluding section.

Keywords: Cost-benefit analysis, allocative efficiency, equity and distributional issues, non-market values, stated preference, social discount rate, appraisal optimism

** I acknowledge many helpful comments, especially from Professors Anthony Boardman, Lisa Robinson and Michael Spackman and from Leo Dobes, Kirsten Jensen and Peter Leventis. I am, of course, responsible for any views expressed, or any errors, in the paper. On a personal note, I recognise the great contribution to cost-benefit analysis by my mentor and friend, Professor David Pearce, who passed away sadly and prematurely in 2005.*

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Cost-Benefit Analysis: Then and Now

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1 Introduction

Two years ago, the New South Wales branch of the Economic Society of Australia requested me to provide a presentation on how cost-benefit analysis (CBA) has changed over time in principle and in practice in Australia. Having worked in Australia for a large part of my professional life, I could readily provide a local perspective along with a few more general observations. Though I have worked at various times in a dozen other countries, generally with some involvement with CBA, writing about the changes in CBA over time in multiple countries and for an international audience presents a much greater challenge. While this paper contends that the core general principles of cost-benefit analysis have been largely constant and agreed internationally over time, the details of these principles have not always been agreed and practical applications have varied both over time and across different countries. Inevitably, on such a large topic, the discussion is at many points selective.

This paper starts with a brief history of cost-benefit analysis to the early 1970s. By this time, the core principles of CBA had been established and applied to some major projects. But CBA was in its youth and not widely accepted. Section 3 discusses these core principles of CBA and concludes that these are largely unchanged in the last 50 years. However, Section 4 describes some major issues of principle that remain largely unresolved over the 50 years.

Turning to the practice of CBA, Section 5 outlines the huge increase (internationally) in the applications of CBA over the last 50 years. Section 6 describes some of the major developments in CBA methods and the quality of CBA work that have enabled these major new applications. Despite these developments, Section 7 finds that there remain some significant practical difficulties in the use of CBA, albeit some a function of the political environment in which CBA is applied. There is then a brief concluding section.

2 Brief History of Cost-Benefit Analysis to the 1970s

The origin of CBA is widely attributed to Jules Dupuis (1844). In this work, Dupuit equated the gross social value of a project, such as a road, bridge or canal, with the sum of the utility of users as measured by their willingness to pay for it. The cost of a project, the sum of materials and labour, along with maintenance, was simpler to calculate. If the benefits and costs of a project could be accurately analysed, an informed decision could be made.

Alfred Marshall (1890, *Principles of Economics*, 1E) is generally credited with formalising the fundamental concepts (utility, consumer demand, consumer and producer surplus) into the body of welfare economics. However, 30 years later, in the 1920 (8E) edition, while there are numerous

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references to demand, utility, consumer and producer surpluses, there is no mention of CBA in the subject index.

The practical origin of CBA is often attributed to the US *Flood Control Act 1936*. This *Act* required that for any flood control project "the benefits to whomsoever they accrue are in excess of the estimated costs." However, as Shabman (1997) observed, this to some extent simply formalised the analysis of flood control projects in the US that had been going on since the middle of the nineteenth century. On the other hand, as Pearce (1983) points out, the *Act* did not define these costs and benefits and it makes no mention of net benefits. And the basis of CBA in welfare economics was not established.

Pearce (*ibid*) attributed CBA's development within welfare economics to work in the 1950s and specially to Otto Eckstein (1958), Krutilla and Ekstein (1958) and McKean (1958). This approach was then applied in the US to water quality, recreational travel and land conservation during the 1960s. In the US, the *National Environmental Policy Act 1969* required CBA to justify regulatory programs. CBA was also expanded to address the tangible and intangible benefits of public expenditure relating to college education (Hansen and Weisbrod, 1969).

By contrast, CBA arrived in practice in the United Kingdom in the 1960s principally in relation to large new transport projects. CBA was applied to the evaluation of the M1 motorway project in 1960, and to many other transport projects including London's underground Victoria line, the Roskill Commission of Inquiry (1971) into the location of a third London airport and the first Channel Tunnel Study run by Rio Tinto Zinc in conjunction with the Department of Transport in 1971-72.[2] This led to a spate of UK-based books on CBA, including Pearce (1971), Mishan (1971), Layard (ed., 1972), Dasgupta and Pearce (1972) and Sugden and Williams (1978).

In the second half of the 1960s, CBA was also being applied increasingly by international agencies, notably by the World Bank in less developed countries, especially in irrigation, hydroelectricity, and transport (Dasgupta and Pearce, 1972, p.13). This led to several high-quality international CBA texts, including Little and Mirrlees (1969, commissioned by OECD), Dasgupta, Marglin and Sen (United Nations, 1972); Harberger (1972), Squire and Van der Tak (1975, commissioned by the World Bank), and Little and Mirrlees (1974, an update of their 1969 publication).

However, despite these high-quality publications and increasing international practice of CBA, several caveats should be mentioned.

Firstly, in the 1960s, CBA remained a minority topic in the economics profession. In the two leading international economics texts of the early 1960s, Samuelson (5E) 1961 and Lipsey (5E) 1963, there is no reference to CBA in the subject indexes. There were no courses in CBA in the major UK and Australian universities in the 1960s. Indeed, as a student of economics at two prominent universities in the UK in the early 1960s, I cannot recall any reference to CBA (but this could reflect memory loss!).

Secondly, and perhaps reflecting the above, there were deep divisions among economists about the practice of CBA. As Pearce and Dasgupta (1972, p. 14) observed: "It would be a mistake to think that, after 15 to 20 years of development, there is a consensus about the proper procedures to be followed". Differences about the valuation of costs and benefits lay at the heart of these divisions.

[2] Acknowledgment. The author worked on the Roskill Commission Airport Inquiry and the Channel Tunnel study.

As described by Abelson (1976), numerous advocates of CBA had shown by then how market and non-market values could be estimated. For example, Prest and Turvey (1965) and Layard (1972) had shown how market imperfections could be dealt with to arrive at more accurate valuations of market goods. Flowerdew (1972) and Foster (1974) showed how, using revealed preference methods, many social and environmental impacts of aircraft and roads (noise, visual intrusion, neighbourhood severance, disturbance costs, accidents and so on) could be valued.

However, many economists (and others) remained skeptical that non-market goods, especially environmental goods, could be valued in monetary terms. Self (1970) described the Roskill Inquiry into a third London airport as "Nonsense on Stilts" for undervaluing the environmental effects of aircraft. Schumacher (1973) contended more generally that it was absurd to "measure the immeasurable" or to "put a price on the priceless".

There were also criticisms that CBA was concerned only with economic efficiency and that market prices may not reflect morally correct values. This is, of course, an enduring issue that we will return to throughout this review.

Thirdly, in the 1970s (and for some decades later), there was a widespread inter-disciplinary competition for recognition. As discussed in Abelson (1976), for project evaluation, many people, though not usually economists, advocated the use of Planning Balance Sheets, Goal Achievement Matrices or Environmental Impact Statements as preferred evaluation methods.

However, as Professor Alan Walters (1973) observed: "On the one side there is the super generalist – the planner. His eclectic sweep includes all – even aesthetic and moral welfare. But the planner pays a high price for his omnipresence; there is no analytical discipline, nor are there well-established propositions of planning."[3]

Conclusion

By the mid-1970s, the principles of CBA were well established by leading international economists from several countries. And CBA was often employed in project evaluation, especially for transport and water projects.

However, the concept of CBA was challenged both from within the economics profession and, more especially by non-economists. Applications of CBA were limited mainly to infrastructure projects rather than policies.

And, as Dasgupta and Pearce (1974 p.14) observed, there were still weak connections between economic theory (based on welfare economics) and the practice of CBA. There were many valuation problems, especially around the value of non-market goods. And there were many differences in practice as to what would be included, or excluded, from CBA studies.

3 Broadly Agreed Core Principles of Cost-Benefit Analysis

Turning to the core principles of CBA, the position of this paper is that the core CBA principles enunciated in the late 1960s and early 1970s have stayed broadly constant.

Of course, this is a judgment call on (1) what are the core principles and (2) whether any differences over these principles are substantial. There are some grey lines here. When is there sufficient agreement to say matters are agreed rather than debated? A classic, and ongoing, issue is the

[3] Professor Alan Walters was also a member of the Roskill Commission.

treatment of distribution. Some elements of the discussion on distribution are agreed — others are not. For expositional simplicity, both the agreements and the disagreements on distribution are discussed in this section of the paper.

Drawing on Dasgupta et al. (1972) and Pearce (1983) as *guides to original CBA principles*, CBA is a procedure for measuring the gains and losses to individuals in the society of concern, using money as the measuring rod, as far as is reasonable, of those gains and losses. In practice, it may not be possible to measure all effects and a CBA will also include references to important unpredictable or non-monetisable effects. The society of concern is a government judgment call. Gains and losses include market and non-market goods and include environmental and social goods as well as economic goods. It is potentially misleading to describe CBA as Economic Analysis as this may lead some people to think CBA does not include environmental and social goods.

The premise of CBA is that individual preferences should count. Values are based on individual willingness to pay. Resource costs are opportunity costs. The value of all the relevant costs and benefits of a project or policy are estimated over the life of the project or policy. Effects over time are adjusted by a social discount rate.

These individual gains (benefits) and costs are aggregated to represent the total gains and losses over time and discounted to provide the net social outcome, as represented by net present value. This is subject to any unquantified costs and benefits. Where there is uncertainty, most texts (e.g. Dasgupta et al., 1972, Boardman et al., 2018) recommend that the aim is to maximise expected net social value (or expected NPV). The UK Treasury Green Book (2003 p.29) also recommends that appraisers should take account of risks by calculating expected values for each option.

Drawing on the Pareto hypothetical compensation principle, projects with a positive NPV are efficient in that the gainers can compensate the losers and there will still be net gains after compensation. This is sometimes described as the principle of allocative efficiency. And projects with a higher NPV (net social benefit) are generally more efficient than projects with a lower NPV.[4]

Most early CBA texts also recognized some important distributional issues, especially when compensation is hypothetical and not actual. It was widely recognised that a dollar does not have equal marginal utility for all persons. Therefore, there is no direct link between individual WTP values and marginal utility. It follows that total WTP does not equal total social utility and the monetized NPV calculation does not equate directly to social welfare. As Robinson et al. (2016) point out, these distributional effects may be important to both citizens and decision makers.

Some academics have argued that cost-benefit and distributional analysis should be conjoined via the application of distribution weights in CBA studies (for example, Squire and Van der Tak, 1975). More influentially, most versions of the UK Treasury Green Book have advocated the use of distributional weights. For example, the Green Book (2003 p.24) stated that "A more in-depth analysis uses distributional weights to adjust explicitly for distributional impacts in the cost benefit analysis". The Green Book (2020, Appendix 3) expresses similar views. Drawing on Layard et al. (2008), it suggests weights based on the principle of the diminishing marginal utility of income

[4] An exception occurs when government has a capital expenditure constraint and the SDR does not reflect the marginal return on public projects. In this case, ranking projects by their benefit-cost ratio, with project capex in the denominator, maximises the collective net present value of the selected projects.

estimated at around 1.3. It also proposes working with equivalised household income instead of actual individual incomes.[5]

But the most common view, then and now, is that there is no objective, or agreed, way to weight the costs and benefits to allow for distributional effects. Thus, Boardman et al. (2020) argue for the exclusion of distributional weights from what they refer to as "core" BCA, which should be preserved as a protocol for assessing allocative efficiency.

In lieu of such a weighted CBA, a separate, supplementary, report on distributional effects may be helpful to decision makers, as Robinson et al (2016) recommend for US regulatory agencies. But two points should be noted. First, a report on distributional issues will generally need to consider various impacts that may not be included in the CBA, such as how a project or policy affects prices, how price effects are passed on between parties, and how transfer payments affect different parties. Second, a distributional report may consider distributional effects by region, gender, ethnicity and so on, not just by household income. Further difficulties arise here when effects are not monetisable.

Another potential change in CBA principles relates to the reliance on individual preferences. As we have seen, 50 years ago there was considerable skepticism that individual WTP values could be estimated for non-market goods. This was to a large extent a practical valuation problem. But it also reflected views on the nature of individual preferences. Some preferences may be inferior or depraved due to poor mental health, lack of education or producer dominance via advertising. More recently, the development of behavioral economics has thrown further doubt on the values of individual preferences, as individuals think fast and emotionally rather than slowly and rationally, are strongly influenced by recent events, are unable to gauge probabilities accurately, and tend to have loss aversion (Kahneman, 2011). This issue is discussed further in Section 6 below. Notwithstanding these reservations, our take is that central case CBAs, then and now, are generally based on individual WTP values and that alternative valuations of preferences would be dealt with as sensitivity cases.

Thus, CBA remains a procedure for measuring the gains and losses to individuals in the society of concern, based on individual preferences, using money as the metric of those gains and losses, which include environmental, social and economic goods. These gains (benefits) and losses (costs) are aggregated to represent the total gains and losses, as represented by NPV, subject to potentially important non-monetised effects. Projects with a positive NPV, and no significant non-monetized effects, are efficient in that the gainers can compensate the losers and there will still be net gains. This is sometimes described as the principle of allocative efficiency. CBA may be supported by a distributional analysis.

These general principles are supported by high-quality academic texts on cost-benefit analysis. As one of the authors of Boardman (1995, 1E) observed to this writer, "the main purpose (of the first edition) was to write a book that was both theoretically correct and practical… In terms of new principles, our first edition was pretty much a synthesis of existing principles" although it also included discussion of some new or unused practical issues such as contingent valuation and Monte Carlo simulation for sensitivity analysis. Drawing on some internationally recognised recent CBA texts such as Johansson and Kristrom (2016), Nas (2016), and Boardman et al. (2018, 5E), most current CBA experts broadly endorse all these traditional principles described above.

[5] It may be noted that social valuations of the value of additional individual, or household, income may differ from weights based on the marginal utility of income.

Likewise, as discussed in Abelson (2020a) most national and international guides on cost-benefit analysis adopt these classic, underlying, CBA principles, albeit with some minor variations of principle and practice. And most recently, the European Commission guide (2021, p.20) also strongly endorses these same principles.

4 General Principles: Some Unresolved Issues

Although the general economic principles for CBA are well-established and have been broadly constant over 50 years, there are also several ongoing, unresolved, disputed issues. We briefly describe some of these issues in this section. Several of these issues reflect value judgements rather than conceptual differences about CBA. But either way, these are ongoing then and now issues, not differences over time.

As we have observed, a constant general CBA practice is reliance on the Pareto compensation principle. But there is a potentially substantial difference between the Kaldor *compensating variation* (CV) principle and the Hicksian *equivalent variation* (EV) alternative. Under the commonly adopted CV principle, benefits and costs are valued relative to the existing welfare status of the affected parties. How much would individuals be willing to pay for some good or service and be no worse off than at present? On the other hand, under the EV principle, where individuals have a right to the good or service, this would be valued by the amount that they would be willing to accept for not having that good or service and be as well off as before. Suppose that an additional service, in a regional hospital, costs $100m and that the regional community would be willing to pay $80m for the service. Under the CV principle, the service would not meet the net benefit (NPV) test. On the other hand, if (under the EV principle) the regional community has a right to this (metropolitan level) health service, they could require say $120m as compensation (willingness to accept) for not having the service. In this case, provision of the service would meet the net benefit test.

This choice between the CV and EV valuation principle is an ongoing problem. There is no technical resolution as the choice depends on value judgements as to rights. As Hammitt (2015, p.215) observes, “this leaves it vulnerable to the problem that the monetary value of a change is not uniquely defined: e.g., it depends on whether the value is measured from the situation with or without the policy. Hence the Kaldor–Hicks compensation test is in some cases ambiguous, when the Kaldor and Hicks criteria yield opposing conclusions.”

A related issue is the treatment of losses. Under the (CV) approach, losses are valued at the amounts that individuals would be willing to accept (WTA) as compensation and be no worse off than at present (see, for example, Dasgupta and Pearce, 1972). However, it was not clear how WTA amounts would be estimated. More recently, Knetsch et al. (2012) provide arguments for using WTA measures, including situations when they believe this approach is relevant. And Boardman et al. (2018, pp. 442-6) note that some recent contingent valuation (CV) surveys have attempted to estimate WTA values that had not previously been attempted. But they also point out that, without a budget constraint, survey respondents are likely to exaggerate their WTA amounts and they recommend that to elicit reasonable WTA amounts, CV surveys should include budget constraints.

Accordingly, our take here is that the principle of including WTA values in CBA has long been generally acknowledged and ways to do this are now being researched. The ongoing issue is the practical one: how to do this. In my experience, few CBAs include WTA values for losses of goods or services, be they market or non-market goods and services.

We noted in the previous section that general practice is to view distributional effects as issues that are dealt with, most appropriately, separately from the standard CBA. However, this is not the complete picture regarding equity issues. Common traditional, and current, practice is to use **average value** parameters for some goods, such as the values of life and leisure travel time savings rather than to apply income related WTP values. For example, the HM Treasury Green Book (2003 p.59) stated that "It is accepted practice to use a national average standard value of non-working time (equity value of time savings) for all modes of transport for appraisal purposes." And the UK Green Book (2020, Annex 1) reports on a wide range of environmental attributes and their valuations, with the implications that average values should be used.

However, there appears to have been surprisingly little discussion of when to use individual (WTP) private values and when to use average values. For example, should local urban or environmental amenities have equal value when some households are willing to pay more for these amenities than other households? The answer may depend in part on whether the beneficiaries pay for the service or benefit provided. But given the lack of discussion of this issue, when to apply average values may be described as another unresolved issue.

A further unresolved issue is the reasoning and value for the social discount rate (SDR). As Dasgupta et al. (1972) observed, the SDR was not agreed, but always front and centre of discussions. And so it remains. There has been a voluminous literature on the SDR over the 50 years without much resolution.

There is no issue on the first best principle: the SDR should reflect the social time preference rate (STPR). As proposed by Ramsay (1928), this would equal the sum of the pure time preference rate and the marginal utility of additional income over time. However, there are significant differences of view on the value to be attached to pure time preference component. There are also disagreements on whether, when comparing public expenditure with private consumption, the cost of public expenditure should allow for the marginal excess burden of taxation – and, if so, by what amount.

On the other hand, because of taxes on private savings and the returns required to allow for market risk, the social opportunity cost of capital (SOCC, the return on alternative market projects) is generally significantly higher than the STPR. Indeed, because of constrained government budget expenditure, the marginal return on public expenditure is also often above the STPR (sometimes well above). As Dasgupta and Pearce (1972, p. 146) pointed out 50 years ago, we have to consider how to deal with this *second-best* world. This can be done by setting the SDR equal to the marginal alternative rate of return on capital or by adopting a synthetic rate of return that allows for a combination of consumption and capital expenditure foregone.

Another alternative is to adopt the shadow price of public spending method first suggested by Ekstein (1958). Under this method, a shadow price for the capital employed is based on the estimated present value of consumption foregone in alternative use. This is computed by estimating the stream of consumption foregone and discounting this with the social time preference rate. This represents the real opportunity cost of the capital employed. The forecast steam of project benefits is then also discounted with the same time preference rate. This may well be viewed as the optimal approach to discounting in a second-best world, but it is very rarely recommended or applied.

The outcome is that both academics and practitioners are divided on their approach to the SDR. The STPR is supported strongly by Boardman et al. (2018) and slightly less strongly by Spackman (2020). The SOCC approach is supported by Burgess and Zerby (2013) and Harberger and Jenkins (2015) as well as by Abelson and Dalton (2017).

At a practical level, the UK and most European countries recommend an estimated STPR (European Commission, 2021) Australia, Canada and New Zealand recommend an estimated SOCC. In the US, the Office of Management Bureau recommends SOCC; the Environmental Protection Agency recommends STPR.[6]

Other contested SDR issues are suggestions that the SDR might vary with type of effect and with time. For example, the UK Green Book (2020, p.87) suggests that a lower STPR might be applied to health and fatality impacts and to environmental impacts and that the SDR might also be lower for longer term effects (known as hyperbolic discounting). But this is again a contested view.[7]

A related unresolved issue is the treatment of the marginal excess tax burden (METB). In principle, as Boardman et al. (2018, 2020) write, a CBA should allow for any METB and they suggest that an average rate of 20% could be applied generally in the US. However, there are significant practical difficulties in estimating the net tax effects over project lives as direct and indirect public revenues may partly, or fully, offset tax-funded costs. Consistency across evaluations would be difficult to achieve. Thus, as Abelson (2020a) showed, few governments recommend including METB, and very few CBAs make any METB allowance – probably more on grounds of practicality than of principle.

5 CBA in Practice: The Rise in CBA Applications

While the major principles of CBA have been broadly constant over 50 years, the practice of CBA has become much more widely accepted and there has been an extraordinary increase in the range of applications.[8] CBA is now taken more seriously by many governments and quasi-government agencies and there are numerous government and agency CBA guidelines. This is due in large part to the major advances in CBA methods. In particular, the scope of valuation of non-marketed impacts has extended into areas that might have seemed unrealistic fifty years ago, especially in environmental policy.

In this section we focus on the new applications first generally and then with an area focus, US, UK, Europe, Canada, Australia, New Zealand and the World Bank respectively. Advances in methods are discussed on the next section.

In the 1960s and 70s, CBA/BCA was largely confined to appraising and designing publicly funded capital projects, notably for water, transport and power. It was sometimes almost equated with government "investment appraisal". In these cases, government generally bore most of the costs while the benefits accrued to various entities, sometimes including public agencies.

As shown in Table 1, over the years CBA has been extended to numerous social programs, recurrent expenditures and regulations. Under regulations, private firms or households may bear some, or all, of the costs as well as gaining some, or all, of the benefits. Government appraisal now extends over virtually all fields of government spending and regulation.[9]

[6] As one reader observed, the US has a two-way bet. Dollars are determined by the SOCC; rule setting by the STPR.

[7] One reader suggests that a lower SDR for health, fatality and environmental impacts is not seen in the UK as a lower SDR but as a "sensible way of incorporating the effects of real price increases over time". The issue of changes in real prices over time is discussed in Section 7 below.

[8] As another reader observed, this year's annual Society of BCA conference (2022) extends to almost all areas of government microeconomic analysis.

[9] A further Australian reader observation: defence expenditure seems to be an exception.

Table 1 Examples of Cost-Benefit Analysis Now

Economic infrastructure	Social programs	Recurrent expenditure	Policies Regulations
Transport: Roads, rail, ports and airports	Health care: hospitals, mental health care	Public health programs subsidies for medicines	Environmental regulations
Utilities: Water supply, Power	Investment in vocational education and training	Determining class sizes	Safety regulations: pharmaceuticals, foods
Communications: Telephone, Broadband	Early childhood programs	Random breath testing for vehicle drivers	Urban planning
Environment: Renewable energy	Investment in justice programs	Location of government offices	Deregulation: airlines, taxis

Numerous examples of these new applications of CBA can be given. The following are some necessarily selective examples of the extended application of CBA in recent years along with some national developments.

Arguably, the Washington State Institute of Public Policy (WSIPP), created in 1983, has set the gold standard for the depth, quality and originality of its research reports and BCAs, including estimating and valuing changes in outcomes produced by numerous programs. The public policy areas include criminal and juvenile justice, K–12 and early education, child welfare, substance abuse, mental health, public health, public assistance, employment and workforce development, health care, general prevention and higher education.

Ongoing work currently shown in the WSIPP website includes: evaluation of cannabis legalization, various children services, wilderness therapy, shot-term foster care support services, the effectiveness of the drug offender sentencing alternative (DOSA), postsecondary education pathways, standardized juvenile court assessment tool evaluation, analysis of the adult problem gambling prevalence study, the effect of integration on the involuntary treatment systems for substance abuse and mental health and pre-K-12 education: early achievers quality rating and improvement system and effective practices to assist struggling students.

Boardman et al. (2018, pp.110-7) describe the major increased use of CBA in regulatory impact assessments (RIAs) in the United States following on from the *National Environmental Policy Act 1969* that required CBA to justify regulatory programs. In 1981, President Reagan mandated, by Executive Order, the use of CBA for establishing major rules by federal agencies: there should be no regulation unless the potential benefits to society outweigh the potential costs. President Clinton extended the definition of major rules. Not all regulations are deemed "major". President Obama introduced reviews for existing rules. The first comprehensive US Environmental Protection Agency guidance was issued in 2000 (updated in 2010, with later supplements). Boardman et al. (*ibid*) report that, between fiscal years 2005 and 2014, RIAs assessed the monetized costs and benefits of 120 proposed or existing regulations.[10]

[10] Dudley (2020) also examines the evolution of executive regulatory oversight and analysis in the US from the 1970s to today.

Sunstein (2018, p.23) describes the growth in applications of CBA to regulatory policies in the US as "The Cost-Benefit Revolution". "Cost-benefit analysis includes everything that matters to people's welfare".[11]

Boardman et al. (*ibid*) also mention several evaluation case studies of social programs in the US: a nurse-family partnership program, the early detection of Alzheimer's disease, Welfare to Work programs, and the Tulsa IDA Account program.

Enthoven (2019) describes more broadly the beginning and growth of benefit-cost analysis in the United States government drawing on the work of the Rand Corporation. Since the 1960's, the Corporation has applied BCA beyond the military to include health services, education, urban problems including homelessness, ethics in scientific research, and climate research.

Also in the US, the Department of Health and Human Services (2016) produced a first-class guide on application of CBA to policies and regulations in health and human services.

Turning to the UK**,** the Treasury has been producing practical guidance on how to appraise policies, programmes and projects for over 40 years since 1975. The 1997, 2003 and 2018 editions of the Green Book contained major updates but nothing materially inconsistent with the leading textbooks of the time. As we will see in the next section, the Green Book has been advancing valuation of environmental impacts that have long been a part of the appraisal process but have become increasingly important in recent years. Significantly, the 2020 Green Book (p.40) stresses that "Social CBA is the recommended approach for detailed comparison of the shortlist of options". And on page 89, "multi-criteria analysis is not a recognised Green Book approach (to shortlist evaluation) because of its lack of transparent objectivity."

Still based in the UK, Bradley and Green (Eds: 2020) provide a masterly and comprehensive edited international volume on estimating the major costs and benefits of education and cite many cost-benefit applications in the education sector.

Turning to Europe**,** Florio (2021) documents the major developments in use of CBA over the last 20 years in Europe. Although the concepts of costs and benefits of projects date back to studies at the Ecole des Ponts et Chaussees (Paris) in the 19th century, in the 20th century, CBA in its current form was used less extensively in Europe than in the United States. However, since the start of the 21st century, there has been a rapid increase in its use in many European countries and at the European Union (EU) level. As Florio observes, this partly reflects the public provision of transport, energy, water and waste management, health services, etc. In 2014, the European Commission produced an excellent guide to benefit-cost analysis.

And recently the EU (2021) has produced another important guide to CBA. This states (p.16) that: "CBA is the preferred approach for assessing public investment projects, as it offers a robust, objective and evidence-based analytical framework for project evaluation. In the EU, it has been, and it continues to be, widely used across different policy sectors and institutions as the main EA tool to identify welfare-maximising projects, subject to the resource constraints. Conducting a CBA could be, however, a resource-intensive process and should be proportionate to the size, importance and/or risk profile of the investment. Depending on the project's scale, nature and/or data availability, a comprehensive CBA may not always be recommended or even possible. In such cases, Least-Cost Analysis (LCA) or Cost-Effectiveness Analysis (CEA) could be adopted as an

[11] The US Office of Management and Budget also developed major economic guidelines, principally for policies and regulations in 1996 and revised in 2003.

alternative. A Multi-Criteria Analysis (MCA) could also be used as an alternative, even though it is more often used as a complement to the other tools." Appendix I provides an overview of existing CBA national guidance in Europe.

In 1995 the Canadian Treasury Board provided a CBA guide for federal departments and agencies to support regulatory decisions. In 1999, the Government of Canada instituted the policy that a CBA must be carried out for all significant regulatory proposals to assess their potential impacts on the environment, workers, businesses, consumers, and other sectors of society.

In Australia, CBA has been an officially recommended evaluation practice for over 30 years. In 1991, the Australian Government Department of Finance (DOF) published the *Handbook of Cost-Benefit Analysis,* prepared by an expert group of economists, designed to guide public servants in the use of CBA principally for project investment. This was again an exposition of existing principles and practice. In 2006, DOF published an updated *Handbook* with more reference to evaluation of policies and a substantially expanded discussion of valuation methods. Another important change. The 1991 edition (p.76) recommended Planning Balance Sheets to supplement CBA. This was dropped in the 2006 edition.[12]

In 2002, the Commonwealth Office of Best Practice Regulation (OBPR) formally required that new national regulations must be supported by a CBA. OBPR (2021a, p. 19) provides a strong reindorsement: "The Australian Government is committed to the use of cost–benefit analysis to assess regulatory proposals and encourage better decision making".

In recent years Infrastructure Australia (IA, the Australian Government's independent infrastructure advisor) has produced several guides to assessment of infrastructure investment. The IA position is a little ambivalent. IA (2021a) discusses the overall assessment framework, stresses such objectives as sustainability, resilience and deliverability and leaves the door open to almost any assessment approach. On the other hand, the IA (2021b) report on Economic Appraisal states (p.8) that "We require the use of CBA as it includes cost and benefit measures to estimate the impacts for the Australian community…. CBA is preferred as it is the most robust technique for appraisal, allowing the social, economic and environmental merits of a proposal to be identified, measured, valued and compared."

In New Zealand**,** CBA has long been an expectation in business cases and regulatory proposals, but until recently practice was limited principally to capital expenditure in the transport sector. In 2015, the Treasury introduced an official *Guide to Social Cost-Benefit Analysis*. It also developed the *CBAx Tool.* This is a spreadsheet model that "contains a database of values to help agencies monetise impacts". In addition, "The aims are to help agencies to take a consistent approach across government to cost benefit analysis, … to take a long-term and broad view of societal impacts, costs and benefits … to rigorously assess these by monetising and discounting impacts, where possible, … and to be transparent about the assumptions and evidence base." The Tool is regularly updated. (Google, *The Treasury's CBAx Tool*.)

Turning to international evaluations, CBA was traditionally a World Bank signature issue.[13] World Bank Staff Working Paper (1976) provided a guide intended to interpret and supplement the social cost-benefit methodology set out in Little and Mirrlees (1974) CBA guide for developing countries and Squire and Van der Tak's (1975) book on project evaluation commissioned by the World Bank.

[12] Acknowledgement: I was responsible for re-drafting the 1991 *Handbook* to produce the revised 2006 *Handbook* for the Commonwealth Department of Finance and Administration.

[13] The Asian Development Bank (2013) has also produced an excellent guide to cost-benefit-analysis.

CBA was the Bank's answer to the results agenda long before that term became popular. The requirement to conduct CBA stems from the mandate in the Articles of Agreement that the Bank should strive to increase the standard of living in member countries. When a country borrows—and repays—funds for projects in which benefits fall short of costs, the standard of living of the country declines.

However, in 2010, an Independent Evaluation Group within the World Bank found that the percentage of Bank projects that are justified by CBA had been declining for several decades, owing to a decline in adherence to standards and to difficulty in applying cost-benefit analysis. The Group found that, where CBAs had been applied to evaluate projects, the analysis was generally excellent. But, in many cases, there had been a lack of attention to fundamental analytical issues such as the public sector rationale and comparison of the chosen project against alternatives. The major reason given for the limited use of CBA was that the analysis was usually prepared after the decision to proceed with the project had been made. We return to this issue in Section 8 below.

Conclusions

Cost–benefit analysis has become the dominant method of evaluation of projects and policies in all economic, social and environmental sectors in developed economies (at least democratic ones) and in international development agencies.[14] This reflects in large part the role of CBA in identifying a proposal's objectives and in quantifying the associated costs and benefits within a clear (and testable) valuation framework.

However, it is not without challenges. Some guides emphasise the need for strategic fit and / or the need to meet undefined objectives such as resilience and sustainability. And, as discussed in the next section, behavioural economics has cast some doubt on valuations based on individual preferences. And quantitative measurement of wellbeing/happiness has emerged as an alternative to money valuation and is seen by some economists as an alternative to conventional CBA in some contexts.

Also, as one experienced reader observed, there is a high level of noncompliance with various government guidance documents, due primarily to data, time, and resource constraints, as well as lack of enforcement, and at times due to political or policy concerns. In some cases, noncompliance may also result because the guidance is viewed as incorrect or outdated. This means that while these documents can nudge analysts in particular directions, they are not definitive and do not necessarily represent the overall "state of the art."

And there is, of course, the long-standing issue that CBA does not deal thoroughly with much beyond that which can be monetised, including some environmental issues and many distributional issues.

Notwithstanding these challenges, CBA has become the leading method of project and policy evaluation over the last 50 years.

[14] One experienced reader suggested that CBA would be described more accurately as the dominant form of analysis, not of evaluation, as CBA can never be more than part of the much larger whole. I have opted to stay with "evaluation".

6 CBA in Practice: Evolving CBA Methods

Over the last 50 years, CBA practices have evolved greatly. This reflects a huge increase in study and attention to CBA along with associated sophistication. This sophistication has both driven the increased range of applications described above and been driven by these increased uses.

In this section, we outline some of these changes in methods. But it should be stressed that many of these changes are evolutionary. Many of the current methods existed in some form 50 years ago. Thus, many changes are incremental, not fundamental.

For a classic example of improved methods, we could take the application of CBA in evaluating airport location. The Roskill Commission (1971) report for a third London airport, using a CBA framework that would be recognisable to-day, attempted to assess all the important costs and benefits including amenity (noise) costs and travel time savings of alternative airport locations. The report was critically assessed by Pearce and Dasgupta (1972, Chapter 9) citing traffic modelling and forecasting problems as well as issues with the estimated values of travel time and noise nuisance, and equity compensation issues. More recently, Forsyth et al. (2021) found that general equilibrium (CGE) modelling can improve the evaluation (not replace CBA) by modeling non-local externalities, such as greenhouse gas emissions; analyzing distributional aspects in terms of the ultimate incidence of the benefits and costs; and estimating the wider economic benefits of aviation; the benefits and costs of tourism; and the effects of an airport on employment.[15]

But before discussing the evolution of CBA methods, a brief word on some other ways in which CBA practice has changed.

Some CBA practice changes

Some changes have occurred because the nature of many economies has changed with less regulated economies.

A key example of change is the use in CBA studies of what were commonly called “accounting” or “shadow” prices to reflect real economic values. These adjectives have essentially similar meaning. In the 1960’s and 1970’s there were numerous government controls and other market imperfections, including imperfectly competitive markets, especially in less developed countries. These controls distorted the allocation of resources, exchange rates, import prices via quotas or tariffs, and many other local prices via high indirect taxes.

Numerous influential articles and book chapters were devoted to estimating real costs and values by use of “accounting” or “shadow” pricing. Examples include McKean (1968) on the use of shadow prices, Little and Mirrlees (1969) on the use of world prices, and Sen (1972) on foreign exchange rates and shadow prices.[16] Pearce and Dasgupta (1972) devote a whole chapter (4) to estimating real economic costs and benefits via accounting (or shadow) prices. And Layard and Glaister (1994) start their edited book on CBA with two chapters on shadow prices including Sen (1972) again and Dreze and Stern (1990).

Of course, market imperfections still exist to-day, albeit usually in less extreme form, and allowances for them are a basic part of CBA. Johansson and Kristrom (2016) devote Chapter 3 of their book to dealing with market distortions. But they also observe (p.4) that “The world was quite different then

[15] But a word of caution is necessary that CGE models do not always capture the opportunity costs of project expenditure. Thus, CGE modeling my supplement, but not replace, CBA.
[16] These three papers were all re-produced in Layard (1972).

(in the early 1970s) with fixed exchange rates, much less trade and limited international capital markets: environment and natural resources played a more marginal role". As an example, the discussion of shadow valuing of foreign exchange in the 1991 Australian *Handbook of Cost-Benefit Analysis* was dropped in the 2006 *Handbook*. Boardman et al. (2018, Chapters 5 and 6) also discuss extensively how to value outcomes in distorted markets using shadow prices. And on pages 190-2, the text discusses the use of the term "accounting" prices by Little and Mirrlees (1974) especially for application in developing countries with highly distorted markets. But the text notes that it is confusing to use the term "accounting" prices, and recommends, as is common to-day, the use of the "shadow" pricing term. More recently, the European Commission (2021, p.22) notes that, in practice, distortions in investment projects in Europe are not so substantial; therefore, for most elements, it can be assumed that their shadow pricing corresponds to market prices."[17]

Another significant change has been a general decline in the use of the internal rate of return (IRR) and, on the other hand, increased use of the benefit-cost ratio (BCR) as measures of project or policy value, along with the ongoing main measure of net social benefit over 50 years (the net present value). For example, Dasgupta and Pearce (1972, Chapter 7) give much more attention to the IRR than to the BCR. On the other hand, Boardman et al. (2018) focus more on the BCR. Actually, most leading texts, including these, have been critical of both the IRR and the BCR. But older CBA reports tended to report an estimated IRR along with NPV, and less often the BCR, whereas most studies to-day report the estimated BCR and NPV and not the IRR.[18]

The development of CBA methods

As we have seen the core concept of CBA, the estimation of all relevant costs and benefits to the relevant society has not changed. But, 50 years ago, many non-economists and some economists doubted that many non-market costs and benefits could be reliably valued. The issues are complicated because reliable valuation involves not just valuing impacts, but also identifying and forecasting them. Here we focus mainly on valuations but also reference some changes in estimating impacts. The general picture is that there have been major advances in valuation methods and practices. But we should not underestimate the valuation methods that had been developed by the 1970s and 1980s.

Pearce (Ed., *The Valuation of Social Cost*, 1979) provides a useful perspective on CBA valuations and methods in the 1970s. The book covers the theory of social cost measurement, valuing noise nuisance, air pollution, recreational land use, water pollution, human life and suffering, and social severance. The valuation methods rely heavily on revealed preferences including hedonic property price studies, travel costs studies, damages and loss of output. There is no reference to stated choice valuation methods (contingent valuation or stated choice models).[19]

Freeman (1993) provides a helpful update on valuation methods over the next decade. Freeman (pp. 24-5) distinguishes between observed behaviour and "hypothetical" values. Observed behaviour includes directly observed markets and indirectly observed revealed preferences. Hypothetical methods draw valuations from people's responses to hypothetical question rather than real world

[17] But, as one reader observed, competitive free trade could decline substantially post the Russian invasion of Ukraine.

[18] This point may reflect a southern hemisphere perspective. The European Commission (2021, p.24) prefers what they call the estimated rate of return over the BCR for ranking projects with constrained budgets.

[19] Similar comments apply to Abelson (1979, *Cost-Benefit Analysis and Environmental Problems*) which discusses valuing environmental impacts, soil conservation, sand mining, aircraft noise, and amenity and airport location.

choices. Direct hypothetical models involve asking people directly how they value various non-market goods — essentially new contingent valuation methods. Freeman describes indirect hypothetical methods as "contingent ranking" whereby people are asked to choose between a set of cards each depicting a variety of environmental or other attributes – in essence an early form of choice modelling.[20]

Fast forward to Boardman et al. (2018) and we find major advances in valuation methods in two major areas. One is estimating outcomes from experiments and quasi-experiments based on five commonly used evaluation designs: comparison of net changes, or of post-treatment outcomes, between treatment and control groups; simple before and after comparisons; and comparisons of net changes, or post- treatment outcomes, between treatment and quasi-control groups (see Chapter 14). Boardman et al. (*ibid*.) also notes the use of experiments and quasi experiments to determine impacts of economic and social programs, including education and training programs, and welfare to work programs.

The second major advance discussed by Boardman et al. (Chapter 16) is the increasingly common and sophisticated use of contingent valuation (CTV) methods. This authority was significantly established by the report of an eminent panel of economists (Arrow et al., 1993) in the wake of the disastrous Exxon Valdez oil spill in the Prince William Sound in Alaska in 1989 and subsequent estimates of the damages (Carson et al., 2003). Boardman et al. (*ibid*. p.422) note that, in the US, CTV studies have been accepted extensively by government agencies, including the Environmental Valuation Reference Inventory, for health and medical interventions, in preservation of archaeological sites and in public goods produced by sports stadiums. By comparison, the Australian *Handbook of Cost Benefit Analysis* (1991) and the UK Green Book (2003) make only brief mentions of stated preference methods.[21]

On the other hand, Boardman et al. (2018) make little, or no, mention of three other recent developments in valuations: stated choice methods (also known as conjoint or discrete choice analysis), subjective well-being (happiness) valuations, and the potential impacts of behavioural economics on CBA valuations. But each of these is described in Johannson and Kristrom (JK, 2016).

JK (*ibid.*, pp.166-9) describe how stated choice analysis works, broadly as outlined by Freeman (*ibid*.). The basic idea of stated choice modelling (CM) is similar to that in hedonic price models: many goods can be defined in terms of their attributes and the levels that these attributes take. For example, a waterway can be defined in terms of its recreational facilities, vegetation, fish life, birds, and other fauna. In CM, a sample of people is asked to choose between alternatives (say waterway alternatives) with various attributes, including a monetary cost. They are typically presented with six to ten choice sets. Each choice set typically contains three options, including the status quo. And each option contains several attributes, usually four or five, including a dollar attribute. Valuations of goods can be inferred from the monetary trade-offs implied by the choices. The JK description of CM was based on Louviere et al. (*Stated Choice Methods*, 2010), written principally by two prominent Australian academics (Louviere and Hensher), which may explain why there have been many stated choice studies carried out in Australia, but apparently less in the US. And there appears to be no reference to choice modelling in the UK Treasury Green Book (2020).

[20] Boardman et al. (1E, 1995) also discussed contingent valuation which was then a relatively new methodology and not discussed in many texts.

[21] As an experienced reader observed: "The methods of valuing environmental, safety risk, and other impacts that have no clear market value have obviously developed radically. From my recollection, in the 1970s there were no stated preference studies and the technique developed steadily from the 1980s."

JK (*ibid.* pp. 200-1) also discuss the subjective well-being (SWB), or happiness, valuation method. Subjective well-being was a major topic in Stiglitz et al. (2008). Estimating SWB values is generally credited to UK academics / consultants, Fujiwara and Campbell (2011), and has been frequently referenced in UK Treasury Green Books since then. The SWB method aims to provide values for lifestyle outcomes to input into CBA evaluations of public policies. In this method, individual SWB is typically represented by an individual's expressed life satisfaction (LS, happiness) measured on an 11-point scale (from 10 at the top down to 0). The SWB method then regresses the reported LSs against household income and a large number of lifestyle attributes, such as level of health, employment, accommodation for homeless, improved numeracy skills, local crime, other aspects of the local community, involvement with exercise or sport and so on. Then, if a lifestyle effect, such as home ownership, produces say a 10% increase in LS, the equation will indicate the increase in income that would produce an equivalent increase in LS. This becomes the value of the lifestyle attribute.[22]

SWB valuation attempts to ascribe monetary values to important life outcomes that are hard to value using traditional valuation measures. It is generally accepted that LS measures provide credible information on how people feel about their lives. They are based on reported experience of outcomes rather than on hypothetical outcomes in SP surveys. And they are not subject to incentive biases, strategic responses, anchoring and other biases in SP surveys. Thus, SWB studies may provide some valuations that are not otherwise available. The UK Green Book (2020, p. 60) cites values for community cohesion, families and children.[23]

However, at this stage, the SWB valuation process appears to have several unresolved issues. Many well-being variables, such as state of health or community involvement, tend to be described broadly and discretely in binary (yes/no) form. These metrics are often too broad to be helpful and do not provide values for incremental or marginal changes. There are often many correlated variables. And the estimated valuations are highly sensitive to estimates of average income which may be defined as individual, household or equivalised household income, usually after tax. Accordingly, the UK Treasury Green Book (2020, p.60) notes that "the methodology is continuing to evolve". The cautious view is also common, though not unanimous, in Australia. But New Zealand has strongly adopted the well-being valuation approach and includes locally estimated well-being parameters in the Treasury CBAx data base.

Another recent development is the emergence of behavioural economics (JK, *ibid*. pp. 198-200). JK highlight the paper by Robinson and Hammitt (RH, 2011) as a first step at developing criteria for incorporating behavioural factors into CBA. RH noted that behavioural research emphasizes the need to recognize that health and environmental risks and values are affected by psychological as well as physical attributes. They also emphasized the need to consider the influence of other-regarding preferences on valuation. In addition to acting altruistically, individuals may act reciprocally to reward or punish others, or use the status of others as the baseline against which to assess their own well-being. However, they recommended continuing to focus on the preferences of those affected by the policy options and working to ensure that these preferences are based on

[22] Most LS models use a single regression equation and use the estimated regression coefficients as an "exchange rate" between the lifestyle outcome and income. Some models regress lifestyle satisfaction against lifestyle outcomes and income separately and use the estimated coefficients from the separate equations to estimate the income equivalent of the lifestyle outcome.

[23] For a fuller discussion of wellbeing, see HM Treasury, 2021, *Wellbeing Guidance for Appraisal: Supplementary Green Book Guidance*.

knowledge and careful reflection, rather than adopting a more paternalistic approach to policy analysis.

Sunstein (2020) argues likewise that regulators should adopt a working presumption in favour of respect for people's self-regarding choices, but only if those choices are adequately informed and sufficiently free from behavioural biases. However, people may make poor choices that make their lives go less well. For example, people might die prematurely or suffer from serious illness as a result of poor decisions due to lack of information or behavioural bias. In which case, some intervention may be justified.[24]

An important corollary of all these advances in valuation methods has been the development of meta-analysis. Traditionally cost-benefit studies often relied on benefit transfers – drawing on valuations from like situations. Meta analysis draws likewise on other studies but more systematically to estimate the average effectiveness of a particular topic given the weight of the most credible research studies. Again, the Washington State Institute for Public Policy (2019a) has been a leader in this field. WSIPP reviews research and summarizes information on the effects of various programs on outcomes of legislative or policy interest. WSIPP calculates a statistic for each outcome—an effect size. WSIPP uses meta-analysis to create a program average effect size. This represents the average effect of the program as measured in relevant, high-quality, studies. Using both the program effect size and other key information, WSIPP estimates the size of the expected change over time if a program were implemented.

Along with these advances in valuation methods, there have been many advances in actual valuations and their applications. In this space, we can cite only a few examples, the value of life, a host of environmental values, values in transport studies, and values in some social programs.

Traditionally, as shown by Freeman (1993), the value of life (known as the value of statistical life, VSL) was based on the present value of the loss of average future earnings (an *ex-post* cost of illness approach) rather than on a (*ex-ante*) willingness to pay to avoid the risk of death. However, in the 1990s, various experts started to use wage-risk studies (e.g. Viscusi, 1993) and contingent valuation methods (e.g. Jones-Lee at al., 1995) to estimate the VSL. Abelson (2003a) describes some of these changes. In 2008, drawing in Abelson (2008), the Australian Office of Best Practice Regulation recommended a major change from the loss of earnings then valued at around $ A1.0m per life to a $3.5m willingness to pay value. As described by Viscusi (2018), similar changes occurred internationally, though there remains an ongoing debate about the relative merits of market wage risk studies and stated preference studies.[25]

The UK Green Book (2020, Annex 1) reports on a wide range of environmental attributes and provides detailed references (sources) for the valuations. These include:

- Effects of air quality on health, quality of life, economic activity and the functioning of ecosystems.
- Effects of varying noise levels on health, well-being, productivity and the natural environment.
- The environmental externalities of waste disposal.
- The valuation of water resources.

[24] Nardinelli (2018, pp. 527-8) also provides a helpful discussion of behavioural issues in cost-benefit analysis.
[25] There is also a major ongoing difference regarding the value of a statistical life year (VSLY). In Australia, the VSLY is the annual value over 40 years that, appropriately summed and discounted, equates to the VSL (Abelson 2008). In 2021, this was A$222,000, based on a $5.1m for life (OBPR 2021). But the UK Green Book (2020, p.87) values a Quality Adjusted Life Year (QALY) at only £60,000. It is hard to explain this discrepancy.

- The effect of water quality on biodiversity, amenity and recreation.
- The social costs of flood risk and coastal erosion (harm to people, property, infrastructure and environment.
- Methods for valuing biodiversity.
- A guide to valuing energy use and greenhouse gas emissions.

Turning to transport, this is now subject to much more sophisticated forecasting models and valuation methods than existed 50 years ago. Drawing on Australian transport guides, Australian Transport Assessment and Planning (2020) and Transport for NSW (2020), there is detailed guidance on transport-related values on:

- Travel time savings, including values of business and leisure travel time, both in-vehicle and out-of-vehicle time (e.g. access, waiting, transfer and unexpected delay time).
- Road vehicle operating costs for difference vehicles and types of roads.
- Urban road congestion costs, average and marginal.
- Road safety benefits.
- Environmental impacts by vehicle type, including air, water and noise pollution and greenhouse gas emissions, nature and landscape impacts.
- Various active transport benefits, including health, environmental benefits and congestion cost savings.
- Public transport benefits, including values for station and vehicle quality, de-crowding and reliability.
- Road maintenance savings.

Similar valuations can be found in the UK Department for Transport *TAG Data Book* (last updated November 2021).

Turning now again to the Washington State Institute for Public Policy, WSIPP (2019b) reports on several monetary valuations that it employs in social program. Drawing from p.3, WSIPP currently bases the monetary effects of outcomes on the combination of labour market benefits, program cost savings and an allowance for the deadweight costs of market distortions.

- Labor market earnings – wages.
- Health care – cost for health care insurance and services.
- Crime – cost of the criminal justice system and harm to victims of crimes.
- Child welfare – child welfare system costs and costs to victims of child abuse and neglect.
- K–12 education – school system costs.
- Higher education – tuition costs for college education.
- Public assistance – direct and food assistance.
- Mortality – value of a reduction in mortality risk.
- Deadweight cost – loss of value to society from market distortion.

The WSIPP benefit-cost model estimates the dollar value of offering a program—a defined set of government efforts—to an additional person. The model does this by valuing changes in outcomes (e.g. crime, depression, test scores) produced by programs and comparing them to the costs of providing those programs. For example, “cognitive behavioral therapy for adult depression” is a program that provides a specific type of talk therapy to adults to reduce the symptoms of depression. The benefit and cost estimates reflect the difference between a person who receives the program and one who does not.

As observed before, most of these developments in valuations are incremental and evolutionary rather than revolutionary. But collectively they amount to a revolution in valuations over the last 50 years. And an important practical outcome has been public accessibility to these values via public guides and data bases such as the UK Green Book's many references or New Zealand Treasury's *CBAx Tool*.

Turning briefly to another topic, there have been some advances in the treatment of risk. In the 1970s and 1980s, there was little discussion of applying the gold standard Monte Carlo simulation technique to obtain CBA results. In a major 490-page CBA text, (Layard and Glaister, eds., 1994), there is no reference to Monte Carlo analysis. Aware of this vacuum, Boardman et al (*ibid.* 1E., 1995) encouraged analysts to use Monte Carlo simulation to evaluate risk. And the 2018 edition (5E) gives more information to help analysts to use it as well as an illustrative case. But as one of the authors commented to me, "although we have seen some increase in use in use of Monte Carlo simulation in CBA since then, it still does not play the central role we believe it should".

Another practical innovation in the treatment of risk is the application of real options. The concept of real options is described in some detail, and their use recommended, in HM Treasury Green Book (2020, pp. 111-3): "If the value of flexibility is not accounted for, the social value of an option will be systematically underestimated". In Australia, the Victorian Government Treasury (2018) provides a detailed guide on how to apply real options analysis. On the other hand, real options do not appear in the subject indexes of Johannson and Kristrom (2016) or of Boardman et al. (2018).

In brief summary, there has been a huge increase in practical cost-benefit methods, especially in valuing non-market goods and services. This has been enabled especially by advances in stated preference methods as well as in revealed preference methods. Using these methods, almost everything can be valued, although not without some risks. There have also been advances in modelling outcomes, though mostly by non-economic professions and we have not focused on these in this review.

These various advances have been encouraged by the increased applications in CBA noted in the previous section and have, in turn, enabled these increased applications.

7 CBA: Some Ongoing Practical Issues

In the words of an experienced (UK) CBA expert: "Despite much progress since the 1970s there are many questions on which there are no signs of convergence". Here I highlight some ongoing practical issues following broadly the main steps in preparing a CBA starting with setting up the Base Case and options, through forecasting and valuation, on to dealing with risk and equity, and finally to overall bureaucratic problems (appraisal optimism).

Previously I have outlined some ongoing issues of principles, notably with the social discount rate and the treatment of distributional issues. However, the line between principles and practice is not always a clear one. Issues of practice may arise because there is a lack of clarity on the underlying principle. Others may reflect apparently ongoing poor practice. Also, some of the new practices just mentioned in Section 6, such as subjective well-being valuations and applications of behavioural economics, remain contested issues. Given the broadscale of the issues, our discussion below of ongoing practical issues is inevitably selective, but hopefully it provides some useful messages.[26]

[26] Nardinelli (2018) provides a useful discussion of the practical pitfalls in conducting cost-benefit analysis.

As Nardinelli (2018, p. 526) observes, baselines change and can be slippery. It is necessary to separate the stationary and moving parts. For example, when estimating the impacts of public health programs, such as programs to reduce tobacco consumption, coronary heart disease or road accidents, one needs to forecast what would happen in the Base Case *without* these new policies, where in some cases the problems may be declining in the Base Case (Abelson, ed., 2003b). On the other hand, when reviewing, in the mid-1990s, four options for a high speed rail system between Sydney and Canberra, the Steering Committee for the review instructed me to assume that, due to air space congestion, the average flying time between the two cities would be 15 minutes longer than then current 50 minutes scheduled time, thus creating extra benefits for passengers transferring from air to the proposed rail project. There was no evidence for this. In my experience, blackening the base case is a common practice with the aim of enhancing the proposed options.

Somewhat related to this, management, and low-cost, options are often ignored or under-played especially for infrastructure projects. Roads are often constructed to alleviate traffic congestion, with little thought given to an optimal road pricing system. Dams are built to avoid water restrictions, again with little thought to an efficient water pricing system or allocation of water rights. A few years ago, a major tunnel (the Lane Cove tunnel in Sydney) was built to alleviate traffic congestion, but no consideration was given to grade separation options at the two major intersections which were responsible for most of the traffic congestion.

Thirdly, there is the issue of forecasting – or more colourfully what Sunstein (2014) describes as "the knowledge problem". Of course, forecasting affects the Base Case as well as the options. This responsibility is often passed off to a third party and the CBA provider often takes no responsibility for these forecasts; indeed, CBA providers often start their reports by formally denying any legal responsibility or liability for third party inputs. As Nardinelli (*ibid*. p.524) observes, "identifying causation causes much grief for practical benefit-cost analysts ... The failure to link the causes of the problem to the effects of the regulation is a major pitfall. Real-world problems often have multiple causes, so the proposed fixes may sound appropriate and effective. If the problem involves health, causation is particularly problematic. How much of a given cancer is indeed caused by the failure we have identified?" In some cases, we need to forecast how a policy will change behaviour and change the environmental, health or safety problem.

To give another example, it is routinely assumed in Australian public transport studies that anyone using public transport will get a significant exercise / public health benefit due to walking to, or from, the public transport, known as an "active transport" benefit (and get no negative health outcome from travelling on crowded public transport). But many people working from home, and sometimes also driving to work, will get substantial travel time savings and may well use some, or all, of that saved time in beneficial physical exercise. In essence, this is another forecasting issue, albeit a relatively minor one.

Turning to valuations, an ongoing practical issue is how to deal with changes in real values over time. Boardman et al. (2018, 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). This view is supported in principle by the UK Treasury Green Book (2020, p.42): "Where there is historical evidence and an expectation that this will continue into the future, different rates of inflation can be used to reflect the relative difference. For example, information technology has become relatively less expensive over time and land use for development relatively more expensive."

However, it is hard to allow for changes in real values over time without some consistent central guidance on these changes and Abelson (2020) showed that few official guidelines recommend this practice. In my experience, few CBA studies adopt changes in real values over time. One exception is transport studies that allow the value of business travel time savings to rise over time as productivity rises. But this is a selective approach. If productivity rises over time, should returns to investment in education and health also be expected to rise over time? There is a risk that allowing for selective changes in real values over time could be distortionary.

Another unresolved practical valuation issue is the treatment of existence (or non-use) values. As we have seen, Boardman et al. (2018) has described how non-use values can be estimated. And Bos and Ruiis (2020) argue that it is possible to develop biodiversity points as a quantitative measure for biodiversity. They note that biodiversity points have been applied for over a decade in the Netherlands for measuring the impact of roads, enclosure dams, and other water management projects on the non-use value of biodiversity. They argue that biodiversity points are a simple, transparent, and standardized way to aggregate and quantify the qualitative or ordinal assessments by ecological experts.

On the other hand, Binder (2021) argues against including existence values in CBA. He argues that it is hard to ensure that existence value estimates are consistent with qualities of CBA that its proponents value: the objectivity, commensurability, and moral salience of the values analysed. He concludes that inclusion of existence values in benefit–cost analyses compromises the quality of the BCA with respect to each of these criteria.

Another strongly contested issue is secondary productivity gains arising from investment in infrastructure. This is a broad subject with a long history (Ferrari et al., 2019). Drawing on Infrastructure Australia (2021a), these secondary benefits may include the benefit of increased accessibility to health services, employment and education and may be of special relevance to infrastructure proposals in non-urban settings where accessibility is a major barrier to reaching these services. Also, wider economic benefits (WEBs) may arise with major urban transport projects which result in agglomeration economies (see, for example, UK Department for Transport, 2018). And the UK Treasury Green Book (2020, Annex 2) supports "Place-Based Analysis" where appraisal may include employment changes in the area under consideration and, where appropriate, "employment multipliers can be applied following the adjustment for leakage, displacement and substitution".

Suffice to say here, these are contested views. Johansson and Kristrom (2016, p. 195) write: "It is extremely difficult to show that an individual investment has noticeable agglomeration benefits (while proponents of infrastructure investments often claim that they are socially profitable due to their agglomeration economies)". Boardman et al. (2018) makes no subject index reference to agglomeration economies, wider economic benefits or place-based analysis. For a sceptical overview of the various claims for wider economic benefits, see Abelson (2019).[27]

Turning now to the treatment of risk and uncertainty. As we saw in Section 6, the economics profession now largely supports the use of Monte Carlo analysis for describing uncertain outcomes (or more precisely risky outcomes).[28] However, practice has not caught up. In the writer's

[27] And the European Commission (2021, p.21) states that wider impacts achieved through the multiplier effect (e.g. contributions to regional gross domestic product or unemployment rates) should be excluded from the analysis because they are usually transformed, redistributed and/or capitalised forms of the direct effects already captured in the CBA.

[28] Traditional decision analysis distinguishes between risk and uncertainty. With risk, the probabilities of possible outcomes are known; with uncertainty, those outcomes are known, but not their probabilities.

experience, most CBAs report simple sensitivity tests, usually without any indication of probabilities, which are designed to show that simple changes in assumptions do not change the predicted central outcome. While it may often not be necessary to undertake a full Monte Carlo analysis, ignoring probabilities is a significant weakness of common current practice. Also, in the writer's experience, CBA reports often work with forecast P50 costs, assuming a normal distribution of costs, rather than with expected (mean) costs, which are almost always higher than P50 costs.

Another ongoing issue is the hidden treatment of equity in CBA. As we have seen, values of life and usually of health treatments, the value of leisure travel time savings, and the values of some environmental goods are usually taken as uniform across relevant societies. The Green Book (2020 p.62) states that "On grounds of equity in appraisal, the VPF, QALY and SLY values are based on average values from representative samples of the population". And most of the non-market valuations described in Annex 1 (*ibid*.), including values for environmental and natural capital, air quality, noise, waste recreation, amenity values, landscape, water resources and water quality, climate change, biodiversity, greenhouse gas emissions, appear to be average values. On the other hand, the benefits of educational services, water and sewerage services, business travel time savings or access to open public spaces are usually based on the amounts that the beneficiaries are willing to pay for these services. Of course, where beneficiaries do pay, the benefits may be redistributed. But more clarity on when to use average (equal) and individual (unequal) values would help.

Finally, I turn to chronic appraisal optimism, sometimes referred to less courteously as *appraisal bias*. Appraisal optimism has been long recognised by the UK Treasury Green Book. In the 2013 edition, the UK Treasury wrote: "There is a demonstrated, systematic, tendency for project appraisers to be overly optimistic". Drawing on a sample of 2062 infrastructure investments in 104 countries, covering dams, bus rapid transit, rail, tunnels, power plants, buildings, bridges and roads, Flyvberg and Bester (2022) found that average cost overruns were around 40% and that benefit overestimates averaged about 10 per cent, but with many substantial variations. Abelson (2020b) provides further evidence of chronic appraisal optimism over time.

Thirty years ago, Little and Mirrlees (1991) reviewed cost-benefit studies over the previous 20 years in the World Bank and found chronic appraisal optimism. In their words: "The difficulty is that appraisers will be judged on the number of "good" projects they find relative to the numbers others find… Worse than this, project analysts would never get promoted if they were honestly compelled to report unfavorably on several projects. Promotion would come from writing good reports that would help steer the project through the processes of approval, and not from improving projects or improving project selection. Economic rates of return on projects became more and more optimistic, without justification."

Unfortunately, the bureaucratic (political) problem identified by Little and Mirrlees appears to be common in many places some 30 years later. Problems arise especially where political commitments to projects are made without due process. The bureaucratic rewards for getting projects done are higher than the rewards for stopping projects. In a speech in 2019, the (then) Australian Prime Minister (Scott Morrison) declared that responsibility for setting policy lies with those elected. It is the job of public servants to carry out these policies. Public servants must remember that "they are on tap, not on top."[29]

[29] https://theconversation.com/scott-morrison-tells-public-servants-keep-in-mind-the-bacon-and-eggs-principle-122021.

The UK Green Book (2013 and 2020) recommends that specific adjustments for appraisal optimism should be made during the project appraisal. But this seems unlikely to resolve the optimism problem as optimists will still make the necessary adjustments to meet their views. Given the numerous behavioural biases in project planning and management cited by Flyvbjerg (2021), appraisal optimism seems likely to be here for the long run.

8 Conclusions

By the early-1970s, the core principles of CBA were well established as a procedure for measuring the gains and losses to individuals in the society of concern, based on individual preferences, using money as the measuring rod of those gains and losses. And CBA was often employed in project evaluation, principally for infrastructure projects.

Notwithstanding this on-going concurrence on the core principles, there are several on-going unresolved issues. These include when, if ever, to apply the EV principle of valuation, the valuation of losses, the handling of the marginal cost (excess burden) of public funding, existence values, the choice of the social discount rate, and the treatment of distributional issues (equity) in cost-benefit analysis. This is in large part because resolution of these issues depends on value judgements as to rights rather than simply on technical resolution.

On the other hand, over the last 50 years, there has been an extraordinary increase in the range of applications of CBA over numerous social programs, government recurrent expenditures and regulations as well as government capital expenditures. This increase in applications has been greatly facilitated by major advances in CBA methods, especially in valuation methods.

Also, partly cause and partly consequence of these changes in applications and methods, over the last three decades, many governments and quasi-government agencies in developed democratic countries have produced guides to CBA and formally adopted CBA as their first-choice evaluation method, displacing alternatives such as planning balance sheets and multi-criteria analysis.[30]

In the words of Kenneth Arrow, “The systematic use of benefit-cost analysis in determining the allocation of public expenditures has been of the greatest use in public policy."[31]

However, the adoption of CBA still has challenges. Some guides emphasise the need for strategic fit and / or meeting vague objectives such as resilience and sustainability. Behavioural economics has cast some doubt on valuations based on individual preferences. And quantitative measurement and valuation of wellbeing/happiness has emerged and is seen by some economists as an alternative to conventional CBA in some contexts.

And practical issues remain. Many CBA studies fail to meet textbook or government standards. The failures noted here include blackening base cases, selecting poor options, weak forecasting, several valuation issues, the treatment of risk, the process for dealing with equity, and chronic optimism bias.

In the words of Cass Sunstein (2018, p.215) “The cost-benefit revolution has produced immeasurable benefits. It has stopped bad things, spurred good things and turned good things into better things. But the revolution remains unfinished.”

[30] One reader pointed out that view this could reflect an Australian perspective on MCA studies. Their perspective is that, in the UK, high quality MCA studies often complement CBA studies.
[31] Kenneth Arrow testimonial on the website of the *Journal of Benefit Cost Analysis.*

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