

9.4 Benefit/Cost Evaluation of Alternatives

The benefit/cost method of analysis is a procedure wherein the magnitude of the benefits (B) associated with an alternative is compared with the magnitude of its costs (C). In dividing the benefits by the costs, a number equal to or greater than one would obviously mean that benefits exceed costs, indicating economic attractiveness.

A conventional B/C analysis is used almost exclusively for government projects. As such, the following terms apply:

Benefits (B) - Favorable consequences to the public

Disbenefits (D) - Unfavorable consequences to the public

Costs (C) - Consequences to the government (savings to the government are regarded as negative costs)

The sign convention treats benefits and costs as positive values and disbenefits as negatives. Thus, a conventional benefit-to-cost ratio is calculated as

$$B/C = (B - D) / C$$

In non-government evaluations, some analysts place maintenance and operation (M&O) costs in the numerator as disbenefits, in which case the resulting ratio is known as a modified B/C ratio.

A B/C ratio can be conducted in terms of PW, AW, or FW values, as long as all values are expressed in the same units. The next example illustrates the calculations involved.

Example 9.1

The U.S. Parks and Wildlife Service is considering providing public access to a previously inaccessible portion of Carlsbad Caverns. The cost of the project is expected to be \$1.8 million, with maintenance expected to cost \$60,000 per year. However, increased tourism is expected to generate additional income of \$250,000 per year to local businesses. Calculate the B/C ratio for the permanent project using an interest rate of 8% per year.

Solution: Using an AW analysis,

$$B = 250,000$$

$$C = 1,800,000 (0.08) + 60,000 = 204,000$$

$$B/C = 250,000 / 204,000 = 1.22$$

Therefore, the project should be undertaken.

When only one alternative is involved, it is obviously being compared against the do-nothing alternative. When two or more mutually exclusive alternatives are being compared, it is important to insure that the alternative with the larger equivalent cost is also the one which yields

the larger equivalent benefits. When this is not the case, the higher cost alternative is obviously eliminated by inspection. Also, when two or more alternatives are involved, do-nothing is added as an alternative unless otherwise stated or when only costs are involved in the calculations, as shown in the next example.

Example 9.2

The costs associated with two routes for a new road are shown below. Using an interest rate of 8% per year, determine which route should be selected according to a B/C analysis over a 25 year study period.

	Long Route	Short Route
First cost, \$	10,000,000	15,000,000
Road user costs, \$/yr	800,000	500,000
Life, yrs	30	30

Solution:

The consequences to the public are the road user costs. The benefits are the lower road-user costs associated with the shorter route (the higher cost alternative). Thus,

$$\begin{aligned} B &= 800,000 - 500,000 \\ &= \$300,000 \text{ per year} \end{aligned}$$

$$\begin{aligned} C &= (15,000,000 - 10,000,000) (A/P, 8\%, 25) \\ &= 5,000,000 (0.09368) \\ &= \$468,400 \end{aligned}$$

$$\begin{aligned} B/C &= 300,000 / 468,400 \\ &= 0.64 \end{aligned}$$

Therefore, build the long route.

When two or more alternatives under consideration are independent rather than mutually exclusive, then each one is compared only against the do-nothing alternative and all are selected which have a B/C ratio ≥ 1 . Mutually exclusive multiple alternatives are handled just as in a rate of return analysis. That is, they must first be ranked in terms of increasing initial investment cost and then compared on an incremental basis as shown in the next example.

Example 9.3 Determine which of the four alternatives shown below should be selected on the basis of a B/C analysis using an interest rate of 10% per year.

	W	X	Y	Z
First cost, \$	1,600,000	1,500,000	1,900,000	1,200,000
Annual M&O cost, \$/yr	50,000	60,000	35,000	80,000
Benefits, \$/yr	269,000	260,000	282,000	250,000
Disbenefits, \$/yr	13,000	15,000	22,000	20,000
Life, years	20	20	20	20

Solution:

First rank the alternatives in terms of increasing initial investment cost, including do-nothing: DN, Z, X, W, Y. Next, compare the first two alternatives on an incremental basis:

DN vs Z

$$B = 250,000$$

$$D = 20,000$$

$$\begin{aligned} C &= 1,200,000 (A/P, 10\%, 20) + 80,000 \\ &= 1,200,000 (0.11746) + 80,000 \\ &= \$220,952 \end{aligned}$$

$$\begin{aligned} B/C &= (250,000 - 20,000) / 220,952 \\ &= 1.04 \quad \text{eliminate DN} \end{aligned}$$

Z vs X

$$\begin{aligned} B &= (260,000 - 250,000) - (15,000 - 20,000) \\ &= \$15,000 \end{aligned}$$

$$\begin{aligned} C &= (1,500,000 - 1,200,000) (A/P, 10\%, 20) + (60,000 - 80,000) \\ &= 300,000 (0.11746) - 20,000 \\ &= \$15,238 \end{aligned}$$

$$\begin{aligned} B/C &= 15,000 / 15,238 \\ &= 0.98 \quad \text{eliminate X} \end{aligned}$$

Z vs W

$$\begin{aligned} B &= (269,000 - 250,000) - (13,000 - 20,000) \\ &= \$26,000 \end{aligned}$$

$$\begin{aligned} C &= (1,600,000 - 1,200,000) (A/P, 10\%, 20) + (50,000 - 80,000) \\ &= 400,000 (0.11746) - 30,000 \\ &= \$16,984 \end{aligned}$$

$$\begin{aligned} B/C &= 26,000 / 16,984 \\ &= 1.53 \quad \text{eliminate Z} \end{aligned}$$

W vs Y

$$\begin{aligned} B &= (282,000 - 269,000) - (22,000 - 13,000) \\ &= 4,000 \end{aligned}$$

$$\begin{aligned} C &= (1,900,000 - 1,600,000) (A/P, 10\%, 20) + (35,000 - 50,000) \\ &= 300,000 (0.11746) - 15,000 \\ &= \$20,238 \end{aligned}$$

$$\begin{aligned} B/C &= 4,000 / 20,238 \\ &= 0.20 \quad \text{eliminate Y} \end{aligned}$$

Therefore, select alternative W
