THE USE OF COST-BENEFIT ANALYSIS IN PROJECT EVALUATION

by

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CHAPTER I

INTRODUCTION

A project can be defined as an activity on which funds are used in expectation of benefits exceeding costs. A project generally can be analyzed and evaluated as an independent unit, though the final selection process must consider interdependence among projects and constraints imposed by budget limitation. After initial evaluation, one can adjust the composition of project proposals and devise a new project to conform more closely to governmental or private investment goals.

Generally, government may be assumed to have these primary goals.

i) To increase the total national income

ii) To improve the distribution of national income

iii) To maintain economic stability and full employment

iv) To encourage efficient allocation of scare resources

Cost-benefit analysis is one of the ways a government encourages efficient allocation of those limited resources. It attempts to indicate whether the value of the output of a project exceeds the value of the input. Just as cost-benefit analysis can help to achieve economic efficiency for the public sector, it can also enhance profitability in the private sector. As planning and managing capital expenditure are important for a private investor, given a specific amount of funds, capital budgeting is an

effective way of selecting and assigning priorities to projects within the framework of the company's objectives and targets. Thus, capital budgeting enables a private investor to plan ahead, to see in advance what funds it is likely to have available, and then to plan the most effective use of them. In this report, I will focus mainly on the public sector and how decisions are made in project evaluation.

THE BASIS FOR COST-BENEFIT ANALYSIS

Economics is the study of the allocation of scare resources among competing uses. Cost-benefit analysis is applied welfare economics; that is, it entails the application of the principles of welfare economics to a specific activity, program or project. Welfare economics is the branch of economics that formulates the criteria to distinguish between those activities, programs or projects that would make the society better off and those that would make it worse off [1, 1977, p.13]. In other words, it can provide guidance in the efficient allocation of resources.

According to economic efficiency criteria, social welfare can be said to have increased if an activity results in a net increase in the value of the goods and services produced throughout the economy. Conversely, social well being will diminish if an activity reduces the net value of the goods and services produced. The value of the goods and services produced measured by the people's willingness to pay for the goods and services. I

will discuss the concept of willingness to pay in Chapter IV.

The Pareto Optimality criterion applies welfare economics to the procedure of moving from one allocation of resources to an allocation that provides greater utility to individuals within the economy. An efficient allocation of resources occurs only when there are no possible reallocations that could make at least one person better off without making another person worse off. However. this procedure involves tradeoffs among individuals which cannot, for all practical purposes, be carried out; certainly not for large projects in the public sector.

According to the Hicks-Kaldor criterion or Potential Pareto Optimality, an increase in general welfare occurs if those that are made better off from some changes could, in principle, fully compensate those that are made worse off and still achieve an improvement in welfare. According to this criterion all changes do not, infact, actually have to occur. It is this criterion of economy efficiency upon which cost-benefit analysis is based [1, 1977, p.13]. Thus, cost-benefit analysis can be considered a tool for determining whether a specific reallocation of resources actually does increase the value of goods and services produced,[1] and hence, the general welfare of society.

1. Anderson, Lee G. and Settle, Russeil F. Benefit-Cost Analysis: A Practical Guide., 1977.

THE ORIGIN AND DEVELOPMENT OF COST-BENEFIT ANALYSIS

The cost-benefit model of project evaluation is not new. This notion first emerged in France back in 1844 with the publication of an essay entitled "On the Measurement of the Utility of Public Work" by Jules Dupuit. Sassone and Schaffer point out that Dupuit opens his discussion as follows [19, 1978, p.3]:

> Legislators have prescribed the formalities necessary for certain works to be declared of public utility. Political economy has not yet defined in any precise manner the conditions which these works must fulfill in order to be really useful; at least, the ideas which have been put about on this subject appear to us to be vague, incomplete, and often inaccurate.

The application of cost-benefit analysis started with the United States Flood Control Act of 1936. This act authorized federal assistance in developing flood-control programs "if the benefits to whomsoever they may accrue are in excess of the estimated costs" [19, 1978, p.4]. However, in the Flood Control Act, no consistent methods were developed by which to examine the benefits and costs. For example, The Corps of Engineers, the Soil conservation Service, The Bureau of Reclamation, and other agencies all used different approaches. Subsequently, the Federal Government attempted to standarize its project evaluation procedures.

In 1950, the US Federal Inter-Agency River Basin Committee issued Proposed Practice for Economic Analysis of River Basin Project. This document, known as the "Green Book", attempted to

instill some agreed set of rules for comparing costs and benefits. Further attempts at formalization came with the US Bureau of Budget's Budget Circular A-47 in 1952. These were early attempts, and they were followed by the general introduction of economic techniques into budget management in the USA across many areas of expenditure. At this stage, the important development was the introduction of "cost-effectiveness analysis" by which the benefit is measured in physical units and the costs are expressed in monetary units [16, 1983, p.15].

In 1962, Budget Circular A-47 was replaced by Senate Document 97, "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources." After an extended review, this document was replaced in 1973 by "Principles and Standards for Planning Water and Related Land Resources" [19, 1978, p.5]. At this stage, much more than gains and losses in Gross National Product are under consideration. For example, four accounts are used to display beneficial and adverse effects and to analyze the trade off among plans. Those accounts are national economic development, environmental quality, regional development and social well being.[2]

In 1968, cost-benefit analysis was extended to less developed countries with the publication of a Manual of Industrial Project Analysis In Developing Countries [10, 1968] known as the

2. Those accounts are stated briefly by Sassone and Schaffer in Cost-Benefit Analysis: A Handbook., 1978.

"Little-Mirrlees" Analysis. This manual was prepared for the Organization for Economic Co-operation and Development (OECD) and was then revised and published as Project Appraisal and Planning for Developing Countries in 1974 [11, 1974]. In 1972, The United Nations Industrial Development Organization (UNIDO) published Guidelines for Project Evaluation; the authors of this publication are P.Dasgupta, A.Sen, and S.Marglin. Although different in detail from the manual written by Little and Mirrlees, essentially the two documents share the same philosophy.[3] In 1975, Economic Analysis of Projects, which heavily relied on Little and Mirrlees, was published [21, 1975]. The authors of this publication are Lyn Squire and H.G. Van Der Tak.

3. The reference for this is from Pearce, D.W. Cost-Benefit Analysis. Second Edition, 1983. He did not discuss in detail what are their similarities and differences. For more details, we can refer to Little and Mirrlees, Project Appraisal and Planning for Developing Countries., 1974.

CHAPTER II

PROJECT AND ITS CYCLE

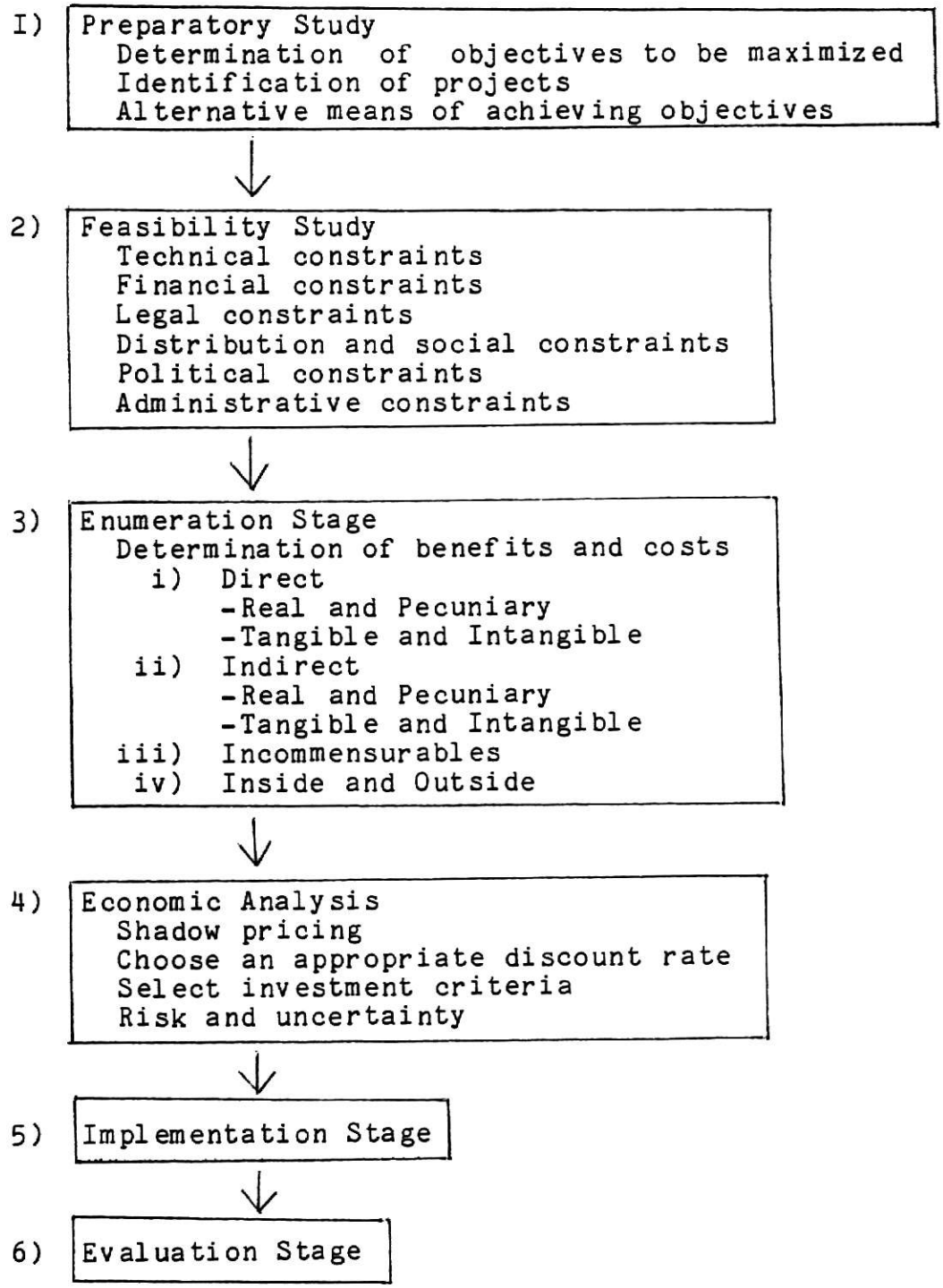
In countries with comprehensive planning, the identification, selection and preparation of projects theoretically would follow from a national development plan, with strategic sectors identified along with production targets to provide the general criteria for project selection. There is a common sequence in the way projects are planned and carried out known as the "Project Cycle".[4]

There are six stages in a project cycle (see Table 1) and activities appropriate to each stage are identified in this chapter; in later chapters, details attendant to analysis within each stage are explored in detail.

The starting point of a project cycle is the preparatory study. Before any effort is carried out, the establishment of the objective to be carried out is important. For example, objective might be to increase the export of agricultural products or to improve the country's balance of payment. After the objective has been identified, potential projects and alternative means of achieving objectives must then be found. Common sources of ideas are well-informed technical specialists and local leaders. They

4. Discussions on the various stages of project cycle are mainly taken from Economic Analysis of Agricultural Projects by Gittinger, J.P; 1982., p.21-26.

Table 1. A Project Cycle



can help to identify the reas where they feel new investments might be profitable and modifications of existing programs could be useful. Moreover, ideas could be generated from surveys of potential investment in selected regions or for specified types of social capital.[5]

After the projects have been identified, the analyst should then set up the alternative means of achieving the objectives. For instance, one could consider differing construction techniques for a proposed dam or roadway. Subsequent analysis will indicate which alternative provides the greatest net present value. He should also take into consideration of the effects of various alternatives on employment, ecology, infrastructure demand, capital services and other factors. For example, if a manufacturing plant is to locate in a city, its effects on the health or employment opportunities of the residents in that area must be considered.

Once the objectives have been determined and potential projects are identified, feasibility studies of projects must then be undertaken. A feasibility study of a project is important because it will provide information for deciding whether the project should be abandoned, revised or advanced to subsequent stages of planning. The analysis of the feasibility of a project can be conducted at different levels of effort with respect to

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5. Gittinger, J.P. stated in his book that surveys will help the analyst to examine the current status of a particular region or sector, the future needs for the region and the prospects for expanding investment in the region., see page 22.

time, budget, and personnel, depending on the circumstances. A major responsibility of the analyst at this stage is to ensure that all constraints on the projects have been explicitly considered. Technical and financial constraints are the two most important constraints in project analysis. But there are other constraints which analysts must also considere during a project's feasibility study: legal, distributional, social, political and administrative constraints.

1. Technical constraints

   In a feasibility study, we need a technical analysis to see whether or not the project is technically feasible. Given technologies and production possibilities, there is always a limit as to what the analyst can achieve in a project. For example, climate and geology can impose technical constraints, such as rainfall and effect of soil on construction techniques.

2. Financial Constraints

   During financial analysis of a project, the analyst must ensure that the costs of the project do not exceed the funds available for it. Therefore, the preparation of a financial statement is important to ensure that the financial requirement for the proposed project can be met. In this analysis, the analyst will need to have budget projections that estimate future receipts and expenditures. For example, if the funds available for an irrigation project are $100 million, the estimated cost of the project must then be compared to ensure that the project is financially feasible.

3. Legal constraints

Laws, property rights, government rules and regulations must be taken into account in the analysis of a project. A project must be carried out according to the laws or other legal regulations set by the government.

4. Distributional and social constraints

Development of a certain project may be limited by the distribution of income generated according to region, income class, etc. These distributional constraints generally derive from political constraints. (see additional comments in Chapter III).

5. Political constraints

The projects which are considered to be economically efficient may not be feasible because political objectives may conflict with the expected impact of a project. For example, the executive or legislative may require specific impacts on region or specific groups, such as low income elderly.

6. Administratives constraints

Effective projects require that personnel are available, or can be hired or trained, to carry out the project objective. The best project is worthless unless personnel with the proper mix of technical and administrative skills are available.

Thus, it is important that in the feasibility study of the project, all of these constraints be taken into account. If the

analyst is able to realize early the constraints which will have to be faced by the project, he will be able to exclude those alternative projects which obviously are not feasible at the early stage of analysis.

The third stage of the cycle is the enumeration stage. At this stage, determination of the benefits and costs of the more promising projects must be made . The analyst must identify the direct and indirect effects of each project. Direct effects refer to the direct output of a project, whereas indirect effects can be defined as the impact of the project on the rest of the economy. Those effects can be real or pecuniary. Real effects are the effects derived by the final consumer of the project and they reflect an addition to the social welfare. Pecuniary effects come about because of changes in relative prices when a project is carried out and they do not reflect net gains or costs to society as a whole; therefore, they should not be included in the benefit-cost calculation.

The effects of a project can also be classified as tangible, intangible or incommensurable. Tangible effects refer to the effects which can be valued in the market, whereas the effects which cannot be valued are referred as intangible. Incommensurables are closely related to intangibles with the difference being that incommensurables involve a dollar value being given even though the effects are not easy to value. The analyst must also consider inside effects and outside effects of a project. I will discuss these distinction in more detail in Chapter III.

The fourth stage in the cycle is economic analysis of the project. This analysis helps to determine how much a proposed project will contribute to the development of the whole economy and what these contributions are worth, relative to the scare resources being invested. At this stage, shadow prices are usually used to value the benefits and costs of a project to reflect its real value or costs. An appropriate discount rate is selected to discount the future benefits and costs into a present value so that comparison of benefits and costs can be made by applying some investment criteria. Risk and uncertainty must also be taken into account at this stage. Finally, the analyst must choose the best alternative in which to invest the money. Thus, this stage provides an opportunity to review every aspect of the project plan to make sure the proposal is appropriate before a large sum of money is committed. I will discuss this stage more in Chapters V and VI.

The fifth stage of the cycle is the implementation stage. Some important points to remember at this stage are as follows:

1. The better and more realistic a project plan, the more likely it is that the plan can be carried out successfully and, thus, expected benefits can be realised.
2. It is important that project implementation be flexible to allow for changes that could occur. For example, technical, political, economical changes will probably affect its implementation [7, 1982].

The final stage of the cycle is called the evaluation stage. At this stage, the analyst looks systematically at the elements of success and failure in the project's experience to learn how to plan better for the future.

CHAPTER III

ENUMERATION OF COSTS AND BENEFITS

Once the project has been identified, the next step in cost-benefit analysis is to determine the benefits and costs of that project. Benefits and costs of a project may be classified into different categories. It is essential that the analyst try to distinguish them properly to avoid the problem of double counting. In this chapter, I will try to describe various categories of benefits and costs by taking an irrigation project as an example. (see Table 2)[6]

Generally, both benefits and costs may be divided into two main categories, direct (primary) effects and indirect (secondary) effects. Direct effects are the effects that result from the goods and services that are directly produced by the project. Benefits are measured by the willingness to pay for the direct output, and the costs of producing direct output are measured in terms of the foregone production.[7] For example, the willingness to pay for the use of water from a dam for irrigation is a direct benefit.

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6. Sources of benefits and costs are taken from Public Finance in Theory and Practice, by Richard Musgrave and Peggy Musgrave., 1984, p.163.

7. Anderson, Lee G. and Settle, Russeil F. Benefit-Cost Analysis: A Practical Guide., 1977.

Table 2. Different Components of Benefits and Costs of an Irrigation Project

		Benefits
Direct	Real	Increase in farm output
	Pecuniary	Increase in the profit of the seller of farm equipment
Indirect	Real	Create recreational area
	Pecuniary	Relative improvement in position of farm equipment industry
Direct	Tangible	Increase in the earning of farmer
	Intangible	Improvement in the scenery of the area
Indirect	Tangible	Reduced soil erosion
	Intangible	Preservation of rural society
		Costs
Direct	Real	Cost of pipes
	Pecuniary	Increase in the price paid by the buyer of farm equipment
Indirect	Real	Cost of building the recreational facility in the area
	Pecuniary	Reduced in demand for recreational facilities in other area
Direct	Tangible	Cost of the inputs, such as steel, cements and pipes
	Intangible	Loss of wilderness
Indirect	Tangible	Diversion of water
	Intangible	Destruction of wildlife
Inside effect		Flood control inside the jurisdiction
Outside effect		Prevent flooding for the neighboring area

Indirect effects reflect the impact of the project on the rest of the economy. Indirect effects are the changes in the value of production generated indirectly by the project. For example, an irrigation dam may reduce flooding or create a recreational area.

Both direct and indirect effects can be divided into real (or technological) or pecuniary. Real effects consist of an increased (or decrease) in consumer satisfaction or an increase (or decrease) in the amount of resources required to produce the goods and services. For example, an irrigation project in a rural area which increases productivity of land yield a net increase in output (if project benefits ecceed costs). Pecuniary effects, on the other hand, represent a change in some people's well being at the expense of the well being of others. These effects represent a redistribution of income. For example, an irrigation project might result in an increase in the price of farm equipment. The seller of the farm equipment would benefit by an increase in profit but their gains would be a cost (loss) to the purchaser of farm equipment. Thus, the pecuniary effects represent an income transfer from the purchaser of farm equipment to the seller of farm equipment. As a result, it has been recommended that the pecuniary effects should be omitted in the estimation of benefits for a project because the economy as a whole does not get a net welfare gain [1, 1977, p.23-25].

Both direct and indirect effects can also be divided into tangible or intangible, base on the relative ease with which

values can be appraised in monetary terms. Tangible effects are the effects that are valued in money terms, such as an increase in the future earning of farmer. Intangible effects are not susceptible to being valued in money terms. These might include the improvement of the scenery of an area which may result from an irrigation project. In any event, failure to monetize certain project effects does not mean that they should be excluded in decision making. The cost-benefit analyst should try to list them and describe such unmeasurable effects as thoroughly as possible.

Another group of a project's effects which is closely related to intangibles is incommensurables. This is an effect of a project that cannot readily be expressed in common terms but is given a dollar value by using a shadow price. It is an important effect which cannot be ignored by the project analyst. Examples of incommensurables include human life and time saving.

Besides the above effects, the public decision maker should also try to distinguish between benefits and costs which accrue inside the jurisdiction in which the project is undertaken and others which accrue outside.[8] For example, the dam used for irrigation may also generate flood control services to the area under the jurisdiction and this is considered an inside effect. However, if that dam would also prevent flooding for the neighboring area, its effects are considered an outside effect.

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8. The reference for these effects is Public Finance in Theory and Practice by R. Musgrave and P. Musgrave., 1984, p. 165.

From the above discussion, it is clear that different components of the benefits and costs must be carefully taken into account. To further the discussion about the direct and indirect effects of a project, we can apply two approaches: the general equilibrium approach and the partial equilibrium approach. The main difference between these two approaches is that the partial equilibrium approach focuses attention solely on the direct effects of the project, while the general equilibrium approach considers all effects whether directly or indirectly related to the project.

According to Anderson and Settle, the general equilibrium approach provides a complete picture of all benefits and costs of the project as well as its income distribution effects, which are not reflected in the partial equilibrium approach. However, we must be aware that sometimes analysts do not necessarily include income distribution effects in a general equilibrium analysis of a project. The following discussion will contain an outline of the general rationale for the inclusion of income distribution weights in project selection.[9]

According to some project analysts, consideration of income distribution has to be taken into account in arriving at a measure of the project's worth because marginal increments in consumption accruing to different income groups must be assigned different values. Usually, the application of weights is biased so as to

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9. Squire, Lyn and Van Der Tak, Herman G. Economic Analysis of Projects., 1975.

bias project choice in favour of those investments which redistribute income to the the poor.

Others, however, argue for excluding distribution weights. According to them, if the government, through its control of fiscal policy, is able to redistribute income costlessly, there is no need to include distribution weights in project selection. Project selection should under such circumstances aim to maximize income and allow the fiscal system to redistribute it in a desirable fashion [21, 1975, p.51-53]. However, in general, it has been argued that redistribution can never be costless, as all fiscal measures have an administrative cost and other costs, such as unfavorable effect on incentives. Moreover, the unequal distribution of income-consumption in most developing countries and the difficulty of raising additional revenue indicate severe constraints on the government's use of the fiscal system. Thus, it is argued that distribution weights are required for project selection to redistribute incomes to the poor or the target groups.

One of the important problems in performing a cost-benefit analysis is to avoid the possibility of double counting among costs and benefits categories. Sometimes, the classification of the costs and benefits may result in the overlapping of various categories with each other, thus leading to confusion in measurement and perhaps double counting. For example, an increase in the export of agricultural goods may mistakenly be claimed as additional benefits of an irrigation project when such benefits

are already reflected in the measurement of production benefits for a the irrigation roject.

CHAPTER IV

ECONOMIC CONCEPTS OF COSTS AND BENEFITS

After the analyst has identified the components of costs and benefits, these components must be measured. Measurement involves the quantification of the costs and benefits and their valuation. The valuation of costs and benefits can be made by using market prices and shadow prices.

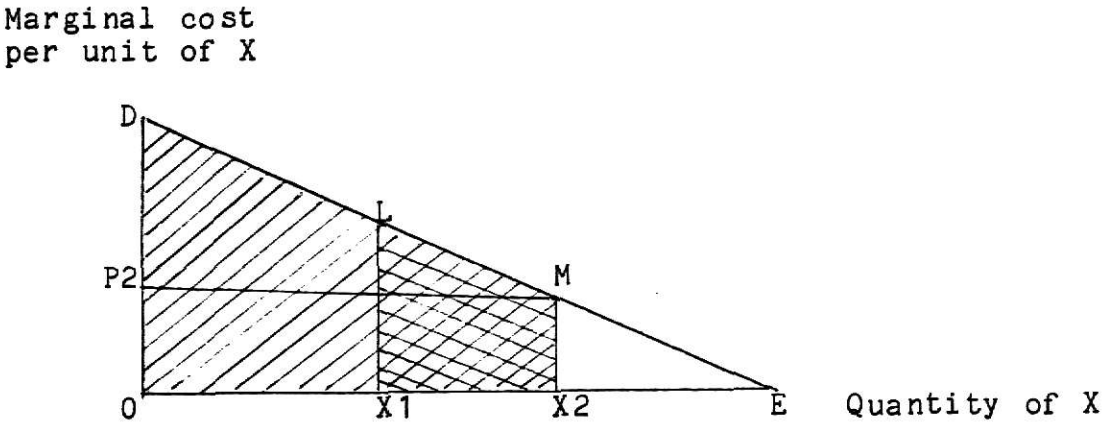
WILLINGNESS TO PAY

The social value of a project is the amount of value that the individual member of society obtains and that value is measured by his willingness to pay for it. The basic tool used by economists to measure willingness to pay for goods and services is the demand curve. A demand curve shows the relationship between prices and the amounts of the good purchased per period of time, with all other relevant variables such as income, taste and prices of other goods held constant.

To illustrate this point, I will refer to Figure 1 below. DE is an individual demand curve for commodity x. If that individual receives 0X2 of commodity x, he is willing to pay price P2 for the marginal unit of x and total payment of 0X2MP2, his total utility at quantity 0X2 would be 0X2MD, that is, the shaded area under the demand curve. If that individual were consuming 0X1 of

Figure 1

Willingness to Pay



commodity X prior to resource reallocation, the benefit attributable to the reallocation would be shown by the cross-hatched area(X1X2ML).[10] The gross benefits of a project, then, must include a willingness to pay for the outputs of the project by those people who receive it.

CONSUMER SURPLUS

Consumer surplus is defined as the maximum sum of money a consumer would be willing to pay for a given amount of commodity, less the amount he actually pays. To see how consumer surplus is used in cost-benefit analysis, see the following example.[11]

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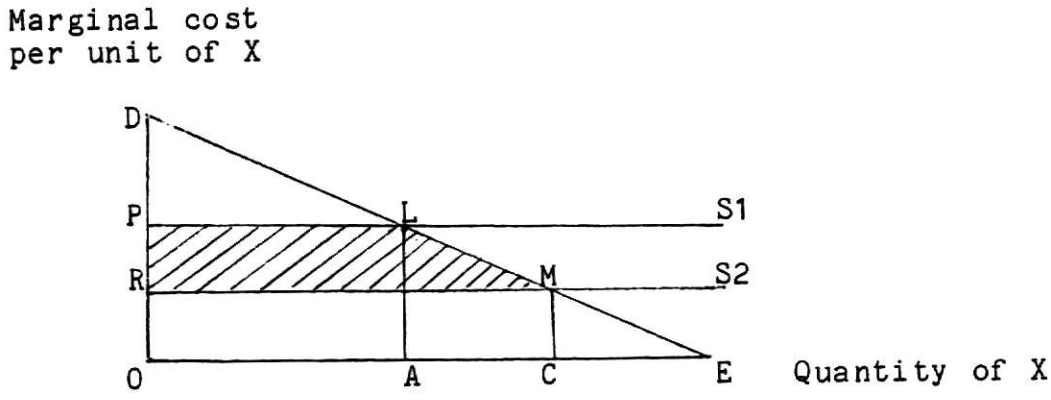
10. Peskin, Henry M. and Seskin, Eugene P. Cost-Benefit Analysis and Water Pollution Policy., 1975.

11. Musgrave, Richard. A and Musgrave, Peggy.B Public Finance in Theory and Practice., 1984, p. 167-168.

Figure 2

The Use of Consumer Surplus in Cost-Benefit Analysis



In Figure 2, DE is the demand schedule for a private good and PS1 is its supply schedule. Assume output is OA and price is OP, consumer surplus will be equal to DPL. Suppose a public facility is provided which reduces private costs (for example, road improvements which reduce transport costs). The private cost schedule thus falls to RS2, price drops to OR, output would increase to OC and consumer surplus rises to DRM. The gain in consumer surplus PRLM is part of the social benefits of the public project which should be included in the benefit-cost calculation. The total benefits from that public project must then be calculated so that it can be compared against the total costs of that project to see whether it is a good project.

OPPORTUNITY COST

The concept of opportunity cost is often used to measure the social cost of a certain project. The opportunity cost of a certain resource is its worth in some other alternative use. For example, the opportunity cost of land and capital used in the project is equal to the market value produced by such factors in the uses from which they are to be withdrawn. In general, in order to calculate the opportunity cost of a factor brought into a new project, we should add to the marginal value of the factor in its current use the sum that would exactly compensate the worker for all costs, both subjective and objective, associated with moving into employment in a new job.[12] According to Mishan [14, 1982, p.67]:

> In the case of involuntary unemployment in a less than full employment economy, the opportunity cost of unemployed labor is equal to the value that the labor attached to non-market activities. If the project has the effect of bringing the involuntary unemployed factors into production, the opportunity cost to the project of using those factors will in general be less than their market prices. How much it is less than market price is dependent on the period of idleness which can be expected if there is no opportunity set up by the project.

However, on the other hand, one has to clarify that if unemployed individuals would have an opportunity for employment, say through migration, the opportunity cost is positive.

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12. Mishan, E.J. Cost-Benefit Analysis. Third Edition. London., 1982. p. 66.

SHADOW PRICES AND SHADOW WAGE RATE

Normally, in a cost-benefit analysis, if market prices do exist for the items, the initial inclination is to use them to evaluate costs and benefits [6, 1977, p.285]. Cost-benefit analysis in the more advanced countries usually assumes that the price mechanism works well and thus, market prices have been used where available. For those costs and benefits which have no market prices, an appropriate social value in monetary terms will be taken. However, for developing countries, problems frequently arise as to whether the market prices do reflect the real costs and benefits to society.

A shadow price can be defined as a value associated with a unit of some good which indicates how much some specified index of performance can be increased or decreased by the use (or loss) of the marginal unit of that commodity.[13] Shadow prices are the social values of goods created, used up, or otherwise affected by a project.

Shadow prices are used if there is market imperfection, if no market price exists in the economy, or when political and social objectives are included in the valuation process.

As discussed earlier, market prices as a measure of social costs and values depend on the willingness to buy and sell goods freely at market prices. In a competitive market, this is true

13. Defination from Sassone and Schaffer. Cost-Benefit Analysis: A Handbook., 1978.

because the price of a commodity tends to be at the level where quantities supplied equal quantities demanded. However, questions arise when a market is constrained in the way that prevents it from reaching such equilibrium. Thus, the prices one has to pay will not reflect social costs of resources.

Some of the market imperfections which may arise in an economy are as follows:[14]

1. Price controls by the government in certain items, which affect the relationship between relative prices.
2. Import control or subsidies. Examples of import control are quotas, tariff and taxes . These would cause a distortion to occur between market prices of goods and real costs of producing them.
3. Price of foreign exchange is set by the government. This tends to result in the country's currency being either undervalued or overvalued. In this way, a distortion occurs in the domestic prices relative to the world prices.
4. Unemployed or underemployed resources.

The above problems can be corrected by calculating the opportunity costs of the inputs to determine the shadow prices.[15] The following discussion should help to explain the solution.

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14. Refer to Fyffe, C. Project Feasibility Analysis: A Guide to Profitable New Ventures., 1977, p. 286.

15. Anderson, Lee G. and Settle, Russeil F. Benefit-Cost Analysis: A Practical Guide., 1977.

When there is a policy of price control by the government in certain items, the opportunity costs of such items should be the willingness to pay for such items before price control policy is being carried out.

If there are taxes, quotas or tariff, these should be excluded from the calculation of opportunity costs because they do not represent foregone production elsewhere in the economy, however, the opposite will be true in the case of subsidies.

When the price of foreign exchange is set by the government, border price is often used to value the "traded goods" and domestic price is used to value the "non-traded goods" because these prices will represent the correct social opportunity costs of producing those goods. Sometimes, a shadow exchange rate has been recommended to solve the problems. There have been a lot of controversies regarding the derivation of a shadow exchange rate. UNIDO Guidelines introduced a simple formula to calculate an average shadow exchange rate (SER). That is :

$$SER = OER \frac{[(M + Ti) + (X + Sx)]}{M + X}$$

Where OER = Official exchange rate

M = C.i.f value of import

X = F.o.b value of export

Ti = Import tax revenues

Sx = Export subsidies

However, Little and Mirrlees believe that the shadow prices used for traded and non-traded goods should be the world prices as these would represent a country's actual trading opportunities.[16]

When resources used on a project would not otherwise be used, the opportunity cost of using them is zero or less than the actual market price if it is underemployed.

The need for shadow pricing increases when the price of commodities do not exist at all. Usually, market prices do not exist for public goods and externalities.

Public goods can be defined as goods which are provided by the government and are consumed jointly by individuals. For example, national defense, national parks and lighthouses. Governments undertake to provide these goods and finance them through taxes. Thus, there is no unit price for these goods, and social values of the goods are made using a shadow price. Shadow prices may be assigned in several ways, such as the value of similar goods in the private markets, the result of consumer surveys, and prices implicit in historic governmental decisions [19, 1978, p.37].

Externalities exist when the action of an individual affects the welfare of another and no compensation or penalty is given. Externalities involve social costs, and should be valued using shadow prices and included in a cost-benefit analysis. Examples

16. There are more discussions on the world price used by Little and Mirrlees in their book. I will not discuss further their analysis in this report.

of externalities are air pollution, noise and traffic congestion.

SHADOW WAGE RATE

Similar consideration must be made regarding the economic costs of employing labor on the project. The shadow wage rate aims at measuring the opportunity cost of labor, that is, the marginal output of labor that is foregone elsewhere because of its use in the project. When severe unemployment exists in the economy and is expected to persist even when the project is undertaken, the shadow wage would be zero and not whatever market wage is actually being paid [21, 1975, p.30]. There must be different shadow wage rates for different skills, times, and locations. If rural labor is employed in industrial employment, the industrial wage may be greater than the wage obtained in the rural area. The higher industrial wage rate may or may not reflect labor's marginal productivity and there is no common yardstick to measure marginal productivity in agriculture; therefore, adjustment must be made in the estimation of the output foregone by using a shadow wage rate that is considered relevant.

TRANSFER PAYMENT

One of the important points for an analyst to remember is in the consideration of transfer payments in estimating costs and benefits. Some payments that appear as the expenditures of a certain project do not represent direct claims on the country's

resources but rather, it reflects a transfer of the control over resources from one sector to another sector of society.[17] Common examples are interest, taxes, subsidies and credit transactions that include loans, receipts and repayment of principal. All these claims should not be included in an economic analysis of the project. Those are considered transfer payments and should not constitute a resource cost [7, 1982, p.251]. However, though taxes and interest are not a resource cost, they do have some impact on the distribution of income and saving [21, 1975, p.19]. Thus, if a government is concerned about using the project selection as a means of improving income distribution and increasing savings, taxes and interests have to be taken into account in estimating the costs and benefits of a project by using the shadow prices of factor inputs which I have discussed earlier in this chapter.

THE CHOICE OF DISCOUNT RATE

When the benefits or costs of a project extend beyond a one-year time limit, it is important that those benefits and costs be discounted back to some common point in time for purpose of comparison. Thus, a discount rate must be chosen to discount the future benefits and costs into the present values.

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17. Gittinger, J.Price. Economic Analysis of Agricultural Project., 1982, p. 250-251.

In any cost-benefit analysis, one of the most crucial controversies arises concerning the choice of an appropriate discount rate to evaluate project alternatives. Choice of an appropriate discount rate will not only influence the type of projects which will be undertaken but it will affect resource allocation between the public and private sectors of the economy. Sometimes, a small change in the discount rate will make a significant difference in the project evaluation. In the evaluation of a single project, the discount rate will affect whether the net present value is greater or less than zero. In a comparison of projects, the discount rate will affect their net present value ranking. (See Table 3 and 4)

Table 3. Cash Flow For Project A and B

	Cash Flow ($)			
Year	0	1	2	3
Project A	-100	200	10	20
Project B	-100	0	0	300

Table 4. Effects of Discount Rate on Net Present Value

Discount Rate	Net Present Value at 3 Percent	Net Present Value at 20 Percent
Project A	121.72	85.1
Project B	174	73.6

From the above example, note that project B is superior to project A when using a discount rate of 3 percent, but project A is superior to project B when a discount rate of 20 percent is

used. Thus, the choice of a discount rate is likely to have a profound impact on the type of projects to be chosen. Normally, a low rate favors investments with long lives, whereas a high rate favors those whose benefits become available soon after the initial investment.[18]

Since the choice of a discount rate is so important in cost-benefit analysis, we must then consider an appropriate discount rate. The approach which is most commonly used to select an appropriate discount rate is the opportunity cost of capital. This approach has been most clearly discussed by Baumol.[19] His discussion is based on the fact that the resources invested in a particular manner in one sector might be withdrawn from that sector and invested elsewhere to yield either a higher or lower rate of return. This means that if resources can earn 10 percent in the private sector, then they should not be transferred to the public sector, unless they can earn greater than 10 percent in the public sector. As Baumol states:

> ..... the correct discount rate for the evaluation of a government project is the percentage rate of return that the resources utilized would otherwise provided in the private sector [quoted in 12, 1974, p.478].

The appropriate measure of opportunity cost is a weighted

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18. Brealey, Richard and Myers, Steward. Principles of Corporate Finance., 1981.

19. Mc.Guigan, James R. and Moyer. Managerial Economics. Second Edition., 1979.

average of the individual rate of return, where the weights for each sector are determined by the amount of resources being taken from that sector relative to the total amount of resources from that sector.

As the choice of a discount rate can influence strongly which public policies should and should not be implemented, the choice of an appropriate discount rate is important not only to the policy's analyst, but also to the politician. Thus, the choice of the discount rate will then itself become a public policy decision that will in most cases be politically determined. For example, under the Nixon administration, the Office of Management and Budget(OMB) in March 1973 directed most federal agencies to apply a 10 percent real rate of discount when calculating the present value of the costs and benefits of federal projects (OMB, 1972).[20]

Many economists today agree that in the perfectly competitive economy, the rate of return in the private sector and the public sector should be the same and should then equal the market rate of interest [9, 1982, p.9-12].

However, once one moves from the perfectly competitive economy to an economy that is distorted by taxes, credit restriction, and other imperfections, there is a sharp disagreement about the appropriate rate of discount for evaluating public investment [9, 1982. p.9].

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20. Refer to Lind, Robert C. and Others, Discounting For Time and Risk in Energy Policy., 1982.

Some economists argue that market imperfections cause the rate of return on private capital to be higher than the rate that should be used to evaluate public investment. This group of economists then argues that a lower rate, which is equal to the consumption rate of interest, that is, the rate at which consumers are willing to forego consumption today for consumption in the future, should be used by the government in the benefit-cost calculation. There is also a suggestion that the rate used to evaluate the public investment should be a weighted average of the private rate of return and the consumption rate of interest [9, 1982, p.9].

Similarly, there are also economists who argue that discount rates used to evaluate public investment should be adjusted upwards for certain projects to account for the risk that will be involved, as in the case of private sector's investments [9, 1982, p.9].

Thus, various controversies arise regarding the choice of an appropriate discount rate. The above addresses the main controversies pertaining to the choice of the discount rate to be used for finding the present value of costs and benefits.

CHAPTER V

CRITERIA USED IN COMPARING COSTS AND BENEFITS

Among the basic questions of cost-benefit analysis is how those costs and benefits are to be compared and which criteria are to be used in deciding whether a project represents an efficient use of the resources.

Some of the criteria used for comparing costs and benefits are as follows:

1) Net Present Value
2) Benefit-Cost Ratio
3) Internal Rate of Return
4) Pay-back Period
5) Cut-off period
6) Annual Equivalent Cash Flow

As net present value and benefit-cost ratio are the two most commonly used criteria in the public sector, I will later discuss how the decision on project selections is made in situations of budget constraint and no budget constraint using those two criteria.

NET PRESENT VALUE (NPV)

When costs and benefits components are to be compared, the comparison must be made at a given point of time. Since in most

cases both costs and benefits accrue over a period of years, they must be discounted in order to take into account of the time factor.

The net present value of a project is calculated by discounting the stream of future benefits back to the present, and then subtracting accumulated costs from this project at that same point in time. If the net present value is positive, the implication is that the investment is desirable. However, if there are two or more projects that are substitutes for another, that is, only one will be undertaken, we should select the project with the highest net present value.

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1 + i)^t}$$

where:

NPV = Net present value

Bt = Benefit in year t

Ct = Costs in year t

n = length of life of the project

i = social discount rate[21]

21. See Chapter IV for theories regarding the selection of the discount rate.

Below is an example to illustrate how to calculate the net present value of a project.

Table 5. Net Cash Flow Per Year

	Year				
Project A	0	1	2	3	4
Expenditures (net)	$1,500	$ 500	$ 200	$ 0	$ 0
Receipts (benefit)	0	1,000	2,000	300	100
Cash flow	-1,500	500	1,800	300	100

Assume social discount rate = 10 %

$$NPV_{0.1} = \sum_{t=0}^{4} \frac{B_t - C_t}{(1+i)^t}$$

$$= \frac{-1,500}{1.1^0} + \frac{500}{1.1^1} + \frac{1,800}{1.1^2} + \frac{300}{1.1^3} + \frac{100}{1.1^4}$$

$$= -1,500 + 454.5 + 1,487.6 + 225.4 + 68.3$$

$$= \$735.80$$

Advantages:

1. This method is appropriate as a basis for comparison because it considers the time value of money according to the value of the discount rate selected.
2. It concentrates the equivalent of any cash flow in a single index at a particular point of time (t=0).

Disadvantages

1. This method assumes that benefits (cash inflows) and costs (cash outflows) can be forecast for the entire lifetime of the project.
2. This method requires equal time periods for comparison of several projects with identical benefits or production capacity, otherwise, it may end up selecting a less useful project.[22] (see example in Table 9)
3. The choice of discount rate can affect the ranking of the alternative and thus, its selection. For example, a high discount rate tends to favor short life projects while a lower discount rate would favor long life projects.

BENEFIT-COST RATIO

The benefit-cost ratio is normally defined in terms of discounted values. Assume d is the discount rate, its formula is:

$$\frac{B}{C} = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+d)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+d)^t}}$$

22. Fytte, Clifton. Project Feasibility Analysis: A Guide to Profitable New Venture, 1977.

The decision rule for this criterion is to accept a project if benefit-cost ratio is greater than one and reject the project if the ratio is less than one.

Table 6. Benefit-Cost Ratio

Project	Discounted benefits ($)	Discounted costs ($)	Benefit-cost Ratio
A	$ 7,703.55	$ 7,500	1.027
B	9,719.70	10,000	0.972
C	11,731.50	10,000	1.173

The advantages and disadvantages of these criteria are almost the same as net present value criteria. However, there is one advantage of this method over the net present value in the situation of budget constraint. The net present value has an inherent bias in favor of large projects, the use of cost-benefit ratio places all projects on an equal footing by indicating how much benefit can be achieved for each dollar of project outlay [12, 1979].

As stated earlier, benefit-cost ratio is very closely related to the net present value technique. The only difference is the fact that the benefit-cost ratio measures the relative present value return per dollar invested while the net present value approach gives the dollar difference between the present value of returns and the net investment. Both techniques normally will give the same accept-reject decision. However, in some mutually-exclusive projects, the net present value and benefit-

cost ratio methods will conflict. In the situation of mutually-exclusive project, the choice of one project precludes the choice of any other projects. That is, only one project is chosen from a group of acceptable projects. Net present value is a better evaluation technique when selecting a mutually exclusive project because it will help us to choose the project with the greatest total net benefits.[23] For example: Let us assume the discount rate is 5 %;

	Benefits and Cost Before Discounting					
Project	B0	C0	B1	C1	B-C Ratio	NPV
A	0	1	2	0	1.9	0.9
B	0	5	8	0	1.5	2.6

Notice that both projects are acceptable if the discount rate is 5 percent, as both have net present value of greater than zero and benefit-cost ratio of greater than one. However, when ranked by net present value, project B is superior, while project A is better when ranked by benefit-cost ratio. Since project B does yield a greater increase in society's total net benefits, the net present value method is preferred when selecting mutually-exclusive projects.

23. Steiner, Henry Malcolm. Public and Private Investments: Socioeconomic Analysis., 1980.

SELECTION OF INDEPENDENT PROJECTS UNDER BUDGET CONSTRAINT AND NO BUDGET CONSTRAINT USING NET PRESENT VALUE AND BENEFIT-COST RATIO CRITERIONS

In this discussion, let us assume there are multiple independent projects to choose from. An independent project is one that can be performed without affecting other projects. If there is no budget constraint, then the budget is the first cost of those projects that qualifies economically according to the criteria used, such as net present value or benefit-cost ratio. Normally, if there is no budget constraint, the analyst should list the projects from the one delivering the highest net present value to the one delivering the lowest net present value.

However, if there is a budget constraint, then the problem is to choose the best project of those proposed whose first costs fit into the budget. Benefit-cost ratio would be a better approach in this situation because it would help the analyst to set the project priority to get the groups of projects that give the highest total net present value. Thus, the analyst must list the projects, ordered from best to worst according to benefit-cost ratio and get the combination of projects that fit into the budget.[24] For further illustration, see the following example.

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24. This example has been discussed in greater detail by Steiner, Henry.M. in Public and Private Investment: Socioeconomic Analysis, 1980, p.170-173.

Table 7. Project Ranking Using NPV and B-C Ratio Techniques

Project	PV of Benefit($)	First Cost ($)	Total NPV	B-C Ratio	Priority
1	90	30	60	3.0	2
2	60	30	30	2.0	3
3	40	20	20	2.0	3
4	35	20	15	1.75	4
5	20	10	10	2.0	3
6	8	1	7	8.0	1
7	10	5	5	2.0	3

With an unlimited budget, all projects would be constructed according to the net present value ranking.

If there is a budget constraint of $50 million, the benefit-cost ratio informs us that the projects selected will be 6, 1, 5 and 7, with a total cost of $46 million and total net present value of $82 million. If we were to restrict ourselves to the first cost and net present value of the projects and ignore the benefit-cost ratio column, we would not have been able to select the projects to be built under the budget constraint without a programming solution. For example, we would have selected projects 1 and 3 with a total net present value of $80 million, which is less than the $82 million that we obtained by using benefit-cost ratio ranking. Thus, we see that in order to maximize the total net present value over several independent projects subject to a budget constraint, the rule is to adopt projects based on the

benefit-cost ratio ranking.[25]

INTERNAL RATE OF RETURN (IRR)

The internal rate of return is defined as the rate of discount which makes net present value equal to zero. This means that to find the IRR for an investment project lasting for t years, we must solve for IRR in the following ways:

$$NPV = C_0 + \frac{C_1}{(1+IRR)^1} + \frac{C_2}{(1+IRR)^2} + \ldots\ldots + \frac{C_t}{(1+IRR)^t} = 0$$

The IRR usually must be found by trial and error or by a computer search technique. For example;

	Year 0	Year 1	Year 2
Cash flow	-$400	$200	$400

If discount rate = 0

$$NPV = -400 + \frac{200}{(1.0)^1} + \frac{400}{(1.0)^2} = \$200$$

If discount rate = 30%

$$NPV = -400 + \frac{200}{(1.3)^1} + \frac{400}{(1.3)^2} = -\$9.47$$

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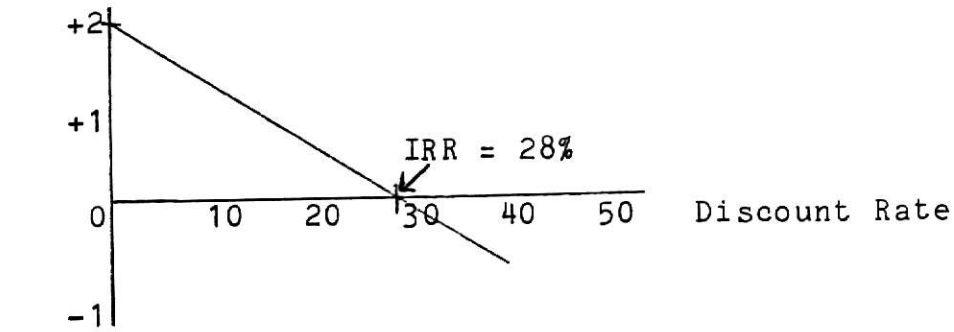
25. Reference from Brealey and Myers. Principles of Corporate Finance. 1981.

Figure 3

Derivation of an Internal Rate of Return



At a discount rate of 0, NPV is positive, thus, we know that discount rate must be greater than zero. At a discount rate of 30 percent, NPV is negative, the IRR must be less than 30 percent. Through trial and error, we will get a desired discount rate which gives NPV of zero. In this case it is 28 percent. (see Figure 3)

After calculating IRR, the analyst would then compare it with a predetermined level of social discount rate to determine the acceptability of the project. Let d = predetermined social discount rate.

If IRR > d, accept the project

If IRR < d, reject the project

IRR has long been used as a project acceptance criterion. This method is familiar to many businessmen and administrators because it is easy to use.

Advantages:

1. This method does not require the prior determination of a

discount rate. Therefore, if the project analyst has several different projects to be surveyed, he may independently calculate the IRR on each, and use the resulting figures as a basis of comparison.

Though IRR can be a handy measure, it can be very misleading too if it is not used with caution. Some of the disadvantages are as follows.

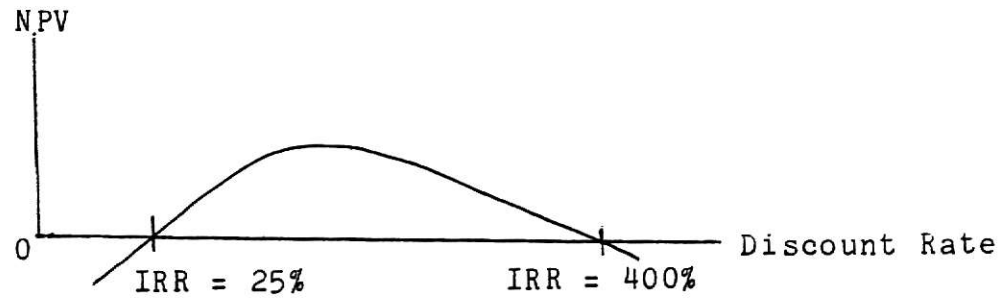
Disadvantages

1. There may be a problem of multiple IRR in some projects; that is, the net present value of a project may become zero at more than one discount rate. For example, an investment project for which there are abandoment costs.

Cash flows ($)	Year 0	Year 1	Year 2	IRR (%)
Project A	-4,000	+25,000	-25,000	25 and 400

Figure 4

Multiple Internal Rates of Return



From the above figure, as the discount rate increases, NPV initially rises and then declines.

2. Objections have also been raised about this criterion because of the implicit assumption that it makes about the reinvestment rate of funds generated during the life of the investment

project. For example, it implicitly assumes that $25,000 cash inflows during the first year can be reinvested, at for example, 25 percent rate per year over the remaining two years of the project and similar conditions hold for the cash inflows during the succeeding years in the project life. This assumption is unrealistic because it does not relate to the current opportunity cost of capital.

3. Sometimes, the project analyst has to choose among several alternative ways of doing the same job or of using the same facility, that is, they need to choose from among mutually exclusive projects. Under these circumstances, the IRR method can be misleading too. For example,

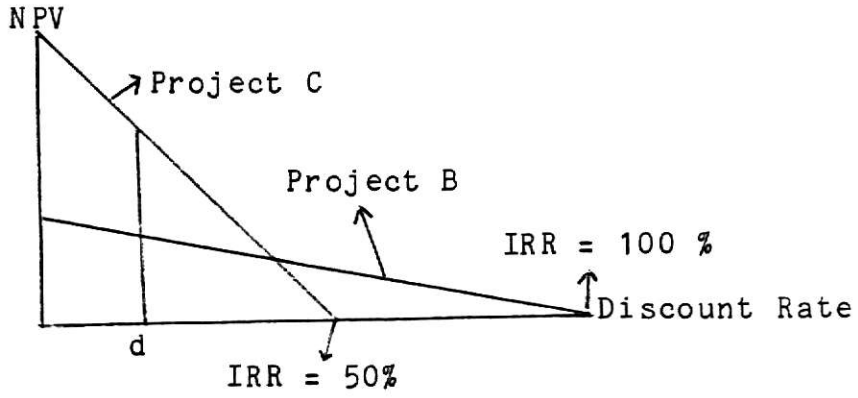
Cash flows ($)	Year 0	Year 1	IRR (%)	NPV at 10%
Project B	-100	+200	100	82
Project C	-10,000	+15,000	50	3836

From the above example, both project B and C are good projects but project C has higher NPV, therefore, it is considered a better choice. However, in the IRR method, project B will be chosen as it has higher IRR. Thus, this will be misleading when project B is chosen because it has higher IRR instead of the gain in NPV in project C.

Thus, the IRR and NPV can lead to different conclusions regarding the desirability of two projects. Conflict arises when the rule of choosing all projects satisfying either of these criteria cannot be followed.

Figure 5

Conflict Between NPV and IRR



In the above figure, we notice that the higher the discount rate, the lower the NPV. If d is selected discount rate for calculation, project C is superior to project B using the NPV criterion.

As for IRR criterion, the discount rate that makes NPV equal to zero is 100 percent for project B and 50 percent for Project C. Thus, it indicates that project B is superior to project C. Thus, a conflicting answer arises regarding the selection of projects.

4. Problems arise with the IRR method when the term structure of the interest rate (discount rate) is taken into account. The IRR rule tells us to accept a project if the IRR is greater than the opportunity cost of capital. But what do we do when we have several opportunity costs due to short term and long term interest rate?

These two criteria, pay-back period and cut-cff period, can be used for public projects when resources are not available for the thorough analysis required for the net present value, benefit-cost ratio, and internal rate of return. However, the pay-back and cut-off criterion are more often used in the private sector than in the public sector.

PAY-BACK PERIOD

The pay-back period is defined as the number of years required for the earnings from the investment to equal to the cost of investment with no interest. In this method, the project which recovers its costs in the shortest period of time is the best.

Table 8. Pay-back Period For Project A, B and C

Project	Expenditures	Pay-back period			
		1	2	3	4
A	-$1,200	$1,300	$ 0	$ 0	$ 0
B	-1,000	200	300	500	300
C	-700	700	100	0	500

From the above example, clearly project A should be ranked first since its pay-back period is less than a year. For project B, it has to take three years to recover its costs. Project C requires a year to recover its costs.

The advantage of this method is that it is simple to use and calculate. It also measures the liquidity of a project. Since the pay-back period measures the time required to recover the

initial investment in the project, it provides an indication of the relative desirability of projects with respect to liquidity considerations.

The disadvantage is that this method completely ignores all earnings beyond the pay-back period and thus, may result in choosing a short life project rather than one that offers good returns over a long period of time. For example, project C.

CUT-OFF PERIOD

In this method, a specified time in the future is chosen. A project is acceptable only if it will cover all its costs by that time. However. one must remember that this method tends to discriminate against projects with benefits that occur some time after the decision date. Thus, this method is not suitable for the evaluation of public projects which will not be able to earn its benefits quickly, furthermore, there is no good basis for choosing a time period.

ANNUAL EQUIVALENT CASH FLOW[26]

In cases for which net present value is positive or for which the benefit-cost ratio exceeds 1.0 for all technical alternatives, the analyst may wish to consider cost-effectiveness

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26. This approach is taken from Brealey, Richard and Meyers, Steward. Principles of Corporate Finance., 1981, p. 96-98.

analysis to select the techniques which provide the greatest pay off per resource dollar or seek the least cost means of achieving a given output. In this approach we have to make two important assumptions.

1. The machines to be compared have identical capacity and produce the same benefits.
2. There is a replacement cycle in the analysis. That is, each machine is always replaced in the last year of its life with identical equipment.

Suppose that there are two machines, machine X and machine Y. Machine X costs $20,000 and will last for three years. It costs $5,000 per year to operate. Machine Y cost only $15,000, but it will last only two years, and costs $6,000 per year to operate. As the machines have same benefits, that is, they produce the same output, the only method to choose between is on the basis of cost. Assume discount rate is 10 rercent, the present value of cost for machine X and Y are shown in the example below.

	Cash Flow (in thousands of dollar)				
	Year				
Machine	0	1	2	3	Present value of cost
X	-20	-5	-5	-5	32.43
Y	-15	-6	-6		25.41

From the example above, though machine Y has a lower present value of cost, at this stage we cannot simply make our decision and choose machine Y. This is because machine Y will have to be

replaced a year earlier than machine X. We have to consider the replacement cycle for both machine to make a right choice of the machine.

	Cash Flow (in thousands of dollar)							
				Year				
Machine	0	1	2	3	4	5	6	Present value of cost
X	-20	-5	-5	-25	-5	-5	-5	56.79
Y	-15	-6	-21	-6	-21	-6	-6	63.75

From the table above, we can see that by year 6, the owner of machine X wears out the second machine and the owner of machine Y wears out the third. Looking at the replacement cycle of the two machine, it is obvious that machine X would has a lower present value of cost and thus, it should be selected.

There is an easier way to solve the problem of unequal lives amoung projects by calculating its equivalent annual cost. Equivalent annual cost is equal to the present value of cost divided by the annuity factor. (see Appendix B)

Machine X

$$\frac{-32.43}{\text{Annuity Factor}}$$

$$\frac{-32.43}{2.487} = -13.03$$

Machine Y

$$\frac{-25.41}{\text{Annuity Factor}}$$

$$\frac{-25.41}{1.736} = -14.63$$

Table 9. Annual Equivalent Cash Flow

g	Cash Flow (thousands of dollar) Year				
Machine	0	1	2	3	Present value of cost
X	-20	-5	-5	-5	32.43
Annuity		-13.03	-13.03	-13.03	32.43
Y	-15	-6	-6		25.41
Annuity		-14.63	-14.63		25.41

The rule for comparing machine of different live is, therefore, to select the machine that has the lowest equivalent annual cost, that is, machine X.

PUBLIC SECTOR ANALYSIS VERSUS PRIVATE SECTOR ANALYSIS[27]

1. For the public sector, the main objective to increase the returns and social welfare of the society as a whole, whereas, the private sector would aim at achieving the greatest return for private entity or firm.
2. In public sector analysis, certain prices may be changed to better reflect real social costs and benefits. The adjusted prices are known as shadow prices. In private sector analysis, market prices are always used.
3. Taxes and subsidies are treated as transfer payment in public

27. Refer to Gittinger, J.Price., Economic Analysis of Agriculture Project., 1982, p.16-21.

sector analysis, but in private sector analysis, taxes are treated as costs and subsidies are treated as benefits of the firms.

4. In public sector analysis, interest on capital is not separated and deducted from the gross return because it is considered part of the total return to capital available to the society as a whole. However, in private sector analysis, interest paid to the lender must be deducted from its benefit stream.

5. A private project analysis does not tell us anything about income distribution, but in public project analysis, income distribution effects may be taken into account.

6. In the public sector, a social discount rate is normally used to discount future benefits or costs into the present value, but in the private sector, normally, the interest rate which appears in the market is used for discounting the benefits and costs of a project.

CHAPTER VI

RISK AND UNCERTAINTY

Risk refers to a situation in which information about the probability of an outcome's occurence is available, whereas uncertainty exists when the probability distribution of future events is completely unknown. The probability of an event is the percentage chance of a particular outcome. Normally, the effects of an investment project can be realised only after some period of time. Thus, in project analysis, one cannot escape the problem of risk and uncertainty . The important question is how risk and uncertainty are to be taken into account in the project selections.

There are some methods to deal with risk and uncertainty.[28] Below are some of the main techniques.

1. Expected Value Approach

   In this approach, risk is explicitly put into consideration in the analysis to treat the estimated benefits and costs as random variables that can be described by some probability distribution. Expected value, which is a weighted average of the alternative outcome, will then be calculated. To illustrate this point, take an example to estimate the expected

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28. Sources from Anderson, Lee G. and Settle, Russeil F. Cost-Benefit Analysis: A Practical Guide., 1977.

value of benefits. Suppose that the historical record of the analysis suggested that the discounted benefits from a flood control project will range from zero (if no flood occurs) to $100 billion (if worst possible flood occurs). Let b be billion. With the four possible outcomes along with the probability that will occur, the discounted value will be as follows:

Discounted Benefits (Billion)	Probability of Occurance
$0	0.3
$30	0.4
$50	0.2
$100	0.1

Expected value of benefits E(B) = ($0 X 0.3) + ($30b X 0.4)
+($50b X 0.2) + ($100b X 0.1)
= $32b

As each estimated annual benefit and cost is a random variable, an appropriate discounting procedure is needed to translate expected future benefits E(B), and cost E(C) into an expected present value, E(PV).

$$E(\text{PV of benefits}) = \frac{E(B0)}{(1+r)^0} + \frac{E(B1)}{(1+r)^1} + \frac{E(B2)}{(1+r)^2} + \cdots + \frac{E(Bn)}{(1+r)^n}$$

Where $E(Bi)$ is the expected value of the benefits for the i^{th} year.

2. Best Guesses

To deal with uncertainty for which there is no probability distribution, estimation of occurence with "best guesses" must be made. This estimate can be made from the analyst's past experience or from a careful study. The range of estimates can be in the form of specified level, such as pessimistic, most likely or optimistic.

3. Cut-off period

One approach to deal with risk and uncertainty is to have a certain cut-off period. This strategy would help to adopt only those projects which could cover the costs incurred by the project prior to the cut-off period . In this way, risk and uncertainty can be handled with caution.

4. Discount rate adjustments

Another approach involves arbitrary adjustments to the discount rate. In this approach, normally, adjustments are made to increase the rate used to discount benefits and to decrease the rate used to discount costs. Thus, it tends to reduce the magnitude of discounted benefits while increasing that of discounted costs. As a result, it tends to result in fewer projects being adopted because of risk and uncertainty.[29]

5. Game theory: Maximin strategy

Sometimes, game theory techniques are very useful in evaluating alternative public sector projects, especially when there

29. Sources from Anderson and Settle, Benefit-Cost Analysis: A Practical Guide., 1977, p. 92-100.

is no reliable information about probability distribution. Maximin strategy refers to maximizing the minimum. This approach implicitly assumes that the worst possible outcome always occurs. It also assumes that if flooding does not occur, there may be other kinds of benefit, such as irrigation and fishing. To illustrate this technique, assume that the analyst is evaluating three mutually exclusive and equal-costs flood control projects (A, B and C). Let m be million, the expected benefit of those three projects can be described as follows:

	Expected Benefit of Project		
	A	B	C
Severe flooding	$100m	$120m	$150m
No flooding	$30m	$60m	$20m

The maximin strategy indicates that project B is preferable to project A and C because project B provides a minimum expected benefit of $60m compared to $30m and $20m for project A and C, respectively. However, in some instances, this maximin criterion will lead to the rejection of the more preferable projects. For example:

	Expected Benefit of Project		
	A	B	C
Severe flooding	$700m	$150m	$800m
No flooding	$49m	$50m	$48m

Using maximin criterion, project B will still be selected

as it has the highest expected benefit ($50m) though it is now certainly inferior to either project A or C because the opportunity cost of not selecting other project, would be very high if flooding does occur.

5. Game theory: Minimax-Regret

Minimax-regret approach refer to minimizing regret or loss that might occur. This approach can be explained more clearly using the example above. Suppose that severe flooding does occur, project C would have provided the highest expected benefit ($800m). If project A has been taken rather than project C, the foregone benefits from not undertaking project C would be $100m and if project B is undertaken instead of project C, the foregone benefits would be $650m. However, if no flooding occurs, project B would provide the highest expected benefit, that is $50m. If projects A or C are selected, the foregone benefits from not undertaking project B is indicated in the bottom row of the following table.

	Least-Regret matrix		
	A	B	C
Severe flooding	$100m	$650m	$0m
No flooding	$1m	$0m	$2m

From the above, it can thus be concluded that selection of project A might cause a foregone benefit of $100m, selection of project B would cause a potential loss of $650m, whereas selection of project C involves a maximum regret of $2m only.

Thus, the minimax-regret strategy would lead the analyst to select project C.

6. Sensitivity Analysis

Another approach to handling risk and uncertainty is sensitivity analysis. Sensitivity analysis can be used to examine how the project's net benefits, such as net present value, vary with changes in one of the variables in an analysis, especially those in which uncertainty in value exists. For instance, the decision maker may want to know the effect of changes in the discount rate on the net present value. The analyst can calculate net present value for the project at a low, medium, and high discount rate.

The analyst can have far more confidence in predicting that some variables will fall within a certain range (For example, between $10 billion to $100 billion) than in predicting a precise value for that variable. The analyst can also recalculate the benefit-cost ratios or net present value for some alternative value (For example, upper and lower bound estimates of the variable) when there is some uncertainty about the reliability of an estimated benefit or cost. Sensitivity analysis helps to provide a better understanding of the critical elements on which the outcome of the project depends. In other words, it helps the analyst to focus attention on the variables for which a further effort should be made to firm up the estimates and narrow down the range of uncertainty. If the

sensitivity analysis reveals that even relatively large changes in a particular estimate do not alter the general outcome of the study, the fact that some risk or uncertainty may surround that estimate is unimportant.

CHAPTER VII

EXAMPLE OF A COST-BENEFIT ANALYSIS

PERFORMING A MANPOWER TRAINING PROGRAM

Society undertakes manpower training programs in order to achieve a wide range of economic and non-economic objectives. The main economic objective is to increase the aggregate production of the nation. If training is successful, it will at least increase the annual national output for one or more years. Social economic benefit is obtained if there is an increase in annual product attainable from training. Furthermore, training activities use up resources which otherwise will be used to produce other goods and services. Thus, one can define the social economic costs of training as the value of the output which could have been produced with the resources actually employed in training.[30]

To an individual, a training program may enable him to achieve some objectives too, such as an improvement in his disposable income, fringe benefits, welfare payments and etc.

Whether disposable income is raised by training is important as a guide not only to the individual who is thinking of enrolling in the class, but also to the society as a whole, in seeking either to increase the disposable income of persons in low income

30. The source for this example was from The Economic Benefits and Costs of Retraining by Hardin and Borus.

groups or to expand the output of the nation. An Increase in national product will be attained only if the individual trainees are rewarded for their training program by means of economic improvements.

Generally, manpower programs may be established to achieve several objectives.

1. Increase the efficiency with which the unemployed become employed.
2. Raising the average skill level of the labor force.
3. Supplying skilled persons in areas and jobs where there are labor shortages.
4. Increase price stability.
5. Achieve a more equitable distribution of income and reducing poverty.

If the program is successful in achieving any of these objectives, then the earning of the trainee increases as a result of training. Poverty is reduced when the trained poor get jobs; skilled labor shortages are reduced when individuals are trained in those skills. However, participation in a training program may lead to losses in disposable income during the class. This depends on whether there are training allowances for him. Training carried out and financed by government agencies will directly affect the outlay of government on resources during training, and it may alter the amount of transfer payments both during and after the training. Finally, by altering the level of taxable earning, it may change the amount of taxes collected

during and after the training.

DETAILED ESTIMATES IN MEASURING ITS COSTS AND BENEFITS[31]

In order to prepare estimates of the effects of training upon national income, disposable income and government budget, a series of detailed estimates such as those which follow is required:

1. Improvement in earning from the year before the training to the year after the training has completed.
2. Unemployment benefits in the year after the training.
3. Welfare payments to the individual in the year after the training.
4. Income during the participation of the training program.
5. Expenses during the training program.
6. Transfer payments including unemployment benefits, welfare payment, and training allowances during the training period.
7. Cost of instruction and administration for the government agency.
8. Tax receipts of the governments in the year before and after the training program.

The above estimates are useful in calculating the economic benefits and costs of a training program conducted by the

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31. Hardin, Einar. and Borus, Michael E. The Economic Benefits and Costs of Retraining., 1971, p.17.

government agencies. The benefits and costs of the training program to society, individual and government can be discussed as follows.

COMPONENTS OF THE COSTS AND BENEFITS IN MANPOWER TRAINING PROGRAM[32]

Society

Costs

1. Opportunity costs
2. Operating costs of the training program
3. Induced reductions in income of workers displaced by program participants (displacement effects)

Benefits

1. Improved income of program participants
2. Increase in the productivity of the future generations
3. Reduction in administrative expenses of transfer payments (For example, unemployment and welfare program)
4. Reduced costs to society due to bad citizenship

32. These benefits and costs of manpower training program are taken from the survey done by Barsby, Steve L. Refer to his book for more detail.

Individual

Costs

1. Opportunity costs
2. Loss of income during the training period
3. Costs related to program participation. (For example, fees and books)

Benefits

1. Increase in income
2. Additional fringe benefits due to increased income

Government

Costs

1. Costs of instruction and administration
2. Additional subsidies paid during training

Benefits

1. Increase in tax revenue through an increase in tax base
2. Decrease in expenses of transfer payment programs and crime control administration

From the above, we can see that the list of costs and benefits are not identical for each of them. Society benefits from the training program to the extent that total income is increased, fewer resources have to be utilized in administration of government transfer payment programs, and to the extent that the costs of crime are reduced. Individuals who have benefited from the training program and pay the resulting taxes do not

benefit directly from them. They must be subtracted from increased earnings when private benefits are calculated. The government also does not gain the full benefits from increased earnings, but only from the increases in tax revenue which is stimulated by increased earnings of the training participants. Anyhow, government will have their budget situation improved because of the reduction in transfer payment programs and crime control costs. Looking at the three lists of benefits, society seems to have the greatest amount of benefits from a manpower training program. However, this does not mean that society may achieve the greatest net benefits because the costs of the training program has to included in the calculation. This depends on who pays for the program. For a government program, normally, the government and society would be the ones who bear more program costs than the individual.

Normally, the benefits from a training program always persist for a number of years and so does the cost. Thus, to make comparisons between benefits and costs, an appropriate discount rate should be made to discount all the future benefits and costs into a present value. The following is an example of how those benefits and costs are compared. To make the comparison easier, assume that the costs are incurred only during the training year of the program, that is year 0.

Table 10. Net Value of A Manpower Training Program

	Year					
	0	1	2	3	4	5
Costs($)						
Costs of instruction	5,000					
Costs of administration	2,000					
Opportunity cost	800					
Subsidies from government	400					
Other costs	3,000					
Total costs($)	11,200					
Benefits($)						
After tax earning		1,500	2,500	3,500	4,000	4,000
Fringe benefits		200	200	300	300	300
Reduction in crime		100	100	100	100	100
Tax collection		100	200	250	300	300
Other benefits		100	200	300	300	400
Total benefits($)		2,000	3,200	4,450	5,000	5,100
Net value($) =	-11,200	2,000	3,200	4,450	5,000	5,100

Assume social discount rate used is 8%

Net present value

$$NPV_{0.08} = -\$11,200 + \$2000(0.926) + \$3200(0.857) + \$4450(0.794) + \$5000(0.735) + \$5100(0.681)$$

$$= -\$11,200 + \$1,852 + \$2,742.4 + \$3,533.3 + \$3,675 + \$3,473.1$$

$$= \$4,075.8$$

Benefit-cost ratio

$$\frac{\$1,852 + \$2,742.4 + \$3,533.3 + \$3,675 + \$3,473.1}{\$11,200}$$

$$= 1.36$$

Internal rate of return

$$NPV_{0.18} = \$11,200 + \$2,000(0.847) + \$3,200(0.718) + \$4450(0.609) + \$5,000(0.516) + \$5100(0.437)$$

$$= +\$310.4$$

$$NPV_{0.20} = \$11,20\ 0 + \$2,000(0.833) + \$3,200(0.694) + \$4,450(0.579) + \$5,000(0.482) + \$5,100(0.402)$$

$$= -\$276.4$$

Thus, internal rate of return for the program is approximately 19%.

Pay-back period

	Year			
0	1	2	3	4
Net value 11,200	$2,000	$3,200	$4,450	$5,000

In Conclusion:

Pay-back period = approximately 3.5 years

Net present value ($) = $4,075.8

Internal rate of return (%) = approximately 19%

Benefit-cost ratio = 1.36

Thus, from the above calculation, it can be concluded that this training program is worthwhile. It has high net present value, high internal rate of return, benefit-cost ratio of greater than unity, and the pay back period of approximately 3.5 years only. In the above example, we assumed that the service life of the program is five years only for simplicity. In reality, the benefits obtained from the manpower training last for a longer period than that.

PROBLEMS ENCOUNTERED IN ESTIMATING ITS COSTS AND BENEFITS[33]

Problems encountered in estimating costs

1. Accounting cost

   The most obvious problem in determination of the costs of a manpower training program is lack of good accounting data. For example, how much in additional subsidies does the government have to pay if the training period is extended by one month? One of the reasons for this may be because all levels of

33. Barsby, Steve L. Cost-Benefit Analysis and Manpower Program. 1972, P. 13-19.

government have been slow to adopt accounting practices that permit cost calculation for this program.

2. Joint costs

A "Joint cost" problem arises when a given expenditure serves more than one activity either simultaneously or in sequence [3, 1972, p.14]. The problem in this situation is to decide what portions of those costs to allocate to various activities. For instance, computer machines bought for use in the manpower training program are often used by students from other departments. The cost should be allocated to different uses by identifying the opportunity cost involved. For example, if the machine was not being used by those students, it would be available to someone else who might rent it. However, there is no right way to decide this cost. It depends on how a decision maker sees it.

3. Opportunity costs

The determination of opportunity costs also raises some problems. In a manpower training program, opportunity costs generally consist of earnings the participants of some program gave up in order to participate. There is no direct way to measure this loss, but it may be estimated as the participant's earning prior to their enrolling into the program. The loss of earnings may be measured by the use of control groups with the same characteristics as the participant except for participation in the program. One of the most serious and unsolved

problems in calculating opportunity costs is to find a means of estimating the "vacuum effect." This effect means the number of jobs vacated by program participants that were filled by workers who otherwise would have been unemployed. If this effect operates, opportunity costs for society are considered to be reduced. However, in doing a benefit-cost analysis for a manpower training program, "vacuum effect" generally is assumed to be zero [3, 1972], partly because of the difficulties involved in measuring it.

Problems encountered in estimating benefits

1. Control groups

   Difficulties are involved when an analyst tries to show that the improvements experienced by training program participants in earnings and employment are a result of participation in the program and not from other causes, such as changes in economic condition. An analyst for a manpower training program would normally use one or more separate control groups in order to isolate a program's effect on its participants.

   However, to get an appropriate control group is difficult. The control group has to be picked at random from persons who had applied and qualified for the program. Furthermore, size of the control group is also important. Normally, large control groups are not easy to select at random.

2. Lack of data

Benefits from manpower training are not easy to calculate because there is a lack of good data for measuring benefits like reduction in crime and increase in productivity. Thus, normally only earnings of program participants are included in the analysis; other indirect benefits which cannot be quantified have to be given an estimated value.

CHAPTER VIII

CONCLUSION

SUMMARY AND ROLE OF COST-BENEFIT ANALYSIS IN DECISION MAKING

Despite the problems stated earlier and on the above, cost-benefit analysis is still considered the most common and useful way in the evaluation of a project. It plays an important role in the decision making process. Below are some of the important roles play by an cost-benefit analysis.[34]

1. Cost-benefit analysis can help decision makers make difficult resource allocations to increase the well being of the society as a whole.
2. Cost-benefit analysis can help decision makers to establish project priorities, choose the most desirable project, and cancel out the least desirable alternatives. In this way, it can help to increase efficiency in the economy.
3. If being used properly and carefully, cost-benefit analysis could display explicitly the rationale for decision. This could elevate the level of public discussion and increase the usefulness of public participation in government decisions.

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34. Swartzman, Daniel; Richard A. Liroff and Kelvin G. Croke. Cost-Benegit Analysis and Environmental Regulation: Politics, Ethics, and Methods., 1982.

4. By highlighting the limits of data, cost-benefit analysis can indicate the extent of our ignorance and the level of uncertainty involved in a decision. This would allow the public to evaluate the decision and point out areas for future research.

To play such an important role in the decision making process, program objectives must first be set by the decision maker. Then alternative means of achieving those objectives must be specified, bearing in mind the constraints of the projects. For example, technological, financial, political, legal and other constraints which may limit the choice of certain alternatives must be considered. The program alternatives are then compared by considering all direct and indirect benefits and costs, whether they are tangible or intangible, real or pecuniary. As cost and benefits always occur over a time horizon, those costs and benefits must be discounted into a present value using an appropriate discount rate. Finally, the program which is considered more beneficial to society as a whole by yielding the stated objectives will be selected.

APPENDIX A

The Present Value of $1 for Selected Discount Rates and Time Periods

	Discount Rate									
Year	1%	3%	5%	8%	10%	15%	18%	20%	25%	30%
1	.990	.971	.952	.926	.909	.870	.847	.833	.800	.769
2	.980	.943	.907	.857	.826	.756	.718	.694	.640	.592
3	.971	.915	.864	.794	.751	.658	.609	.579	.512	.455
4	.961	.889	.823	.735	.683	.572	.516	.482	.410	.350
5	.951	.863	.784	.681	.621	.497	.437	.402	.328	.269
10	.905	.744	.614	.463	.386	.247	.191	.162	.107	.073
15	.861	.642	.481	.315	.239	.123	.084	.065	.035	.020
20	.820	.554	.377	.215	.149	.061	.037	.026	.012	.005
25	.780	.478	.295	.146	.092	.030	.016	.010	.004	.001
30	.742	.412	.231	.099	.057	.015	.007	.004	.001	
40	.672	.307	.142	.046	.022	.004	.001	.001		
50	.608	.228	.087	.021	.009	.001	.001			

APPENDIX B

The Present Value of $1 Per Period for Selected Discount Rate and Time Periods (annuity)

	Discount Rate								
Year	1%	3%	5%	8%	10%	15%	18%	20%	25%
1	0.990	0.971	0.952	0.926	0.909	0.870	0.847	0.833	0.800
2	1.970	1.913	1.859	1.783	1.736	1.626	1.566	1.528	1.440
3	2.941	2.829	2.723	2.577	2.487	2.283	2.174	2.106	1.952
4	3.902	3.717	3.546	3.312	3.170	2.855	2.690	2.589	2.362
5	4.854	4.580	4.329	3.993	3.791	3.352	3.127	2.991	2.689
10	9.471	8.530	7.722	6.710	6.145	5.019	4.494	4.192	3.571
15	13.865	11.938	10.380	8.559	7.606	5.847	5.092	4.675	3.859
20	18.046	14.877	12.462	9.818	8.514	6.259	5.353	4.870	3.954
25	22.023	17.413	14.094	10.675	9.077	6.464	5.467	4.948	3.985
30	25.808	19.600	15.373	11.258	9.427	6.566	5.517	4.979	3.995
40	32.835	23.116	17.159	11.925	9.779	6.642	5.548	4.997	3.999
50	39.196	25.732	18.256	12.234	9.915	6.661	5.552	4.999	4.000

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THE USE OF COST-BENEFIT ANALYSIS IN PROJECT EVALUATION

by

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ABSTRACT

The notion of cost-benefit analysis first appeared in France in an 1844 essay by Jules Dupuit. In this century, it has been widely used in evaluating public projects. It is one of the ways a government encourages efficient allocation of scare resources.

Welfare economics is the branch of economics that formulates the criteria to distinguish between projects that would make society better off and those that make it worse off. Cost-benefit analysis is considered applied welfare economics.

There are six stages in a project cycle. These are preparatory study, feasibility study, enumeration stage, economic analysis, implementation and evaluation stages. A project may result in a number of effects which can be divided into two main categories, that is, direct and indirect effects. Both direct and indirect effects can then be divided into real or pecuniary, tangible or intangible components. There are also inside and outside effects.

Before a project cost-benefit analysis is carried out, the analyst must consider some of the important constraints on projects and include only those projects which are feasible. Constraints include technical, financial, legal, distribution, social, political, and administrative constraints.

A shadow price is often used in the valuation of benefits and costs in cost-benefit analysis as the market price does not reflect the real social value or cost of a project, especially

when there are market imperfections in the economy. After assigning a dollar value to benefits and costs, an appropriate discount rate must be used to discount the future benefits and costs into a present value. There are some controversies arising today among economists regarding the choice of the discount rate. Risk and uncertainty must also be taken into consideration when performing a certain projects. Finally, costs and benefits may be compared using some criteria, such as net present value, benefit-cost ratio, internal rate of return, pay back period, cut-off period, and annual equivalent cash flow.

A manpower training program provides a simple example of the implementation stage of a cost-benefit analysis. The example indicates how specific problems may be encountered in the estimation of the project's benefits and costs: for example, obtaining control groups, lack of data, estimating accounting costs, joint costs, and opportunity costs. Despite the problems which may arise in cost-benefit analysis, it nevertheless plays an important role in public decision making.