A Primer for Benefit and Cost Assessments

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ABSTRACT

While economic concerns are not the only issue important in the decision-making process, analysis of the benefits and costs of a program or project is often a fundamental criterion in program selection. In this article, issues concerning the practical application of benefit-cost analysis will be discussed and the value of the concept relative to policy analysis will be considered.* It provides a primer of the techniques available for benefit-cost analysis often used for program or project assessments and evaluation.

In highly competitive business environments, competition for funds among various interests and programs is often an important factor in selecting which programs to support and implement. Benefits and costs can be either qualitative or quantitative. When funds are limited many organizations use benefit cost assessments to set priorities and simplify decision-making. Benefit-cost analysis techniques are used to assess the financial aspects of programs or projects developed for the public, non-profit and private sectors. They are used to evaluate a program or project during the planning stages, prior to implementation, or while a program is underway. Benefit-cost analysis techniques are also used to evaluate individual projects within a program or to perform an evaluation after a program is completed. This article offers a review of the benefit-cost techniques available for program evaluation.

BENEFITS AND COSTS

Benefits and costs are those aspects of a program that have a direct bearing on outcomes and impacts. Benefits and costs can be either

*This article repeatedly references the discussion by James Edwin Kee titled "Benefit-Cost Analysis in Program Evaluation," a chapter found in the *Handbook of Practical Program Evaluation* [1].

direct or indirect. Kee notes that, "Direct benefits and costs are closely related to the primary objective(s) of the project. Indirect or secondary benefits and costs are by-products, multipliers, spillovers, or investment effects of the project or program" [1:466]. Examples of direct benefits may include the value of water and sewer usage reduction, the cost of employee labor eliminated, and the costs of avoided improvements to structures. Indirect benefits and costs include those that are unintended. Applied technologies resulting from scientific researchers, which were discovered by research activities in an unassociated field, are also examples. The use of Teflon® and Velcro ®, developed by the U.S. space program, found consumer applications and became household products. Other associated costs might include insurance, increased maintenance, or valuing risks.

To begin a financial analysis, fundamental questions that must be addressed include "what has value?" or more likely "what do the decision makers value?" Benefits and costs can be quantifiable or non-quantifiable, qualitative or non-qualitative. Kee refers to such benefits as "tangible" or "intangible" to distinguish between those that can be assigned an explicit price and "those for which you cannot assign an explicit price" [1:467]. In addition, the spillover costs associated with the program or project under evaluation may cause unintended results. Indirect costs such as pollution, increases in traffic, noise, and air pollution, are often cited by economists as negative externalities. Negative externalities can cause discomfort, harm, or unreimbursed expense to parties and stakeholders who may have no direct association with the program or project. External costs are typically not included in the program costs. However, these costs may be "internalized" by the affected outside parties.

Forms of Benefit-Cost Analysis

There are various methodologies available to the researcher to evaluate the financial or economic impact of a program or project. Quantitative approaches are those methodologies that involve a financial analysis of the benefits and costs of a program when such impacts can be both valued and quantified. According to Kee, there are three basic steps to the calculating a benefit-cost ratio (BCR): 1) determine the benefits of a proposed or existing program and assign a value to those benefits; 2) calculate the program costs; and 3) compare the benefits to the costs [1:457]. Essentially, the BCR equals B/C, where B is the total sum of benefits and C is the total sum of program or project costs.

Calculating the simple payback period (SPP) is a commonly used, somewhat colloquial technique. Gross costs are used and savings values are annualized. The SPP is equal to the anticipated total project cost divided by the anticipated annual project savings less annual project costs. If a new environmental control system were installed in a building at a cost of $100,000 and the anticipated annual savings was $20,000, the SPP would equal five years. In the denominator, if program annual costs exceed savings, the result is negative and the project unsupportable. The project's rate of return (ROR) is generally expressed as the reciprocal of the SPP and can be stated a percentage or otherwise as a quantity. For these assessments, the cost of borrowing money (interest rate) is generally not included in the calculations.

A more sophisticated variation of benefit-cost analysis is the net present value (NPV) analysis. The net present value approach "converts all costs and benefit to their present value at the beginning of the project" [1:461]. Or stating this differently, the net present value approach is performed by discounting back the cash inflows over the life of the investment to determine whether they are equal to or exceed the required investment. The basic discount rate is often the cost of capital to the purchasing entity. Thus, inflows that arrive in later periods must provide a return that at least equals the cost of financing those returns [2]. Kee summarizes the concept using the NPV with following formula:

$$NPV = B^{y1} - C^{y1} + \frac{B^{y2} - C^{y2}}{1 + r} + \frac{B^{y3} - C^{y3}}{(1 + r)^2} + \ldots \frac{B^{yx} - C^{yx}}{(1 + r)^{x-1}}$$

In this equation, the net present value is defined in terms of the total benefits (B) and the total program or project costs (C) for a series of periods and the rate of return or interest rate r [1:461]. The denominators, functions of r, are subject to fluctuations in the rates of interest. A net present value analysis is a fundamental and often used approach employing computational logic incorporated in various other approaches to assessing benefits and costs.

Other techniques can be used to justify existing programs and proposed programs or projects. These include return on investment (ROI) which is similar to the ROR, the savings-to-investment ratio (SIR), and internal rate of return (IRR).

The return on investment (ROI) approach calculates the "discount rate that would make the present value of the project equal to zero" [1:457]. This provides a value that estimates the annualized rate of return (yield) for the project. From a practical point of view, the decision maker uses the yield to compare a project to others and make an objective selection among competitive investments.

The SIR is calculated by dividing the present value of the benefits of a project by the present value of the costs of the project. If the SIR of a project is greater than one, it is considered profitable. A project with an SIR less than one is considered unprofitable. This technique is often used in the public sector by organizations such as the U.S. Army Corps of Engineers [4:58-80]. This approach is similar to a discounted benefit to costs ratio (BCR).

The internal rate of return (IRR) method is used to determine the yield on an investment. The IRR is a calculation of the interest rate that equates the cash outlays of an investment with the subsequent cash inflows of the investment [3:306-312].

Output from these costs and benefit analysis approaches is often tabulated by the researcher and provided in a more easily understood form. The sample output table provided in Table 1 indicates the combined costs of the project, the financing of the project and the costs of annual measurement of benefits. Benefits are quantified as dollar savings from various combined sources and from operating savings. Total annual savings are compared to costs and a resulting cash flow is projected. The total sums of benefits and costs for the project are noted in the last row of Table 1. Note that this analysis focuses on quantifiable, non-discounted, direct and indirect costs and benefits. Escalation rates can be applied to costs and savings as needed to better approximate the cash flows over extended periods of time. Such approximations become more important if inflationary conditions are anticipated.

Kee takes this concept a step further and suggests tabulation of "real" benefits and costs. He uses as a framework for analysis categories such as direct tangible, direct intangible, indirect tangible, and indirect intangible [1:465].

While program assessment techniques such as the BCR, IRR, ROI, SIR, and NPV focus directly on quantifiable benefits, a cost-effectiveness analysis provides the ability to incorporate qualitative concerns. The cost-effectiveness analysis compares program costs to units of program benefits [1:457-9]. Examples include dollars expended per increase in

Table 1
Sample Costs and Benefits Table

PROJECT NAME:		**Sample County Schools**					
Financing:		**15 Years at 4.8%**					
Total Project Cost:		**$872,322**					
Year	Annual Loan Repayment	Performance Measurement Service 0% esc.	Total Annual Cost	Annual Savings	Annual Operating Savings 3% esc.	Total Annual Savings	Projected Annual Cash Flow
1	($79,013)	($7,000)	($86,013)	$77,506	$12,648	$90,154	$4,141
2	(79,013)	(7,000)	(86,013)	77,506	13,028	90,533	4,521
3	(79,013)	(7,000)	(86,013)	77,506	13,418	90,924	4,911
4	(79,013)	(7,000)	(86,013)	77,506	13,821	91,327	5,314
5	(79,013)	(7,000)	(86,013)	77,506	14,236	91,741	5,729
6	(79,013)	(7,000)	(86,013)	77,506	14,663	92,168	6,156
7	(79,013)	(7,000)	(86,013)	77,506	15,102	92,608	6,595
8	(79,013)	(7,000)	(86,013)	77,506	15,556	93,061	7,049
9	(79,013)	(7,000)	(86,013)	77,506	16,022	93,528	7,515
10	(79,013)	(7,000)	(86,013)	77,506	16,503	94,009	7,996
11	(79,013)	(7,000)	(86,013)	77,506	16,998	94,504	8,491
12	(79,013)	(7,000)	(86,013)	77,506	17,508	95,014	9,001
13	(79,013)	(7,000)	(86,013)	77,506	18,033	95,539	9,526
14	(79,013)	(7,000)	(86,013)	77,506	18,574	96,080	10,067
15	(79,013)	(7,000)	(86,013)	77,506	19,131	96,637	10,624
Total	**($1,185,190)**	**($105,000)**	**$ (1,290,190)**	**$1,162,585**	**$235,240**	**$ 1,397,826**	**$107,635**

energy efficiency for an energy program or water use reduction project. Cost-effectiveness analysis is often used when data is non-quantifiable or when data needed to quantify benefits is not available. These may include externalities whose costs are estimated.

When performing a benefit-cost analysis, issues of concern include the perspective of the program evaluator, the use of sensitivity analysis, how benefits and costs are managed, and the costs of delay. The observance of known intangible benefits and costs are often problematic. Kee suggests, "Benefits and costs are often in the eye of the beholder; a cost to one person or government agency may appear to be a benefit to another" [1:482]. Assessing the probabilities that the predicted and intended outcomes of a program will occur may require a sensitivity analysis to "examine a range of alternative assumptions and determine how they impact the analysis" [1:483].

Careful use and analysis of intangible benefits is important in the analysis process. Decision makers with a financially focused agenda may be skeptical of an analysis that highly values intangible benefits. For example, is "improving employee comfort" a tangible or intangible benefit? Many evaluators would consider such benefits tangible only if the benefits can be quantified, which in such cases may be difficult. In such instances, "tornado" charts or diagrams are useful. These charts are a form of bar chart that displays the savings and costs in a hierarchical format, with the larger more quantifiable impacts displayed at the top and smaller more qualitative impacts at the bottom [5]. These are often used when business risks must be assessed and graphic display of the relative importance of benefits is needed.

The economic cost of delay is worthy of consideration. Delaying a project often means that the status quo will be maintained and that current costs associated with lack of action will continue to occur. An empirical example is offered:

> An energy conservation project for a government entity in Indiana was developed by the author. Implementation costs totaled $18,000. The anticipated annual savings ranged between $28,000 and $44,000 annually in avoided energy costs. The project required two months to implement. However, the project was not implemented until four years after it was developed. As a result, the non-discounted cost of delay is estimated to range from $112,000 (4 X $28,000) to $176,000 (4 X $44,000).

In this real-world example, the government was unable to "budget" funds to implement the project since the "savings" accruing from the project would be credited to an account different from the debited cost center. This argument discounted the importance of the fact that both accounts were budgeted from the same pool of taxpayer dollars. This example provides an alternative perspective concerning the cost of delay and its impact on a benefit-cost analysis. The costs of doing nothing (maintaining the status quo) for a series of recurring periods may substantially exceed the costs of the initial investment.

Practical Applications

Applying benefit-cost analysis techniques requires that costs and benefits be identifiable, measurable and capable of valuation. It is also helpful strategically if the entity paying the costs is the same entity accruing the benefits which provides motivation to move forward. Regardless, data pertinent to the design of the evaluation must be obtained and tabulated. Identifying benefits involves the process of compiling and categorizing the benefits and costs. Measurement is an activity whereby the units of benefits are compared to a quantifiable constant. Valuation is the process that involves converting the units to a value. Kee suggests, "the evaluator should use a market value when one is available, or a surrogate such as willingness to pay" [1:470].

Kee provides examples of benefits such as direct cost savings, employee time saved, the valuing of lives, increased productivity, additional employment, recreational benefits and land values. He also provides categorical examples of costs such as one-time, fixed, up-front, ongoing, recurring, compliance, sunk costs, cost of money and mitigation costs [1:470-7]. Each set of benefits and costs are specific to the project or program being evaluated and all can be used in the assessment. For an energy reduction program, one would tabulate the data on current and proposed energy use, identify the types and amounts of energy used, measure the change in unit energy usage and apply a market value to the benefits. This value would be compared to the value of program costs.

The basic data that is needed varies as a function of the economic analysis technique, the detail required and depth of the argument. To assess energy and water conservation projects, the minimum data needed might include unit energy costs, historical usage of all energy sources, costs and usages for water, project costs, project savings and life of equipment. Other costs and savings data may be required to incorporate maintenance or other anticipated costs and savings not directly related to the energy impact.

How Does This Apply to Policy Analysis and Evaluation?

If the answer to the "do something" or "do nothing" question is to "do something," then it is inevitable that the next question is "do what" or "do exactly what?" When answering the "do exactly what" question after being directed to "do something," the question becomes "why are you doing that particular something?" If part of the justification is economic, then "the something you are planning on doing" may be supported with an analysis of its cost effectiveness.

Projects can be completed with internal or external resources and the costs will likely vary. A make vs. buy analysis is a method of comparing the cost of performing the service or manufacturing the good with "in-house" means to the costs of having the service or good provided by an external source. In these cases, assessing a project's economic merits requires multiple evaluations. Thus, an analysis of benefits and costs becomes important and a benefit-cost analysis will involve options based on variable time periods. "Program evaluation almost always requires the analyst to compare benefits and costs that occurred in different periods of time" [1:486-7]. Iterative assessments can be necessary to maximize returns, generate greater cash flows or create more profitable alternatives. Showing that an option is the most profitable can provide a persuasive argument to move forward with the program.

Flahery and Watters observed that economic assessments are very site specific, making the evaluation process more complex. Savings calculations can indicate how a program is impacted by its regulatory environment [6:47-60]. While the process needed to perform an analysis can be similar, the outcomes for one project are often not transferable to similar projects, creating ample opportunities for analysts.

No discussion concerning benefit-cost analysis would be complete without a de facto "cost analysis" of the concept. Indeed there are drawbacks (costs) when using benefit-cost analysis. The apparent ease of applying these techniques can be illusionary. In addition to the technical and financial costs of performing a BCR, innumerable obstacles may present themselves. Obtaining the data to perform a benefit-cost analysis may present difficulties for the researcher. Using an overly comprehensive approach can lead to "analysis paralysis" with significant costs incurred collecting and processing incremental bits of data. Distributional concerns and equity issues that may be unimportant to the private sector decision-making process may be highly valued by the public sector, complicating the analysis design [1:486]. Multiple-causation concerns may require controlled experiments to properly evaluate a program or changes to a program [1:486]. Measurement methods needed to value benefit and cost flows may be unavailable, costly to perform or require costly technical expertise. Non-quantifiable political impacts of a program or project may present both rational and irrational obstacles, preventing implementation, regardless of how logically appropriate and beneficial the projected outcomes appear to be. Finally, certain agencies may require that specific analysis techniques be used for their program or project evaluation.

CONCLUSION

The goal of this discussion was to provide a review of the benefit-cost analysis techniques available for program evaluation. To this end, this article benefited from James Kee and his perspective on benefit-cost analysis of program evaluations [1].

Various benefit-cost techniques were considered including the BCR, NPV, ROI, ROR, SPP and others. Issues concerning the practical application of benefit-cost analysis were discussed in detail. The value of the concept relative to policy analysis was supported on a theoretical basis. The option of maintaining the status quo was considered as was the cost of delay.

Benefit-cost analysis techniques were determined to be beneficial to the researcher in assessing and valuing the benefits of programs and projects. Using an appropriate research perspective, benefit-cost analysis provides decision makers with critical information that can be used to support, modify or reject a program or project. Despite these strengths, benefit-cost analysis has it drawbacks. These include factors such as the financial costs of performing a study, the availability of technical expertise and the difficulties imposed by measuring savings and costs. In addition, political aspects of the decision making process can be problematic.

Regardless, benefit-cost analysis can be a key to a successful program or project. In today's cloud-based, "big data" environment, benefit cost analysis is a useful for program assessments. Those programs with the greatest benefits often have a greater likelihood of success. As a result, knowledge of benefit-cost analysis is an important tool for the researcher in assessing programs or projects.

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