Introduction to Cost-Benefit Analysis and Alternative Evaluation Methodologies
January 2006
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INTRODUCTION

Managers in Australian Government agencies\(^1\) are often called on to evaluate programmes and projects to ensure that they represent an efficient and effective use of public money. Cost-benefit analysis (CBA) is a method of quantitative economic analysis that is widely used to evaluate existing and proposed projects, programmes and policies, and which can inform decision-making. *Introduction to Cost-Benefit Analysis and Alternative Evaluation Methodologies* (hereafter the *Introduction to CBA*) introduces CBA in a non-technical way and outlines the basic steps for its use.

The *Introduction to CBA* also discusses two alternative quantitative methods for evaluating proposals that have broad relevance to Australian Government agencies: financial evaluation and cost-effectiveness analysis. However, the *Introduction to CBA* focuses mainly on CBA.

Three case studies are also provided. They are a cost-benefit analysis of an infrastructure proposal; a financial evaluation of a property project; and a cost-effectiveness analysis of a health programme.

The *Introduction to CBA* also includes a short technical section. Readers seeking a more technical account of these methods should refer to published texts on this matter, including *Handbook of Cost-Benefit Analysis* (hereafter the *Handbook of CBA*) published by the Department of Finance and Administration (2006).

The *Introduction to CBA* replaces the Department's *Introduction to Cost-Benefit Analysis for Program Managers* (second edition, 1995).

Although CBA is generally a useful instrument for the evaluation of projects, programmes and policies, and for showing the opportunity costs of such projects and policies, the use of CBA may not always be appropriate. CBA is also not the only relevant factor to take into account in decision-making – there are a number of factors that cannot adequately be taken into account by CBA.

CBA is only one method of evaluation. Agencies preparing evaluations may have a justified preference for using an alternative method, two of which are outlined in this *Introduction to CBA*. When performing an evaluation, the choice of evaluation methodology should be appropriately documented and defensible.

In issuing this revision, the Department of Finance and Administration would like to acknowledge the authors of the original publication as well as Professor Peter Abelson for the revised material included as part of this *Introduction to CBA*.

Department of Finance and Administration
January 2006

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\(^1\) For the purposes of Introduction to CBA, the term 'agencies' covers *Financial Management and Accountability Act 1997* Agencies and *Commonwealth Authorities and Companies Act 1997* bodies.
Overview of Cost-Benefit Analysis
A Overview of Cost-Benefit Analysis

1 COST-BENEFIT ANALYSIS – AN OVERVIEW

1.1 Explanation of cost-benefit analysis

Cost-benefit analysis (CBA) is a tool used to determine the worth of a project, programme or policy. It is used to assist in making judgments and appraising available options. CBA principles and practice are well established – as evidenced by the vast amounts of literature available from academics, CBA practitioners, and government agencies (both domestically and abroad).

CBA is a quantitative analytical tool to aid decision-makers in the efficient allocation of resources. It identifies and attempts to quantify the costs and benefits of a programme or activity and converts available data into manageable information. The strength of the method is that it provides a framework for analysing data in a logical and consistent way. CBA helps managers answer questions such as:

- Does the proposal provide a net benefit to the community as a whole?
- Should the proposed project, programme or policy be undertaken?
- Should the project or programme be continued?
- Which of various alternative projects or programmes should be undertaken?

A CBA adds rigour to a programme evaluation because, among other things, it makes explicit the links between inputs and outcomes, clarifies the underlying assumptions, and points to gaps in information. By endeavouring to express outcomes (benefits) and inputs (costs) in dollar terms, it facilitates comparisons across different types of programmes as well as options within a particular programme.

1.2 What is a CBA attempting to achieve?

A CBA is normally undertaken as one aspect of a more comprehensive assessment of a programme’s appropriateness, efficiency and effectiveness. A CBA is primarily designed to answer the question ‘does the expenditure of public money on this particular programme provide a net benefit to the Australian economy and the Australian public, bearing in mind that these resources could be applied in an alternative use?’

In principle, CBAs enable agencies to compare the relative merit of different (or alternative) programmes or projects in terms of their returns on the use of public resources. CBA may also be used to evaluate the social returns on the use of privately owned resources as in regulation reviews.

In practice, it is often difficult to provide a clear ranking of alternative demands on public funds. Another important stumbling block faced by economists in all evaluations is that the assessment depends on what would have happened without the project or programme, which has to be forecast. What is foregone when we undertake a project is known as the ‘opportunity cost’. Section 5.1 discusses opportunity cost.

It should be noted that outcomes are often achieved at a cost. For instance, if an outcome involves an agency committing public resources to ‘improve rural health services’, then individuals and social groups living in country areas stand to ‘win’. Individuals living in metropolitan areas receive no benefit from the agency using the public resources for this purpose. This can be viewed as a ‘cost’ to people living in cities. CBA does not take into account these distributional/equity issues; it is only concerned with efficiency. As such, outcomes should be interpreted as meaning benefits for the purposes of Introduction to CBA.
1.3 Types of evaluations

There are many ways to evaluate programmes and activities. However, there are three methods that have frequent relevance to Australian Government agencies. These methods are:

- CBA;
- financial evaluation; and
- cost-effectiveness analysis.

Financial and cost-effectiveness analyses are alternative methods to CBA but share some common characteristics. These alternative methods are summarised below. Section C of this Introduction to CBA provides a more extensive discussion.

Cost-Benefit Analysis

CBA is a methodology for assessing the net benefits accruing to society as a whole as a result of a project, programme or policy. Most often a CBA is conducted from the point of view of the local country or possibly the international community as well. It can, in principle, be conducted from the perspective of a state, a region, or even a local community, but such a restricted approach is less common. The appropriate time period over which a CBA should be conducted is generally the projected life of the project or programme.

The CBA method considers the flow of real resource costs and benefits, and excludes, for example, taxes and subsidies, which are regarded as transfer payments from one part of the economy to another. CBA attempts to measure the value of all costs and benefits that are expected to result from the activity. It includes estimating costs and benefits which are ‘unpriced’ and not the subject of normal market transactions but which nevertheless entail the use of real resources.

Financial Evaluation

A financial evaluation (or ‘investment evaluation’) is generally conducted from the perspective of an individual firm or agency rather than from the vantage point of the community as a whole. It is essentially concerned with assessing the impact of a programme or project on the organisation’s own financial performance. A financial evaluation can be used to answer the question of whether a proposal offers an acceptable return from an organisation’s perspective. Financial evaluations can be used for other reasons – such as determining the lowest cost procurement method – but the Introduction to CBA is primarily focussed on evaluating programmes and projects.

In a financial evaluation, only cash flows in and out of the organisation are considered; cash flows involving other parties are excluded, as are ‘unpriced’ costs and benefits. Unlike CBA, the relevant money values include the effects of taxes and subsidies on the relevant agency.
A Overview of Cost-Benefit Analysis

Cost-Effectiveness Analysis
Cost-effectiveness analysis (CEA) is aimed at determining the cost of achieving a specific physical target. Such studies may be undertaken from a national or local perspective. They differ from CBA in that benefits are expressed in physical units rather than in money units. Costs, as in CBA, are expressed in money terms. In relaxing the approach towards benefits measurement, CEA is useful in areas such as health, accident safety and education where it is often easier to quantify benefits in physical terms than to value them in dollars.

CBA is generally the preferred method when markets or prices do not adequately reflect all the costs and benefits of a proposal. When markets are competitive and most costs and benefits are reflected in market prices, financial evaluation can provide an adequate guide to the social viability of a proposal. Financial evaluation is also important when government as a whole or an agency of government has financial objectives or responsibilities to fulfil or when it is involved in a purely financial decision such as a comparison of different procurement methods (e.g. traditional government ownership vs. outsourcing). CEA is useful most often when the benefits of a proposal are difficult to quantify in monetary terms but the government wishes to know which option will achieve social benefits or government objectives most cost effectively.

1.4 Programme evaluation and CBA
Programme evaluation is essentially an assessment of a programme, or part of it, in order to aid judgments about its appropriateness, efficiency and effectiveness. Programme evaluations encompass policy/programme reviews, efficiency (or process) and effectiveness (or impact) evaluations, post-implementation reviews, major enquiries and some audits.

The term ‘appropriateness’ refers here to the extent that the outcomes of the programme match Government policy and priorities and community needs. ‘Efficiency’ is concerned with the net impact on community welfare and defined in terms of how well outputs are maximised for a given level of resource inputs, or resources minimised for a given level of output. ‘Effectiveness’ is concerned with the extent to which programme outcomes achieve stated objectives.

CBA is a useful tool in programme evaluation. It examines whether a particular use of resources generates net returns. A particular use of funds may be effective in terms of achieving the objectives of a programme, but may still generate a negative net return to the community if the benefits from these objectives are judged not to be worth the costs involved. Alternatively, an investment could achieve a positive return for the community but fall short of achieving the objectives of a particular programme.

It is important to note the distinction between outputs and outcomes in a government programme context. Outputs are physical deliverables over which managers have a high degree of control whereas outcomes reflect the real programme impacts or benefits.
1.5 What if outcomes are difficult to value?

If outcomes cannot be quantified in money terms, it is not possible to undertake a formal CBA. However, there is an increasing volume of economic literature directed towards finding ways to attach dollar values to benefits so they can be measured on the same basis as costs, thus allowing comparisons to be made between alternative uses of public funds. For example, additional future earnings of trainees compared with what they would have gained otherwise may provide an indication of the benefit of a training programme. When valuing the cost of aircraft noise, the difference between house prices under aircraft flight paths and those not under them may provide a reasonable guide. However, while useful, the estimation of dollar values in such circumstances often involves a significant degree of judgment and imprecision.

Another alternative is to quantify benefits as much as possible and determine ratios of the quantity of benefits per dollar spent, i.e. undertake a cost-effectiveness analysis. This approach may be useful when specific physical outcomes are compared but provides little policy guidance when comparing different outcomes, such as lives saved and children educated.

1.6 CBA in practice

In practice, CBA studies are diverse in terms of size, sector, approach and impact. Typical examples undertaken by Australian Government agencies include CBAs of infrastructure proposals (e.g. roads, dams, rail), agricultural, environmental, and scientific research, information technology and property sales/acquisitions.

The assessment of costs and benefits is also undertaken in determining the impact of proposed regulation. The Office of Regulation Review’s Guidelines for Commonwealth Regulation Impact Statements3 requires officers to analyse and document, through a Regulatory Impact Statement (RIS), the costs and benefits of all options considered. Agencies should refer to this document or the Office of Regulation Review for further guidance in preparing a RIS and advice on whether a RIS is required.

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3 Refer to Part B of the Office or Regulation Review's publication A Guide to Regulation (December 1998).
## 2 WHY UNDERTAKE A COST-BENEFIT ANALYSIS?

The main reason for undertaking a CBA is to determine whether a project, programme or policy will make the wider community better or worse off. In other words, whether the net impact of the project is positive or negative. Some of the key benefits of undertaking a CBA are discussed below.

### 2.1 CBA facilitates meaningful comparisons

CBA aims to quantify the net benefits to the Australian public of a proposal (expressed in terms of money value, percentage return or ratio). This provides a common basis for comparison with any other proposal that has been similarly assessed.

In principle, the standardised framework means proposals from very different areas can be compared. However, there are often risks in basing a decision on the results of studies that do not share common objectives or a common framework of assumptions. Provided this common base is achieved, the method can be a very useful aid to decision-makers. For example, road upgrading proposals can be compared with proposals to upgrade rail, or even to upgrade a hospital, despite major technological and institutional differences between the contexts.

### 2.2 CBA is conducive to good programme management

The basic idea of CBA is that it reflects the value of a programme or project to the community. In the process, the value to key stakeholders will also be estimated. For example, in conducting an evaluation of a rehabilitation service, the value to the recipients of the service would be determined, whether in terms of long-term lifetime earnings, enhanced sense of personal well-being, or some other significant factor.

For a further example, in the evaluation of a proposed extension to a national park, estimates of the value placed on it by those who benefit and lose from the extension would need to be determined. Users may be tourists, scientists, neighbouring farmers, viewers of television documentaries or others. CBA can contribute to good programme management because it is concerned with efficiency and is sensitive to the priorities of key stakeholders’ needs.

### 2.3 CBA and distributional impact

A key advantage of CBA is that it provides a quantitative measure of the net benefit of an investment, allowing direct comparisons between dissimilar projects. Unless programmed otherwise, equal weight is accorded between winners and losers.

The cost-benefit process implicitly estimates the size of gains and losses for affected individuals and groups. This information is important in public sector decision-making and should be made explicit because it is important to identify those who stand to gain and lose from a programme or project.
2.4 CBA encourages clear thinking about the true ‘value added’

A CBA provides an estimate of the worth of a proposal relative to an accompanying estimate of what would happen in the absence of the proposal. The difference between these values can be viewed as the ‘value added’ from adopting a proposal. For example, suppose that the benefits of a new overseas marketing campaign to promote Australia as a holiday destination are estimated in terms of new visitors attracted to Australia. It is first necessary to estimate the number of new visitors who would have been attracted in the absence of the advertising. While this may appear an obvious point, it can be easily overlooked, resulting in an inaccurate estimate of the net benefits that can be attributed to the campaign.

2.5 CBA as integral to an evaluation strategy

A rigorous evaluation process should generally be based on multiple lines of evidence. The conclusions are more robust and more credible if the evaluation process involves a number of discrete analyses. With CBA’s emphasis on the quantification of costs and benefits on a comparable basis, it is a useful technique to add to an evaluation strategy which includes other methods as well.

2.6 CBA can help to meet legislative requirements

Agencies subject to the Financial Management and Accountability Act 1997 (FMA Act) are required to use Commonwealth resources in an efficient, effective and ethical manner. A CBA will determine whether there is a net benefit to the Australian community in adopting a policy proposal. Where there is a net benefit, its implementation may be considered efficient. In terms of the ethical use of Commonwealth resources, a CBA requires the consideration of equity and other social issues. Section 4.7 of this Introduction to CBA discusses equity and other distributional issues.

Officers of authorities and companies subject to the Commonwealth Authorities and Companies Act 1997 (CAC Act) should exercise care and diligence in making decisions impacting on their entities. A CBA may be utilised by officers as a tool to aid decision-making. As discussed above, CBA principles and practice are well established and widely used.

The decision to conduct a CBA, and the manner in which it is conducted, is ultimately a decision for each FMA Act agency and CAC Act body.

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4 Assuming that the net benefit of adopting the proposal exceeds the net benefit of the ‘before’ situation.
A Overview of Cost-Benefit Analysis

3 WHEN IS A COST-BENEFIT ANALYSIS USED?

CBAs can be used to guide a wide range of decisions. For the purposes of this *Introduction to CBA*, however, four contexts for the use of CBA of particular relevance to Australian Government agencies will be covered. These are briefly discussed below.

3.1 Analysing capital expenditure

Many projects involve capital expenditure for a new or replacement capital project. Capital projects, including buildings and equipment but also other forms of infrastructure and productive investment, should be subjected to an analysis of their costs and benefits over their lifetime. Key questions are whether or not to undertake the investment, whether to undertake it now or later, and which option to choose.

3.2 Analysing a policy option

In principle, any proposal or policy option can be subjected to CBA. Policies almost always confer benefits on some parties and impose costs on others. These benefits and costs can be valued in the same way as benefits and costs arising from capital expenditures. However, the qualification ‘in principle’ is important because benefits and costs may be difficult to quantify. Those proposals that involve minimal or no external costs and/or external benefits present little difficulty. As previously noted, in such cases where there are minimal non-market effects, financial analysis can also be used to evaluate policies.

3.3 Using or disposing of an existing asset

A CBA can be undertaken where an agency is considering the retention or disposal of an existing asset. CBAs can address issues such as whether or not to sell land, whether to relocate facilities, and whether to repair an asset or to replace it.

3.4 Post evaluation of a project or programme

CBA provides a valuable means of determining whether or not a particular programme or project has generated a net benefit for the community. Used retrospectively instead of prospectively, the known outcome from the activity, in terms of both costs and benefits, can be compared with what would have happened in the absence of the project, which is often described as ‘the counterfactual’. This provides transparency and accountability in reporting on how well public funds have been spent. It is also useful for technical reasons as it provides evidence on the validity and appropriateness of assumptions, forecasts and analyses used in future decision-making.
3.5 Quantification issues

In each of these cases, quantification of the effects in money terms is an important part of the evaluation. However, projects or proposals frequently offer benefits that have no market value and are difficult to quantify. For example, the benefits of a health programme that is designed to improve the quality of human life lend themselves more readily to a qualitative rather than quantitative assessment. In this instance, a cost-effectiveness analysis based on ‘number of lives saved per dollar spent’ could be employed (see Section C).

However, there are various techniques for making quantitative estimates, which allow more proposals to be appraised using CBA. The two main general approaches are known as ‘revealed preference’ and ‘stated preference’ methods.

Revealed preference methods allow an analyst to infer values from actions (in markets or elsewhere). For example, one revealed preference method involves measuring prices in markets that are distinguished only by an externality. As an illustration, the cost of aircraft noise disturbance on the community can be estimated by comparing house prices in noise-affected areas with prices of similar houses in similar areas but which are not subject to aircraft noise. Provided the houses in the two areas are otherwise comparable, the difference in price approximates the value the community places on the noise nuisance.

Stated preference techniques are a generic term for asking people in one or other way about their preferences. They are used especially where no market actually exists. For example, surveys may be used to estimate how much people are willing to pay to preserve a natural wilderness area. These monetary amounts are taken to represent what people are willing to give up (i.e. trade-off) to secure preservation of the wilderness area. Both stated and revealed preference methods of valuation are described in Appendix III of the Handbook of CBA.

Where the benefits of a proposal are difficult to quantify in monetary terms, then a cost-effectiveness analysis may be preferred to a CBA. Cost-effectiveness analysis is covered under Section C in this Introduction to CBA.
SECTION B

Conducting a Cost-Benefit Analysis
4 COST-BENEFIT ANALYSIS – EXPLANATION OF THE PROCESS

This Introduction to CBA proposes a structured process for conducting a CBA which agencies are encouraged to follow. However, agencies are ultimately responsible for their own programme and project evaluations and can use alternative approaches at their discretion.

The purpose of a CBA, like any policy analysis, is to provide information that will materially assist decision-making. The basic steps for conducting a CBA are illustrated in Figure 1 and discussed below. The assessment involves identifying, quantifying and, where possible, valuing in money terms the costs, benefits and uncertainties of each option. It also involves quantifying costs and benefits that occur at different points in time on a comparable basis.

Figure 1 Key steps in the Cost-Benefit Analysis Process
4.1 Determine scope and objectives

The first step is to outline the nature of the problem to be addressed: its background, context and rationale. The information presented at this stage should also provide an initial indication of how appropriate the objectives of the initiative are in relation to current Australian Government priorities and/or community needs. These objectives should be defined, initially, in terms of the market failure or market imperfections that could warrant government intervention. Following this, the outcomes expected from undertaking the proposal should be identified. They should be clearly distinguished from the means of meeting them. Further, the objectives should not be so general that it will be difficult to establish subsequently whether, or to what extent, they have been met.

The following table includes questions to assist agencies in determining appropriate objectives.

<table>
<thead>
<tr>
<th>Questions to Consider in Setting Objectives</th>
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<tbody>
<tr>
<td>• What is the programme, project or activity trying to achieve?</td>
</tr>
<tr>
<td>• How do these achievements relate to the agency’s objectives?</td>
</tr>
<tr>
<td>• Do the objectives take into account the interests of the economy and the Australian public?</td>
</tr>
<tr>
<td>• What factors are critical in achieving the objectives?</td>
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<tr>
<td>• Are the objectives measurable?</td>
</tr>
<tr>
<td>• Do the objectives reflect outputs or outcomes?</td>
</tr>
<tr>
<td>• Are the objectives consistent with relevant Australian Government policies?</td>
</tr>
</tbody>
</table>

4.2 Assess the constraints

The next step is to identify the constraints in meeting the objectives to ensure all alternatives examined in the analysis are feasible. Constraints may be financial, distributional, institutional, managerial, environmental and political in nature.

4.3 Consider the alternatives

A CBA involves the identification and specification of a set of alternatives. In most cases, a ‘do nothing’ option should be included as a base case. This option is generally required because costs and benefits are nearly always measured as incremental to what would have happened had the project not gone ahead.
B Conducting a Cost-Benefit Analysis

While it is important to provide decision-makers with a range of options, the process of developing and analysing these can be expensive and time consuming. For major investments, it may be necessary to outline various potential options and then to have decision-makers select, after a preliminary screening, a smaller number for detailed appraisal. In any case, an appropriate level of consultation should be undertaken as best practice, either formally or informally, in creating a set of alternatives.

To illustrate, take the case where an agency is considering whether to purchase a commercial property. The CBA should cover alternative options facing the agency, such as doing nothing, acquisition of the property, or upgrading/renovating the existing property.

4.4 Identify, quantify and value the costs and benefits of each alternative

A critical step in the CBA process involves identifying, quantifying and valuing the costs and benefits of each alternative. The types of benefits and costs will depend on the project. To illustrate, consider the construction of a toll motorway to relieve traffic congestion. Relevant costs would include the labour, capital and material costs to construct the road and the value of the land as reflected in the loss of the use of the land for alternative purposes. Benefits of the motorway would include lives saved, reduced travel time (which generally results in fuel and productivity benefits) and possibly the reduction of traffic on alternative routes, including the impact on inlet and outlet roads.

Typical costs of a proposal would include:

- initial capital costs;
- capital costs of any buildings, equipment, or facilities that need to be replaced during the life of the project;
- operating and maintenance costs over the period of a programme or project; and
- costs which cannot be valued in money terms (often described as ‘intangibles’).

Typical benefits of a proposal would include:

- benefits which can be valued in money terms, in the form of revenues, cost savings or non-market outputs; and
- benefits which cannot be valued in money terms (also described as ‘intangibles’).

Estimating the magnitude of costs can be difficult and will normally involve input from accountants, economists and other specialists.
The conceptual basis for valuing costs in CBA is their ‘opportunity cost’. Implementing a programme or policy requires the use of resources (or inputs) that could be utilised elsewhere. The opportunity cost reflects the benefits forgone by society in not using these resources for an alternative purpose. The opportunity cost of a resource is measured by its value in the ‘next best’ or most valuable alternative use. Refer to Section 5.1 for a discussion of opportunity cost in practice.

Intangible costs and benefits are those that cannot be assessed realistically in actual or approximate money terms, for example, some health and education benefits, and some illiteracy and environmental degradation costs. Such costs and benefits should be identified and quantified to the extent possible (for example, the cost of avoiding downstream pollution may be regarded as a proxy for the cost of pollution). Projects where a substantial amount of the benefit is intangible may be better evaluated using cost-effectiveness analysis.

Costs and benefits occurring at different time periods need to be set on a comparable basis. Normally they should be expressed in ‘real terms’ (this is, in constant prices) at the price levels prevailing in the year the analysis is carried out because inflation simply raises the values of all costs and benefits of future years by a given percentage. However, where the price of a particular good or service is expected to increase or decrease significantly more or less than the general rate of inflation (for example, oil prices may be expected to move faster or slower than general inflation), these changes in relative prices also need to be accounted for in the analysis.

Market prices will not exist for all goods and services. Furthermore, the prevailing prices may not reflect their ‘real value’ in the economy. Prices are distorted through taxes, subsidies and regulations that affect prices. Also, for some benefits and costs there is no established market (e.g. clean air). CBA attempts to take account of ‘real value’ by adjusting for such distortions.

Importantly, all estimates of costs and benefits, even those that relate to well-known market resources or goods are subject to uncertainty and risk. Future costs and benefits cannot be forecast precisely. In some cases, the unknowns or risks are particularly high. In these cases, the recommended procedure is first to make the best average estimates of each cost and benefit and to forecast the average net social benefit or net present value that is likely to occur given the range of risks and uncertainties. Secondly, the analyst should estimate and show the range of outcomes that is likely to occur. This is usually done by sensitivity tests that show how the estimated net present value will change with changes in key variables. A full risk analysis would provide a complete distribution of possible outcomes allowing for a full distribution of all key variables.

Undertaking a CBA generally involves a degree of judgement. Individuals involved in an evaluation can often hold overly optimistic views in setting the costs, benefits and time profile of a project or activity. This behaviour is known as ‘optimism bias’. To counter this bias, appropriate adjustments can be made to the costs, benefits and time profile of the project or activity. Calculating adjustments for optimism bias is beyond the scope of these guidelines.

5 The UK Treasury’s Green Book - Appraisal and Evaluation in Central Government (pp.85-87) and Supplementary Green Book Guidance – Optimism Bias provide useful guidance on optimism bias.
Conducting a Cost-Benefit Analysis

The Introduction to CBA has thus far ignored that projects financed through tax revenue may result in further costs to society. That is, the imposition of a tax results in a deadweight loss – the excess tax burden. A related concept is the marginal excess tax burden which measures the change in deadweight loss resulting from an increase or decrease in tax. Refer to the Handbook of CBA for a comprehensive discussion of the excess tax burden, the marginal excess tax burden, and its relevance to CBA.

4.5 Calculate the Net Present Value

In CBA, the net social benefit (NSB), or the excess of total benefit over total cost, is represented by the net present value (NPV) of the proposal. Before determining the value (or NPV) of a proposal, the costs \( C \) and benefits \( B \) need to be quantified for the expected duration of the project. The NSB is calculated by subtracting the cost stream from the benefit stream and is represented as follows:

\[
NSB = B - C
\]

The NPV of a proposal is determined by applying a ‘discount rate’ (discussed below) to the identified costs and benefits. It is necessary to ‘discount’ costs and benefits occurring later relative to those occurring sooner. This is because money received now can be invested and converted into a larger future amount and because people generally prefer to receive income now rather than in the future.

Valuing each alternative by calculating NPVs facilitates comparison between proposals that exhibit different timing of their benefits and costs. Programmes with positive NPVs generally indicate an efficient use of the community’s resources.

The NPV is calculated as follows:

\[
NPV = \sum_{t=0}^{t} \frac{(B_t - C_t)}{(1+r)^t}
\]

where:
- \( B_t \) is the benefit at time \( t \);
- \( C_t \) is the cost at time \( t \); and
- \( r \) is the discount rate.

Where all projected costs and benefits are valued in real terms, they should be discounted by a real discount rate. This can be estimated approximately by subtracting the expected (or actual) inflation rate from the nominal discount rate. If nominal (current price) values are used for projected costs and benefits, they should be discounted by a nominal discount rate. Section 5.3 discusses discount rates from a conceptual and practical perspective.
The discount rate can also be varied to test the sensitivity of the proposal to changes in this variable and, implicitly, to the phasing of costs and benefits. Sensitivity analysis is discussed in Section 4.6 below.

The Internal Rate of Return (IRR) is typically presented as supplementary information to the NPV. The IRR is the discount rate that will result in a NPV of zero. The project’s IRR needs to be above the benchmark discount rate for the project to be considered viable (financially or economically, depending on the nature of the analysis).6

4.6 Sensitivity analysis and dealing with uncertainty

The values of future costs and benefits on which the NPV is based are forecasts that cannot be known with certainty. While they should be forecast expected values, it is important to test the NPV for ‘optimistic’ and ‘pessimistic’ scenarios. This is achieved by changing the values of key variables in the analysis, such as the discount rate, costs and benefits, and measuring the impact of the changes on the NPV. This is known as sensitivity analysis and is a critical component of any CBA.

Where the NPV is shown to be very sensitive to changes in a variable, the analyst should check on the appropriateness and impact of this variable, and whether any changes to the design of the programme or underlying assumptions are warranted.

Uncertainties, or situations with unknown probabilities, that could have a significant impact on the project outcome should be clearly detailed in the report and, if necessary, monitored during implementation. When dealing with uncertain data, the expected value should be used. The expected value is the weighted sum of the likely outcomes (each outcome having its own probability of occurring). In order to attempt to quantify the likely impact, a probability may be assigned to a particular variable where dealing with uncertain data. These probabilities are then used as weightings in order to derive an expected value.

For example, assume a proposal that has two possible outcomes. The probability of producing an NPV of $5 million is 60% and the probability of producing an NPV of $3 million is 40%. We can now work out the expected NPV (ENPV) as follows:

\[
\text{ENPV} = (0.6 \times \$5m) + (0.4 \times \$3m) = \$4.2m
\]

The expected NPV in this situation is $4.2 million. However, such a single value may not fully convey the uncertainty associated with forecasting the outcome. Hence, it is generally appropriate to present the results as a range that includes the most likely results, as well as results in possible best and worst case scenarios.

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6 Mishan’s Cost-Benefit Analysis (1982, pp 221-224) provides a detailed explanation of the IRR, describes how to measure it, and provides an example to illustrate. See also Department of Finance and Administration the Handbook of CBA (2005).
4.7 Consider equity and distributional implications

There may also be broader social justice considerations where a project involves a significant redistribution of income, regardless of the net economic gains to the community. For example, a limitation may arise if the costs fall on low-income earners and the benefits accrue to higher income earners. Cost-benefit analysts should provide programme managers and policy makers with an indication of the income distributional effects of a proposal. This may be useful where distributional impacts rather than economic efficiency are the objective.  

Benefits are typically measured in terms of estimated willingness to pay prices for a good. However, willingness to pay is generally constrained by income and wealth, which are not distributed equally in the community. In these circumstances, the project’s NPV may be considered an inadequate measure of its worth to society and decision-makers would need additional information on the distributional consequences of the project to determine its overall merit.

Due to the potential redistributive impact of a proposal, determining the ‘winners’ and ‘losers’ (along with the size of their wins and losses) is important. However, this is an equity consideration. CBAs aggregate costs and benefits across individuals, without regard to the distribution of those costs and benefits between individuals. To illustrate, a CBA of a new highway that bypasses a country town will compare, primarily, the costs of constructing the new road with the benefits in terms of travel time savings and reduced accidents (involving both travelers and local residents). However, building the road is likely to have distributional consequences: for example, retailers in the town may be adversely affected while new retailing opportunities — such as service stations, restaurants and motels — may open up along the new highway. These distributional consequences are not captured by the CBA.

4.8 Report the results and prepare a recommendation

The final stage in the CBA process is to write up the analysis and prepare recommendations. The reasons for a particular recommendation should be clearly set out. It is important to highlight the assumptions used in forecasting the costs and benefits of the proposal or programme. Ideally, the ‘critical assumptions’ would appear at the beginning of the report. The detailed analysis including the full list of assumptions can be included in an appendix or supplementary report depending on their scale and complexity. The report is designed to document and increase the transparency of the process. It is important that sufficient detail be provided to allow the results to be replicated by an interested reader.

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7 Other categories besides income may be considered when assessing the distributional effects of a proposal. These categories could include race, age, sex, region, family size, occupation and educational background.

8 There is no standard format for presenting CBA results. In the Handbook of Cost-Benefit Analysis (2005), Finance recommends that the key results be summarised on a one-page worksheet.
Conducting a Cost-Benefit Analysis

The report should include the following information:

**Information to be Included in CBA Report**

- Executive summary outlining the critical assumptions, key results and recommendation(s)
- Background to the analysis – why it was undertaken
- Objectives of the project, programme or activity
- Key risks associated with the proposal
- Outline of alternatives considered
- Time profiles of costs, benefits and net benefits
- Key assumptions underpinning the analysis
- The discount rate applied
- NPV calculations
- Sensitivity analysis
- Other important information including distributional effects, other quantified costs and benefits, and intangible costs and benefits
- Comparison of the preferred option to alternatives
- How the outcome of the proposal could later be evaluated
- Concluding comments
5 TECHNICAL TOPICS

This section will discuss some common technical issues faced when performing a CBA. As noted previously, the *Handbook of CBA* and an abundance of literature from practitioners and academics examine the technical aspects of CBA.

5.1 Opportunity cost in practice

In CBA, the concept of opportunity cost is fundamental. The cost of using a resource is the cost of forgoing the best alternative use. Normally, this means valuing a resource on the basis of actual market price or, in the absence of market prices, on estimates of the amount that a producer is willing to pay for it. The latter approach may be relevant for public sector physical assets, such as prisons, hospitals or airports that may not be readily adaptable to other purposes. Note: willingness to pay is the *maximum* value placed by a firm or individual on a resource or on a good or service in monetary terms. The valuation takes into account both the market price and any producer or consumer surplus.

Externalities, for which there may be no direct market signals, can be significant. Externalities are impacts on third parties that are not the primary parties (producers or consumers) in an economic exchange. They may be benefits (or costs) received by third parties who are not required to pay. Externalities can be ‘positive’ (i.e. benefits) or ‘negative’ (i.e. costs). National defence represents a ‘positive’ externality. An example of a ‘negative’ externality to the community is the air pollution resulting from a manufacturing plant.

Valuation of ‘externalities’ is often complex. It may involve revealed or stated preference methods. The former includes methods such as the analysis of consumer behavior in related markets. The latter includes surveys in which consumers state their preferences on the basis of a hypothetical market (contingent valuation). Alternatively, the analyst may estimate threshold values usually based on the costs of eliminating an externality (such as the cost of cleaning up pollution).

5.2 Project length of life – time horizon and terminal/residual value

A CBA requires careful consideration of the project length of life (generally measured in years). A project or programme should generally be appraised over its projected life. For facilities such as roads or bridges, this generally accords with estimated physical lifetime.

When conducting a CBA, all of the benefits and costs of a programme or project should generally be discounted over the life of the programme or project. However, when assessing programmes or projects with long lives, it may be appropriate for the CBA to be conducted on the basis of a shorter timeframe (the useful life). Adopting a shorter time frame may be a valid approach as uncertainty with forward estimates increases with increasingly extrapolated data and, over extended time horizons, the process of discounting typically makes distant costs or benefits insignificant relative to the present. Where a shorter timeframe is adopted, it is critical that a terminal value be included in the CBA, to reflect all subsequent benefits and costs. Sensitivity analysis should then be performed on the terminal value that has been accepted.
For example, a rail corridor may have an indefinite or very long life. However, its useful life may be more closely correlated with the useful life of the rail track itself – perhaps 20, 30 or 50 years.

Care is needed in comparing two options with different lengths of life where there may be continuing need for (or benefit from) the product in question. One way is to focus on the life of the most critical items, and include replacement costs for other items as they fall due. Another approach is to extend both options into the future as far as is necessary to find a common ending date – a ‘lowest common multiple’ approach. For example, to compare a four-year project and a six-year project, both could be extended to a 12 year project life. However, this approach may not always be feasible or appropriate. For example, if a project does not extend for the assumed length of time, then this approach may distort the evaluation result. An alternative approach is to calculate an annualised value or ‘equivalent annual cost’ for the capital values of each option.

5.3 Setting a discount rate

**Theory of discounting in CBA**

It is necessary to discount costs and benefits occurring later relative to those occurring sooner since money has an opportunity cost – money received now can be invested and converted into a larger future amount. While discounting costs and benefits is integral to conducting a CBA, a critical consideration is the discount rate used. Three distinct discounting methods are briefly outlined. They are discussed in greater detail in the *Handbook of CBA*.

1. **Private Time Preference Rate and the Social Time Preference Rate:**

Most individuals prefer present to future consumption – commonly referred to as ‘time preference’, which is measured by the real interest rate on money borrowed or lent. The rate at which individuals are willing to trade present for future consumption is known as the ‘private time preference rate’ (PTPR). Suppose that, in present day prices, an individual requires $103 next year in return for giving up $100 now, her real private time preference rate is 3 per cent. A method closely related to the PTPR is the Social Time Preference Rate (STPR). The STPR represents society’s preference for present against future consumption. One of the major differences between the two methods is that the STPR is measured from a society perspective, while the PTPR is measured from the perspective of an individual. It should also be noted that the STPR may allow for inter-generational values that are not measured by the PTPR and the rate tends to be lower than the PTPR. Discounting using the PTPR or the STPR is appropriate where the costs and benefits are measured in terms of consumption.

2. **Social Opportunity Cost of Capital:**

However, in most cases, making an investment implies giving up one or more other investments. The value given up is the social opportunity cost of capital (SOC). This reflects the rate of return on the investment elsewhere in the economy that is displaced by the proposal (rather than consumption discount rate). In other words, it is the return forgone by implementing a proposal.
3. Project-Specific Cost of Capital:

When a project has a specific source of finance, it may be appropriate to discount the future costs and benefits using a project specific cost of capital. This method is based on the Capital Asset Pricing Model (CAPM) framework. It relates to specific government activities and is based on estimated rates of return in the private sector for similar activities.

These are the main bases for discount rates. However, as discussed in detail in the *Handbook of CBA*, there are still further possible bases for a discount rate.

4. Level of the discount rate

The discount rate application can vary considerably between countries. For example, the US Office of Management and Budget recommends a rate which “approximates the marginal pretax rate of return on an average investment in the private sector” whereas HM Treasury (UK) recommends that a social STPR be used in some circumstances.

It can be argued that the level of the discount rate should reflect the type of project being evaluated. Hence, where a proposal represents a social or health programme that could only be provided by government, the choice of discount rate would take into account the fact that a commercial return is not the objective. Regardless of the basis for the selection of discount rate, CBA reports (see section 4.8) should explain how and why the discount rate was selected.

Non-systematic risks should be accounted for directly (for example, via expected cash flows) rather than being incorporated into the discount rate.

Agencies should be aware that a three tiered, risk weighted discount rate framework will be determined based on the CAPM framework, for varying levels of risk in agencies’ property proposals. Other discount rates may be determined for particular types of projects in the future. Agencies should contact the Department of Finance and Administration to discuss the relevant rates.

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10 Refer to HM Treasury’s *Appraisal and Evaluation in Central Government*.

11 Agencies should consult with Budget Group within Finance in setting their discount rate.
5.4 Decision rules

Various decision rules are widely used in the CBA of projects and programmes. The NPV is the preferred selection criterion because of its simplicity, generality and intuitive appeal. The NPV of a proposal must be greater than zero. There are, however, other common rules in addition to NPV such as the IRR and the Benefit-Cost Ratio (BCR). Section 5.6 provides an example of how to calculate the BCR.

The IRR is the discount rate at which the NPV of the project is zero. The decision-maker is implicitly asked to make a judgment as to whether this rate of return is ‘acceptable’ or not. If the recommended discount rate were 8 per cent (in real terms), then projects having an IRR greater than 8 per cent would be regarded as ‘acceptable’. The IRR criterion is commonly used by international financial institutions.

The BCR can be estimated in two ways. One method is to calculate the present value of benefits to the present value of costs. Another method is to calculate the ratio of the present value of net recurrent benefits to the present value of capital costs. An advantage of the latter is that it indicates the return on capital employed. However the former is possibly used more often. In either case, a ratio of greater than 1 (one) shows there is net benefit to a particular project having considered the present values of the costs and benefits. The BCR should always be greater than 1 in order for the benefits of a proposal to exceed the associated costs.

While both the IRR and BCR have intuitive and presentational appeal, they may not be appropriate in certain circumstances. The IRR may mislead where alternative projects differ in scale or where projects have different lengths of life. BCRs may also give incorrect rankings when projects differ in size. While BCRs are useful for ranking a number of projects they are sensitive to the way costs are defined and may not generate a definitive outcome. It is therefore recommended that the rules be used only as supplementary information to the consideration of the NPV for a project.

5.5 Treatment of depreciation and interest

CBAs are conducted on a cash accounting basis. The full cash cost of a capital item is recorded in the analysis at the time of purchase so that over the life of the project the item can be considered to be depreciated in full.

Depreciation is an accrual accounting concept. It allows an annual expense for capital items. However, it is a non-cash expense (cost) and should not be included in a CBA. To do so would be a form of double counting because the full cost is allowed for at time of purchase. When a project extends beyond actual life of an asset, the cost of replacing it is simply included in the cash flow in the year when it would be replaced, and provision made for any residual value at the end of the project life.

Interest payments are also excluded from the cash flow in CBA because they are implicitly reflected in the process of discounting.
Conducting a Cost-Benefit Analysis

5.6 Examples of how to calculate the NPV and the BCR

Example 1 - Calculating the Net Present Value

The example below assumes a project with a life of 5 years.

Note: A real discount rate \( r \) of 8% is used. The discount factor is calculated as follows:

\[
\text{Discount factor} = \frac{1}{(1+r)^t}
\]

For example, the discount factor for year 3 (i.e. \( t = 3 \)) is calculated as follows:

\[
\text{Discount factor (for year 3)} = \frac{1}{(1 + 0.08)^3} = 0.794
\]

<table>
<thead>
<tr>
<th>(1) Year</th>
<th>(2) Cost (Sm)</th>
<th>(3) Benefit</th>
<th>(4) Discount factor for 8%</th>
<th>(5) NPV of costs = (2)x(4)</th>
<th>(6) NPV of benefits = (3)x(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>0</td>
<td>0.926</td>
<td>37.036</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>15</td>
<td>0.857</td>
<td>25.719</td>
<td>12.860</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>30</td>
<td>0.794</td>
<td>15.876</td>
<td>23.814</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>60</td>
<td>0.735</td>
<td>14.700</td>
<td>44.100</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>90</td>
<td>0.681</td>
<td>10.209</td>
<td>61.254</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>103.540</strong></td>
<td><strong>142.030</strong></td>
<td></td>
</tr>
</tbody>
</table>

The project is expected to produce a net benefit \([= \text{NPV (benefits)} - \text{NPV (costs)}]\) of $38m \([= $142m - $104m]\).

Example 2 - Calculating the Benefit-Cost Ratio

Using the simpler benefit-cost ratio (BCR), it can be represented as follows:

\[
BCR = \frac{\text{Net Present Value of benefits}}{\text{Net Present Value of costs}}
\]

Using the data provided in Example 1 above, the BCR is calculated as follows:

\[
BCR = \frac{142.03}{103.54} = 1.37
\]

Therefore, the BCR for the project is 1.37
6 FINANCIAL EVALUATION

6.1 What is financial evaluation?

A financial evaluation attempts to determine the net financial benefit (or loss) to an agency rather than the net benefit (or loss) to the economy or society. Financial evaluations are only concerned with cash flows in and out of the organisation.

With financial evaluation, the comparison is between the cash receipts and the cash expenditures of an activity, which in turn yields a net cash flow. Therefore, a financial evaluation is essentially a straightforward cash flow analysis. In a financial evaluation, no account is taken of external costs or benefits.

The key differences between a financial evaluation and a CBA are summarised in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Financial analysis</th>
<th>Cost-benefit analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perspective</td>
<td>Agency/organisation/Firm</td>
<td>Economy, society</td>
</tr>
<tr>
<td>Objective</td>
<td>Analysis of the net financial impact of the proposal on the agency</td>
<td>Maximising social returns to the economy’s resources</td>
</tr>
<tr>
<td>Pricing</td>
<td>Market prices</td>
<td>Opportunity costs</td>
</tr>
<tr>
<td>Transfer payments:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- taxes</td>
<td>Included</td>
<td>Excluded</td>
</tr>
<tr>
<td>- subsidies</td>
<td>Included</td>
<td>Excluded</td>
</tr>
<tr>
<td>Income distributional effects</td>
<td>Excluded</td>
<td>Noted but not incorporated</td>
</tr>
<tr>
<td>Externalities</td>
<td>Excluded</td>
<td>Included</td>
</tr>
<tr>
<td>Interest and depreciation</td>
<td>Excluded</td>
<td>Excluded</td>
</tr>
</tbody>
</table>

When markets are competitive and most costs and benefits are reflected in market prices, financial evaluation can provide an adequate guide to the social viability of a proposal. Financial evaluation is also important when government as a whole or an agency of government has financial objectives or responsibilities to fulfil or when it is involved in a purely financial decision such as a comparison of different procurement methods (e.g. traditional government ownership vs. outsourcing).
6.2 How is a financial evaluation conducted?

A financial evaluation explicitly compares receipts and expenditures, generating a net cash flow. The net cash flow is then normally discounted to determine the NPV of the proposal. Section 4.5 of this *Introduction to CBA* explains how to calculate a NPV and Section 5.6 provides an example to illustrate.

For practical purposes, the principles applying to setting the discount rate in financial evaluation are the same as a cost-benefit analysis – as outlined in Section 5.3 of this *Introduction to CBA*. 
7 COST-EFFECTIVENESS ANALYSIS

7.1 What is cost-effectiveness analysis?

Cost-effectiveness analysis (CEA) measures the benefits in physical units rather than in monetary terms. For instance, through measuring cost per life saved or child educated. It offers a priority ranking of programmes or activities on the basis of a comparative 'cost per unit of effectiveness', or alternatively, of comparative 'units of effectiveness per dollar’. It can be particularly useful where benefits are hard to quantify in monetary terms.

CEA differs from CBA in several respects. First, the benefits are not expressed in money units and hence it does not provide an absolute measure of the benefit to the economy of the project. Second, the alternatives being assessed must be similar in nature. Third, the discounting procedure is often applied only to the cost side of the analysis.

The distinction between outputs and outcomes is sometimes blurred (for instance by referring to both as 'results') in determining the cost-effectiveness of a programme. CEA links the level of outcomes to the costs involved. Technically, services may be delivered efficiently in terms of number of services provided per dollar spent (output), but the impact of the service may be negligible when measured against the stated objectives (outcome), making it very cost-ineffective. Decision-makers are particularly concerned with the level and worth of outcomes relative to their costs as well as the programme’s technical efficiency and effectiveness.

7.2 How is a cost-effectiveness analysis conducted?

Performing a CEA involves identifying the benefits relevant to the programme or activity; these benefits are expressed in physical units (e.g. lives saved, tons of hazardous waste reduced, number of children vaccinated). As discussed in 7.1, the associated costs are expressed in monetary terms.

The cost-effectiveness of a proposal can be measured by calculating cost-effectiveness ratios. The simplest ratio is to calculate the average cost per unit of effectiveness. This is represented mathematically as follows:

$$ CE = \frac{C}{E} $$

where CE is the cost-effectiveness of the proposal, C is the cost (measured in dollars) and E represents the effectiveness (i.e. the benefit measured in physical units).

Managers may, however, be more interested in determining whether a new (proposed) programme is preferable to maintaining a current programme. Where this is the case, the incremental cost-effectiveness ratio (ICER) could be used. This is represented as follows:
ICER = \( \frac{(C_n - C_c)}{(E_n - E_c)} \)

or

\[
\text{ICER} = \frac{\Delta \text{Costs}}{\Delta \text{Effectiveness}}
\]

where \( C_n \) is the cost of the new proposal, \( C_c \) is the cost of maintaining the current programme, \( E_n \) is the effectiveness of the new proposal and \( E_c \) is the effectiveness of continuing with the current programme.

The smaller the ratio, the higher is the cost-effectiveness. A cost-effectiveness ratio can be determined for each alternative (or option). Once this is done, each alternative can be ranked from the most cost-effective (lowest ratio) to the least cost effective (highest ratio).
SECTION D

Case Studies
Case Studies

The following case studies represent examples of the evaluations that have been undertaken by Australian Government agencies and demonstrate some of the complexities with which evaluations must contend.

8 COST-BENEFIT ANALYSIS

Cost-benefit analysis of the Brisbane-Melbourne rail link

The following case study is based on information in the Bureau of Transport and Regional Economics’ paper *Brisbane-Melbourne Rail Link: Economic Analysis*. The full report is available on the internet.

1. Background

The Bureau of Transport and Regional Economics (BTRE) completed a CBA of the Brisbane-Melbourne inland rail link in October 2000 at the request of the Minister for Transport and Regional Services. The CBA followed a pre-feasibility study conducted by the Australian Transport & Energy Corridor Ltd (ATEC) relating to the proposal. The objective of the analysis was to determine if construction and operation of the proposed Brisbane-Melbourne rail line would result in a net benefit to Australia as a whole. The CBA relies on the information and assumptions included in ATEC’s pre-feasibility study.

Major railway systems are generally viewed as providing economic opportunities in terms of trade, industry growth and travel. During the period of expenditure, regional areas are also expected to benefit from temporary increases in employment, supplier business revenue and profits; these (secondary) regional benefits were not included as part of the benefit stream as the CBA was conducted from a national, and not regional, perspective. The analysis considered the proposal for a new rail link in light of Australia’s arterial road networks and efficient trucking industry.

2. Methodology

ATEC considered several options in its study but recommended the adoption of one option (Option A2). BTRE’s CBA was based on this Option A2, which has the following characteristics: 2.5 km passing loops; 21 tonne axle loads; 1.25 per cent ruling gradients; and line clearance to permit double stacked containers from Melbourne to Acacia Ridge, via Seymour, Albury-Wodonga, Parkes, Dubbo, Narrabri, Moree and Goondiwindi. A variation of this arrangement (Option A2M), which would achieve lower costs through different curve and grade alignment improvements and catering for shorter train lengths, was also considered.

BTRE’s CBA also included a base case, which was essentially a ‘do nothing’.
BTRE’s methodology for the CBA followed a conventional approach. The CBA:

- discussed the rationale of the proposed rail network;
- discussed alternative options that had been considered;
- explained and quantified costs and benefits;
- estimated the net benefit to Australia (through an NPV);
- included a sensitivity analysis; and
- made a recommendation.

3. Costs and benefits

The costs considered in the CBA related to constructing the proposed rail line. The estimated cost of the proposal was between $1.2b and $1.68b. The BTRE estimated that around 80 per cent of the cost in constructing the railway would be for new lines between Brisbane and Moree and for upgrading existing tracks. The costs covered in the CBA included the following:

- construction and commissioning of new rail links;
- upgrading existing sections;
- acquisition of land;
- planning;
- design; and
- approvals.

The benefit streams were considered as four separate categories. The first category related to the benefits from transferring existing rail freight from the current network to the new network. Expected benefits were lower operating costs and higher trip speeds on the new rail network relative to the existing rail network. The BTRE estimated that this would account for around 20 per cent of the total benefit stream. The expected net benefit of capturing existing rail freight was $66 million per annum in its first year of operation (based on ATEC freight estimates for 2000 to 2005).

The second benefit category related to transfers from road freight to the new rail network. This was expected to account for around 65 per cent of total benefits. The study forecast that around 50 per cent of freight on the A2/A2M rail network would be ‘won over’ from road. The expected economic benefit from this transfer was $224 million per annum in its first year of operation (based on ATEC freight estimates for 2000 to 2005).

The third benefit category considered in the CBA was ‘induced freight’. The demand for rail freight was expected to increase as a result of the lower transportation costs. The estimated benefits of induced freight was $52 million per annum for the first year and accounted for around 15 per cent of total benefits.
Finally, the benefit from landbridging of freight was considered. This involves transporting imported/exported goods by rail between ports. The benefits of landbridging includes the reduction of shipping costs and transit times for freight. The expected economic benefit from landbridging containers was $8 million per annum in its first year of operation (based on ATEC freight estimates for 2000 to 2005).

4. Results and sensitivity analysis

Once the costs and benefits of the proposal were quantified, the data was used to determine the net benefit of the proposal. Note: the NPV results are in year 2000 dollar values and the project is assumed to operate from 2005 to 2034. The results are presented in the table below.

CBA results (Year 2000 dollar values)

<table>
<thead>
<tr>
<th>Economic Results12</th>
<th>Sensitivity Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Present value of benefits</td>
<td></td>
</tr>
<tr>
<td>4% discount rate</td>
<td>$10.2bn</td>
</tr>
<tr>
<td>7% discount rate</td>
<td>$6.1bn</td>
</tr>
<tr>
<td>(2) Construction costs</td>
<td>$1.2bn to $1.7bn</td>
</tr>
<tr>
<td>(3) Net Present Value</td>
<td></td>
</tr>
<tr>
<td>= (1) – (2)</td>
<td></td>
</tr>
<tr>
<td>4% discount rate</td>
<td>$8.5bn to $9.0bn</td>
</tr>
<tr>
<td>7% discount rate</td>
<td>$4.4bn to $4.9bn</td>
</tr>
<tr>
<td>(4) Benefit-cost ratio</td>
<td></td>
</tr>
<tr>
<td>= (1) / (2)</td>
<td></td>
</tr>
<tr>
<td>4% discount rate</td>
<td>6.1 to 8.5</td>
</tr>
<tr>
<td>7% discount rate</td>
<td>3.6 to 5.1</td>
</tr>
</tbody>
</table>

Based on these discount rates, the BTRE estimated the NPV of the proposed rail link to be between $8.5bn and $9.0bn or between $4.4bn and $4.9bn with discount rates of 4 per cent and 7 per cent respectively. Given the circumstances, BTRE determined a 4 per cent discount rate was appropriate. This rate reflected the 10-year Treasury bond rate (in real terms) at the time of the analysis.

The BTRE also conducted a sensitivity analysis as part of the CBA. The sensitivity test involved changing the magnitude of key variables and measuring its impact on the NPV. As part of the BTRE’s sensitivity analysis, construction costs were increased by 50 per cent.

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12 Based on ATEC freight estimations, 2000 to 2015.
13 Given the circumstances, BTRE determined a 4 per cent discount rate was appropriate.
14 BTRE also used a 7 per cent discount rate as this was the rate in previous analyses. It facilitates meaningful comparisons between this CBA to previous ones.
In addition, the estimated values of the four benefit streams were adjusted to test the impact of possible lower values on the NPV. For example, in the case of the first benefit category (i.e. transferring existing rail freight from the current network to the new rail network), the benefits were reduced by 70 per cent. This change reflects the risk that ‘relations with existing rail authorities do not result in the free or lower priced handover of all existing rail customers …’ (p12, ‘Brisbane-Melbourne Rail Link: Economic Analysis’, BTRE).

Based on the sensitivity analysis scenario considered by the BTRE, the net benefit of the proposal is $2.4 billion with a real discount rate of 4 per cent.

5. Conclusions

Based on ATEC forecasts of cost and demand, the BTRE concluded that the proposed Brisbane-Melbourne rail link would result in a net benefit to the Australian community in excess of $8 billion. Further, even with the sensitivity analysis scenario, which assumed more pessimistic costs and benefits, the rail link would result in a net benefit to the Australian community.
9 FINANCIAL EVALUATION

Financial evaluation of a property proposal

1. Background

This case study simulates a financial property evaluation investigating the feasibility of refurbishing, and subsequently tenanting out, an existing commercial building owned by the Australian Government. The building includes car parking charged to tenants in addition to the office space rent.

To justify the Government’s long-term investment in retaining such a property, the project would need to be financially viable. For the purposes of this case study, in accordance with the Commonwealth Property Principles (CPP) applicable at the time, the Australian Government’s required return on property was set at a nominal rate of 10 per cent.15

2. Methodology

One of the methodologies used to determine the financial viability of refurbishing a building is discounted cash flow (DCF). This is a common method for determining the value of commercial properties. For the purposes of this case study, a DCF was conducted on the basis of a 20-year lease term, with the key assumptions outlined in the table below:

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>$5,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building value</td>
<td></td>
</tr>
<tr>
<td>Rent growth – All Areas</td>
<td>5.0%</td>
</tr>
<tr>
<td>Outgoing escalation</td>
<td>5.0%</td>
</tr>
<tr>
<td>Rent reviews</td>
<td>Annual</td>
</tr>
<tr>
<td>Discount rate (target Internal Rate of Return)</td>
<td>10.0%</td>
</tr>
<tr>
<td>Base office rent</td>
<td>$350 per square metre</td>
</tr>
<tr>
<td>Development cost</td>
<td>$35,000,000</td>
</tr>
<tr>
<td>Mid-term refurbishment (today’s values escalated)</td>
<td>$100 per square metre</td>
</tr>
<tr>
<td>Operating costs</td>
<td>$50 per square metre</td>
</tr>
</tbody>
</table>

15 The Department of Finance and Administration now annually determines a three tiered, risk weighted framework for discount rates to be used in the business case assessment of property proposals. Agencies conducting a CBA should contact the Department of Finance and Administration to discuss the rate applicable to any particular project or programme.
A financial evaluation is conducted using a structured and logical process. The first step involved analysing the construction (including development and refurbishment) costs, ongoing building management costs, and consultants’ costs to determine the overall cost of the proposal. All costs associated with the project were modelled using industry benchmarks and forecasts. The second step was to apply a market-based rental for leasing out this quality of building. The market rate for A Grade office space was estimated at $350 per square metre. In this example, for the purposes of the evaluation, it was assumed that rental would increase each year by a fixed rate of 5.0 per cent.

The third step was to forecast the rental (office and car-parking) stream (including escalations) and operating expenses (including escalations) over the life of the tenancy (20 years) to determine the net cash flows. These net cash flows, including the residual value of the project in the final year of the lease term, were then discounted back to determine the NPV. In addition to calculating the NPV, the IRR of the project was also determined – taking into account the cost of the refurbishment in the early years and the future income stream in subsequent years.

Various scenarios of rental, rental escalation and construction costs were modelled to determine the impact on the NPV and to determine whether under these scenarios the project would outperform or match the applicable cost of capital rate (10 per cent in this example). In addition, different rental structures (which fall within market ranges) were analysed to see whether they would achieve an IRR that would exceed the relevant cost of capital rate. It was possible to vary the cash flow stream (by, for example, offering tenants higher rents with lower escalations) whilst maintaining the financial feasibility of the project (i.e. outperforming or matching the cost of capital rate).

An optimal rental and escalation was found that was both commercially achievable (tenants were willing to pay rent at the optimal level) and financially acceptable (the IRR exceeded the Australian Government’s cost of capital rate).

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### 3. Results and sensitivity analysis

The table below outlines how the net cash flows of the proposal were determined.

<table>
<thead>
<tr>
<th>YEAR COMMENCING</th>
<th>Year 0 July 2004</th>
<th>Year 1 July 2005</th>
<th>...</th>
<th>Year 21 July 2025</th>
<th>Year 22 July 2026</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Growth rate</strong></td>
<td>Adopted</td>
<td>5.0%</td>
<td>5.0%</td>
<td>5.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td><strong>INCOME</strong></td>
<td><strong>AREA</strong></td>
<td><strong>$ per m²</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Grade Office Space</td>
<td>10,000 m²</td>
<td>$350</td>
<td>$3,500,000</td>
<td>$8,844,326</td>
<td>$9,286,542</td>
</tr>
<tr>
<td>Basement</td>
<td>1,000 m²</td>
<td>$100</td>
<td>$100,000</td>
<td>$240,662</td>
<td>$252,695</td>
</tr>
<tr>
<td>Total floor space (A Grade Office space + basement)</td>
<td>11,000 m²</td>
<td>$3,600,000</td>
<td>$9,084,988</td>
<td>$9,539,237</td>
<td></td>
</tr>
<tr>
<td>Cars in open area</td>
<td>100</td>
<td>$500</td>
<td>$50,000</td>
<td>$120,331</td>
<td>$126,348</td>
</tr>
<tr>
<td>Cars under cover</td>
<td>50</td>
<td>$1,500</td>
<td>$75,000</td>
<td>$180,496</td>
<td>$189,521</td>
</tr>
<tr>
<td>Total car spaces (Cars in open area + under cover)</td>
<td>150</td>
<td>$125,000</td>
<td>$300,827</td>
<td>$315,869</td>
<td></td>
</tr>
<tr>
<td><strong>Gross Income</strong></td>
<td></td>
<td></td>
<td>$3,725,000</td>
<td>$0</td>
<td>$9,385,815</td>
</tr>
<tr>
<td>less Operating expenses</td>
<td>11,000 m²</td>
<td>$50</td>
<td>$550,000</td>
<td>$1,522,187</td>
<td>$1,598,296</td>
</tr>
<tr>
<td><strong>Net Income</strong></td>
<td></td>
<td></td>
<td>$3,175,000</td>
<td>$0</td>
<td>$7,863,628</td>
</tr>
<tr>
<td>INVESTMENT COST (land and building value + capital inputs)</td>
<td>$5,000,000</td>
<td>-$18,500,000</td>
<td>$0</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>SALE PRICE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capitalisation rate</td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td>$82,568,098</td>
</tr>
<tr>
<td>Selling costs</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td>$4,128,405</td>
</tr>
<tr>
<td>NET PROCEEDS</td>
<td></td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$86,696,503</td>
</tr>
<tr>
<td><strong>NET CASH FLOW</strong></td>
<td></td>
<td>-$5,000,000</td>
<td>-$18,500,000</td>
<td>$7,863,628</td>
<td>$94,953,312</td>
</tr>
</tbody>
</table>
The net cash flows were then discounted by 10 per cent to determine the NPV. For example, the present value in the final year (year 22) was calculated as follows:

$$\text{Present Value} = \frac{\text{NCF}}{(1 + i)^t}$$

$$= \frac{11,664,632}{(1 + 0.10)^{22}}$$

$$= $11,664,632$$

The estimated NPV of the project was $1,453,624 and the estimated IRR was 11.41 per cent. Based on this analysis, the project will exceed the rate of return target i.e. the IRR exceeds the cost of capital rate of 10 per cent.\(^{17}\)

A sensitivity analysis was conducted as part of the evaluation. This involved changing the magnitude of key variables and measuring their modified impact on the NPV. For example, the impact of changes to the base office rent rate was assessed. If the base rate were to fall from $350 per square metre to $340, the NPV will fall by $1,111,141 to $342,483 (therefore generating an IRR of 11.1 per cent). Alternatively, an increase in rent from $350 per square metre to $360 per square metre results in a $1,111,141 increase in the NPV to $2,564,765 (therefore generating an IRR of 11.72 per cent).

4. Conclusion

Based on the financial analysis, the refurbishment and tenanting of the building would result in a net benefit of around $1.5 million and generate an IRR in excess of the relevant cost of capital rate of 10 per cent. Therefore, under the assumptions adopted, the refurbishment and subsequent tenanting out of the building qualified as a financially viable option.

\(^{17}\) The Department of Finance and Administration now annually determines a three tiered, risk-weighted framework for discount rates to be used in the business case assessment of property proposals. Agencies conducting a CBA should contact the Department of Finance and Administration to discuss the rate applicable to any particular project or programme.
D Case Studies

10 COST-EFFECTIVENESS ANALYSIS

Cost-effectiveness analysis of new medical technologies

The following case study is based on an assessment report released by the Medical Services Advisory Committee (MSAC) in August 2001.¹⁸

1. Background

It is Australian Government policy that an evidence-based review, including cost-effectiveness analysis, be undertaken before a new medical technology becomes eligible for funding under Medicare benefits arrangements. In this context, ‘technology’ means processes of care, not just devices or products. Reviews are conducted by the independent and expert MSAC.

This case study relates to photodynamic therapy with verteporfin for macular degeneration (PDT), a technology that was the subject of a medical industry application to MSAC.

PDT is a treatment for a form of macular degeneration, a disease which causes vision loss and eventually blindness, especially in older people. There is no other treatment which is considered standard therapy for the particular form of macular degeneration for which PDT was reviewed.

2. Methodology

MSAC conducted an incremental cost-effectiveness analysis taking into account whole of health system costs (that is, ‘who pays’ did not figure in evaluations, and costs were generally limited to health system costs). The process involved:

- defining relevant research questions. For example, which patients would the technology benefit and what is the health outcome being sought?
- undertaking a systematic review of clinical evidence for health benefits of PDT; and
- identifying costs of PDT, both immediate and downstream. This was achieved through a mixture of analysis of historical resource use and modelling.

The PDT review considered evidence from clinical trials including use of a placebo. Outcomes of the clinical trials were expressed in terms of loss of visual acuity assessed by whether patients had lost the ability to read fifteen or less ‘lines’ on an eye chart. Given that this is not a meaningful measure of health benefit for CEA, economic analysis was performed in terms of costs per year of vision year gained. It is important in CEA that outcomes are measured in terms that are useful when put into an economic analysis, even if they do not allow direct comparison with other health outcomes. For example, trials of some treatments for coronary artery disease are reported in terms of lumen patency, that is the internal diameter of the coronary arteries before and after treatment. However cost per additional millimetre of lumen is not useful for decision making compared with, say cost per adverse cardiac event avoided.

¹⁸ This review (number 1026) can be obtained from the MSAC website at www.msac.gov.au
Resources taken into account included costs for an average course of treatment based on clinical trials, applicant data and Medicare benefits data for related services. Account was also taken of resource use avoided, such as community nursing. This inclusion of non-health system costs was considered slightly unusual for MSAC.

3. Results

The PDT review found that the treatment retarded rates of vision loss in the patient group with the relevant kind of macular degeneration. The economic analysis found the incremental cost effectiveness ratio (ICER) was $26,850 to $35,453 per vision year gained (at 2001 prices) for treatment effects of up to two years—the length of patient follow-up in the clinical trials. The range resulted from statistical uncertainty in the trial results and sensitivity analyses, which varied assumptions about resources use or use avoidance. Analyses were performed for a five-year timeframe. This produced ICERs ranging from $6,120 to $20,935 per vision year gained. These findings were more uncertain due to assumptions that had to be made about duration of retardation of vision loss due to the treatment.

4. Conclusions

For the PDT proposal, MSAC recommended that funding of over $30 million per year be made available for the relevant patient group for this purpose.
References


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