

Cost Benefit Analysis Primer

New Zealand Treasury



Version 1.12

December 2005

Business Analysis Team

The Treasury

1 The Terrace, PO Box 3724, Wellington, New Zealand

Phone: 04-472 2733, Fax: 04-473 0982

Website: www.treasury.govt.nz

Table of Contents

Table of Contents	1
Executive Summary	3
1 Introduction	5
1.1 When to use this Primer	5
1.1.1 Who should use the CBA Primer?	6
1.2 Cost Benefit Analysis.....	6
1.2.1 Economic scarcity and its effect on resource allocation	6
1.2.2 What is Cost Benefit Analysis and how can it help?.....	7
1.2.3 Where does Cost Benefit Analysis fit into the overall assessment process?	7
1.3 Proportionality of Analysis	8
1.4 When to conduct Cost Benefit Analysis?.....	8
1.5 Relationship to other guidance	9
2 Identifying and Estimating Relevant Costs and Benefits	10
2.1 Establish the Assumptions and Scope	11
2.2 Period of Analysis.....	13
2.3 Identifying Benefits and Costs	13
2.3.1 What is a Benefit?	14
2.3.2 What is a Cost?	14
2.3.3 Sunk Costs	16
2.3.4 Marginal versus Average Costs and Benefits.....	16
2.3.5 Capital versus Operating Costs.....	16
2.3.6 Depreciation	17
2.3.7 Capital Charge and Financial Transactions.....	17
2.3.8 Contingencies.....	17
2.3.9 Taxes.....	17
2.3.10 Deadweight Losses	18
2.3.11 Behavioural Effects.....	18
2.3.12 Externalities	19
2.3.13 Transfer Payments	19
2.3.14 Double Counting.....	19
2.3.15 Concluding Comments	20
2.4 Valuing Relevant Costs and Benefits	20
2.4.1 Real versus nominal values.....	21
2.4.2 Valuing Costs and Benefits Using Market Values	21
2.4.3 Valuing Costs or Benefits when there are No Market Values (Intangibles).....	21
2.4.4 Distributional Effects.....	24
2.5 Concluding Comments	24

3	Analysing the Options.....	25
3.1	Cashflows	25
3.2	Discounting and Discount Rates	26
3.2.1	The Discounting Formula	26
3.3	Choosing a Discount Rate	27
3.3.1	Long-lived Projects	28
3.3.2	Annual versus Monthly	29
3.4	Net Present Value	29
3.5	Equal Proposal Lives.....	31
3.6	Alternative Decision Guidance Methods.....	32
3.6.1	Internal Rate of Return	32
3.6.2	Payback Period	33
3.6.3	Benefit-cost Ratio	33
4	Assessing Risk, Uncertainty and Intangibles	35
4.1	Risk and Uncertainty	35
4.2	Optimism Bias	36
4.3	Sensitivity Analysis	36
4.4	Scenario Analysis	37
4.5	Intangibles	38
4.6	Multi-Criteria Analysis.....	38
4.7	Concluding Comments	39
5	Selection and Presentation.....	40
5.1	Pulling It All Together	40
5.2	Selecting the Preferred Option	40
5.3	The Relationship Between CBA and Fiscal Impacts	41
5.4	Tips and Traps.....	43
5.5	Concluding Comments	44
	Bibliography	45
	Glossary.....	46
Annex 1:	Monte Carlo Analysis	49

Executive Summary

The public sector is a major user of New Zealand's available resources and as such, should ensure that it makes a significant positive contribution to the economy and society. More particularly, no new proposal should be adopted without first answering:

- what are the specific outcomes sought?
- are there better ways to achieve these outcomes?
- are there better uses for these resources?
- is this an appropriate role for government?

Cost Benefit Analysis (CBA) is one decision-making tool that can help provide assurance around these questions. Quantifying all costs and benefits in monetary terms makes it possible to quantitatively rank alternative proposals: between a given proposal and the status quo; or between competing proposals. Decision-makers can be provided with a consistent basis for assessing proposals and can be better informed about the implications of using economic resources.

This primer seeks to improve the quality of policy and spending proposals by providing guidance on the issues that should be considered and how proposals will be assessed by the Treasury. It is intended for public sector policy and financial analysts and provides simple, accessible and practical assistance. The Primer presents an overview of Cost Benefit Analysis in a New Zealand public sector context, with particular emphasis on the basic questions that are likely to arise. For more complex issues or more detailed guidance, the reader is referred to the bibliography or the relevant Treasury Vote team.

Cost Benefit Analysis (CBA) is just one of the process steps undertaken when preparing a policy or spending proposal. A fully developed proposal should:

1. Define the problem
2. State the public policy objectives
3. Identify the feasible options
4. Analyse the options (using CBA or similar techniques)
5. Assess how the preferred option will be implemented
6. Describe the consultation undertaken, and
7. Present the overall assessment.

Steps 1 to 3 and 5 to 7 are beyond the scope of this primer.

It is also useful to consider Cost Benefit Analysis as a series of steps:

- a) Confirm the desired outcomes of the proposal(s)
- b) Establish the assumptions and scope underlying the analysis
- c) Decide an appropriate period for the analysis (often termed the 'appraisal period')

- d) Identify all significant benefits and costs
- e) Assign monetary values to the benefits and costs,¹ wherever possible
- f) Discount the benefits and costs to present values (see chapter 3)
- g) Assess risk and uncertainty (see chapter 4)
- h) Consider the effect of any intangible costs and benefits that could not be reliably assigned monetary values (chapter 4)
- i) Select the preferred option (see chapter 5).

Steps a) to f) are covered in chapter 2 where the preferred approach is to undertake CBA from a national perspective rather than a more narrow government or departmental perspective. The chapter then goes on to highlight issues to consider when identifying benefits and costs before dealing with techniques for valuing them.

Discounting, discount rates, and decision rules are introduced in chapter 3. Chapter 4 introduces techniques for assessing and dealing with risk, uncertainty, and intangibles that cannot be reliably quantified. These techniques include sensitivity analysis, scenario analysis, and multi-criteria analysis. The final chapter pulls all the elements discussed in the primer together and provides additional guidance on presenting the CBA to decision makers. Some tips and traps are also provided as a final check.

¹ In a national context, benefits and costs are often termed social benefits and social costs.

1 Introduction

1.1 When to use this Primer

This primer seeks to improve the quality of proposals by providing guidance on the issues that should be considered and how proposals will be assessed by the Treasury. It should be used when:

- Preparing policy proposals
- Preparing Cabinet papers with financial and/or economic implications, where consultation with Treasury is required (refer to the [Cabinet Office step-by-step guide](#)²), including:
 - proposals where additional funding is not sought from the Crown, but expenditure exceeds the financial delegation limits set out in Cabinet Office Circular CO(99)7,³ and
 - proposals for regulatory interventions⁴
- Preparing papers to joint ministers acting under a delegation from Cabinet where approval is being sought from the Minister of Finance
- Preparing papers to individual ministers
- Preparing budget initiative proposals submitted as part of the annual Budget process
- Preparing business cases including those submitted to Treasury to support any proposal seeking additional funding (operating or capital) required by [CO\(02\)17](#)⁵
- Preparing internal approval papers in accordance with departmental delegations, and
- Reporting on a department's future performance as required by section 40 (d) of the Public Finance Act 1989 including:
 - (i) the impacts, outcomes or objectives achieved or contributed to by the department, and
 - (ii) the cost effectiveness of the interventions that the department delivers or administers.⁶

² <http://www.dpmc.govt.nz/cabinet/guide/index.html>

³ <http://www.dpmc.govt.nz/cabinet/circulars/co99/7.html>

⁴ See <http://www.med.govt.nz/buslt/compliance/risbccs/index.html> for more information and guidance on regulatory impact statements.

⁵ <http://www.dpmc.govt.nz/cabinet/circulars/co02/17.html>. Includes business cases for major IT projects required by CO(01)4 (<http://www.dpmc.govt.nz/cabinet/circulars/co01/4.html>) where no additional funding is sought from the Crown.

⁶ Section 40 (d) Public Finance Act 1989, as amended.

The Primer could also be a valuable resource within the wider Public sector, for example by Crown entities, SOEs, local and regional Government, the NGO sector, academia and the consulting community when:

- Preparing and/or assessing spending proposals seeking new funding, or
- Evaluating the value for money of existing expenditure or pilot initiatives.

Table 1.1: Common types of decisions covered by the primer:⁷

Decision	Description
Policy and initiative development	Decisions on the level and type of services or other actions to be provided, or on the extent of regulation with economic/financial implications.
New or replacement capital projects	Decisions to undertake a project, its scale and location, timing, and the degree of private sector involvement. Common examples include vehicle replacement, information technology and property projects.
Use or disposal of existing assets	Decisions to sell land, or other assets, replace or relocate facilities or operations, whether to contract out or market test services.
Major procurement decisions	Decisions to purchase the delivery of services, works or goods, usually from private sector suppliers.

1.1.1 Who should use the CBA Primer?

Cost Benefit Analysis can be undertaken on many different levels of detail and sophistication. This Primer is targeted at public sector policy and financial analysts with little economic or financial knowledge. It is intended to provide simple, accessible and practical assistance. To accomplish this, it provides a basic overview of Cost Benefit Analysis in a New Zealand public sector context, with particular emphasis on the basic questions that are likely to arise. For more complex issues or more detailed guidance the reader is referred to other more detailed sources (see Bibliography) or the relevant Treasury Vote team.

1.2 Cost Benefit Analysis

1.2.1 Economic scarcity and its effect on resource allocation

Like all countries, New Zealand has limited resources. The public sector is a major user of the country's available resources, and as such, should ensure that it makes a significant positive contribution to the economy and society in relation to the resources it consumes. The efficient use of resources has a major impact on the welfare and living standards of citizens.

⁷ Adapted from UK Green Book, Chapter 1, <http://greenbook.treasury.gov.uk/>.

Government decision-makers require assurance that proposals for new spending will result in a net increase in national welfare and meet Government's public policy and fiscal objectives. No new proposal should be adopted without first answering:

- what are the specific outcomes sought?
- are there better ways to achieve these outcomes?
- are there better uses for these resources?
- is this an appropriate role for government?⁸

Resource scarcity means that a decision to proceed with one proposal may preclude proceeding with other proposals. There are always alternatives that need to be compared, even if it is a choice between doing "proposal X" and not doing "proposal X".

1.2.2 What is Cost Benefit Analysis and how can it help?

Cost Benefit Analysis (CBA) is an economic assessment tool. By quantifying all costs and benefits in monetary terms, and discounting, it is possible to determine the net benefits (or costs) of a proposal in today's dollars. These net benefits/costs can then be used to quantitatively rank alternative proposals:

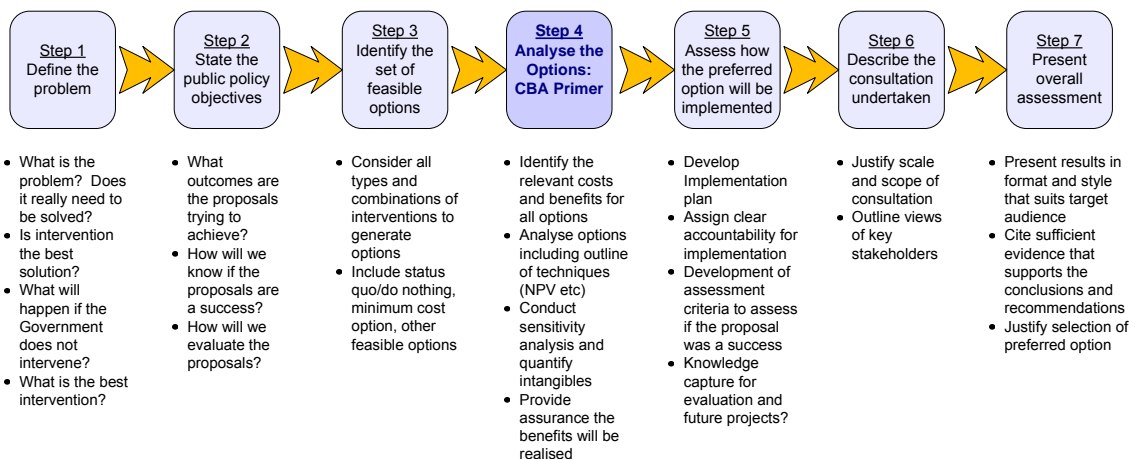
- between a given proposal and the status quo, or
- between competing proposals.

Decision-makers can be provided with a consistent basis for assessing proposals and can be better informed about the implications of using economic resources. CBA can also be used to test the effectiveness of a proposal after it has been implemented.

1.2.3 Where does Cost Benefit Analysis fit into the overall assessment process?

Cost Benefit Analysis (CBA) is just one of the process steps required to prepare a policy or spending proposal. A fully developed proposal should encompass:

⁸ Competitive neutrality is an important consideration when assessing whether an activity is an appropriate role for government. Competitive neutrality means that Government activities do not enjoy net competitive advantages over potential private sector competitors by virtue of their public sector ownership. If competitive neutrality does not exist then resources are not being put to their best use.



This primer assumes that the first three steps outlined above have been addressed as a precursor to analysing the options.

1.3 Proportionality of Analysis

The extent or depth of the analysis should be tailored to the relative size, impacts, and risks of the proposal. Not all proposals will require full cost benefit analysis or involve all the detailed elements listed above. Talk to your Treasury Vote team for guidance.

1.4 When to conduct Cost Benefit Analysis?

Cost Benefit Analysis is flexible and can generally be applied to assess most proposals. However, it has some limitations that mean it is not suitable for assessing every proposal. For example, it is often not possible to assign a monetary value to all costs and benefits. If the techniques described in chapters 2⁹ and 4¹⁰ do not provide a sufficient base from which to conduct CBA, alternative assessment techniques such as Cost Effectiveness Analysis (CEA) and Cost Utility Analysis (CUA) may prove useful.¹¹

⁹ i.e. techniques to assist in the quantification of costs and benefits such as shadow prices, hedonic pricing etc.

¹⁰ i.e. qualitative analysis techniques such as Multi-Criteria Analysis (MCA).

¹¹ Cost Effectiveness Analysis (CEA) is similar to Cost Benefit Analysis except that it does not attempt to place a value on the major benefits of the proposal. Instead, CEA compares the costs of alternative ways of producing the same or similar outputs/benefits. It is often used to find the option that meets a predefined objective at a minimum cost. CUA is a variant of CEA that measures the relative effectiveness of alternative interventions in achieving two or more given objectives. Both CEA and CUA provide measures of the *relative* effectiveness of alternative interventions in achieving a given objective (or two given objectives in the case of CUA). The unit of measurement is usually non-monetary. See Broadman et al (1996), Dixon (1991), Stokey and Zeckhauser (1978), Viscusi (1997), and Pradhan (1996).

1.5 Relationship to other guidance

This primer is not intended to override or replace existing guidance. In particular, it is intended to complement existing guidance such as:

- Budget guidance
- [Cabinet Office Step by Step Guide](#)¹² for detailed expectations of policy proposals for Cabinet consideration
- [Ministry of Economic Development Regulatory Impact Statement Guide](#)¹³ for detailed expectations of proposals with regulatory impacts

Links to other authoritative and related guidance are included where appropriate and are listed in the bibliography.

¹² <http://www.dpmc.govt.nz/cabinet/guide/>

¹³ <http://www.med.govt.nz/buslt/compliance/risbccs/index.html>

2 Identifying and Estimating Relevant Costs and Benefits

Cost Benefit Analysis (CBA) is a tool to aid decision making. Identifying and estimating all relevant costs and benefits helps provide a consistent basis for the comparison of alternative proposals. Ideally CBA will demonstrate that the expected benefits of a given proposal exceed the expected costs. That is, to determine if there is a *net benefit*. If the net benefit is greater than zero then the proposal may be worthwhile pursuing.¹⁴ This chapter looks at which costs and benefits to include and how these are assigned monetary values.

This sounds straightforward. But how are items such as taxes, inflation, and intangibles treated? Intangibles are benefits and costs associated with a proposal that either cannot be quantified, or are difficult to quantify in monetary terms. For example, how would you assess the value of a health programme that improves New Zealanders' health status and quality of life over time? When thinking about some of these more complex issues, the need to be consistent and avoid double-counting cannot be emphasised enough. This chapter provides guidance on these issues.

It is also useful to consider Cost Benefit Analysis as a series of steps:

- i. Confirm desired outcomes of the proposal(s)¹⁵
- ii. Establish the assumptions and scope underlying the analysis
- iii. Decide an appropriate period for the analysis (often termed the 'appraisal period')
- iv. Identify all significant benefits and costs, and provide assurance that these will be realised
- v. Assign monetary values to the benefits and costs wherever possible¹⁶
- vi. Discount the benefits and costs to present values (see chapter 3)
- vii. Assess risk, and uncertainty (see chapter 4)
- viii. Consider the effect of any intangible costs and benefits that could not be reliably assigned monetary values (chapter 4)
- ix. Select the preferred proposal (see chapter 5).

¹⁴ Other considerations in the decision include: appropriateness of government intervention; the attractiveness of competing proposals/uses of funding; strategic value; affordability; the importance of possible intangible costs/benefits; and any implementation difficulties.

¹⁵ For example, see http://io.ssc.govt.nz/pathfinder/documents/pathfinder-BB1-identify_ocs.pdf.

¹⁶ In a national context, benefits and costs are often termed social benefits and social costs.

2.1 Establish the Assumptions and Scope

What assumptions need to be made to conduct the analysis? Early consideration of this question will make the identification of the costs and benefits much easier and can save a significant amount of time.

There are a number of general default assumptions that should guide the analysis:

- consider the impacts of a proposal across all sectors of the economy by thinking about the inter-relationships between sectors (economists term this ‘general equilibrium analysis’). Suppose, for example, a government supplies cheap power, transport, or some other subsidy to beef meat producers. This results in a lower price for beef, which in turn decreases demand for sheep meat. The net benefit needs to take into account both the beef and sheep meat markets
- include all intangible costs and benefits where they can be reliably estimated
- assume all resources in the economy are fully utilised (e.g. full labour employment, otherwise the costs and benefits of additional employment must be considered)
- include all subsequent or contingent costs/investments. For example, if the upgrade of an agency’s computer system requires the simultaneous upgrade of the telephone system, then the analysis must include both the computer and telephone upgrades, and
- exclude international impacts (unless these are explicitly being evaluated).

Treasury’s expectation is that ‘Cost Benefit Analysis’ will be undertaken from a national perspective rather than a government or departmental perspective wherever possible. This is often termed ‘economic Cost Benefit Analysis’ and is preferred because the actions of one agency or department can impose costs or benefits on individuals or the nation as a whole (e.g. increasing the size of a programme operated by a particular department may assist the operation of the department but may nonetheless require a large increase in income tax on individuals). Put another way, economic CBA seeks to capture all benefits and costs regardless of to whom they accrue.

An alternative approach to the national perspective is ‘financial analysis’ which considers the case when costs and benefits are limited to impacts on an individual agency or department. An example of this is a new accounting package for a department or a lease versus buy decision for real estate.¹⁷

¹⁷ The key difference between ‘financial analysis’ and ‘economic cost benefit analysis’ is that the latter considers all benefits and losses regardless of to whom they accrue whereas the former only considers the benefits and losses to an individual agency or department. Other alternatives include ‘international analysis’ for proposals with impacts outside New Zealand, and ‘whole of government’ analysis which concentrates on the impacts from the perspective of the Crown as a whole.

Cost Benefit Analysis also needs to be distinguished from the fiscal costings which typically are included in a Cabinet or other approval paper (see section 5.3). The key differences between the different types/levels of analysis are summarised in Figure 2.1a.

Figure 2.1a: Levels of Analysis – Elements to be included

	Impacts across all economic sectors	Impacts across selected sectors	Economic costs and benefits	Accounting costs and benefits	Depreciation	Capital charge	Interest and financing costs	Taxes included in prices	Transfer payments included
National economic CBA	Yes	No	Yes	No	No	No	No	No	No
Financial analysis	No	Yes	Yes	No	No	No	No	No	Yes
Fiscal costing	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes

Default assumptions for economic Cost Benefit Analysis and possible variations are summarised as follows:

Table 2.1a: Default Assumptions for Economic Cost Benefit Analysis

Issue	Default Assumptions	Possible Variations
Scope of Analysis	National economy	<ul style="list-style-type: none"> • 'International analysis' if dealing with trade agreements or proposals that have spillover effects outside New Zealand • 'Financial analysis' for proposals that are agency or department specific and that have no or minimal effects on the wider economy
Form of Analysis	Consider the impacts of a proposal across all sectors of the economy ('general equilibrium analysis')	Analyses the impacts from the perspective of a single sector or department ('partial equilibrium analysis')
Period of Analysis	Economic life of the underlying proposal or assets, subject to a maximum of 20 years	Longer than 20 years where benefits or costs to the economy emerge slowly e.g. early childhood education
Financing/Capital Charge costs	Exclude	Exclude
Depreciation	Exclude	Exclude
Intangibles	Include if these can be reliably measured (refer section 2.4)	Exclude and conduct a qualitative assessment if these cannot be reliably measured (refer chapter 4)
Taxes	Tax inclusive prices should be used	<ul style="list-style-type: none"> • Adjust for tax if competing proposals contain differences in the treatment

		of taxation
Transfer payments (e.g. social welfare benefits)	Exclude if there is no change in societal welfare	<ul style="list-style-type: none"> • GST exclusive for presentations to ministers • Include transfers for fiscal costings and financial analysis • Include deadweight losses if significant and measurable • Identify and value fee revenue separately
Discount rate	10% real rate per annum	<ul style="list-style-type: none"> • Agreed sector rate • Capital charge rate or WACC¹⁸ for financial analysis • Refer to chapter 3 for details

These assumptions are explained in sections 2.2 to 2.4 below. Refer to chapter 3 for information on the selection of discount rates.

2.2 Period of Analysis

As a general rule, the period of analysis should usually extend to the useful life of the proposal, e.g. the asset life of a new computer system.¹⁹ However, for some proposals it is not possible to identify a finite asset life e.g. many health policies. In such cases, the recommended approach is to use an analysis period of 20 years, because impacts beyond 20 years tend to be insignificant after the time value of money (discounting) is taken into account.²⁰ Shortening the analysis period on the grounds of uncertainty is not appropriate as it typically shifts the uncertainty from the estimates of future costs/benefits to the estimate of residual value of the proposal or asset.

Residual values are also an important component of the total value of a proposal and should be included. The residual or terminal value of a project is its estimated value at the end of the analysis period (an asset's residual value at the end of its economic life should be zero).

2.3 Identifying Benefits and Costs

Example 2.3a: Benefits and Costs for Roothing Analysis

When evaluating roading proposals, Transfund typically considers the following:

Benefits:

- Reduction in loss of life and disability
- Reduction in health care costs

¹⁸ WACC = Weighted Average Cost of Capital.

¹⁹ This approach is similar to the life cycle costing approach. For more details on life cycle costing see New Zealand Standard 4536 (1999).

²⁰ See chapter 3 for an explanation of the time value of money (discounting).

<ul style="list-style-type: none"> • Reduction in travel time • Reduction in vehicle operating expenditure • Environmental benefits less environmental damages • Residual value
<p>Costs:</p> <ul style="list-style-type: none"> • Capital cost • Maintenance cost • Cost of any disruption to existing transport operations

2.3.1 What is a Benefit?

An economic benefit is any gain in the welfare of society or the individuals that comprise it from the proposal being considered. Identifying and quantifying benefits is undoubtedly one of the toughest and most time consuming elements of CBA. It is also one of the easiest elements to get wrong. For these reasons, it is essential that the process and assumptions used in identifying and quantifying benefits are thoroughly documented and explained for decision makers.

A useful starting point is to note that benefits can be monetary or non-monetary, qualitative, or quantitative. For example, consider the following combinations:

Table 2.3a: Possible Benefit Categories²¹

Benefit	Type	Example
Monetary	Quantitative	Operating cost reduction
Non-monetary	Quantitative	Lower number of customer complaints, reduction in the number of road accidents, increased percentage of government departments on the internet
Non-monetary	Qualitative	Increase in staff skills
Outcomes	Quantitative and qualitative	Improvement in the education and health status of New Zealanders

2.3.2 What is a Cost?

Economic costs²² relate to actual resource use in the economy and reflect the best alternative uses that the resources could be put to (i.e. they are opportunity costs). It is important to explore what alternative opportunities may exist. Examples of opportunities include:

- using land in a different, or more valuable, way than its current use
- the alternative use of an employee’s time, and
- investing in a public transport system instead of building additional roads.

²¹ UK Green Book, Chapter 5, <http://greenbook.treasury.gov.uk/>.

²² Transfers of resources from one entity to another are not considered economic costs because they do not create or consume resources for the economy as a whole.

In all of these examples, the opportunity cost is the next best alternative that must be given up in order to take up the opportunity. As discussed a little later in section 2.4, opportunity costs are usually reflected in market prices (e.g. the salary of an employee). These opportunity costs should be included in the analysis.

Accounting costs do not necessarily relate to actual resource use and therefore may differ significantly from economic costs. Depreciation and capital charges (discussed below) are examples of accounting costs that do not necessarily correspond to actual resource usage.

Costs can be monetary, non-monetary, qualitative, or quantitative:

Table 2.3b: Possible Cost Categories

Cost	Type	Description and Example
Monetary	Quantitative – Fixed Costs	Remain constant over different volumes of activity/production (e.g. rent for an office building is constant irrespective of the number of staff working in the building)
	Quantitative – Variable Costs	Vary according to the volume of activity/production (e.g. electricity costs are likely to increase as the number of staff in an office building increases)
	Quantitative - Semi-variable costs	Include both a fixed and variable component (building maintenance is an example, where there is usually a degree of planned maintenance, and a degree of responsive maintenance whose costs vary in proportion to activity, e.g. the number of call-outs)
Non-monetary	Quantitative	Increase in the number of customer complaints, or, road accidents
Non-monetary	Qualitative	Decline in staff skills
Outcomes	Quantitative and qualitative	Reduced skills and health

When attempting to identify all relevant costs and benefits, it is useful to constantly ask 'Is the cost or benefit relevant and material to the analysis?'.²³ If a proposed benefit or cost is outside the scope (refer section 2.1) or immaterial then it should be excluded. Similarly, if the amount of effort or resources required to quantify a particular cost or benefit outweighs the advantages of including it, then clearly it should not be quantified. Instead it should be identified and a qualitative assessment of its potential impact made (refer to chapter 4).

Costs and benefits do not necessarily have to correspond to physical flows of cash (although they usually do). If costs or benefits can be quantified in monetary terms,²⁴

²³ For a cost or benefit to be material, its impact on the analysis must be significant and capable of influencing the final decision or final selection from a range of alternative proposals. The interests and priorities of key stakeholders should also be considered.

²⁴ Subject to the cost or benefit being able to be reliably and efficiently estimated, and it being material to the analysis.

they can be included in the analysis as per any other cash flow (e.g. costs of death or injury).

Some further points to consider are outlined below.

2.3.3 Sunk Costs

Sunk costs are costs incurred before the start of the appraisal period and for which there is no value to the resources in some alternative use. Common examples include the costs of policy development or feasibility studies undertaken at an earlier date. Sunk costs are not included in an economic CBA because there is no opportunity cost involved and their inclusion may distort the analysis at hand by requiring a very high return on the investment. Put another way, sunk costs are irrelevant because they are the outcome of past decisions and should therefore be excluded from future decisions.

2.3.4 Marginal versus Average Costs and Benefits

For resources to be allocated to their best possible use (allocative efficiency), it is essential that marginal, not average, benefits and costs be used in CBA.²⁵ In practice, this means that only costs that change existing expenditure should be included. Overhead costs should not be included unless there is an incremental change in overhead costs resulting from the initiative (which is unlikely unless the initiative is for a significant increase relative to current departmental funding). An example of this might be a proposal that increases total staff. An increase of 2 staff from a base of 100 staff is unlikely to result in an incremental change in overheads whereas an increase of 50 staff probably would.

Another example might be a proposal for a new highway. In calculating the operating costs of a new highway, marginal operating costs saved on alternative routes due to reduced traffic should be taken into account. Since operating costs can be expected to rise less than proportionately with the flow of traffic per unit of time, marginal operating costs will be lower than average operating costs. Often only average operating costs are recorded and the analyst adopts these averages for expediency. This will tend to exaggerate the cost savings.

2.3.5 Capital versus Operating Costs

Economic Cost Benefit Analysis values all resource flows associated with a proposal, irrespective of the accounting distinction between “operating” or ongoing expenses and “capital” or one off expenses.

²⁵ Marginal costs are the additional costs that result from the addition of another unit of production. Average costs are total costs divided by total production. An economic CBA entails a “with” or “without” comparison, so marginal costs and benefits should be used.

2.3.6 Depreciation

Depreciation is an accounting allowance that recognises that physical assets wear out or become obsolete by spreading purchase costs over the useful life of the assets.²⁶

Depreciation allowances do not have a direct economic effect and should therefore be excluded from economic CBA. In addition, including both purchase costs of the asset and depreciation allowances for its replacement would be double counting. Where an asset needs to be replaced during the analysis period, the replacement investment should be included in the period it occurs.

2.3.7 Capital Charge and Financial Transactions

An economic CBA usually excludes financial transactions, such as capital charge,²⁷ and interest costs. This is because the analysis is not concerned with the transfer of resources in one part of the economy to another, but rather in the increase/decrease in the supply of resources in the total economy as a result of the proposal.

A further reason for excluding interest costs and the capital charge as these are implicitly included in the discount rate (including interest payments in addition to using the discounting procedure discussed in chapter 3 would double-count financing costs).

2.3.8 Contingencies

Where contingencies are part of the expected costs or benefits of the proposal, they should be included in the CBA. For example, a proposal on new office accommodation should include any contingency for escalating construction costs or delays. For smaller proposals, the value of the contingency can be estimated by multiplying the impact of the contingent event by the probability of the contingent event occurring. For larger proposals, quantitative risk analysis techniques such as those described in chapter 4 should be used.

2.3.9 Taxes

Tax exclusive prices should be used in economic CBA. This means that costs involving government expenditure should be exclusive of GST,²⁸ any other indirect taxes and income tax on the inputs employed.

²⁶ Where the appraisal period matches the economic life of the asset, the residual value would be zero and accumulated depreciation should be sufficient to replace the asset. Note also that regular maintenance is not the same as depreciation; maintenance is a real use of economic resources and should therefore be included in the analysis.

²⁷ The capital charge is an accounting charge designed to make departments explicitly aware of the cost of capital invested in their activities (i.e. opportunity cost), and encourages departments to: (i) dispose of poor performing assets and replace them with assets that provide a greater return; and (ii) reduce their level of capital to the minimum consistent with the supply of their contracted outputs. The capital charge is excluded from CBA because the opportunity cost to the Crown of investing capital is incorporated in the discount rate.

²⁸ Economic analysis on a GST-inclusive basis would in principle be equally valid provided GST-inclusive figures are used consistently. Note that Government expenditure is appropriated on a GST-exclusive basis. Presentations to Ministers (e.g. Cabinet papers) should therefore also be GST-exclusive.

It is also appropriate to adjust market prices for the effect of taxation where this may make a material difference to the decision on the preferred proposal. In practice, it is relatively rare that adjustments for taxation are required, because similar tax regimes usually apply across the range of alternative proposals. However, where tax regimes applying to different alternatives vary substantially, adjustment is necessary to avoid distorting the option choice.²⁹ This avoids a situation where tax considerations (which are transfer payments not a net benefit to society) drive investment choice.

For example, if the desired outcome was to reduce the time taken to commute to work in a given city, and were comparing roading proposals to other options such as rail and ferries, the indirect tax on petrol should be removed to ensure consistency across proposals.

2.3.10 Deadweight Losses

A deadweight loss is the net cost to society attributable to a move away from an economy's competitive equilibrium, usually through the imposition of a tax or regulation. For example, imposing a tax on a particular good or service causes some consumers to purchase less of that good or service than they would in the absence of the tax. The deadweight loss (sometimes termed excess burden) is the loss of welfare resulting from the tax-induced behavioural change. It is effectively a transfer from the taxpayer to nobody.³⁰

The recommended approach is to consider whether or not to include deadweight losses on a case-by-case basis. As a general rule, deadweight losses should be included if they are of sufficient size relative to the overall costs and benefits of the proposal that they are capable of altering the decision as to whether or not to proceed with the proposal. Having said this, deadweight losses are notoriously difficult to quantify. Estimates vary from 14%³¹ up to 50%³² of the revenue collected. Treasury suggests a rate of 20% as a default deadweight loss value in the absence of an alternative evidence based value. Thus public expenditures should be multiplied by a factor of 1.2 prior to discounting to incorporate the effects of deadweight loss.

Irrespective of their significance, deadweight losses should be identified and explained to decision makers (refer to section 4.5 on intangibles).

2.3.11 Behavioural Effects

Government interventions often cause changes in the behaviour of agencies, consumers or other economic agents. For example, investing in extra courtrooms may speed up court hearings and encourage people to litigate more readily. However, these

²⁹ UK Greenbook, Chapter 5, <http://greenbook.treasury.gov.uk/chapter05.htm#fortaxes>.

³⁰ For a diagrammatic demonstration of the deadweight loss of a tax see Varian, H.R. *Intermediate Microeconomics*, 3rd edition, New York: W.W. Norton & Company, p.294.

³¹ Diewert, W.E. & Lawrence, D.A. (1994). *The Marginal Costs of Taxation in New Zealand*, Wellington: New Zealand Business Roundtable.

³² Bates, W. (2001). How much government?: The effects of High Government Spending on Economic Performance, Wellington: New Zealand Business Roundtable, p.viii; Feldstein, M. (2005). "Rethinking Social Insurance", *American Economic Review*, Vol. 95: No.1 (March 2005), p.9.

behavioural effects are frequently uncertain, ambiguous, difficult to quantify, or of small magnitude. Their inclusion should be considered on a case by case basis taking into account their significance in relation to the overall costs and benefits of the proposal and their ability to altering the decision as to whether or not to proceed with the proposal.

Where there are behavioural effects, they should be separately identified and commented on even if they are not significant or cannot be estimated accurately enough to be included in the analysis (refer to section 4.5 on intangibles).

2.3.12 Externalities

Undertaking a project may result in benefits received or costs borne by those not associated with the activity and for which payment is neither given nor received. This is particularly the case for environmental and health proposals. For example, the construction of a wool scouring plant that discharges residues into a nearby river will have a negative impact on those who use the river downstream of the plant. Alternatively, the achievement of one outcome may have a detrimental impact on the achievement of another. These spillovers are termed “externalities” and can be positive or negative in nature.

The recommended approach is to consider whether or not to include externalities on a case-by-case basis. As a general rule, externalities should be included if they can be quantified (refer to section 2.4) and are of sufficient size relative to the overall costs and benefits of the proposal that they are capable of altering the decision as to whether or not to proceed with the proposal. Any assumptions utilised in arriving at this decision should be fully explained and justified.

If the externalities are unable to be quantified, they should at least be identified and explained to decision makers (refer to section 4.5 on intangibles).

2.3.13 Transfer Payments

A transfer payment is a payment for which no good or service is obtained in return e.g. a social welfare benefit. Transfer payments may change the distribution of wealth, but do not of themselves give rise to direct economic costs or benefits for the economy as a whole. They should therefore be excluded from CBA unless the resulting increases in the general tax burden, or price distortions, are material to the analysis. In most cases these indirect economic costs are not easily quantifiable and therefore fall outside of the scope of most analyses.

2.3.14 Double Counting

It is very important to avoid double counting costs or benefits. Often external costs/benefits are no more than transfers of internal costs/benefits, which should not be included as this would be double counting. An example of this is development of a new railway linking two towns. The increase in value of houses in close proximity to the two railway stations maybe accepted as a measure of the expected benefits of the railway. If this measure is used, it is important to not also include benefits such as reduced travel times, better access to shopping and other amenities, and an extension of job opportunities. To do so would be double counting because these benefits have been

capitalised into the value of house prices.³³ Careful consideration should therefore be given to the existence and relevance of possible externalities. Often factors that could give rise to externalities are built into market prices and have therefore already been accounted for (the exception is where transaction costs are very high).

2.3.15 Concluding Comments

For most proposals the common costs and benefits to be included for analysis are:

- direct establishment costs (staff, consultants, information technology, rent, etc)
- purchase of fixed assets
- indirect establishment costs (e.g. other overheads and negative externalities on areas such as the environment and human health)
- direct establishment benefits (e.g. reduced operating costs)
- indirect establishment benefits (e.g. positive externalities on areas such as the environment and human health)
- release of funds for other uses
- residual values
- positive or negative changes in outcomes (e.g. reduced traffic accidents).

A useful rule is to include only those costs and benefits that involve the actual use of resources and that would be affected by the proposal under consideration.

2.4 Valuing Relevant Costs and Benefits

With the relevant costs and benefits identified, the next step is to assign dollar values. The key thing is that CBA should provide a clear and consistent picture of the relative costs and benefits of alternative proposals to assist decision makers. It is not the role of analysts to decide in advance the proposals/options they believe are the most appropriate and weight the analysis accordingly (refer to the discussion on optimism bias in section 4.2).

In general, all benefits and costs should be quantified and valued in dollar terms unless it is clearly impractical to do so. This may happen because the costs and benefits:

- (i) cannot be reliably measured, or
- (ii) are not significant³⁴ to the analysis, or
- (iii) are significant to the analysis but the resource/staff cost of attempting to value them outweighs the advantage of including them in the analysis.

³³ Mishan, E.J. 'On the conceptual underpinning of a cost-benefit analysis', *The Singaporean Economic Review*, Vol. 47, No.1 (2002), pp.1-16.

³⁴ For a cost or benefit to be significant, its impact on the analysis must be capable of influencing the final decision or final selection from a range of alternative proposals.

2.4.1 Real versus nominal values

Costs and benefits should be valued in *real* terms (constant prices) as opposed to *nominal* terms (prices at the time the goods or services were provided). That is, the impact of inflation is eliminated from the analysis because we are interested in costs and benefits in a common money value. The only time that we make *real* adjustments to prices over time is if the price of a particular good or service is expected to increase or decrease *relative* to all other goods and services. In such cases the relative change should be quantified and built into the analysis. Common examples where relative price changes maybe relevant to the analysis are:

- high technology products for which prices are expected to fall in real terms e.g. the very latest computer technology
- high technology products for which prices are expected to rise in real terms e.g. health technology and defence hardware
- natural resources where supply is scarce or constrained e.g. oil/petrol and electricity, and/or
- wages and other input prices that are expected to increase faster than the rate of general inflation.

A useful working rule is that we assume the costs of a good or service will remain constant in real terms (i.e. before inflation) unless we are reasonably sure that its price will change relative to all other prices in the economy.

2.4.2 Valuing Costs and Benefits Using Market Values

Costs and benefits should normally be based upon market prices as they are the easiest to identify and usually reflect implicit opportunity costs.³⁵ Real or estimated market prices are therefore the starting point when attempting to value costs and benefits. However, market prices may need to be adjusted for distortions such as tax differences between options or monopoly pricing.³⁶

2.4.3 Valuing Costs or Benefits when there are No Market Values (Intangibles)

There are often cases where a market does not exist or market prices are not directly observable or easy to estimate. In such cases, it may be difficult to estimate costs and benefits (or even to determine to whom the costs and benefits accrue). Wider social and environmental costs and benefits commonly fall into this category, but should not be ignored simply because they cannot easily be costed. One indicator of the level of benefit is the willingness to contribute financially to a project, for example, through donations or by voting to be levied to fund additional outputs. For example, members of a club might vote to increase the annual club subscription, or local farmers might vote to be levied to raise funds for a flood control or irrigation scheme.

³⁵ UK Green Book, Chapter 5, <http://greenbook.treasury.gov.uk/>.

³⁶ A monopoly is where there is only one producer/seller in a given industry. The lack of competition allows a monopoly to significantly influence the price of a good or service; it will choose a (higher) price that maximises its profits rather than a (lower) price that that is optimal for the rest of society.

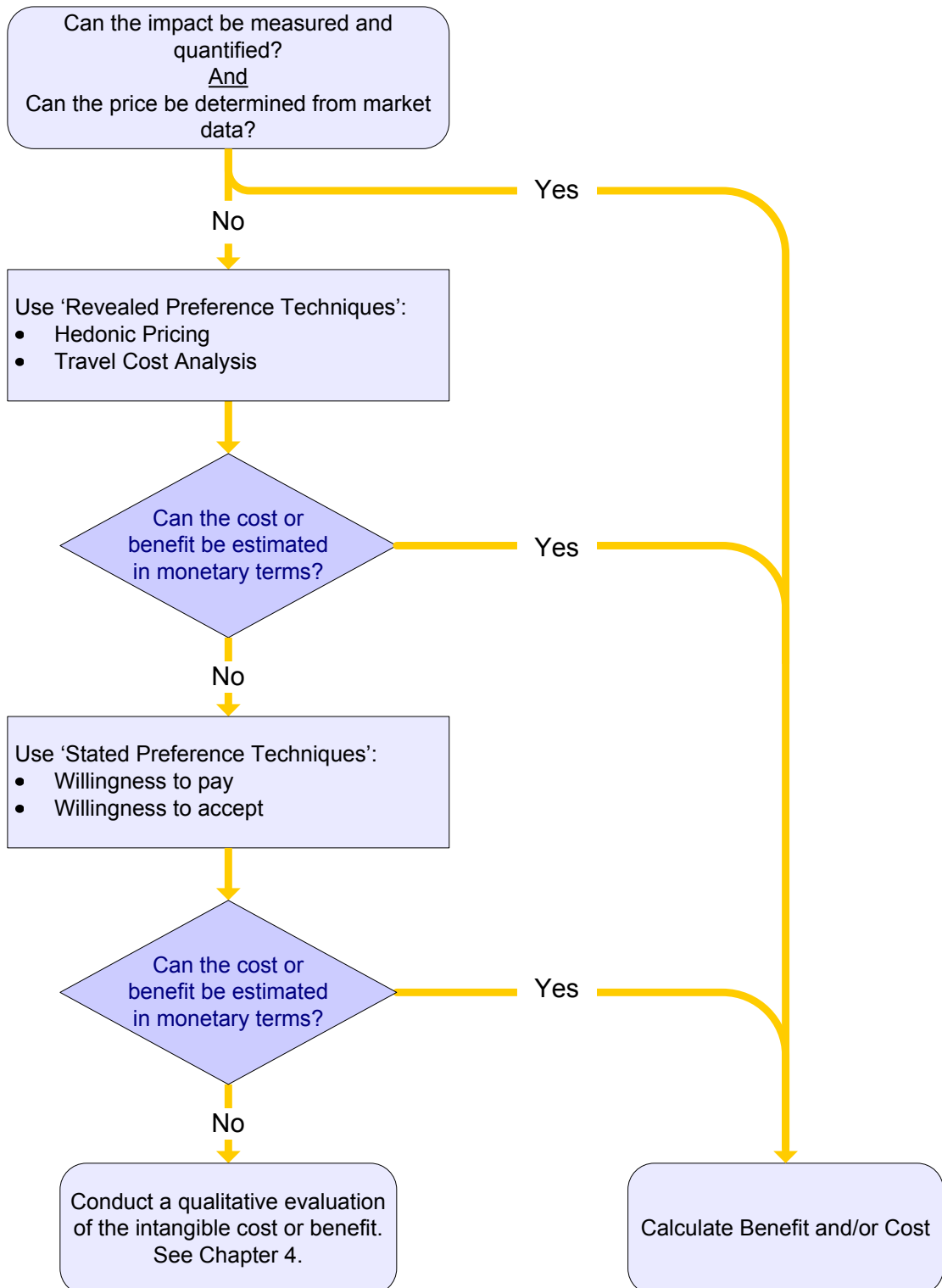
However, there is a trade-off between including intangibles and the robustness of the assumptions used in quantifying the costs and benefits. Some suggested techniques to establish a value for inclusion in the analysis are listed below. Note that these methods can be resource intensive and their use should therefore be balanced against the expected significance of the impacts, the availability of the necessary information, and the resource cost involved.³⁷

- a. *Shadow Prices* - market prices of goods or services do not always reflect the true cost or value of those goods or services. For example, a subsidy on a particular good is likely to make the price of the good lower than the true cost of the resources that went into making it. The true cost would instead be the price of the good, plus the per unit value of the subsidy.
- b. *Revealed Preference Testing* - compares situations where people have historically made trade-offs between a cost and some form of benefit e.g. farmers who have contributed towards some form of flood protection works to reduce the risk of their farm being flooded. This information can give an indication of the extent to which people are prepared to pay for a given benefit. Examples of this method include:
 - I. **Hedonic pricing** uses the different characteristics of a traded good to estimate the value of a non-traded good. For example, the value of a piece of lakefront could be calculated by comparing the price of a house on the lakefront with the price of a similar house located elsewhere.
 - II. **Travel Cost Analysis** uses the value of traded goods and services to estimate the value of non-traded goods. For example, the value of a recreational park to people might be calculated as the sum of the costs incurred by people travelling to the park (including travel time). This may result in a minimum value for the park, as it ignores what is likely to be a significant value to the consumer above what is paid (consumer surplus).
- c. *Stated Preference Testing* - surveys people to identify their preference for trading off costs and benefits under certain hypothetical scenarios. The approach simulates a market by estimating a consumer's:
 - I. **Willingness to pay** for good or service.
 - II. **Willingness to accept** compensation to tolerate a negative or bad economic outcome.

³⁷ Based on Ministry of Economic Development. (1999). A Guide to Preparing Regulatory Impact Statements. <http://www.med.govt.nz/buslt/compliance/risbccs/regimpact/index.html>

The following diagram outlines a process for attempting to quantify intangibles:³⁸

Figure 2.4a: Estimating Non-monetary Benefits and Costs



³⁸ Adapted from UK Green Book, Chapter 5, <http://greenbook.treasury.gov.uk/>.

If it is still not possible to quantify some costs and benefits with any accuracy, their inclusion in the quantitative analysis may in fact be more misleading than helpful. In such circumstances it is important to include either:

- a) a robust sensitivity analysis around key variables (recommended); or
- b) a qualitative evaluation of those costs and benefits.

Refer to chapter 4 for more details on these techniques.

2.4.4 Distributional Effects

Proposals can have uneven effects on different individuals and sectors of the population such as age, gender, health/disability, ethnic, socio-economic, skill, and geographic groupings.

The analysis should identify the winners and losers of these 'distributional effects' and, if possible, quantify the *net benefit* for inclusion in the analysis.³⁹ However, determining this can be difficult because benefits and costs are often redistributed in unintended and unexpected ways. For example, a subsidy for the production of a good or service will usually raise the incomes of the commodity's suppliers, but it can also benefit consumers of the commodity through lower prices and reduce the incomes for suppliers of competing products. A subsidy also raises the value of specialised resources used in the production of the subsidised commodity. As the subsidy is incorporated in asset values, its distributional effects can change.

It is also important that the distribution of benefits and costs between residents and foreigners is considered. While benefits and costs to foreigners should not be included in national Cost Benefit Analysis, they should be identified, valued and explained to ensure that decision makers are aware of the cross-border impacts of proposals.

Where the decision is made not to specifically include or adjust for distributional effects, the reasons for this decision need to be clearly documented and explained.

2.5 Concluding Comments

This chapter has described how to identify and value all the relevant costs and benefits that fall within the appraisal period. Where costs and benefits have been identified but cannot be easily measured in monetary terms, these are excluded from the quantitative analysis detailed in chapter 3. Nonetheless, these intangibles can impact on the decision making process and the selection of the preferred proposal. Chapter 4 describes qualitative and other analysis techniques that can be used to ensure that such intangibles and uncertainties are factored into the decision making process.

³⁹ A proposal that involves transferring welfare from person A to person B is only a benefit if the welfare gain to B exceeds the welfare loss to A.

3 Analysing the Options

3.1 Cashflows

Chapter 2 provided guidance about the types of costs and benefits that should be included in a cost-benefit analysis. Chapter 2 also indicated that costs and benefits over the *economic life* of the proposal should be included. And *real* costs and benefits (i.e. all prices in today's dollars) should be used unless significant *relative* price changes are expected.

In simple terms, once the advice in chapter 2 is followed, a forecast of the relevant net cashflows should be available for each period of the project, over the known length of time over which the proposal is being evaluated. There would be one net cashflow for each year, for example, or one for each month for shorter proposals. For proposals of less than four years, it is a good idea to use monthly flows. Remember that costs and benefits do not necessarily have to correspond to physical flows of cash (although they usually do). If non-monetary/qualitative costs or benefits can be estimated in monetary terms, they can be included in the analysis as per any other cash flow (e.g. costs of death or injury).

These cashflows will be referred to as cashflows for “net present value” purposes. The term “net present value”, abbreviated to NPV, will be explained in the course of this chapter.

Some net cashflows may be positive and some may be negative.

Example 3.1: Net Cashflows

The Ministry of Information Technology is considering an interim upgrade to its existing fines-collection software.

The interim upgrade will initially require a significant investment of \$100 million. From the first year the upgrade is fully operational, running costs (IT staff, training of operators) will be \$20 million a year higher than with the existing system. However, the upgrade is expected to reduce the on-the-ground costs of collecting fines considerably, because collection agencies will be provided with correct and timely information, and the system will be able to identify those people most likely to pay if followed up. These cost savings are expected to amount to \$65 million per year. All amounts are expressed in today's prices (i.e. in real terms).

The upgraded system would run for a three-year period after which a completely new replacement system is expected to be available.

The table below shows the expected cash inflows, outflows and net cashflows for NPV purposes. All cashflows are marginal (or incremental), i.e. over and above the cashflows in the case of no upgrade (i.e. the status quo or do nothing option).

Year	0	1	2	3
Forecast cash inflow	0	65	65	65
less forecast cash outflow	100	20	20	20
Forecast net cashflow	-100	45	45	45

3.2 Discounting and Discount Rates

In all but the simplest proposals, cashflows will occur at several different points in time. In general, it is not appropriate to treat cashflows in one period as having the same weight as cashflows in other periods. Rather, cashflows need to be *discounted*.

The term *discounted* means that cash flows which occur later are given less weight than flows which occur sooner, with larger reductions the further into the future the cash flows occur. The *discounted value* of cash flows is therefore the relevant assessment measure. The discounted value is also known as the *present value*.

An intuitive justification for discounting is that most people would prefer receiving a dollar today over receiving a dollar in a year's time. This is referred to as *time preference* or *the time value of money*.

A second justification for discounting, and the one which is used in practice to derive the *discount rate* (r), is that when a person assesses a proposal, they will require a return at least as high as they can obtain from any other investment of equal risk.

By discounting, the net benefit or cost *over and above the return for other proposals of equal risk* can be determined. A net present value (NPV) above zero indicates a higher return than other proposals of equal risk, an NPV of zero indicates an equal return, and a negative NPV indicates a lower return.

Example 3.2: Discounting – The Rationale

The Ministry of Information Technology expects to receive a net cashflow of \$45 million in the first year after they upgrade their system. However, the Ministry could also receive a net cashflow of \$45 million in one year's time by investing \$40.9 million in high-yield corporate bonds now (assuming a 10% per annum real rate of interest on those bonds). So, assuming the IT proposal is approximately as risky as investing in the corporate bonds, the \$45 million cashflow in one year's time is really only worth as much as having \$40.9 million now. The future cashflow is therefore discounted by the discount rate of 10%, to \$40.9 million, for the purposes of proposal evaluation.

3.2.1 The Discounting Formula

The discounting can mostly easily be done in Excel (see Section 3.4). However, for the sake of completeness there is an explicit formula for the discount factor in period n :

$$\begin{aligned} \text{Discounted value now} &= \text{Future value in } n\text{th period} \times \text{Discount factor} \\ &= \text{Future value in } n\text{th period} \times \frac{1}{(1 + \text{discount rate})^n} \end{aligned}$$

Example 3.3: Discounting Using the Formula

If the Ministry assesses that its proposal is as approximately as risky as other proposals with a real return of 10%, it will choose a discount rate of 10%. The discounted values of expected cash flows are calculated in the following table.

Year (n)	0	1	2	3
Forecast cash inflow	0	65	65	65
Less forecast cash outflow	100	20	20	20
Forecast net cashflow	-100	45	45	45
Discount factor = $1 \div (1 + 10\%)^n$	1.000	0.9091	0.8264	0.7513
Present value = net cashflow x disc. factor	-100	40.9	37.2	33.8

3.3 Choosing a Discount Rate

The discount rate is effectively a *desired return*, or the return that an investor would expect to receive on some other typical proposal of equal risk. The discount rate typically includes:⁴⁰

- The “rate of time preference”. Most people prefer consumption undertaken now rather than later. Thus, a dollar available now is more highly valued than one received later.
- Uncertainty/risk. There is necessarily some degree of uncertainty as to whether a future dollar will actually be received. Its value is lessened in proportion to the expected size of this uncertainty/risk factor.

There is no single rate of return that is appropriate for every project. The Treasury uses a 10% real⁴¹ discount rate whenever there is no other agreed sector discount rate for costing policy proposals.⁴² Where there is an agreed sector rate, it may be used instead.

For financial analysis at the level of the organisation – **not** for national analysis of net benefit – the *Department Capital Charge* rate is used (currently 7.5% for 2006/07). It is an estimate of the government’s average cost of capital, across all departments, revised annually.

For non-departmental projects (Crown Entities and State Owned Enterprises), or in unusual cases where using the standard rate is inappropriate due to an abnormal amount of risk, it may be appropriate to calculate a different rate. A standard approach

⁴⁰ Adapted from Ministry of Economic Development. (1999). A Guide to Preparing Regulatory Impact Statements.
<http://www.med.govt.nz/buslit/compliance/risbccs/regimpact/index.html>

⁴¹ See section 2.4.1 for a discussion on the difference between real and nominal values.

⁴² See <http://www.treasury.govt.nz/workingpapers/2002/02-21.asp>, at page 12.

in the private sector is to use the *weighted average cost of capital (WACC)*.⁴³ Analysts should consult with their Treasury Vote team when considering the use or calculation of an alternative discount rate.

Whatever the discount rate chosen, care must be taken to remove the effect of inflation *if NPV calculations use figures which are all in today's dollars*. Note that the 10% figure used by Treasury in the default case already has inflation removed, as does the Departmental Capital Charge Rate. To remove the effect of inflation from other discount rates, use the formula: $(1 + \text{nominal discount rate}) \div (1 + \text{inflation rate}) - 1$.

Example 3.4: Choosing a Discount Rate

The Ministry of Information Technology is a government department. It does not believe that the upgrade proposal is any more or less risky than other similar projects undertaken by government. Therefore, it adopts the 10% real discount rate.

In typical cases, choosing a higher discount rate reduces the net present value of a project, and choosing a lower rate increases the net present value, but this is not always the case. Because the discount rate has a significant impact on the net present value, it is important to make clear which rate is used and why. Sensitivity analysis (see section 4.3) on the discount rate should also be undertaken.

3.3.1 Long-lived Projects

For very long-lived proposals, and particularly where a substantial proportion of the benefits occur well into the future, the use of discounting with a standard discount rate is likely to create a bias against project acceptance. For example, with a discount rate of 10% per annum, only five percent of any benefits occurring in the thirtieth year will be added to the NPV.

In a commercial setting, the low weight given to distant cashflows reflects the desire of investors to achieve a return sooner rather than later. However, some sources recommend using a lower discount rate for very long-lived proposals, but only if “appraisal of a proposal depends materially upon the discounting of effects in the very long term”.⁴⁴

⁴³ $WACC = D \times (\text{Cost of debt}) + (1 - D) \times (\text{Cost of equity})$

Where:

D is the percentage of debt finance (in market value terms)

Cost of debt = (interest rate payable for the project) \times (1 - corporate tax rate)

Cost of equity = [(risk free rate of return) \times (1 - tax rate of investor) + (equity beta) \times (market risk premium)] \div (1 - corporate tax rate)

The interest rate payable by government departments is often approximated by the risk free rate plus a premium of 1%. The tax rate of the investor has been assumed to be 0.28 (28%) in the past. Values for the asset beta may be obtained from observed equity betas for listed companies. Estimates of the market risk premium in New Zealand have commonly ranged between 5% and 9%. See <http://www.treasury.govt.nz/merp/default.asp> for more information on the market risk premium.

⁴⁴ <http://greenbook.treasury.gov.uk/annex06.htm#long>

It is anticipated that, in New Zealand, lower discount rates would be used only in exceptional circumstances.

3.3.2 Annual versus Monthly

The discount rate will usually be expressed in annual terms (*percent per annum*). If the expected cashflows are annual, the rate may be used directly. If, however, expected cashflows are monthly, the discount rate needs to be converted to a monthly rate. Dividing the annual discount rate by 12 will give an approximate rate to use in the NPV calculation.⁴⁵

3.4 Net Present Value

Given a set of cashflows, how are the net benefits of the proposal actually assessed? In practice, there are many stages of assessment, including both quantitative and qualitative methods.

However, one element of assessment that should be included in virtually all projects is a calculation of the Net Present Value (NPV) of the project. The NPV is the sum of *discounted* net cashflows over the period.⁴⁶ When properly calculated, the NPV is a relatively objective method of determining the improvement in national wealth resulting from a proposal. It is mechanistic, and because of this, starting assumptions need to be explicitly identified.

Once calculated, the NPVs of several projects can be compared. In a commercial setting, it is typical for the project with the highest NPV to be chosen, but in a government setting where many costs and benefits may be difficult to quantify, the NPV may be just one of the decision-making criteria.

Put simply, a proposal with a higher NPV ranks ahead of the alternative, assuming the proposals are otherwise equal. If the proposals are not the same in all other respects, a higher NPV is not conclusive. For example, one proposal may have much greater intangible net benefits. *A negative NPV does not rule out proceeding with a proposal. There may be other qualitative influences on the decision to proceed, and these may be important.*

⁴⁵ A more precise monthly discount rate is given by $((1+(\text{annual rate}\div 100))^{1\div 12}-1) \times 100$. For example, if the annual rate is 10%, the monthly rate will be $((1+(10\div 100))^{1\div 12}-1) \times 100 = 0.797\%$.

⁴⁶ In the case of annual cashflows, and assuming the current year is 'year 0', the formula for NPV is:

$$\text{NPV} = \text{CF}(0) + \frac{\text{CF}(1)}{1+r} + \frac{\text{CF}(2)}{(1+r)^2} + \dots + \frac{\text{CF}(n)}{(1+r)^n}$$

where CF(n) is the net cashflow for NPV purposes in period n and r is the discount rate. Note that the initial cashflow is not discounted if it occurs very close to the beginning of the project (in period 0).

The NPV of a proposal is to be compared to NPVs for alternative options, at least one of which should be the status quo (i.e. the costs and benefits if no action were taken).⁴⁷ Alternatively, all cash flows could be expressed as *differences* in cash flows compared to the cash flows from the status quo. If this alternative is used, an NPV greater than zero indicates that the net benefits of the proposed project are greater than the benefits from the status quo.

Note that NPV analysis is not the same as Cost Benefit Analysis. Cost Benefit Analysis is the wider process of proposal selection. NPV analysis is just one tool which may be applied in Cost Benefit Analysis.

Example 3.5: NPV Calculation

Using the table from Example 3.3 and adding the discounted net cashflows, gives:

Year	0	1	2	3
Forecast cash inflow	0	65	65	65
Less forecast cash outflow	100	20	20	20
Forecast net cashflow	-100	45	45	45
Discount factor = $1 \div (1 + 10\%)^n$	1.000	0.9091	0.8264	0.7513
Present value = future value x disc. factor	-100	40.9	37.2	33.8
Cumulative sum of present values (i.e. NPV)	-100	-59.1	-21.9	11.9

The highlighted figure, the sum of all the present values, is the NPV. The NPV is greater than zero, which implies that the proposal will generate a greater return than other proposals with a similar level of risk (or equivalently, the proposal is superior to the status quo). On this basis, and for the moment ignoring non-monetary considerations, proceeding with the upgrade would be a good idea.

Recall that the cash flows were incremental – over and above the “do nothing” or “status quo” scenario. An alternative would have been to use two scenarios – one involving **total** net national cash flows assuming an upgrade, and one involving **total** net cash flows assuming the status quo. Using such an alternative approach, the project with the *highest* NPV would be chosen (non-monetary considerations aside).

Example 3.6: Using a Spreadsheet to Calculate an NPV.

While manual calculation of an NPV is relatively straightforward, it is likely to be simpler in practice to use the built-in NPV tools in a commercial spreadsheet package.

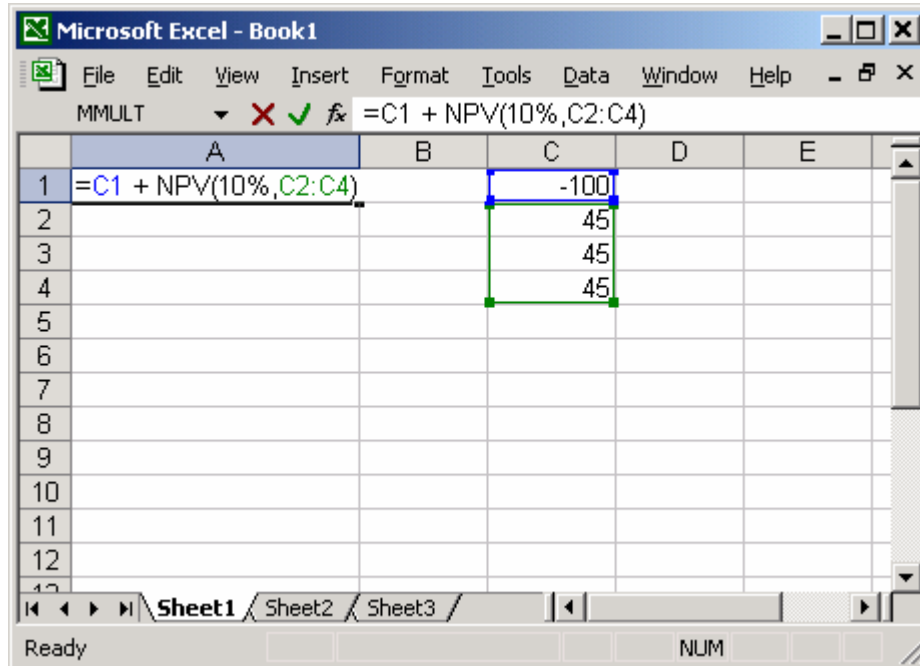
To calculate the NPV for the Ministry’s proposal in Excel (similar functions are available in other packages), follow this procedure:

In Cell A1, enter the formula as shown in the figure below:

=C1+ NPV(10%, C2:C4)

⁴⁷ Some sources recommend using the least-cost project as a benchmark. The Treasury recommends using the status quo. Note that the status quo option should not include sunk costs.

10% is the discount rate for the proposal (it may of course be varied – see Section 4, which covers sensitivity analysis). C1:C4 is the range of cells containing net cashflow data for each period (the areas with a bold outline). The NPV formula is applied to cells C2 to C4. The first cashflow (C1) is excluded from the NPV formula because it occurs immediately and should not be discounted.



Naturally, in cases where the first cashflow occurs one period into the future, rather than immediately, it should be discounted and the formula would be:

$$= NPV(10\%, C1:C4)$$

Excel gives the answer, \$11.9 million, the same figure we determined manually.

3.5 Equal Proposal Lives

To be strictly comparable, NPVs should be for proposals of equal lives or appraisal periods.⁴⁸ In many cases, project lives will be equal. If it does not make sense for the proposal lives to be equal, it is possible to make an adjustment to ensure NPVs are still comparable.

One approach is to calculate a terminal value for the longer-lived proposal at the time the short-lived proposal ends, and then do the analysis over the shorter period.

Another approach is to assume that one or both projects are repeated. For example, a two-year project could be repeated once to enable comparison to a four-year project.

An example where proposal lives may differ is in a lease versus buy decision. Suppose an organisation has a choice between leasing computers for one year or buying

⁴⁸ Note that the requirement for proposal lives to be equal applies to NPV analysis only and not to the alternative decision methods outlined in section 3.6.

computers which will last for three years. To equalise project lives, use a three year appraisal period and assume that the computers will be leased in the second and third years as well.

3.6 Alternative Decision Guidance Methods

The NPV method is the preferred method for the evaluation of proposals. However, there are mathematical alternatives to NPV analysis for evaluating projects. They may be useful in combination with NPV. If an NPV has already been calculated, it is probable that alternative measures can be easily calculated.

The *Internal Rate of Return* is a potentially useful alternative measure, particularly where there is a lot of uncertainty about the discount rate. The *payback method* and *benefit-cost ratio* are also occasionally applied.

3.6.1 Internal Rate of Return

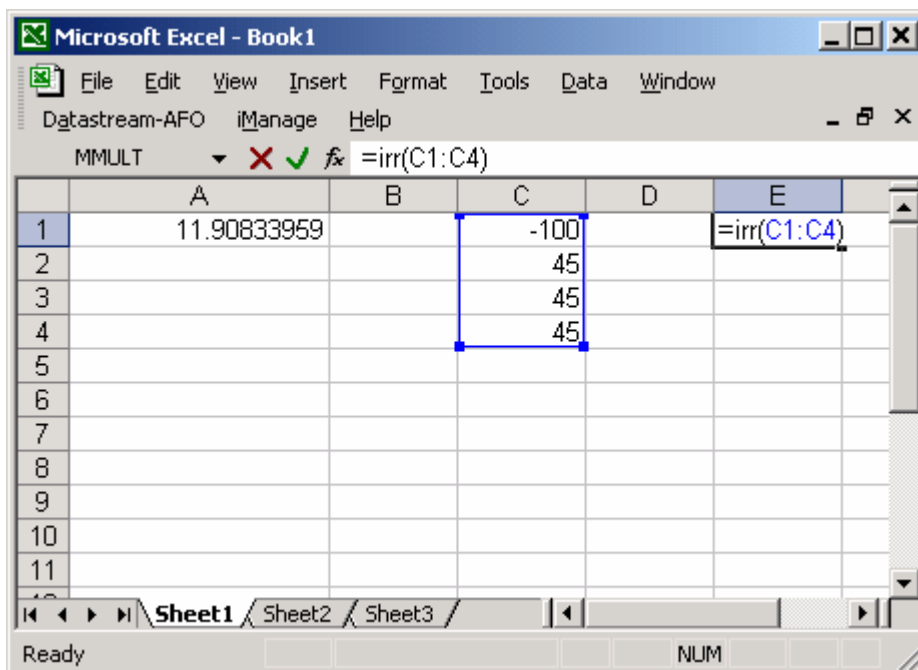
The *Internal Rate of Return (IRR)* method is one alternative to the NPV. It can be useful for proposals for which it is very difficult to determine a suitable discount rate. The IRR is the discount rate which would give an NPV of zero, given expected cashflows. Under many typical circumstances the IRR produces sensible results, and may be calculated easily using a spreadsheet package.

Example 3.7: Calculating an IRR in a Spreadsheet

To calculate the IRR of the Ministry's proposal in Excel, type the following formula in cell E1, as shown in the figure below:

=irr(C1:C4)

C1:C4 is the range containing all cashflows, as before. Excel returns the answer of approximately 17%. *In this case*, any choice of discount rate less than 17% will give an NPV greater than zero.



However, there are cases in which the IRR produces unusual results:

- It may not be possible to find the IRR at all (i.e. there is no discount rate that gives an NPV of zero).
- Mathematically, there may be more than one IRR, and it can be difficult to know which to use.
- The IRR does not distinguish between projects of different sizes. Using IRR as the sole criterion, a project which has an NPV of \$1,000 and an IRR of 25% would be considered preferable to a project which has an NPV of \$1,000,000 and an IRR of 20%. Assuming the smaller project cannot be replicated many times, the project with the large NPV may well be more desirable, even though it has a lower IRR.
- Various extensions to the IRR method have been developed (modified IRRs). While they improve the measure's properties, the additional effort required often means it will be more sensible to simply calculate the NPV, which is a conceptually superior measure.

3.6.2 Payback Period

Another alternative to NPV is the *Payback Period* method. This method determines the point in time at which cumulative net cashflows exceed zero. For a normal project, a large outlay at the beginning of the project is followed by smaller net inflows for several periods, with the cumulative inflows eventually covering the initial outlay and providing some net benefit. The point at which the initial outlay is covered is the payback period.

Example 3.8: Payback Method

The Ministry's proposal predicts that the cumulative sum of present values will exceed zero in the final year of the project (see example 3.5). The payback period is four years.

The payback method has several major weaknesses. Firstly, it does not discount cashflows (although discounting could be added easily to solve this – see example 3.9 below). Secondly, it does not take account of cashflows beyond the payback period, which could be large and affect the desirability of undertaking the project. And thirdly, it is a measure of time, not a measure of value.

3.6.3 Benefit-cost Ratio

A final alternative is the *benefit-cost ratio (BC ratio)*. The BC ratio is given by:

$$BC = \frac{\text{sum of present values of benefits (cash inflows)}}{\text{sum of present values of costs (cash outflows)}}$$

A BC ratio above one implies an NPV greater than zero.

In the case of single cash outflow (occurring in the first period), the benefit-cost ratio is also called the *Profitability Index*.

Example 3.9: Benefit-Cost Ratio

From the table in example 3.5, we see that the sum of the present values of benefits is \$111.9 million and the initial outlay was \$100 million, so the Ministry's proposal has a benefit-cost ratio of $111.9 \div 100 = 1.119$. This implies the proposal has an NPV above zero. This proposal also has a Profitability Index equal to 1.119, since there is a single cash outflow and it is in the first period.

The BC ratio is a useful measure because when there are a large number of proposals, there may not be enough resources available to undertake them all, even if they all have high net present values. As a rule of thumb, picking the projects with the highest BC ratios can ensure maximum value for money in terms of contributing to outcomes. BC ratios have regularly been used to choose which of many proposed roading projects to proceed with.⁴⁹

⁴⁹ An alternative to the BC ratio in circumstances where there are insufficient resources to proceed with all NPV-positive projects, is to use a linear/integer programming approach. A series of constraints are specified and a mathematical method (typically the Simplex method) is used to determine the best solution. This can be proven to produce the maximum sum of the NPVs, given resource and other constraints, but involves complex specification of a model and difficult calculations.

4 Assessing Risk, Uncertainty and Intangibles

4.1 Risk and Uncertainty

The previous chapter detailed the valuation of expected future costs and benefits to enable a comparison of the net benefits for alternative options. There will always be some difference between these estimates and the actual costs and benefits that are eventually realised. These differences can arise because of inherent biases in developing the cost benefit analysis or because of risks or uncertainties that were not foreseen at the time the analysis was undertaken.

The cost benefit analysis should include a risk assessment to determine how exposed each option is to future uncertainty. For example, if uncertain or highly variable costs are over- or under-stated by 5%, how much would this impact on the choice of preferred option?

The extent of the risk assessment should be determined on a case-by-case basis, depending on the scale of the proposal, the degree of uncertainty in key costs or benefits, and the risk tolerance of stakeholders. A comprehensive risk assessment should include:⁵⁰

- establishing the context for managing risks, including environmental risk drivers, organisational objectives and risk management capability, and how much risk stakeholders are prepared to accept
- identification of all the risks that could impact on objectives
- analysis of the risks by considering the sources of risk, their consequences and the likelihood that the consequences will arise
- determining if each risk can be accepted or needs to be treated
- consideration of actions, before and during implementation, to treat (avoid, mitigate, transfer) the risks, and
- communication to decision-makers so that they can make fully informed decisions based on the potential impact of risks and bias on each alternative option.

⁵⁰ AS/NZS 4360:1999 Australian/New Zealand Standard "Risk Management", <http://www.standards.co.nz/default.htm>.

4.2 Optimism Bias

Risk can take many forms. The most familiar form of risk to outcomes is that the estimated future costs arising from the given proposal are overly conservative, or the benefits are overly optimistic. That is, the analysis does not fully reflect the possibility of cost-overruns, short-falls in demand or implementation timing delays. There is a demonstrated, systematic, tendency for analysts to exhibit optimism bias when preparing spending proposals.⁵¹

Optimism bias can be reduced by making explicit adjustments to key assumptions and variables to improve estimates, for example by explicit adjustments to increase costs and reduce, or delay, benefits.⁵²

Both of these approaches assume that that the amount of bias and the level of overall risk can be reasonably estimated. However this is often not possible. Generally a sensitivity analysis approach is preferred and should also be used to test and demonstrate how the results of the analysis vary as individual assumptions, costs or benefits are changed.

4.3 Sensitivity Analysis

Sensitivity analysis is a form of quantitative analysis that examines how net present values, total cost, or other outcomes vary as individual assumptions or variables are changed. This approach can be used to test the robustness of the analysis as well as allowing for optimism bias and uncertainty about future cash flows.

Sensitivity analysis can help draw attention to those factors that require especially careful assessment or management. This analysis can address two key questions. Would the proposal still be worthwhile pursuing if some of the key assumptions do not eventuate? Are there actions that can be taken to reduce the risks before accepting a particular option? Sensitivity analysis can help in forecasting uncertainty and in assessing and treating project risks.

The sensitivity analysis needs to be well designed and clearly presented. The analysis should give a realistic picture of the extent to which the selected option is still worthwhile pursuing even if there are significant changes in key variables.

The decision about which form of sensitivity analysis to undertake and the effort to invest should be made on a case-by-case basis, depending on the scale of the proposal, the degree of future uncertainty around key costs or benefits, and the risk tolerance of stakeholders.

⁵¹ Flyvbjerg, B. & Holm, M.S. & Buhl, S. (2002). 'Underestimating Costs in Public Works Projects: Error or Lie?' *Journal of the American Planning Association*, Summer 2002, Vol. 68 Issue 3, pp.279-96.

⁵² Refer to UK Green Book, Chapter 5 at <http://greenbook.treasury.gov.uk/chapter05.htm> for further detailed guidance on managing optimism bias.

Sensitivity analysis can also be used as part of the monitoring and risk management regimes that form part of the implementation. This should ensure that the risks key variables are subject to are effectively monitored and managed.⁵³

4.4 Scenario Analysis

The simplest form of sensitivity analysis is scenario analysis. Scenarios can be chosen to draw attention to the major uncertainties upon which the success of a proposal depends. Are there any variables (such as exchange rates, salary costs, demand drivers, timing or assumptions) that materially influence the net benefits? These key variables should be identified using the risk assessment process outlined at the start of the chapter. The scenario analysis should then focus on asking “what if” questions and recalculating the expected NPV for several scenarios. For example, what if one or more sensitive/key variables were changed by $\pm 10\%$ or $\pm 50\%$ or whatever is a realistic and possible variation. What if related Government policy altered or critical legislation is not passed? If these events occur, should the proposal proceed? Under what circumstances does the preferred option change? A common approach is to test three combinations of key variables:

- pessimistic or conservative scenario
- most probable or base scenario
- optimistic scenario.

For example, consider the cost of purchasing a large mainframe computer:

Table 4.4: Sensitivity Analysis

	Conservative Scenario	Base Scenario	Optimistic Scenario
Exchange Rate (\$1NZ:US\$)	\$0.55	\$0.64	\$0.70
Price Discount (in domestic currency) ⁵⁴	10%	15%	25%
Overall NPV	-\$52.5m	-\$45.0m	-\$40.5m

If the NPVs do not alter significantly enough to affect the final decision then it is possible to feel more comfortable about the robustness of the analysis and the net benefits of the proposal.

This approach is usually appropriate for smaller proposals or where the outcome of the cost benefit analysis is more certain. For larger proposals with greater uncertainties, the

⁵³ Ministers agreed that quantitative risk analysis should be used as the basis for appropriations and ongoing access to funding for implementing major IT projects, unless relevant Ministers agree that the size and nature of the project does not warrant this approach. Major IT projects are defined in Cabinet Office Circular (01)4 “Monitoring Regime for major Information Technology (IT) Projects at <http://www.dpnc.govt.nz/cabinet/circulars/co01/4.html>.

⁵⁴ The price discount applies to the domestic price and is therefore a separate variable from the exchange rate.

number of variables can be increased and sensitivity analysis can also be used within each scenario. Or a more complex approach such as Monte Carlo analysis can be used (see Annex 1 for more details).

4.5 Intangibles

Intangible costs and benefits are not easily quantifiable in monetary terms. Intangibles may be either internal or external costs or benefits. As discussed in chapter 2, the recommended approach is to capture all identifiable costs and benefits if there is a reasonable basis to include them and include the resultant resource-flows explicitly in the cost benefit analysis. Some intangibles can be quantified in non-monetary terms (for example, one of the benefits from an e-Government initiative might be “time saved” by paying court fines online).

Intangibles that cannot reasonably be quantified in monetary terms should be excluded from the quantitative analysis detailed in chapter 3. However, these intangible benefits and costs can be significant in relation to the quantitative impacts, and significantly influence the final decision. If they are significant they should be explicitly highlighted and explained in the analysis so that decision-makers are aware of the value judgements they are making in pursuing a particular option. This explanation can be quantitative, qualitative, descriptive, or a combination of these.

4.6 Multi-Criteria Analysis

The most common form of qualitative analysis for comparing unvalued costs and benefits is multi-criteria analysis.⁵⁵ Multi-criteria analysis is a tool for appraising and ranking alternative policy options against a given set of objectives and criteria. It is less rigorous than cost benefit analysis or cost effectiveness analysis, but is more flexible since it is relatively easy to implement and can be used to assess and compare options that involve both monetary and non-monetary impacts. It can aid decision-making by complementing the quantitative cost benefit analysis.

Multi-criteria analysis usually involves setting a list of success criteria (possibly reflecting public policy goals) and assigning weights to each criterion. The alternative options can be assessed and scored (typically by a representative panel of stakeholders) against the criteria, with the assigned scores multiplied by the weightings, yielding a ranking of alternative options.

It can be used without explicit weighting of the criteria. However this reduces the transparency and validity of the ranking process. Even where the weightings of the criteria are explicit, neither the criteria nor the weights are based on any underlying analysis, and can be easily altered. This can be overcome by consulting experts and stakeholders when determining the criteria, weightings and ranking.

⁵⁵ For more information on multi-criteria analysis see the UK Office of the Deputy Prime Minister’s multi-criteria analysis manual at http://www.odpm.gov.uk/stellent/groups/odpm_about/documents/page/odpm_about_608524.hcsp.

An example of multi-criteria analysis for a major information technology project where scores are out of a maximum of 100 might look something like the following:

Table 4.5: Multi-Criteria Analysis Example

Criteria [weight]	Unweighted Scores (out of 100)		
	In-house	Supplier 1	Supplier 2
NPV [60%]	20	100	65
Robustness [20%]	82	90	96
Flexibility [20%]	80	50	78
Overall Weighted Average	44.4	88	73.8

In this case, supplier 1 is likely to be the preferred option.

Importantly multi-criteria analysis provides decision-makers with an audit trail as the results are transparent, explicit and documented.

4.7 Concluding Comments

Decision-makers need a consistent basis for assessing competing proposals and to be fully informed about the implications of using economic resources. By quantifying all significant costs and benefits in monetary terms it is possible to determine the net benefits or costs of a given proposal. However some significant benefits or costs may be subject to uncertainty and/or may not be able to be quantified in monetary terms. This chapter has outlined a number of analytical tools to enable analysts to assess the effects of risk and uncertainty, and to allow decision-makers to make informed trade-offs between the quantitative and qualitative factors that would influence the choice of preferred option.

If more detailed guidance is required please contact your Treasury Vote team.

5 Selection and Presentation

5.1 Pulling It All Together

This primer is divided into three substantive parts:

- identifying and estimating the relevant costs and benefits
- analysing the options/alternatives
- assessing risk, uncertainty and intangibles.

These three parts are strongly linked and it is therefore essential that all three are covered in the final presentation to decision-makers. More particularly, the final presentation should explain:

- the justification for the Government taking action
- all major assumptions including the scope of the analysis
- why certain costs and benefits have been included or excluded
- the valuation methodologies employed to estimate costs and benefits
- the discount rate employed
- any sensitivity analysis undertaken and any significant qualitative or non-monetary impacts identified (including externalities, deadweight losses, and behavioural effects)
- the justification for the decision criteria employed
- the final recommendation in a way that its implications and qualifications are easily understood by decision makers, and
- the biases, limitations and deficiencies of the analysis.

The ultimate outcome of any CBA is a decision whether or not to proceed with a proposal or a particular option. Normally the CBA will be presented to decision-makers as part of an approval paper or business case. In many ways, the presentation of the conclusions and recommendations of the CBA is as important as the underlying analysis. It is therefore important that the points highlighted above be brought out in a clear and concise manner that meets the information needs of decision-makers and provides objective guidance on the required decision. Non-technical language should be used wherever possible, but if it is necessary to use technical terms, these should be clearly explained.

5.2 Selecting the Preferred Option

It is also vital that the rationale for recommending the preferred option is clear and defensible. Sufficient evidence for the selection should be provided along with a clear audit trail for decision-makers to check the assumptions, evidence and calculations leading up to the selection. For example, the preferred option may not be the proposal with the highest Net Present Value due to some critical qualitative or non-quantifiable factors. Where this is the case, the specific reasons why the quantitative analysis has been overridden need to be made clear.

5.3 The Relationship Between CBA and Fiscal Impacts

If Cabinet or Ministerial approval is required by Cabinet Office Circulars [CO\(99\)7](#)⁵⁶, [CO\(01\)4](#)⁵⁷, or [CO\(02\)17](#)⁵⁸ (refer to section 1.1), and the agency concerned is not intending to fund the proposal internally, then the paper should also clearly indicate the impacts on fiscal aggregates. The typical approach is to use financial recommendations of the form set out in the financial recommendations technical guide.⁵⁹ Financial recommendations usually contain appropriation tables similar to the following:

	\$m – increase/(decrease)				
	2005/06	2006/07	2007/08	2008/09	2009/10 & Outyears
<i>Vote Example 1</i>					
Departmental Output Expense:					
Output Class Name 1 (funded by revenue Crown)	0.956	1.148	1.148	1.148	1.148
Net Asset Schedule of [department name]:					
Capital Injection	10.000	2.000	-	-	-
Total Operating	0.956	1.148	1.148	1.148	1.148
Total Capital	10.000	2.000			

This table is a key input into the financial recommendations of the cabinet paper or business case.

Fiscal impacts/costings and economic CBA differ in four key respects:

- economic CBA includes effects on all sectors of the economy, while fiscal costings focus upon the government sector only
- economic CBA uses discounting and often looks beyond the five-year horizon that is reported in the Crown financial statements
- economic CBA reflects real resource use, while fiscal costings can include resource transfers and accounting items such as depreciation and capital charge, and
- economic CBA does not distinguish between capital and operating costs.

⁵⁶ <http://www.dPMC.govt.nz/cabinet/circulars/co99/7.html>

⁵⁷ <http://www.dPMC.govt.nz/cabinet/circulars/co01/4.html>

⁵⁸ <http://www.dPMC.govt.nz/cabinet/circulars/co02/17.html>

⁵⁹ Treasury's Financial Recommendations Technical Guide is available at <http://www.treasury.govt.nz/finrecs/>.

The relationship between CBA and fiscal impacts is illustrated below.

Figure 5.3a: Linking CBA and Fiscal Impacts



That is, economic benefits and costs are replaced with the fiscal impacts (to the Crown) split into operating and capital components. These include financial/accounting costs such as the capital charge, interest costs, and depreciation, to arrive at the overall fiscal impact to the Crown (in terms of impacts on the Crown's operating balance and/or debt).

For guidance on presenting information to Cabinet, refer to the [Cabinet Office step-by-step guide](#).⁶⁰

5.4 Tips and Traps

The following tips and traps are useful to consider before presenting the analysis to decision-makers:

Are all the costs and benefits included? It is very easy to forget something. It pays to explain the project to a reviewer who hasn't been involved in the development of the proposal to see if they can think of anything. Costs should be taken into account even if they do not actually involve spending cash. In particular, the value of land, of existing buildings, and of all services provided by other government departments should normally be included: the only costs that can be ignored are those that have already been incurred and which are for items with no alternative use, or those common to all options. Residual values should be estimated and included, whatever the length of the analysis.

Have you miscounted the use of real economic resources as a benefit? For example, the costs of building a stadium (materials, labour etc) is not a benefit to the economy. Often the jobs created by such projects are just a transfer from elsewhere in the region or country.

Are all the costs and benefits realistically valued? Use the previous points to assess whether you have either overvalued the benefits or undervalued the costs. If you have had to rely on figures provided by those promoting the project, check them for the optimism bias. Seek evidence of benefits and costs from reputable sources.

If the NPV is very high, why hasn't the proposal been implemented earlier? If the NPV is very large, a useful check is to ask why it hasn't been done earlier. A large NPV suggests a very high return, and possibly higher than the existing programmes.

Are there any variables that really influence the results? Often there are one or two variables (prices, values, capital cost) that drive the whole project, usually the capital cost of the project and the level of benefits. As these costs/benefits can be hard to estimate, you can check the robustness of the analysis by undertaking a sensitivity analysis, which is simply a second analysis with a sensitive variable changed by $\pm 10\%$ or $\pm 50\%$ or whatever is a realistic and possible variation. If the benefits of a project are uncertain, a sensitivity analysis will show the impact on the NPV of (say) a 100% variation to the estimated benefits. If the NPV remains positive or negative (whichever is the case) despite the change in the assumption, you can be much more comfortable of the robustness of your result.

Have you considered too few options? Decisions where there are no realistic choices are rare. There is always the "do-nothing"/"status quo" option and there will usually be choices as to the size, scope, form, or timing of projects. It is important that options are not ruled out solely because of differences in technical performance without an examination of comparative costs.

⁶⁰ <http://www.dpmc.govt.nz/cabinet/guide/index.html>

Have you confused real and nominal values? All costs and benefits in an options analysis should be converted to a common money value by removing general inflation. Changes in the price of particular goods and services relative to the general price level should be taken into account. Common examples of relative price changes are changes in real wages and the real exchange rate.

Have you used an appropriate time horizon? Time horizons need to be set in relation to the economic lives of assets, residual values should be included in the analysis for any assets that have some value beyond the appraisal period.

What about uncertainty? Events seldom turn out as expected and this often needs to be taken into account. Sensitivity analysis is the preferred technique for allowing for risk and uncertainty. The analysis should also specify when changing circumstances require a re-analysis.

Have you quantified all relevant factors? Factors such as non-market outputs or important environmental effects should not be ignored, even if they cannot be valued. At least a description of important effects of this kind should always be included.

Have you discounted future costs and benefits? Costs and benefits occurring at different points in time are not equally valuable and should be discounted to a common base date.

Have you used average instead of marginal benefits and costs? Be aware of the bias introduced. The use of average instead of marginal costs could significantly distort the analysis.

Ensure you exclude interest payments on borrowed capital? Interest payments on borrowed capital, while being a financial outlay, have no significance as far as the economic costs of a project are concerned. The real resources used - labour, material and equipment, etc - are the same regardless of the source of financing.

Have you excluded depreciation? Depreciation is an accounting device that does not necessarily reflect real resource use. To include depreciation on top of lump sum capital costs is double-counting.

5.5 Concluding Comments

This primer has been written as an introduction to Cost Benefit Analysis for public sector policy and financial analysts with little previous financial or economic analysis experience. It is pitched at an introductory level. If more information is required, the reader is referred to other sources (see bibliography) or the relevant Treasury Vote team.

Bibliography

- Boardman, A., Greenberg, D., Vining, A. & Weimer, D. (1996). *Cost-Benefit Analysis: Concepts and Practice*. Prentice Hall: New Jersey.
- Diewert, W.E. & Lawrence, D.A. (1994). *The Marginal Costs of Taxation in New Zealand*.
- Dixon, S. (1991). *Cost Utility Analysis in Health Policy*, Wellington: Victoria University of Wellington.
- Gramlich, E.M. (1990). *A Guide to Benefit-Cost Analysis*, Prospect Heights, Illinois: Waveland Press Inc.
- Layard, R. & Glaister, S. (eds.) (1994). *Cost-Benefit Analysis, 2nd Edition*, Cambridge: Cambridge University Press.
- Ministry of Economic Development. (1999). A Guide to Preparing Regulatory Impact Statements. <http://www.med.govt.nz/buslt/compliance/risbccs/regimpact/index.html>
- Mishan, E.J. 'On the conceptual underpinning of a cost-benefit analysis', *The Singaporean Economic Review*, Vol. 47, No.1 (2002), pp.1-16.
- Pradhan, S. (1996). *Evaluating Public Spending: A Framework for Public Expenditure Reviews*. World Bank Discussion Paper Number 323. The World Bank: Washington D.C.
- Stokey, E. & Zeckhauser, R. (1978). *A Primer for Policy Analysis*. W. Norton and Co., New York.
- Treasury. (1999). Office Minute 1999/B41, internal Treasury document.
- UK Department for Transport. *Economic Valuation with Stated Preference Techniques – Summary Guide*. www.odpm.gov.uk/stellent/groups/odpm_about/documents/page/odpm_about_037552.pdf
- UK Treasury. (2003). *The Green Book*, <http://greenbook.treasury.gov.uk/>. Crown copyright material is reproduced with the permission of the Controller of HMSO and the Queen's Printer for Scotland.
- US Office of Management and Budget. (1992). *Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. <http://www.whitehouse.gov/omb/circulars/a094/a094.html>
- Viscusi, W.K. (1997). *Improving the analytical basis for regulatory decision-making*. In OECD (1997), pp. 175-208.
- Vose, D. (1996). *Quantitative risk analysis : a guide to Monte Carlo simulation modelling*, John Wiley & Sons Ltd: Chichester, U.K.

Glossary

Average Cost	Total production cost divided by the number of units produced.
Benefit	An economic benefit is any gain in the welfare of society (or the individuals that comprise it) from the proposal being considered.
Benefit-Cost Ratio	An alternative decision criterion. The BC ratio is given by: $BC = \frac{\text{sum of present values of benefits (cash inflows)}}{\text{sum of present values of costs (cash outflows)}}$
Capital Charge	A financing charge designed to convey the cost of capital and encourage the best use of capital by government departments.
Competitive Neutrality	Competitive neutrality means that government activities do not enjoy net competitive advantages over potential private sector competitors by virtue of their public sector ownership. If competitive neutrality does not exist then resources may not be being put to their best use.
Consumer Surplus	Consumer surplus measures the difference between what a person is willing to pay for a commodity and the amount he/she actually is required to pay.
Cost	Economic costs relate to actual resource use in the economy and reflect the best alternative uses that the resources could be put to (i.e. they are opportunity costs).
Cost Benefit Analysis (CBA)	A systematic process for identifying and assessing all (both direct and indirect) costs and benefits of a proposal. All costs and benefits are assigned a money value, allowing the calculation of the net benefits of different proposals as a basis for evaluating alternatives.
Cost Effectiveness Analysis (CEA)	CEA compares the costs of alternative ways of producing the same or similar outputs/benefits. It is often used to find the option that meets a predefined objective at a minimum cost.
Cost Utility Analysis (CUA)	CUA is a variant of CEA that measures the relative effectiveness of alternative interventions in achieving two or more given objectives.
Deadweight loss (DWL)	The net cost to society attributable to a move away from an economy's competitive equilibrium.
Depreciation	An accounting allowance that recognises that assets wear out and/or become obsolete by spreading purchase costs over the useful life of the assets.
Discount Rate	Effectively a <i>desired return</i> , or the return that an investor would expect to receive on some other typical proposal of equal risk. The discount rate seeks to capture the sum of: <ul style="list-style-type: none">• The "rate of time preference". Most people prefer consumption undertaken now rather than later. Thus, a dollar available now is more highly valued than one received later.• Uncertainty. There is necessarily some degree of uncertainty

⁶¹ Ministry of Economic Development. (1999). A Guide to Preparing Regulatory Impact Statements. <http://www.med.govt.nz/busit/compliance/risbccs/regimpact/index.html>

as to whether a future dollar will actually be received. Its value is lessened in proportion to the expected size of this uncertainty factor.⁶¹

Externalities	Benefits received or costs borne by those not associated with the activity and for which payment is neither given nor received.
Hedonic pricing	A technique for quantifying intangibles that uses the different characteristics of a traded good to estimate the value of a non-traded good.
Intangibles	Costs or benefits that are not easily quantified in monetary terms.
IRR (Internal Rate of Return)	The discount rate which results in a Net Present Value equal to zero.
Marginal Cost	The increase in total cost that results from carrying out one additional unit of activity.
Monte Carlo Analysis	A risk modelling technique that uses statistical sampling and probability distributions to simulate the effects of uncertain variables on model outcomes.
Multi-Criteria Analysis	A tool for appraising and ranking alternative policy options against a given set of objectives and criteria. It often includes both quantitative and qualitative variables.
Net Present Value (NPV)	The sum of <i>discounted</i> net cashflows over the appraisal period.
Opportunity Cost	The cost of the next best opportunity that has to be forgone if the opportunity under consideration is pursued.
Optimism Bias	The demonstrated systematic tendency for appraisers to be over-optimistic about key project parameters, including capital costs, operating costs, works duration and benefits delivery. ⁶²
Payback Period	A method that determines the point in time at which cumulative net cashflows exceed zero.
Risk	<p>The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood. The amount of risk associated with a future uncertain event can be estimated by the formula:</p> $\text{Risk} = P \times L$ <p>Where:</p> <ul style="list-style-type: none">• P is the probability of an event occurring within a given time period• L is the consequence or outcome of the event expressed quantitatively as a variation in value, either as a loss (or gain), injury, disadvantage or threat (or opportunity).⁶³
Sensitivity Analysis	An examination of how the result of a calculation or model varies as individual assumptions are changed.
Scenario Analysis	A simple form of sensitivity analysis that models risk/uncertainty under several sets of assumptions about key variables.

⁶² UK Green Book glossary, <http://greenbook.treasury.gov.uk/glossary.htm>.

⁶³ AS/NZS 4360:1999 Australian/New Zealand Standard "Risk Management", <http://www.standards.co.nz/default.htm>.

Sunk Cost	A cost that is beyond recovery at the point a decision must be made.
Transfer payments	Payments for which no good or service is obtained in return e.g. a social welfare benefit.
Travel Cost Analysis	A technique for quantifying intangibles that uses the value of traded goods and services (in this case the sum of travel costs necessary to reach a destination) to estimate the value of non-traded goods.
Utility	A measure of the satisfaction or welfare gained or lost from a particular activity.

Annex 1: Monte Carlo Analysis

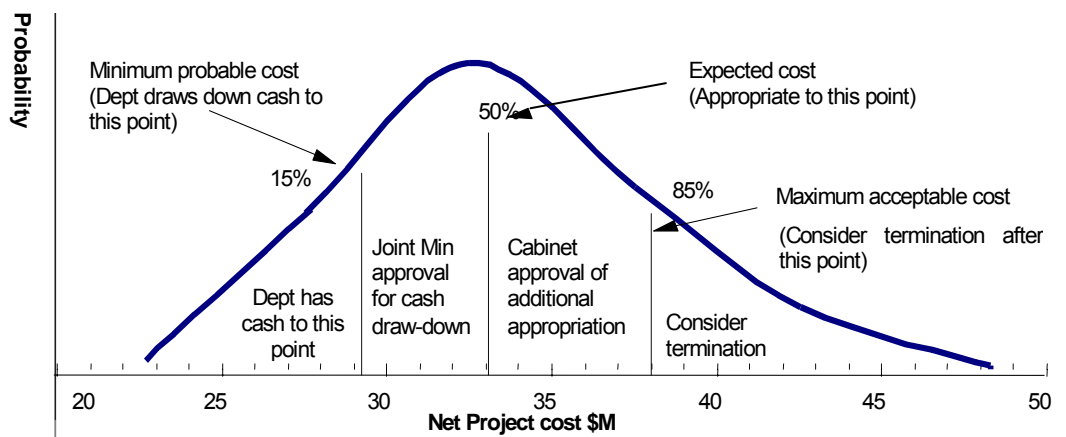
Monte Carlo analysis is a risk modelling technique that uses statistical sampling and probability distributions to simulate the effects of uncertain variables on model outcomes. It can be used to model the effects of key variables such as exchange risk, staff turnover and demand for services on the NPV of a given proposal. The approach provides a systematic assessment of the combined effects of multiple sources of risk in key variables and can also allow for known correlations between these variables.

Monte Carlo provides decision-makers with a visual representation of the:

- expected value and range of variability due to risk and uncertainty on each of the variables modelled
- relationships between these variables and estimated possible outcomes, and
- expected value and range of the possible outcomes, representing the combined effect of the multiple sources of uncertainty.

The process firstly involves the identification and assessment of the key variables. For each variable, a suitable probability distribution (or multivariate distribution) is assigned that best describes the range of uncertainty around the expected value. For each variable being modelled, input values are generated randomly, sampled from the underlying probability distribution function. The computer model combines these inputs to generate an estimated outcome value (for example an NPV). The process is repeated (thousands of times) to generate a probability distribution of possible outcomes. This distribution can be analysed to provide an indication of the variability or robustness of the NPV analysis. For example “there is an 86% chance that the NPV exceeds 0%”.

For example, consider a major IT project where there is significant uncertainty around the net project cost. One output of Monte Carlo analysis is the following diagram:



The diagram shows the probability of delivering the project at the specified cost, given the risk scenarios that have been considered during the analysis. It also gives a visual indication of the range of likely costs associated with the project or module within the project, and is therefore useful in presentation of the proposal to Ministers. The probability curve can also be used to set the thresholds for appropriations and cash-draw down limits for the project/module, based on the likely final costs.

However the technique is complex and requires expert advice to develop the model and interpret the results. The approach should only be used when there are several key variables with significant and/or correlated uncertainties, and when simpler sensitivity analysis approaches are unable to adequately describe the resulting variation in net benefits. For more detailed information see Vose, D. (1996). Quantitative risk analysis : a guide to Monte Carlo simulation modelling, Chichester, U.K.: John Wiley & Sons Ltd.