CHAPTER 1

COST-BENEFIT ANALYSIS: THEORY, PRACTICE AND LIMITATIONS

Cost-benefit analysis is a technique applied for assessing the desirability of projects. It implies the enumeration and evaluation of all costs and benefits associated with the project. The technique is applied for selecting a particular project out of a number of projects. In most cost-benefit analyses the aim is to maximise the present value of all benefits less that of costs, subject to specified constraints.

After the second World war the popularity of cost-benefit analysis has increased in both developed and developing countries. This technique is now widely used in public projects, private projects in order to measure the social benefits of the projects.

1.1 Origin of the Concept

The idea of cost-benefit analysis has come into prominence only in recent years, but it has a long history. The idea of cost-benefit analysis can be traced back to Dupuit's classic paper on "Measurement of public utility works" in France in 1844. At the beginning of this century cost-benefit analysis originated in USA as an administrative tool for water resource development projects. The flood control act of 1936 in USA defined cost-benefit
analysis as a "Principle of comparing benefits to whomsoever they may accrue with the estimated cost". The practice of making analysis then spread to other agencies of water development projects - the purpose was not only to justify the projects but also to decide who should pay.

In 1950 an inter-agency committee produced the "Green Book" which attempted to introduce uniformity in the standard of cost-benefit analysis in an explicit manner. Interest among economists in this technique has grown due to growth of large investment projects. Before the second world war this technique was used only in water resource projects. But after the war its application was extended to other fields of investment such as transport, research and development, large industrial projects and human resource development projects e.g., health, education and other public programmes.

1.2 The Concept

Investment decisions involve some sort of planning which takes into consideration probable returns from the projects. In private sector profitability dominates the selection of projects. But in public sector social benefit

is the dominating factor. In the field of health, education, communication supply of free service or underpricing is justified from the social point of view. The principle of marginal cost-pricing cannot be followed in these cases. Free schooling upto a certain level, low pricing of post-card etc. have been taken for granted. The costs on these accounts are to be justified on social consideration.

Cost-benefit analysis is often adopted to justify public investment of the type in which charging is not possible or in which project decisions are not to be guided solely by the prospect of financial return. Pearce defines cost-benefit analysis as "A technique to evaluate social projects" (1971). The technique can be used easily in projects with measurable returns, it is often used in cases where imputed returns are calculated to ascertain social benefit.

The cost-benefit analysis tries to provide an answer to such questions: should a new industry be established? Should higher education be encouraged in developing countries? And the like. In cost-benefit analysis the benefits and costs of the projects are estimated - at the time of estimation account of time-factor, relevant constraints, risk and uncertainty are considered. Then it is compared with some agreed investment criteria. If the benefits exceed the costs, the project is accepted; if not, the project is rejected.
The general nature of cost-benefit analysis, according to Haveman (1970 : 156), is described in following words - "It is a tool of decision-maker, the function is to generate information on the economic effects of alternative public expenditure decisions and to assist the decision-maker in his search for the set of alternatives that generates the greatest net benefit".

The following steps are necessary in cost-benefit analysis:

(1) Identification, enumeration, measurement and pricing of various relevant benefits and costs and effects of a project.

(2) Discounting these benefits and costs back to present value with social rate of discount.

(3) Adjustment for risk and uncertainty.

(4) Evaluation of the project with some suitable investment criteria incorporating all relevant constraints.

On the basis of these evaluations public authority can select that project which is desirable both from economic and social points of view.

1.3 Estimation of Benefits

Estimation of benefits normally presupposes the possibility of quantitative assessment of the flow of
returns from investment. Technique of assessment may vary from case to case.

Benefits are broadly divided into two categories, viz., direct and indirect. Again direct and indirect benefits can be divided into pecuniary and non-pecuniary, tangible and intangible etc. The direct benefit can be defined as the immediate effect of the project. It is the sum total of the value of immediate products and services for which project costs are incurred. Indirect benefits are all other benefits associated in some way or other with the project. For example, suppose a new road has been constructed - it has increased the mobility of commodities and men. Reduction in cost of mobility, savings in travel time etc. are instances of direct benefits. Now traffic facilities are expected to increase market potential. As a result production of new commercial crops may be encouraged in near future provided all other conditions are favourable; it will not depend on road facility alone. The construction of road expedites the process. This is the indirect benefit of the project. New roads often connect backward areas with progressive areas thereby making possible cultural advancement of the former. This is an intangible benefit of the project. For analytical purposes we should take into consideration all the benefits associated with the project, but in formulating quantitative criterion it is better to restrict the analysis to the estimation of direct benefits only. Indirect benefits
are not brought independently by the project - so it is
difficult to assign the share of the particular project in
the final outcome. Intangible benefits cannot be quantified.

Multiple return: A series of uses may flow from a single
project. Multipurpose river valley project is a case of
this type. The main objective of such a project is to
provide irrigation facilities to increase agricultural
output. It also reduces the danger of flood. Generation of
electricity is possible from stored water in dams. Canals
excavated for irrigation purpose are often navigable. They
also provide facilities for fishing. So all these benefits
should be taken into consideration and assessed separately.
In the final analysis the sum total of all the benefits
should be incorporated.

Externalities: We now come to the wide class of benefits
which accrue to bodies other than the one sponsoring the
project.

McKeen (1958) discusses the distinction between
technological and pecuniary spillovers. One example of the
first type is when construction of a reservoir by the
upstream authority of a river basin necessitates more
dredging by the downstream authority. An example of the
second type is when the improvement of a road leads to
greater profitability of garages and restaurants on that
road, employment of more labour by them, higher rent
payment to landlord etc.. In general this will not be an additional benefit to be credited to road investment. Any net difference in profitability and any net rise in rents and land values is simply a reflection of benefits of more journeys being undertaken than before and it would be double counting if these were included too. In other words, we have to eliminate the purely transfer items from cost-benefit evaluation; we are concerned with the value of increment of output arising from a given investment and not with the increment in value of existing assets. Prest and Turvey (1965 : 688) state the matter in the following way: "The essential points are that progenitors of public investment projects should take into account the external effects of their actions in so far as they alter the physical production possibilities of other producers or the satisfactions that consumer can get from given resources; they should not take side-effects into account if sole effect is via prices of products or factors".  

Joint effect: Another difficulty arises if the ultimate effect is the result of a number of activities taken up simultaneously. Let us suppose that a high yielding variety (HYV) of seeds has been planted on a particular plot of land to raise output. The success of the programme depends

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on irrigation facilities, application of fertilisers and appropriate climate. So to associate increase in output with the introduction of HYV seeds alone is an oversimplification of the issue. Thus benefits which are exclusively due to the effect of a particular activity are to be singled out. All improvements after introduction of an activity should not be ascribed to that activity alone.

**Intangibles**: Some benefits cannot be quantified and others, although they can be quantified, cannot be valued in any market sense. Such benefits have been called intangible benefits. If imputed values of intangibles are reliable they may be accepted; otherwise simple enumeration is better than any rough quantification.

**Collective goods**: Market prices cannot be used to value benefits which are not capable of being marketed. Thus we meet the collective goods issue $^{3}$ Samuelson (1954; ’55; ’58); Musgrave (1959); Head (1962). Some goods and services are of a collective nature in the sense that quantity supplied to any one member of the relevant group cannot be independently varied. For example, all members of the population benefit from defence expenditure, all ships in the vicinity get benefit from a lighthouse. Individuals may differ in their marginal valuation of a

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3. 'Cost-benefit analysis' - Edited by Layard.
given quantity of a commodity. Any attempt to get consumers reveal their preferences regarding collective goods collapses on the rock and the rational thing for the individual consumer to do is to understate his demand, in the expectation that he would be relieved of his share of cost without affecting the quantity obtained. Moreover there is no single best solution but rather a multiplicity of alternative optimum solutions. Where commodities are supplied at zero price or at non-market clearing prices, which bear no relationship to consumers’ preferences, there is no basis for arriving at investment decisions by computing the present value of sales. This problem applies to collective goods and other goods and services supplied free (or at nominal price) by government.

**Valuation of benefit**: Once physical returns are estimated the valuation problems arises. In the beginning the unit of measurement should be clearly defined so that price per unit can be easily assigned. Next, for the product which can be priced, the choice of price-level in terms of which calculation will be made is important. In benefit-cost analysis, it is often suggested that the prices that may be expected at the time of benefit-cost accrual should be accepted. But in case of project appraisal the main difficulty is how to arrive at the expected price-level. In case of 'before and after' the project the analysis
should not be in terms of two separate prices referring to two different time-periods. The calculations may be made in terms of constant prices.

Another problem arises in the treatment of indirect taxes and subsidies. From government point of view tax-receipts are benefits and if the people's ability to pay taxes increases because of the operation of the project, the benefit increases. But from the viewpoint of individual beneficiaries taxes are costs, not benefits. So from the point of view of a particular project output may be valued at factor-cost i.e., market price - indirect taxes and subsidies. This can be implemented when charging is possible. But in cases of projects where charging is not possible some values have to be imputed to the flow of benefits derived from the project.

1.4 Estimation of Costs

Like benefits costs also can be divided into direct costs and indirect costs. Direct cost of a project indicates the costs that are incurred for the implementation of the project. Indirect cost means the opportunity cost of producing one particular project, external diseconomies and unfavourable intangibles of the project. If the government is to make a choice between two different types of projects, say, a road project and an irrigation project - the
opportunity cost of the first is the sacrifice of irrigational facilities in the process and vice-versa. When a particular project is accepted the planner concentrates on the problem of deriving maximum advantage from the project. He is, therefore, more interested in the amount actually spent - the actual monetary cost is accepted with modification here and there.

The most crucial problem in cost-benefit analysis after identifying the relevant costs is to express them in monetary terms. Since there is imperfection in the market the market price fails to reflect the true social cost. That is why shadow prices are used in CBA. According to Dasgupta and Pearce (1972 : 97) "There is always a 'trade-off' between the two and it is the shadow price of the output which reflects these true costs". Shadow prices reflect the true social opportunity costs of using resources in a particular project.

There are several methods for the estimation of shadow prices. One method is through linear programming. The other method is to consider the relationship of prices observed in the market for similar items or market for same items in other countries. Sometimes it is derived by making adjustments in market prices.

On the cost-side there is a double problem, clearly
distinguished in Lerner's treatment of indivisibilities
(1944). First it is necessary to adjust prices of factors
so as to eliminate any rental elements which will be
measured by excesses over transfer earnings in their next
best alternative use. Second, one has an analogous problem
to the demand side. As more factors are used in any one
line of output, the price of alternative product, which it
might have been making, rises further and further. We are
faced with the problem of choice between valuation of
factors at original price (i.e. price ruling prior to
expansion of output of the commodity in question), the
ultimate price or some intermediate level. A price half-way
between the original and ultimate levels will meet the bill,
as on the demand side. Prest and Turvey have observed,
"The adjustments for indivisibilities on the cost side are
likely to be more complex than those on the benefit side".

In order to arrive at a measure of true economic cost,
various refinements are introduced in cost concept. Economic
cost differ from actual money cost when there is market
imperfection and prices fail to reflect the real scarcity
values of factors. This happens when supply is in excess of
demand. In underdeveloped countries the excess supply is
often found in case of unskilled labour, when there is an
excess supply at current market price of any input, that
price overstates the social cost of using that input. When there is large-scale unemployment the opportunity cost of employing a group of unskilled labourers in a particular industry may be regarded as almost nil. When there is underemployment in the economy the real cost of unskilled labour is less than the actual wages paid. In developing economies the primary sector is marked by acute underemployment - hence withdrawal of labour from primary sector to secondary and tertiary sector will not reduce the output of primary sector. Still labour shortage is experienced in peak seasons and so the impact of withdrawal of unskilled labour on agricultural output cannot be neglected totally. But real cost of unskilled labour in the organised sector is less than the prevailing wage-rate.

In case of skilled labour forces the supply and demand fix the wage-rate reflecting the economic cost to the society. But such cost is a negligible portion of total wage-bill.

Little and Mirrles (1969)\(^5\) in their Manual divided goods and services into three categories: (i) Traded goods and services; (ii) Non-traded goods and services and (iii) unskilled labour. Estimation of shadow price is possible in case of traded goods. (ii) Non-traded goods

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should be broken down into traded goods, unskilled labour and residuals. While traded goods should be valued at border prices, the residuals are to be broken further and revalued by the same process. But this process of calculation of values of non-tradables is highly cumbersome.

1.5 Rate of Discount

As benefits and costs do not occur immediately but over a period of time, a rate of discount is essential in cost-benefit analysis. The discount rate reflects society's "trade-off" of present against future benefits and costs. These benefits and costs are discounted back to their present value because in the long-run their values change.

In case of investible funds the economic return from alternative uses should be taken as the price of capital and this may not be equal to market rate of interest. In practical sphere different rates of interest are charged for different types of capital by different lending bodies. So choice of a unique rate of discount is a complicated matter. Theoretically three types of rates are referred to in discussion for analytical purpose. They are social time-preference rate (STPR), social opportunity cost rate (SOCR) and a synthesis of STPR and SOCR. Social time-preference rate is expected to reflect society's valuation of relative desirability of consumption at different points of time. This is different from individual
time preference. Society is likely to put a higher premium for future benefit. The social opportunity cost-rate is a measure of return to society from the next alternative use in which funds employed in public projects may have otherwise been used. It reflects the marginal productivity of capital. Since perfect competition is not found in real world there is no single rate of interest which can accurately measure social opportunity cost of capital. A 'synthetic rate' of discount reflects both STPR and SOCR. In real world with market imperfection and multiple interest rates no single discount rate can be taken as measure of both social time preference and productivity of capital. Economists are in search of a single discount rate for cost-benefit analysis of projects. Marglin (1963) demonstrates a single synthetic rate which is in effect some weighted average of the two rates - SOCR and STPR. Economists are of opinion that one or more than one discount rate may be decided upon by central government for using in all project analysis. The rate may be called accounting rate of interest or in short, ARI. These rates should take into consideration demand for investible funds, the funds at the disposal of society, balance of payments situation, the level of wages and so on. It is proper to treat it constant for a limited time-period. According to Little and Mirrles (1969) in a fairly advanced country ARI cannot be lower than 10% - it may go up to 15% in some cases. In
developing countries it may be lower than 10% - but under no circumstances should it be lower than 5%. Sometimes costs and benefits may be discounted at different rates of interest - high, medium and low. In a controlled economy long-term government interest rate may be expected to represent social time preference rate. A public sector project expected to enjoy a long-life may accept this rate as the discount rate in absence of a reliable one. A premium may be added for uncertainty. The effect of a project not yet undertaken can only be guessed.

When a project is evaluated by net present value method or Benefit-Cost ratio method social discount rate is necessary. But when the internal rate of return method is used for evaluation of projects there is no need for selecting a discount rate as the internal rate itself is a discount rate.

1.6 Investment Criteria

There are three important types of investment criteria which are generally used in cost-benefit analysis. They are (i) Present value of net benefits; (ii) Benefit-cost ratio; (iii) Internal rate of return.

(i) The present value of net benefits (NPV) criterion can be estimated by discounting back the benefits and costs to the starting point of the project and comparing them.
The Net Present discounted value of an investment stream is the present value of the benefits less the present value of costs. If we wish to regard outlays as negative net benefits, the net present discounted value of an investment stream is simply the sum of all the net benefits when discounted to their present value.

Projects having the highest present value of net benefits should be selected. Symbolically the net present value criterion can be expressed in the following way:

\[
\sum_{t=1}^{n} \left( \frac{B_t}{(1+i)^t} - \frac{C_t}{(1+i)^t} \right)
\]

where \( B_1, B_2, B_3, \ldots, B_n \) represent the series of prospective benefits in the year 1, 2, 3, \ldots, \( n \) and \( C_1, C_2, C_3, \ldots, C_n \) represent the series of prospective costs in the year 1, 2, 3, \ldots, \( n \), \( n = \) project life, \( i = \) social discount rate.

In short, the Net Present Value can be expressed as:

\[
NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}, \text{ where } t \text{ represents the time-period of the project-life.}
\]
(ii) According to the benefit-cost ratio a project should be accepted if benefit-cost ratio is greater than unity. Symbolically,

$$\frac{B_1}{(1+i)^1} + \frac{B_2}{(1+i)^2} + \frac{B_3}{(1+i)^3} + \ldots + \frac{B_n}{(1+i)^n} > 1$$

$$\frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \frac{C_3}{(1+i)^3} + \ldots + \frac{C_n}{(1+i)^n}$$

In short, it can be expressed in the form

$$\sum_{t=1}^{n} \frac{B_t}{(1+i)^t} > 1, \quad t \text{ representing the time period of the project.}$$

(iii) The internal rate of return is that discount rate which makes present value of benefits exactly equal to present value of costs.

If social discount rate is less than internal rate, the project will be accepted. The formula for internal rate of return can be represented in the following way:

$$\frac{B_1 - C_1}{(1+r)^1} + \frac{B_2 - C_2}{(1+r)^2} + \ldots + \frac{B_n - C_n}{(1+r)^n} = 0.$$  

In short it can be written as:

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

where $r =$ internal rate of return which should be compared
to \( i \) (social discount rate) and \( t \) is the time-period of project life.

Investment decisions, be it in the public or private sector, involve some sort of planning which takes into consideration probable returns from the project. Where projects involve only costs and benefits expressed in terms of money the common process is to find out the present value of benefits less costs. There are three decision rules for project selection:

1. Projects having the highest present value of net benefits should be selected. Projects where present value of benefits exceed that of costs will be selected.

2. Projects with the highest benefit-cost ratio should be selected.

3. Projects having higher internal rate of return than the accepted social rate of discount should be selected.

The selection of an appropriate investment criterion depends on the nature and type of the project. The use of different investment criteria may not give the same result. Mishan (1975) has suggested three sufficient conditions to ensure a unique result for different projects irrespective of the investment criteria used. The conditions are termed as normalisation procedure. They are (1) the reinvestment
opportunities open to each of the benefits be made explicit and be fully utilised, (ii) a common outlay to investment projects and (iii) a common investment period for all the investment streams under comparison. If these conditions are met there will be no discrepancy in the result of different investment projects with different investment criterion used.

1.7 Distributional Issues in CBA

Cost-benefit analysis was originally devised as an efficiency tool to evaluate public projects. The equity aspect of the project was ignored. Krutilla (1961) and Eckstein (1957) are in favour of ignoring distributional effect of CBA on the ground that change in income distribution is negligible. A second justification for ignoring distributional changes is that investment expenditures should not themselves be instrument of distributional change. The government can alter the distribution through general fiscal policy. The third argument of not integrating distributional effects into objective function, if any one agency undertakes a large number of projects, is that the average distribution effect will be one of no change.

Economic development does not indicate an increase in net national product only - the equitable distribution of income is also necessary. In developing countries it is found that in spite of growth of income the general standard of living of people show little improvement. This is due to the negligence of the distributional aspect of government investments. So it is necessary for government decision-makers to consider equity aspect of the projects.

Many economists like Haveman, Mckean, Krutilla have advocated the necessity of distributional consideration in the appraisal of public investment projects. But progress in this direction was made by Weisbrod in his article in 1968.

1.7.1 Approaches to Distributional Effect

Weisbrod observes that "Economists can assist in improving the quality of decisions on public expenditures by confronting the issue of a project's distributional effects in addition to its allocative-efficiency effects". The important approaches to distributional effects of public investment projects are the following three systems:

(i) The tax-transfer system;
(ii) The display method;
(iii) The combined criteria of efficiency and equity through a weighted system.
(i) **Tax-transfer System**

The distributional aspect can be solved by taxes and transfers by making adjustments among different income groups. If the higher-income groups get larger benefits taxes may be imposed on their gains and government can redistribute the gains among the lower income groups through tax-transfer mechanism. But this mechanism has some disadvantages. First, it has a disincentive effect on the tax-payers. Second, status of the beneficiary group is downgraded. Third, the social welfare function has no relevance for the project, as there are constraints on distribution of income through taxes and transfers. Fourth, the full distributive impact of a set of public project is not clearly understood by the decision-taker at the beginning.

(ii) **The Display Method**

According to Weisbrod this method gives a positive presentation of distributional effects. Weisbrod divides the beneficiary groups into four segments - income groups, age-groups, racial groups and groups belonging to different geographic regions. These are considered as the criteria for analysing distributinal effect. If the real benefits of the groups be not available we can find out how much of project expenditure is spent for benefit of each group.
It is assumed that each group receives benefits in proportion of costs incurred for them.

The limitation of the method is that it is difficult to construct the table showing the size of benefits to different income-groups and different geographic regions. If we want to find out net benefits realised by a particular group we must have to examine the aggregate consumption benefits and direct and indirect cost of a particular project as well as all cash-transfers and find out the extent to which each item affects the group in question. The UNIDO guidelines for project evaluation (1972) state that regional classification make sense only if the benefits and costs of the poor region is distributed uniformly among the population. Secondly, display method does not take into consideration the distributional effects of secondary benefits which play important role in project evaluation.

(iii) Integrating Efficiency and Equity

There are several approaches of integrating efficiency and equity. The approaches made by Mass (1966), Weisbrod (1968) and McGuire and Gran (1969) and others are popular.

A more widely accepted approach is to observe the weights implicit in past government decisions. Assuming that governments make conscious trade-off between efficiency,
benefits and other objectives, detailed scrutiny of past
decisions may permit derivation of trade-off ratios, i.e., -
the weights which reflect social preferences concerning
distribution. This approach has attracted the support of
Mass and empirical studies have been made by Weisbrod and Mcguire
and Garn. Mcguire and Gran propose a decision rule to
evaluate projects by weighting benefit-cost ratio by a
welfare index based upon dual criteria of "local economic
distress, low family income and high employment rate". Mass
derives trade-off ratios for designing government programmes
and projects in the following way. Data should be prepared
showing the effect of alternative trade-offs between
economic efficiency and equity on projects. On the basis of
these data the government should select a trade-off ratio.

Weisbrod\(^7\) observes (1968 : 190), "To obtain full
integration of distributional and allocative efficiency
considerations into a grand-efficiency measure - which
would facilitate consideration of both actual and desirable
marginal rates of substitution (trade-offs) between
efficiency and equity - a social welfare function (SWF) is
required". He starts with generalized Bergson Welfare
Function,

\[ W = f (W_1, W_2, \ldots, W_n) \]

\(^7\) Weisbrod (1968) - "Income-redistribution effects and
benefit-cost analysis in problems in public
expenditure analysis" in "Applying benefit-cost
analysis in public programmes" - ed. by Chase Jr.
where $W$ is an indicator of total economic welfare and the subscripts refer to specific individuals and then modifies it slightly to make it more operative. The specification of social welfare function might be as follows:

$$W = W_1 + W_2 + \ldots + W_n$$

Economic welfare of whole society depends on the summation of individuals' economic welfare. The change in economic welfare is the sum of the weighted changes in income for each person. Thus

$$dW = a(dy_1) + b(dy_2) + \ldots + m(dy_n)$$

where $y$ indicates income and $(a, b, \ldots, m)$ are weights attached to the income of individuals $(1, 2, 3, \ldots, n)$. This form of social welfare function implies no interdependence in utility i.e., $a(dy_1)$, the change in economic welfare attributed to person 1 is assumed to be independent of the change in economic welfare attributed to person 2 and so forth. "Now the problem of estimating $dW$ becomes essentially one of estimating values of weights $a, b, \ldots, m$ - these being in effect, marginal utilities of income for each person" (Weisbrod). Next he examines the costs and benefits of the projects and selects most profitable projects that were not undertaken and then selects a number of projects that were less profitable, but still they were undertaken. The difference between the
benefits of each undertaken project and benefits of the project not undertaken is attributed to distributive benefits which are not included in cost-benefit analysis. The coefficients of $a, b, c, \ldots$ etc. in the above equation are attached to variables indicating the share of different selected groups. This is adjusted by the use of benefit-cost ratio and by analysing past government decisions about the benefits between groups.

Some economists criticized Weisbrod's formula as "theoretical". It is difficult to have relevant information necessary for the government to assess the ultimate distributional consequences of a policy. The method of assigning weights also has been questioned. The problems are that ex-post distributional results may not indicate ex-ante government plans.

A variant on the implicit weight approach involves the use of marginal rates of taxation as weights (Krutilla and Eckstein (1958). As income rises marginal rate of taxation rises. The government should assign less weights to the additional benefits to a richer person than to a poorer one. The marginal rate of tax can be converted into a surrogate for the marginal utility of income. There are limitations of this approach. First, tax-rates do not reflect society's set of value judgements concerning equity.
only. Second, it presumes that only some taxes reflect equity judgements.

Pearce (1971: 30) is of opinion that the "Economist can offer the decision-maker different sets of weights based on what he considers likely approximation of the marginal utility of income function". With an assumed marginal utility function and an assumed elasticity of say, -2, the relative weights are simply

$$a_i = \left( \frac{y_1}{y_2} \right)^2$$

where $y_1$ is the lower income group and $y_2$ the higher income group. The resulting $a_i$ applies to the higher income group. This approach has two serious limitations -

1. The choice of an elasticity is arbitrary.
2. It involves interpersonal comparison of utility.

Marglin has demonstrated the way in which distributional issues can be treated as constraints on the objective function.

Among the methods discussed above Weisbrod's model can be accepted by making suitable modification in order to make it practicable.

1.8 Role of Uncertainty and Sensitivity Analysis

Generally cost-benefit analysis is undertaken in terms of a single estimate of benefit and a single estimate of cost. Unique values are assigned to parameters like rate of discount, life period of project etc. In real world events do not occur with regularity. Forecasting may not come true due to some unforeseen circumstances. Economic events often depend on factors beyond the control of a project analyst.

The elements of risk and uncertainty are being gradually incorporated in cost-benefit analysis. Hirschleifer has stressed the importance of making such allowances. The future outcome of a project is uncertain. Effect of uncertainty is transmitted to projections of benefit-cost estimates. These estimates range through time. The longer the time-period covered the greater is the uncertainty involved. Certain steps have been suggested to face the difficulty. Risk increases with passage of time. So one approach proposes the addition of a 'risk premium' to the discount rate. Two criticisms are advanced against inclusion of risk premium in discount rate. (a) There is no reason for supposing that risk will behave in this orderly fashion. (b) The procedure requires that the risk be assessed in the form of a discount rate, providing no easy guide for the
decision-maker as to how this is to be done. This is described by Henderson (1968) as a 'very crude expedient'.

A more sophisticated approach is to incorporate probability analysis into the system. Instead of relying on a single best value it is better to take into consideration a range of alternatives. The analysis consists in aggregating the probability judgements about many basic variables affecting the final outcome of the project and prepare an estimate of the probability distribution of final outcome. This approach is not free from subjective element.

In order to incorporate uncertainty sensitivity analysis has been developed systematically. The calculation of Benefit-cost ratio, Net present value or Internal rate of return depends on a number of variables. Some variables are exogeneously determined and some of them depend on technical considerations. Sensitivity analysis consists in estimating different values of final measure by changing values of project variables. A number of probable values of parameters like social discount rate, shadow price etc. may be taken to find out benefit-cost ratio, NPV or IRR. If the project gives favourable values within a certain range - the project analyst can recommend the project with confidence. A single measure may be imperfect.
1.9 Limitations of Cost-Benefit Analysis

Many problems are associated with the cost-benefit analysis. The first problem is the problem of measurement of costs and benefits of a project. Benefit-side poses more problems than cost-side. It is difficult to identify and evaluate intangible benefits. Some generalisation is made and that will give superficial analysis. Secondly, calculation of opportunity cost creates another problem. Thirdly, selection of a proper discount rate (social discount rate) and investment criterion are also difficult because of constraints, issues like risk and uncertainty and other side effects. The ideal solutions, which have been suggested, require knowledge relating to many aspects of the economy, e.g., the general level of interest rates compatible with desired growth rate of the economy.

Cost-benefit analysis fails to take into consideration the redistributive aspect of the public economy properly. The second criticism is that the theoretical exposition of CBA can not be converted into practice unless sufficient information and data about the project under consideration are in hand. Moreover the skill of statistician and skill of operational research analyst are relevant in cost-benefit exercise. Thirdly, cost-benefit analysis is important in evaluating big projects where heavy cost is incurred. In
small projects we can apply CBA if we combine the small projects together. Fourthly, it is not possible to make intersectoral expenditure decision with the help of CBA due to the existence of heterogeneous and non-comparable benefits of widely different projects. Fifthly, it is difficult to find out the shadow price of the commodities when the goods are not traded in the market.

Several economists have tried to overcome the limitations of cost-benefit analysis. A K Sen (1972), McKeen (1968) have contributed a lot on shadow prices. Marglin (1963), Harbeger (1969) have discussed the problem of opportunity cost of public investment. Sen (1967) Feldstein (1964, 1973) and others have contributed much to solve the problem of social discount rate.

At present CBA is used in all fields of public sector. Various statistical techniques, econometric tools, mathematical programming etc. are used in CBA. CBA has become a more useful technique now-a-days. The areas where cost-benefit analysis are more common, are the water-projects and transport. Cost-benefit analysis is now extended to the area of human resource development. We are here primarily concerned with studies which might assist policy-makers in choosing where and how to increase expenditure on education. Here we concentrate on costs of education, imputed foregone earnings and on those benefits of education which take the
form of higher incomes. Non-availability of necessary statistical data for this study is obvious. So most of the authors feel obliged to discuss which items are omitted in cost-benefit analysis of education. This technique has also been used in field of research and development, defence. In the field of research and development the estimation of cost of a particular research programme is difficult to ascertain and sometimes it may become unreliable and the nature of benefit resulting therefrom is also complex and all of them cannot be quantified. In the field of defence we are left with the method of finding the least-cost method of reaching a particular target.

To sum up, there are two different sorts of limitations to the usefulness of cost-benefit analysis - those of principle and those of practice. Statistical deficiencies may be remedied over time - but difficulties of principle are likely to remain.

Enumeration and evaluation of costs and benefits of a project are essential in cost-benefit analysis. It is difficult to list all beneficiaries of the project and avoid double counting. At the time of the evaluation of benefits there is the problem of measurability of benefits. One needs to go beyond measurement of benefits on the basis of market price and make allowance for market imperfections,
externalities and so on. Another difficulty is that of allowing for uncertainty in a systematic fashion. Future is uncertain - we cannot predict it before.

On the cost-side measurement of opportunity cost creates problem. One major problem of evaluation of costs and benefits is the problem of choosing an appropriate discount rate.

Inspite of the imperfection, imprecision and controversies, cost-benefit analysis remains the most useful technique in the decision-making process of public investment. "Even if cost-benefit analysis cannot give the right answers, it can sometimes play the purely negative role of screening projects and rejecting those answers which are obviously less promising" - (Prest and Turvey : 730). The technique is more useful in public utility area than in social service area of the government.