BENEFIT COST ANALYIS (BCA)

This article is an overview of Benefit Cost Analysis only, as it is a complex subject particularly, for large projects. The aim is to introduce the valuer to the concept and its place in the "scheme of things". Public sector cash flows include the value of *benefits* as well as income and therefore, are called *benefit cost analysis* or BCA.

The DCF method of valuation and analysis is basically, a financial method and is the main method used in the private sector for project analysis. However, the public sector has different priorities and *benefit cost analysis* is the most common method used for evaluating public projects.

ADVANTAGES OF BCA

The advantages of BCA are that it allows:

- **A better reflection of the government's and/or public's priorities.**
- **Better management of public assets**
- **A better framework for thinking rationally about the use of resources through a systematic approach to capital expenditure and asset management decisions.**
- **The better pursuit of low cost solutions.**
- **The encouragement of new approaches at all stages in the development of a project, from the concept stage to the final decision to proceed. The use of both up front capital costs and ongoing recurrent costs will assist departments and authorities to evaluate the best mix of capital and recurrent costs (an alternative approach in this regard is *life cycle analysis*).**
- **The quantification of benefits and therefore, encourages public managers to question and reexamine the objectives of the department/authority in undertaking a project.**
- **The ongoing assessment and management of the stock of**

assets. BCA does not just focus on the new capital expenditure decision but ensures that the public sector infrastructure is effectively and efficiently utilized.

- **The inclusion of costs and benefits falling outside the department/authority helps to maximise net benefits to society and capture the various linkages between projects. For example, the relationship between a new office building and access to the public as clients.**

BCA is the most sophisticated of the project appraisal techniques and can be applied by most government authorities that cover costs with revenues. For example, water and electricity, rural (eg grain handling), maritime or port management and those authorities which do not fully cover costs by revenue but which produce tangible outputs such as the main roads, urban transport, and public housing. It is also applicable in varying degrees to the social infrastructure such as schools and hospitals.

DISADVANTAGES

The main problem with BCA is the extra cost, time and effort required in it's preparation and therefore, it is only suitable for large, important projects. The final quantitative schedule gives an impression of accuracy or quantifiable certainty which is often not justified. The user of BCA must always be aware of a large margin of error in the quantified amounts.

STEPS IN BCA CONSTRUCTION

The recommended steps in the construction of a benefit cost analysis are as follows:

1. **determine scope and objectives**
2. **determine constraints**
3. **determine alternatives**
4. **identify costs and benefits**
5. **quantify/value costs and benefits**
6. **calculate net present value**
7. **test uncertainty with a sensitivity analysis**
8. **consider equity issues & intangibles**
9. **report**

STEP 1 - DEFINE OBJECTIVES

The objectives should be related to the performance of a particular function and compatible with that of the broader department, group or corporation. The achievement of an objective may be essential, for example, the provision of health or police services.

STEP 2 - IDENTIFY OPTIONS

The BCA should identify the widest range of realistic options at the earliest possible stage of the planning process. The first option is always "do nothing".

STEP 3 - IDENTIFY COSTS

Costs of a project are identified and entered into the cash flow as for a private sector discounted cash flow.

STEP 4 - IDENTIFY BENEFITS

There are five types of benefits:

- **AVOIDED COSTS**
  Incremental costs which would occur if nothing is done to solve a particular problem.

- **SAVINGS**
  Savings are reductions in existing levels of expenditure if the program proceeds. Where manpower savings are claimed, the clear identification of the areas of such savings and costs saved will assist in any post audit review.

- **REVENUES**
  Incremental revenues which result directly or indirectly from a particular program. Revenue changes which would have occurred regardless of the program must not be included.

- **BENEFITS TO CONSUMERS**
  These are not reflected in revenue flows. For a variety of reasons, such as the nature of the service provided or equity considerations in pricing policies, the user of a service may not be charged a price which reflects the benefits received. For example, the recreational use of national parks. While it

may be difficult, attempts should be made to quantify such benefits.

- **BENEFITS TO THE WIDER COMMUNITY**
  The benefits of some services such as education services flow to the community as a whole rather than to individual consumers. An activity may have subsidiary or secondary effects on groups or industries other than the direct recipient. For example, an increase in urban transport can reduce pollution levels and reduce travel times for those in private transport.

Commonly, the price will not reflect the benefits received and therefore, alternative means of valuing the benefits are used, if available.

STEP 5 - IDENTIFY THE QUALITATIVE FACTORS

The BCA should also include other relevant information which can affect the recommendation or decision. It does not necessarily follow that the proposal which is identified by a thorough evaluation as the single most economically attractive option will be the one implemented by management. Other aspects such as environmental considerations, industrial relations, social or regional impact, safety, public relations, resource availability will also have to be taken into account. The qualitative factors should be identified and given subjective weights such as a score out of 5.

STEP 6 - ASSESS NET BENEFITS

Once all costs and benefits over the life of the programme have been identified and quantified they are expressed in present value terms. Costs and benefits should be valued in "real terms" that is, expressed in today's dollars so that nominal increases in prices due to inflation are not included. As well as NPV, NPV rate of return, and IRR, Benefit to Cost Ratio and the Payback Period are also calculated.

For a project to be acceptable the BCR must have a value greater than one. and for choices among mutually exclusive projects, the rule would be to choose the alternative with the highest benefit#cost ratio. However, the rule is liable to an incorrect ranking if the projects differ in size.

Consider the cases of three mutually exclusive projects, A, B, and C in

table 1. If the projects are ranked according to their BCRs project C would be chosen. However, the NPV of project C is less than that for project B. Therefore, ranking the projects according to their Benefit Cost Ratios would lead to an incorrect decision.

TABLE 1

PROJECT A

PV costs = 1.0 million,
PV benefits = 1.3 million
NPV = 0.3 million

BCR = 1.3/1 = 1.3

PROJECT B:

PV costs = 8.0 million,
PV benefits = 9.4 million
NPV = 1.4 million

BCR = 9.4/8.0 = 1.2

PROJECT C:

PV costs = 1.5 million,
PV benefits = 2.1 million
NPV = 0.6 million

BCR = 2.1/1.5 = 1.4

Another problem is that the BCR is sensitive to the way in which costs have been defined in setting out the cash flows. Disbenefits such as aircraft noise nuisance and other negative externalities may be added to the cost stream or alternatively they may be subtracted from the benefit stream. This is shown in table 2:

TABLE 2

	Project A	Project B
PV benefits	2000	2000
PV current costs	500	1800
PV capital costs	1200	100
(NPV)	(300)	(100)

The BCRs if current costs are netted out of benefits:

PROJECT A: BCR1 = (2000-500)/1200 = 1.25
PROJECT B: BCR1 = (2000-1800)/100 = 2.00

The use of BCR1 would recommend project B.

BCRs if current costs are added to capital costs:

PROJECT A: BCR2 = 2000/1700 = 1.18
PROJECT B: BCR2 = 2000/1900 = 1.05

The use of BCR2 would recommend project A. Since project A has the higher NPV it should be the recommended project. Therefore, the better analysis is the use of the NPV as well as the BCR.

ECONOMIC EVALUATION

The economic evaluation of a public sector project will often include wider impacts.

EXAMPLE

The economic evaluation of a dam whose primary purpose is the provision of irrigation for commercial crops will have the following impacts:

- **The provision of irrigated water for cropping, the primary objective and a traded benefit**

- **The provision of urban water, a traded benefit**

- **Flood mitigation benefits, a quantifiable non traded benefit which is external to the users of the water.**

- **Recreational benefits offered by the dam, a quantifiable non traded benefit external to the consumers of the water which may be valued.**

- **Environmental effects on native fauna and flora, an external effect which may be difficult to quantify even in physical terms.**

See opportunity cost

PROBLEM OF DOUBLE ACCOUNTING

The danger of double accounting is particularly important when the effect of the project is incorporated in subsequent valuations of assets or prices.

EXAMPLE

The construction of a dam may increase the value of the land which is now able to be irrigated largely, because the land can now grow cash crops. The increased value includes the present value of all future marginal benefits and incomes caused by the new and reliable water supply.

Double accounting would occur if the net value of the increased crop output is included as well, because land value is the present value of all future income and benefits. That is, by incorporating the increased land values, account has been taken of all future increases in income and benefits resulting from the dam.

OVERSTATEMENT OF BENEFITS

Overstatement of benefits can occur by attributing the total output of a process to a single input for example, where an infrastructure is provided which enables the expansion of an industry. The gross output of that industry should not be attributed to the provision of the infrastructure because account has to be taken of the other resources used in production in the "downstream" industry.

EXAMPLE

The total value of the crops made available by a water irrigation project should not be attributed solely to the project. The net value of the additional production should be derived by deducting all input costs from the value of the output that is, costs of labour, capital and other inputs such as fertilizer and fuel should be deducted from the value of the output. In other words, not all of the increased value can be attributed to the irrigation project.

USE OF SHADOW PRICES

In some cases the prices being obtained may contain distortions which require the use of *shadow prices*. *Shadow prices* are used where:

- **Taxes and subsidies drive a wedge between costs of production and prices.**
- **The resources used would otherwise be unemployed**
- **There are externalities for which prices do not exist.**

See social discount rate

BENEFIT COST EXAMPLE 1

Below is a summary of an example of BCA used for a major new road in Sydney (as published by NSW Treasury). It illustrates the use of benefits to assess the value of the alternative road types and shows how the preferred option was decided.

THE OPTIONS

The report covers the results of an economic evaluation of the Gore Hill Freeway (Sydney) Options. It uses as inputs the results of a traffic analysis which was carried out by the Investigations Section of the Department of Main Roads. The options considered are:

OPTION 1: 6 Lane Surface Arterial Road
OPTION 2: 4 Lane Freeway
OPTION 3: 6 Lane Freeway

SUMMARY OF RESULTS

Table 3 summarizes the results of the *benefit cost analysis.* It shows the *benefit/cost ratio (BCR)* and *net present value (NPV)* for the 3 options, under conditions of low, medium and high traffic growth scenarios and discount rates of 4%, 7% and 10%.

TABLE 3

ECONOMIC VALUE OF ALTERNATIVE SCHEMES (1986)

	OPTION 1 6 LANE ROAD.	OPTION 2 4 LANE FREEWAY	OPTION 3 6 LANE FREEWAY
GROWTH/DISCOUNT RATE (BCR)	NPV-$m (BCR)	NPV-$m (BCR)	NPV-$m
LOW GROWTH			
4%	39.73(1.75)	107.42(2.83)	108.96(2.63)
7%	8 82(1.18)	49.12(1.91)	47.68(1.78)
10%	-6.80(0 85)	18.51(1.37)	15.64(1.28)
MEDIUM GROWTH			
4%	58.83(2.11)	140.92(3.40)	144.51(3.17)
7%	19.25(1.40)	67.40(2.25)	67.07(2.09)
10%	-0.70(0.98)	29.19(1.59)	26.98(1.48)
HIGH GROWTH			
4%	82.48(2.56)	182.38(4.11)	188.51(3.83)
7%	31.92(1 66)	89.61(2.66)	90.04(2.48)
10%	6.57(1.i5)	41.94(1.84)	40.50(1.72)

The results indicate that for the 6 Lane Surface Arterial Road alternative (option 1) the benefits exceed costs under all conditions except at the 10% discount rate under low and medium traffic growth scenarios. The BCR for this option ranges between 0.85 at the low growth rate and high (10%) discount rate, and 2.56 at the high growth rate and 4% discount rate.

The 4 Lane and 6 Lane Freeway options (options 2 and 3) show that the benefits exceed costs under all conditions. The BCR's for those two options range from 1.37 to 4.11 and 1.28 to 3.83 for the 4 Lane and 6 Lane options respectively. The BCR's for the 4 Lane Freeway are marginally higher than for the 6 Lane Freeway, which are in turn consistently higher than for the Surface Arterial option.

Table 4 shows the incremental present value of costs and benefits of the 4 Lane Freeway alternative over the 6 Lane Surface Arterial alternative.

The table shows that under all conditions of traffic growth rates and discount rates, while the costs of the 4 Lane Freeway alternative exceed those of the Surface Arterial, the present value of benefits are considerably greater also. In terms of net user benefits the Freeway option gives a better economic return when compared with the 6 Lane Surface Arterial Road.

TABLE 4
INCREMENTAL VALUE OF 4 LANE FREEWAY (OPTION 2) OVER A 6 LINE SURFACE ARTERIAL ROAD (OPTION 1) ($1986)

	LOW GROWTH			MEDIUM GROWTH			HIGH GROWTH		
	4%	7%	10%	4%	7%	10%	4%	7%	10%
Incremental PV of costs ($m):	5.8	5.3	4.9	5.8	5.3	4.9	5.8	5.3	4.0
Incremental PV of benefits ($m):	73.5	45.6	30.2	87.9	53.5	34.8	105.7	63.0	40
Incremental NPV ($m):	67.7	40.3	25.3	82.1	48.1	29.9	99.9	57.7	35.0
Incremental B/C ratio:	12.7	8.6	6.2	15.2	10.1	7.1	18.3	11.8	8.0

Table 5 shows the incremental present value of costs and benefits of the 6 Lane Freeway alternative over the 4 Lane Freeway. It shows that the 6 Lane Freeway generates additional user benefits but at an increased cost over the 4 Lane option. The growth and 10% discount rate) to $6.1 million (under the high growth and 4% discount rate scenario).

TABLE 5
INCREMENTAL VALUE OF 6 LANE FREEWAY (OPTION 3)
OVER 4 LANE FREEWAY (OPTION 2) ($1986)

	LOW GROWTH			MEDIUM GROWTH			HIGH GROWTH		
	4%	7%	10%	4%	7%	10%	4%	7%	10%
Incremental PV of costs ($m):	8.0	7.4	6.8	8.0	7.4	6.8	8.0	7.4	6
Incremental PV of benefits ($m):	9.5	5.9	3.9	11.6	7.0	4.6	14.1	8.4	5.0
Incremental NPV ($m):	1.5	-1.4	-2.9	3.6	-0.3	-2.2	6.1	1.0	-1.0
Incremental B/C ratio:	1.2	0.8	0.6	1.4	1.0	0.7	1.8	1.1	0