THIRD EDITION

COST-BENEFIT ANALYSIS

Concepts and Practice

Anthony E. Boardman

University of British Columbia

David H. Greenberg

University of Maryland Baltimore County

Aidan R. Vining

Simon Fraser University

David L. Weimer

University of Wisconsin–Madison

PEARSON
Prentice Hall

Upper Saddle River, New Jersey 07458

THE BASIC STEPS OF CBA: COQUIHALLA HIGHWAY EXAMPLE

CBA may look intimidating and complex. To help make the process of conducting a CBA more manageable, we break it down into nine basic steps, which are listed in Table 1-2. We describe and illustrate these steps using a relatively straightforward example—the construction of a new highway. For each step, we also point out some practical difficulties. The conceptual and practical issues that we broach are the focus of the rest of this book. Do not worry if the concepts are unfamiliar to you; this is a dry run. Subsequent chapters fully explain them.

Imagine that in 1986 a cost-benefit analyst, who works for the Province of British Columbia, Canada, was asked to perform a CBA of a proposed highway between the town of Hope in the south-central part of the Province and Merritt, which is more or less due north of Hope. This highway would be called the Coquihalla Highway. The analyst's CBA is presented in Table 1-3.[14] How did the analyst get these results? What were the difficulties? We will go through the nine steps, one at a time.

1. Specify the set of alternative projects. Step 1 requires the analyst to specify the set of alternative projects. In this example, the provincial government required the analyst to consider only two alternative highways, one with tolls and one without. The provincial department of transportation decided that the toll, if applied, would be $40 for large trucks and $8 for cars. Thus, the analyst has a tractable set of alternatives to analyze.

In practice, however, there are often difficulties even at this stage. For many projects, including this one, the number of potential alternatives is huge. This highway could vary on many dimensions including the following:[15]

Road surface: It could be surfaced in bitumen or concrete.

Routing: It could take different routes.

Size: It could have two, three, four, or six lanes.

Tolls: The tolls could be higher or lower.

Wild animal friendliness: The highway could be built with or without "elk tunnels."

Timing: It could be delayed until a later date.

Changing the highway on just one of these dimensions would generate at least one new alternative. Changing two or three simultaneously would greatly increase the number of alternatives.[16] For example, with four dimensions, each with three possible values, there would be 81 alternatives! Neither decision makers nor analysts can cognitively handle comparisons among such a large number of alternatives. In practice, individuals can only focus on approximately four to seven alternatives, at best.[17] Resource and cognitive constraints mean that analysts typically analyze only a few (less than six) alternatives.

TABLE 1-2 The Major Steps in CBA

1. Specify the set of alternative projects
2. Decide whose benefits and costs count (standing)
3. Catalogue the impacts and select measurement indicators
4. Predict the impacts quantitatively over the life of the project
5. Monetize (attach dollar values to) all impacts
6. Discount benefits and costs to obtain present values
7. Compute the net present value of each alternative
8. Perform sensitivity analysis
9. Make a recommendation

CBA compares the net social benefits of investing resources in a particular potential project with the net social benefits of a hypothetical project that would be displaced if the project under evaluation were to proceed. The displaced hypothetical project is sometimes called the *counter-factual.* Usually, the counter-factual is the status quo, which means there is no change in government policy. In Table 1-3 the analyst compares the net social benefits if the highway were built to the net social benefits under the status quo of the highway not being built.

Sometimes the status quo is not a viable alternative. *If a project would displace a specific alternative rather than a hypothetical one, then it should be evaluated relative to the specific displaced alternative.* Thus, if government has committed

TABLE 1-3 Coquihalla Highway CBA (1986 $ Million)

	No Tolls		*With Tolls*	
	***A* Global Perspective**	***B* Provincial Perspective**	***C* Global Perspective**	***D* Provincial Perspective**
Project Benefits:				
Time and Operating Cost Savings	389.8	292.3	290.4	217.8
Horizon Value of Highway	53.3	53.3	53.3	53.3
Safety Benefits (Lives)	36.0	27.0	25.2	18.9
Alternative Routes Benefits	14.6	10.9	9.4	7.1
Toll Revenues	—	—	—	37.4
New Users	0.8	0.6	0.3	0.2
Total Benefits	494.5	384.1	378.6	334.7
Project Costs:				
Construction	338.1	338.1	338.1	338.1
Maintenance	7.6	7.6	7.6	7.6
Toll Collection	—	—	8.4	8.4
Toll Booth Construction	—	—	0.3	0.3
Total Costs	345.7	345.7	354.4	354.4
Net Social Benefits	148.8	38.4	24.2	−19.7

Source: Adapted from Anthony Boardman, Aidan Vining, and W. G. Waters II, "Costs and Benefits through Bureaucratic Lenses: Example of a Highway Project," *Journal of Policy Analysis and Management,* 12(3) 1993, 532–555, Table 1, p. 537.

resources to either a highway project or a rail project, and there is no chance of maintaining the status quo, then the highway project should be compared with the rail project, not the status quo.

This CBA example pertains to a specific highway between Hope and Merritt. There is no attempt to compare this highway project to alternative highway projects in British Columbia, although one could do so. Rarely does the analyst compare a highway project to completely different types of projects, such as health care, antipoverty, or national defense projects. As a practical matter, full optimization is impossible. The limited nature of the comparisons sometimes frustrates politicians and decision makers who imagine that CBA is a *deus ex machina* that will rank *all* policy alternatives. On the other hand, the weight of CBA evidence can and does help in making broad social choices across policy areas.

2. Decide whose benefits and costs count (standing). Next, the analyst must decide who has standing; that is, whose benefits and costs should be counted. In this example, the analyst's superiors in the provincial government were in a position to decide this, not the analyst. They wanted the analysis done from the provincial perspective, but also asked the analyst to take a global perspective. The provincial perspective measures only the benefits and costs that affect British Columbian residents, including costs and benefits borne by the British Columbian government. The global perspective includes the benefits and costs that affect everyone, irrespective of where they reside. Thus, it includes benefits and costs to Americans, Albertans, and even tourists from the United Kingdom. Combining these two perspectives on standing with the no-tolls and with-tolls alternatives gives the four columns in Table 1-3 labeled A through D.

It is often contentious whether an analysis should be performed from the global, national, state (provincial), or local perspective. While federal governments usually take only national costs and benefits into account, critics argue that many issues should be analyzed from a global perspective. Recent environmental issues that fall into this category include ozone depletion, global climate change, and acid rain. At the other extreme, local governments typically want to consider only benefits and costs to local residents and to ignore costs and benefits that occur in adjacent municipalities or are borne by higher levels of government. Our highway example deals with this issue by analyzing costs and benefits from both the global and the British Columbian perspectives.

3. Catalogue the impacts and select measurement indicators. Step 3 requires the analyst to list the physical impacts of the alternatives as benefits or costs and to specify the measurement indicators. We use the term *impacts* broadly to include both inputs (required resources) and outputs. For this proposed highway, the anticipated beneficial impacts are time saved and reduced vehicle operating costs for travelers on the new highway ("Time and Operating Cost Savings" in Table 1-3); the value of the highway at the end of the discounting period of 20 years ("Horizon Value of Highway"); accidents avoided (including lives saved) due to drivers switching to the shorter, safer new highway ("Safety Benefits"); reduced congestion on existing alternative routes—the old road ("Alternative Routes Benefits"); revenues collected from tolls ("Toll Revenues"); and benefits accruing to new travelers ("New Users"). The anticipated cost impacts are construction costs ("Construction"), additional maintenance and snow removal ("Maintenance"), toll collection ("Toll Collection"), and toll booth construction and maintenance ("Toll Booth Construction").

Although the list of impacts appears comprehensive, critics might argue that some relevant impacts were omitted. Health impacts from automobile emissions, impacts on the elk population and other wildlife, and changes in scenic beauty were not considered.

From a CBA perspective, analysts are interested only in project impacts that affect the utility of individuals with standing. Impacts that do not have any value to human beings are not counted. (The caveat is that this applies only where human beings have the relevant knowledge and information to make rational valuations.) Politicians often state the purported impacts of projects in very general terms. For example, they might say that a project will promote "community capacity building." Similarly, politicians have a strong tendency to regard "growth" and "regional development" as beneficial impacts. CBA requires analysts to identify explicitly the ways in which the project would make some individuals better off through, for example, improved skills, better education, or higher incomes. Of course, analysts should also include the negative environmental and congestion impacts of growth.

Put another way, in order to treat something as an impact, we have to know there is a cause-and-effect relationship between some physical outcome of the project and the utility of human beings with standing. For some impacts, this relationship is so obvious that we do not think about it explicitly. For example, we do not question the existence of a causal relationship between motor vehicle usage and accidents involving human morbidity and mortality. For other impacts, the causal relationships may not be so obvious. What about the impact of exhaust fumes from vehicle usage of the highway on residents' blood pressure? Or the impact of more airborne lead on blood pressure? Demonstrating such cause-and-effect relationships often requires an extensive review of scientific research.

The identification and cataloguing of some potentially important impact categories may depend upon the state of scientific or social science knowledge concerning the existence of an impact. For example, controversy has surrounded the effect of chlorinated organic compounds in bleached pulp mill effluent on wildlife. Although an earlier Swedish study found such a link, a later Canadian study found none.[18]

Analysts also should be on the lookout for impacts that different groups of people view in opposite ways. Consider, for example, flooded land. Residents of a flood plain generally view floods as a cost because they damage homes, while duck hunters regard them as a benefit because they attract ducks. Even though opposing valuations of the same impact could be aggregated in one category, it is usually more useful to have two impact categories—one for damaged homes and another for recreation benefits.

Specification of impact category measurement indicators usually occurs at the same time as specification of the impact categories. There are no particular difficulties in specifying measurement indicators of each impact category in this illustration. For example, the number of lives saved per year, the number of person-hours of travel time saved, and the dollar value of gasoline saved are reasonably natural indicators. If environmental impacts had been included, then the choice of indicator would have not been so straightforward. For example, the analyst might have to decide whether to use tons of various pollutants or the resultant health effects (e.g., changes in mortality or morbidity).

The choice of measurement indicator depends on data availability and ease of monetization. For example, an analyst may wish to measure the number of crimes avoided due to a policy intervention but may not have any way to estimate this impact. However, the analyst may have access to changes in arrest rates or changes in conviction rates and may be able to use one or both of these surrogates to estimate changes in crime.[19] Bear in mind, however, that all surrogate indicators involve some loss of information. For example, the conviction rate might be increasing while there is no change in the actual crime rate.

4. Predict the impacts quantitatively over the life of the project. The proposed highway project, like almost all projects, has impacts that extend over time. The fourth task is to quantify all impacts for each alternative in each time period. The analyst must make predictions for the no-tolls and with-tolls alternatives, for each year, and for each category of driver (trucks, passenger cars on business, passenger cars on vacation) about

- the number of vehicle-trips on the new highway,
- the number of vehicle-trips on the old roads, and
- the proportion of travelers from British Columbia.

With these estimates, knowing the highway is 195 kilometers long and with other information, the analyst can estimate

- the total vehicle operating costs that users save,
- the number of accidents avoided, and
- the number of lives saved.

For example, the analyst estimated the new highway would save 6.5 lives each year:

Shorter distance:
$$130 \text{ vkm} \times 0.027 \text{ lives lost per vkm} = 3.5 \text{ lives/year}$$
Safer (4-lane versus 2-lane):
$$313 \text{ vkm} \times 0.027 \text{ lives lost per vkm} \times 0.33 = 3.0 \text{ lives/year}$$
Total lives saved[20] $= 6.5$ lives/year

Lives would be saved for two reasons. First, the new highway will be shorter than existing alternative routes. It is expected that travelers will avoid 130 million vehicle-kilometers (vkm) of driving each year, and evidence suggests that, on average, there are 0.027 deaths per million vehicle-kilometers. The shorter distance is expected, therefore, to save 3.5 lives per year. The new highway is also predicted to be safer per kilometer driven. It is expected that 313 million vehicle-kilometers will be driven each year on the new highway. Based on previous traffic engineering evidence, the analyst estimated that the new highway would lower the fatal accident rate by one-third. Consequently, the new highway is expected to save 3.0 lives per year due to being safer. Combining the two components, 6.5 lives are saved per year.

Now we turn to difficulties of predicting impacts. There is relatively little discussion in the cost-benefit literature of the fact that prediction is both essential and very difficult! Most textbooks focus on theoretical issues, assuming that the relevant market demand and supply curves are known. However, they rarely are.

There are at least three reasons why prediction is often difficult. First, many public policies and programs seek to alter individuals' behavior. But it is often difficult to predict how individuals will respond overall to a change in even a single program parameter. Sometimes the targets of programs respond in unintended and unexpected ways. They may exhibit *compensating behavior* (also described as *offsetting behavior*) that partially or totally negates a predicted positive impact of the project.[21] For example, as automobiles have become intrinsically safer, at least partially because of regulations, drivers have offset these safety enhancements to some extent by engaging in riskier driving behavior.[22] Second, a policy may affect the behavior of third parties in ways that increase or decrease the costs or benefits of the policy. It is often difficult to foresee these *substitution* or *spillover effects.* For example, a law that requires juveniles to wear helmets on bicycles might encourage their parents to also wear helmets (a positive spillover); alternatively, it might lead them to drive their children more and generate more automobile accidents (a negative spillover).[23] Third, prediction may require scientific knowledge that is uncertain. This is illustrated by the current controversy surrounding the burning of fossil fuels, global warming, and the resulting impacts. While the evidence appears to suggest that global warming is a potentially serious problem, some reputable scientists are skeptical of the magnitudes of temperature increases predicted by climate models.[24] The highly publicized controversy surrounding the northern spotted owl also illustrates how widely expert opinions can vary. While some experts see the social costs of logging that eliminates the owl from some areas as relatively minor, Jonathan Rubin and his colleagues have argued the costs may be very large:

> Biologically, the owl is an indicator for old-growth temperate ecosystems: the trees, associated plant communities, and wildlife species that find their optimal habitat in these forests. If the spotted owl cannot survive, its extinction could represent a lack of viability for old-growth habitat itself. Elimination of an ecosystem, itself a unique resource, clearly has greater costs for society than mere extinction of the owl.[25]

Prediction is so important that Chapter 19 is devoted largely to it. As we discuss there, the actual usage levels of the Coquihalla Highway, which was built in 1987, are considerably higher than predicted, but so are the costs. Even this understates the prediction problems as there were errors within benefit categories that did not show up in the aggregate dollar benefit figure because they offset each other. Prediction is especially difficult where projects are unique, have long time horizons, or relationships among variables are complex.

Many of the realities associated with doing steps 3 and 4 are brilliantly summarized by Kenneth Boulding's poem on dam building in the Third World, presented in Exhibit 1-1. Many of his points deal with the omission of impact categories due to misunderstanding or ignorance of cause-and-effect relationships and to prediction errors. He also makes points about the distribution of costs and benefits, which we discuss later.

5. Monetize (attach dollar values to) all impacts. The analyst next has to monetize each of the impacts. To *monetize* means to value in dollars. In the highway example, the analyst has to monetize each unit of time saved, lives saved, and accidents avoided. For this, the analyst needs the monetary value of an hour saved by each type of traveler, the value of a

EXHIBIT 1-1

A BALLAD OF ECOLOGICAL AWARENESS

The cost of building dams is always underestimated,
There's erosion of the delta that the river has created,
There's fertile soil below the dam that's likely to be looted,
And the tangled mat of forest that has got to be uprooted.

There's the breaking up of cultures with old haunts' and habits' loss,
There's the education programme that just doesn't come across,
And the wasted fruits of progress that are seldom much enjoyed
By expelled subsistence farmers who are urban unemployed.

There's disappointing yield of fish, beyond the first explosion;
There's silting up, and drawing down, and watershed erosion.
Above the dam the water's lost by sheer evaporation;
Below, the river scours, and suffers dangerous alteration.

For engineers, however good, are likely to be guilty
Of quietly forgetting that a river can be silty,
While the irrigation people too are frequently forgetting
That water poured upon the land is likely to be wetting.

Then the water in the lake, and what the lake releases,
Is crawling with infected snails and water-borne diseases.
There's a hideous locust breeding ground when water level's low,
And a million ecologic facts we really do not know.

There are benefits, of course, which may be countable, but which
Have a tendency to fall into the pockets of the rich,
While the costs are apt to fall upon the shoulders of the poor.
So cost-benefit analysis is nearly always sure
To justify the building of a solid concrete fact,
While the Ecologic Truth is left behind in the Abstract.

—KENNETH E. BOULDING

statistical life saved, and the value of an avoided accident. Ideally, these estimates should be specific to British Columbia in 1986. Some of the dollar values used in this CBA were

- leisure time saved per vehicle (25 percent of gross wage times the average number of passengers) = \$6.68 per vehicle-hour,
- business time saved per vehicle = \$12 per vehicle-hour,
- truck drivers' time saved per vehicle = \$14 per vehicle-hour, and
- value of a life saved = \$500,000 per life.

These estimates were based on studies conducted prior to 1986. Recent research suggests the value of a statistical life saved is much higher, as we discuss in Chapter 15.

Sometimes, the most intuitively important impacts are difficult to value in monetary terms. The value of environmental impacts is especially contentious. In CBA, the value of an output is typically measured in terms of "willingness-to-pay." As we discuss in Chapter 4, where markets exist and work well, willingness-to-pay can be determined from the appropriate market demand curve. Naturally, problems arise where markets do not exist or do not work well. Obtaining values for such impact categories can be a life's work. Scholars have spent many person-years trying to determine the appropriate value of a statistical life saved. In practice, most CBA analysts do not reinvent these wheels but instead draw upon previous research: They use "plug in" values whenever possible. Although catalogues of impact values are not comprehensive, considerable progress has been made in this regard as we show in Chapter 15.

If no person is willing to pay for some impact, then that impact would have zero value in a CBA. For example, if construction of a dam would lead to the extermination of a species of small fish, but no one with standing is willing to pay a positive amount to save that species, then the extermination of this fish would have a value of zero in a CBA of the dam.

Some government agencies and critics of CBA are unwilling to attach a monetary value to life or to some other impact. This forces them to use an alternative method of analysis, such as *cost-effectiveness analysis* or *multigoal analysis,* which we discuss in Chapters 2 and 17.

6. Discount benefits and costs to obtain present values. For a project that has costs or benefits that accrue over extended periods (years), we need a way to aggregate the benefits and costs that arise in different years. In CBA, future benefits and costs are *discounted* relative to present benefits and costs in order to obtain their *present values, PV.* The need to discount arises due to most people's preference to consume now rather than later and, if we consume now, we usually give up resources—there is an opportunity cost. Discounting has nothing to do with inflation per se, although inflation must be taken into account.

A cost or benefit that occurs in year t is converted to its present value by dividing it by $(1 + s)^t$, where s is the social discount rate. Suppose a project has a life of n years and let B_t and C_t denote the benefits and costs in year t, respectively. The present value of the benefits, $PV(B)$, and the present value of the costs, $PV(C)$, of the project are respectively:

$$PV(B) = \sum_{t=0}^{n} \frac{B_t}{(1+s)^t} \quad \textbf{(1.2)}$$

$$PV(C) = \sum_{t=0}^{n} \frac{C_t}{(1+s)^t} \quad \textbf{(1.3)}$$

In the highway example the analyst used a real (inflation-adjusted) social discount rate of 7.5 percent.

As we discuss in Chapter 10, the choice of the appropriate social discount rate is contentious. Different theories suggest different values. The value of the social discount rate is thus a good candidate for sensitivity analysis. For government analysts, the discount rate is usually mandated by a government agency with authority (e.g., the Office of Management and Budget, the General Accounting Office, the Ministry of Finance, or the Treasury Board). In many jurisdictions, the specified real (inflation-adjusted) discount rate is mandated to be between 7 and 10 percent. But, as we argue in Chapter 10, these rates are too high. In that chapter, we present the case for a range of rates depending on a few well-defined parameters. Most importantly, if the project does not have impacts beyond 50 years (it is *intragenerational*), then we recommend a social discount rate of 3.5 percent. If the project is *intergenerational,* then we recommend time-declining discount rates, as described in that chapter.[26]

7. Compute the net present value of each alternative. The *net present value* of an alternative, *NPV,* equals the difference between the present value of the benefits and the present value of the costs:

$$NPV = PV(B) - PV(C) \tag{1.4}$$

The basic decision rule for a single alternative (relative to the status quo) is simple: *adopt the project if its NPV is positive.* In short, the analyst should recommend proceeding with the project if its $NPV = PV(B) - PV(C) > 0$; that is, if $PV(B) > PV(C)$—its benefits exceed its costs.

When there is more than one alternative to the status quo and all the alternatives are mutually exclusive, then the rule is slightly more complicated: *Select the project with the largest NPV.* This rule assumes implicitly that at least one *NPV* is positive. If no *NPV* is positive, then none of the specified alternatives are superior to the status quo, which should remain in place.

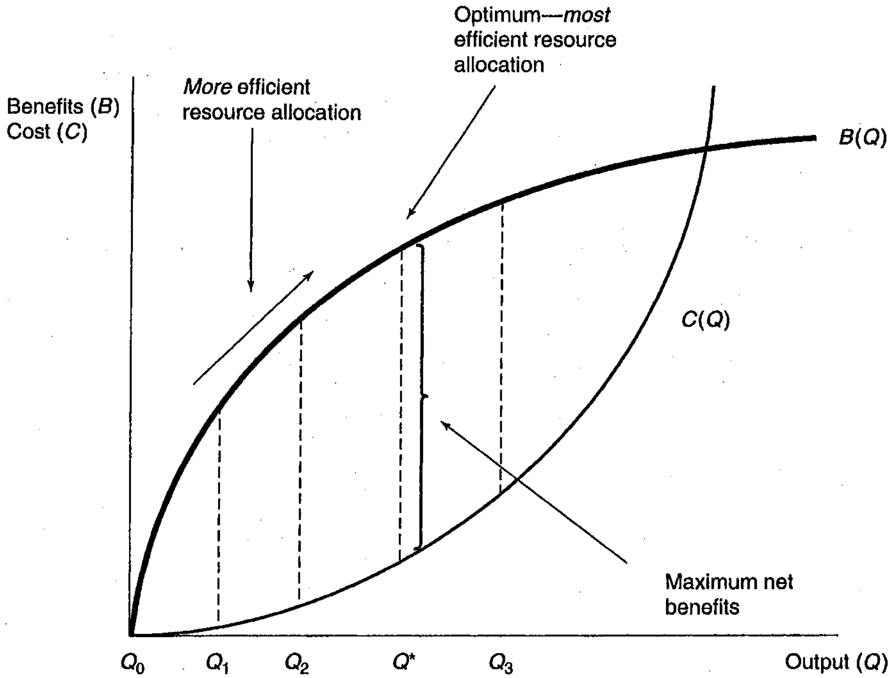
Earlier we emphasized the net social benefits of a project. We show in Chapter 6 that the *NPV* of a project or policy is identical to the present value of the net social benefits:

$$NPV = PV(NSB) \tag{1.5}$$

Thus, selecting the project with the largest *NPV* is equivalent to selecting the project with the largest present value of the net social benefits.

In the highway example, project A has a larger *NPV* than project B, and project C has a larger *NPV* than project D. The no-tolls alternatives have higher *NPV*s than the with-tolls alternatives. Thus, if the analyst were confident in the *NPV*s shown in Table 1-3, the analyst should recommend that the highway should be constructed without tolls. However, the *NPV* of the no-tolls alternative is quite small from the provincial perspective, although positive. Earlier, we emphasized that conducting CBA requires prediction and monetization, which are not always completely accurate. It is important to remember that the *NPV*s presented in Table 1-3 are estimates, and that sensitivity analysis should be conducted before making a final recommendation. However, before turning to sensitivity analysis (step 8), we discuss decision making in a bit more detail.

In fact, there is some confusion about the appropriate decision rule. Both the *internal rate of return,* which is discussed in Chapter 6, and the *benefit-cost ratio,* which is discussed in Chapter 2, have also been proposed as decision rules. This is one area



Moving from Q_0 toward Q^* increases efficiency; that is: $NPV(Q^*) > NPV(Q_2) > NPV(Q_1) > NPV(Q_0)$

Moving beyond Q^* reduces efficiency, but Q_3 is more efficient than Q_0: $NPV(Q^*) > NPV(Q_3) > NPV(Q_0)$

FIGURE 1-1 CBA Seeks More Efficient Resource Allocation

with more heat than light. The appropriate criterion to use is the *NPV* rule. Other methods sometimes give incorrect answers; the *NPV* rule does not.

An obvious caveat about the *NPV* criterion is that it applies only to the actual alternatives specified. Other alternatives might conceivably be better. While the *NPV* criterion results in a *more efficient* allocation of resources, it does not necessarily recommend *the most efficient* allocation of resources. This point is illustrated in Figure 1-1. Consider a project for which the alternatives vary along an output scale, Q. The benefits and costs associated with alternative scales are represented by the functions $B(Q)$ and $C(Q)$, respectively. The benefits increase as the scale increases, but at a decreasing rate. In contrast, costs increase at an increasing rate. A small-scale project (for example, Q_1) has positive net benefits relative to the status quo, Q_0. As the scale increases, the net benefits increase up to the optimal scale, Q^*.[27] As the scale increases beyond Q^*, the net benefits decrease. Net benefits are positive as long as the benefit curve is above the cost curve, they are zero where the cost curve and benefit curve intersect and are negative for larger-scale projects.

Suppose that the analyst evaluates only two alternative output levels, Q_1 and Q_2, relative to the status quo. Clearly, output level Q_2 is preferred to output level Q_1, which, in turn, is preferred to the status quo, Q_0. The analyst would therefore recommend Q_2. However, as the figure shows, net social benefits are maximized at output level Q^*. This optimal output level was not recommended because it was not among the set evaluated. In this example, use of the *NPV* criterion leads to a more efficient alternative than the status quo, but not to the most efficient alternative.

The analyst may not have included the optimum output level in the set of alternatives for a number of reasons. The optimum output level may not have been known, even approximately, until after the analysis was performed. Cognitive capacity limitations, often summarized as *bounded rationality* problems, may have hindered the analyst from considering the optimal alternative.[28] Additionally, budgetary or political constraints may have limited the range of alternatives considered.

8. Perform sensitivity analysis. As the foregoing discussion emphasizes, there may be considerable uncertainty about both the predicted impacts and the appropriate monetary valuation of each unit of the impact. For example, the analyst may be uncertain about the predicted number of lives saved and about the appropriate dollar value to place on a statistical life saved. The analyst may also be uncertain about the appropriate social discount rate and about the appropriate level of standing. Sensitivity analysis, which we discuss in Chapter 7, attempts to deal with these uncertainties. As shown in Table 1-3, the analyst performed sensitivity analysis on the standing issue by computing the *NPV*s from both the global perspective and the provincial perspective.

There are practical limits to the amount of sensitivity analysis that is feasible. Potentially, every assumption in a CBA can be varied, some infinitely. In practice, one has to use judgment and focus on the potentially most important assumptions. Although this can mean that CBA is vulnerable to the biases of the analyst, carefully thought-out scenarios are usually more informative than a mindless varying of assumptions.

9. Make a recommendation. Generally, the analyst should recommend adoption of the project with the largest *NPV*. In the highway example, three of the alternative projects have positive *NPV*s and one has a negative *NPV*. The latter indicates that from the British Columbian perspective it would be more efficient not to build the Coquihalla highway than to build it and charge tolls. Sometimes the status quo is the best alternative. Here, however, from a global perspective both the with-tolls and no-tolls alternatives are preferable to the status quo. Based on selecting the alternative with the largest *NPV*, the analyst would recommend the selection of A above C, and B above D. In short, the no-tolls alternatives are superior. This result gives a flavor of the possibly counterintuitive recommendations that CBA can support. In this case, tolls lower the *NPV* because they deter people from using the highway, and so fewer people enjoy the benefits.[29]

As we have emphasized, however, the *NPV*s are predicted values. Sensitivity analysis, which we have not shown in detail, might suggest that the alternative with the largest expected *NPV* is not necessarily the best alternative under all circumstances.

Finally, it is important to note that analysts make recommendations, not decisions. CBA concerns how resources *should* be allocated; it is *normative*. It does not claim to be a *positive* (i.e., descriptive) theory of how resource allocation decisions are actually made. Such decisions are made in political and bureaucratic arenas. CBA is only one input to this political decision-making process—one that attempts to push it towards more efficient resource allocation. CBA does not always succeed. Politicians are often reluctant to be upstaged by economic arguments. Indeed, the highway was built with tolls!