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BENEFIT-COST RATIO
AND THE EXTENT OF ITS APPLICATION
FOR APPRAISAL DEVELOPMENT PROJECTS
IN LESS-DEVELOPED COUNTRIES

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I. INTRODUCTION

The technique of benefit-cost analysis devised around twenty years ago by the United States Government for appraising water resources especially those multipurpose projects which combine several types of projects such as irrigation, navigation, flood control, generation of electric power, and supply of industrial or drinking water. In fact, this technique and its development in the United States was a product of river basin projects.

In the United States, in the earliest effort, the primary emphasis of river basin projects was on development of the rivers for navigation. With increasing settlement of the Mississippi Valley, major problems of flood protection arose. By 1900, settlement of arid and semi-arid lands of the West required development of irrigation. To these needs water soon added demands for hydroelectric power and for improvement of the quantity and quality of water supplies. Then a philosophy of integrated multi-purpose river basin planning was formulated as part of national conservation movement. It was expressed in remarkably complete form in the 1908 report of the Inland Waterways Commission. Finally, when lagging economic activity in the 1930's the Federal Government assumed major responsibilities for river basin development and intensive planning was begun, resulting in the preparation of plans, at least in outline form, for the major river basins of the nation. Over the past thirty years, the United States has invested about thirty billion dollars in developing its river basins. These developments have varied from relatively small scale projects, often for a single purpose, to large scale, complex, multi-purpose undertakings such as the Tennessee Valley development and the major dam and reservoir systems in the Columbia and Missouri basins.¹ As a result of development in river basin projects, the technique of benefit-cost analysis has developed for evaluating such projects. Usually, without exception, except for political consideration, water resource projects must pass the test of benefit-cost ratio. A project is not undertaken unless its benefit-cost ratio exceeds unity.

1. Eugene W. Weber and Maynard M. Hufschmidt, "River Basin Planning in the United States," Science, Technology and Development, U.S. papers prepared for U.N. Conference on the Application of Science and Technology for the Benefit of the less Developed Areas, Vol., 1, Natural Resources, Energy, Water and River Basin Development, (Washington: U.S. Government Printing Office, 1963), pp. 299 - 312.

With the development of benefit-cost technique and in its trial to measure the indirect effects, intangible effects, as well as effects measured in monetary terms, it has spread to decision - making in other projects in the United States such as public works and public utilities in all levels of government - federal, state and local. In reality the technique of benefit-cost ratio provided basic tool for the choice of projects and decision - making within the department and agencies. However, Professor Burkhead states that "the use of benefit-cost ratios has been fraught with unresolved difficulties in the definition of primary, secondary, and intangible benefits, with difficulties in the choice of an appropriate discount rate for valuing future benefits, with disagreements among federal agencies in the application of the procedures, and with some hostility from Congressional Committees"². Moreover, Professor Lindblom states that "the cost and benefit of authorized program are not typically weighted against each other, systematically and explicitly, when legislative decisions are made".³

Also, the technique of benefit-cost ratio spread outside the United States. It was quoted by some foreign countries. Besides, this technique is adopted by the International Bank for Reconstruction and Development (IBRD) for justifying loans for the economic projects of the member countries. Moreover, nowadays, this technique attracts the attention of many less-developed countries which face the problem of planning the economic development as a tool for appraisal development projects or public works programmes.

The purpose of this paper is to discuss to what extent the technique of benefit-cost ratio is applicable for the appraisal of development projects in less-developed countries. But before discussing this idea, it has to illustrate the significance of this technique, its calculation, and the problems of the calculation; thus, the following three sections will deal with these topics. The fifth section will discuss the applicability of the technique for the appraisal investment projects in general. The sixth will turn to the appraisal of similar projects. A conclusion will close the paper.

2. Jesse Burkhead, Government Budgeting (New York: John Wiley & Sons, Inc. 1959), P. 251

3. Charles Lindblom, "Decision-Making in Taxation and Expenditures" Public Finance: Needs, Sources and Utilizations (Princeton University Press, 1961), pp. 292-296

II. CONCEPTUAL RELATIONSHIP BETWEEN PROFITABILITY AND BENEFIT-COST RATIO

Profitability is the traditional investment criterion for private projects. Annual profits are calculated on the basis of monetary revenues and costs to the entrepreneur, as a result to capital invested. When the project has to be evaluated from the point of a social point of view, benefit-cost ratio has to be applied as a criterion for decision-making. A project is justified when the ratio of benefits to costs exceeds the unity. However, in principle, the bases of benefit-cost ratio and profitability from the point of theoretical side as investment criteria are the same. Conceptually, they are identical in respective spheres.

This conceptual relationship is illustrated in the Manual on Economic Development Projects of the United Nations.⁴ It can be expressed as follows:

"R" represents the benefits-costs ratio
"B" represents benefits
"C" represents costs
"P" represents profits

$$\begin{aligned} R &= \frac{B}{C} \\ &= \frac{C + P}{C} \\ &= 1 + \frac{P}{C} \end{aligned}$$

"R" will increase in proportions to $\frac{P}{C}$, that is the greater the percentages of the profits in relation to the costs. Maximum "R" will, therefore, give the maximum profits, just as in the profitability criterion, and in both cases also per unit of resources employed. The differences lie in the fact that for society, the resources used are represented by the total costs, whereas for the private entrepreneur they are represented by the capital.

4. United Nations, Manual on Economic Development Projects (New York, 1958), P. 234

III. CALCULATION OF BENEFIT-COST RATIO

The typical benefit-cost ratio takes into account only the primary benefits and costs of the project. Primary costs consist of direct and associated costs. Direct costs of a project include the total investment in the project taking into account the interest rate, plus the operation and maintenance costs throughout its useful life. Associated costs cover the preparation for the use of sale of goods or services produced by the project; in the case of an irrigation project, associated costs are those incurred by the farmer, excluding the cost of water, to work the irrigated lands and produce crops. Primary benefits are the value of goods and services obtained from the use of resources represented by primary costs; direct and associated. A project is deemed to be justified when the ratio of primary benefits to primary costs⁵ exceeds the unity. If the available resources are not enough for financing all projects, the projects with the highest benefit-cost ratio receive the first priority.

A simple example of a typical direct benefit-cost ratio can be presented in the following. This example summarizes a typical benefit-cost analysis of multi-purpose project, illustrated by Professor Eckstein.⁶

A. Benefits:

1. Primary irrigations benefit	\$ 130,000
2. Total primary navigation benefit	10,150
a- total cost saving on traffic that would move even without project (\$ 5,000)	
b- benefit from additional traffic that would be generated by project (\$ 5,150)	
3. Primary flood control benefit	3,100
4. Total primary power benefit	35,000
a- firm power (\$30,000)	
b- interruptible power (\$ 5,000)	

Average Annual Total Benefit, All Purposes	\$ 178,250
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B. Costs:

1. Operation and maintenance Costs	\$ 50,000
2. Total investment	
\$ 1,500,000, interest and amortization at 6% (50 Years)	91,800

Total Annual Cost	\$ 141,800
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C. Benefit - Cost Ratio

1.21

5. In some cases, it takes into account only the direct costs. In this respect, Professor Burkhead states that "Costs are estimated to include those incurred by the Government, for initial construction and subsequent operation." Burkhead, Op. Cit, P. 251
6. Otto Eckstein, " Benefit-Costs Annalysis and Regional Development," OEEC Regional Economic Planning, Edited by Walter Isard and John Cumberland (Paris, 1961), PP. 362 - 563.

The example above shows the method of calculation of the ratio. The ratio is related to market value. However, the benefits are imputed in many cases. Professor Eckstein⁷ illustrates some examples. The benefit of an irrigation project which supplies water to farmers is the total value of change of output attributed to the water supply minus extra costs of farm operation. The benefit of flood control is equal to the damages that are averted, as an annual average by the project. Navigation benefits are equal to transportation cost saving on the traffic that would have occurred without the project, and to one-half the cost of saving on additional traffic generated - a crude measure of value of traffic that would not have moved at higher costs without the project. Power benefits are equal to the lesser of the cost from an alternative source or the amount purchasers are willing to pay. The benefits of municipal water supply are set equal to the cost from alternative sources.

This is the typical calculation of benefit-cost ratio. However, this ratio may be calculated in a different significant method. This method depends on the concept of "benefits attributable to the project" which were set up by the Sub-Committee of the Federal Inter - Agency River Basin Committee of the United States. Primary benefit attributable to the project is defined as the difference between the total primary benefits and the associated costs. The direct ratio can be illustrated in algebraic expression as follows:

$$R = \frac{B - C_a}{C} \\ = \frac{B_a}{C}$$

whereas "B_a" represents the primary benefits attributable to the project, and "C_a" the associated costs. This ratio is based on the assumption that the project must be credited. The credit is determined by the benefits attributable to project; these are the primary benefits minus the associated costs. In the case of an irrigation project, the benefits attributable to the project or the credit in favour of the farmers is the increase in the value of output as a result to the project less increase in costs incurred by the farmers for production. Total costs of the project in this method represent the direct costs, that are incurred by the government for construction and subsequent operation and maintenance.

This ratio is very favourable to justify the government projects, especially small - scale irrigation projects in less-developed countries which are provided free of charge⁸. It is a simple, practical as well as a significant ratio.

7. Eckstein, OP. Cit., PP. 259 - 260.

8. This ratio needs the employment of the technique of farm budget in the case of irrigation projects.

IV. INDIRECT EFFECT AND SOCIAL PRICING IN CALCULATION IN BENEFIT-COST RATIO

The benefit-cost ratio which is calculated on the basis of primary benefit and primary or direct costs provides no criterion for evaluating some type of projects, especially those providing services free of charge by the government. In other words, it has been said that the direct benefit-cost ratio is not favorable for appraising such projects, since it neglects the indirect effects of the projects. This can be illustrated in some type of government investment in social overhead or general economic infra-structure of the country. A direct benefit-cost ratio of a toll-road project is very low and may be less than unity. A benefit-cost ratio of a road project which services are provided free of charge is zero, although its indirect benefits may be of great importance to the national economy, and perhaps, more than a project with a very high ratio. Even in the case of the multi-purpose projects water resources, the calculation of indirect effects are of great significance for evaluating such projects.

For that deficiency in the direct benefit-cost ratio the report of the Sub-Committee of the Federal Inter-Agency River Basin Committee of the United States, issued in 1950, introduced a modification in the direct benefits-costs criterion for the evaluation of the river basin projects. The most important modifications are:⁹

1. The benefit-cost ratio has to take into account the indirect effect; secondary benefits and costs which may appear in the rest of the economy as a result of the project.

The secondary benefits are those values which are added over and above those of the project's immediate goods and services as a result of activities which it initiates or induces. In the case of irrigation project, the secondary benefit is the difference between the value of the bread and that of the wheat which it contains. The secondary costs are the value of goods and services used as a consequence of the project; that include subsequent manufacturing costs of the immediate goods or services of the project and all costs over and above the primary costs deriving from or induced by the project. In the case of the irrigation project, the secondary costs are the costs of transport, milling of wheat, baking and distribution.

Also, the benefit-cost ratio has to take into account without necessarily going into figures the project's intangible benefits and costs. An example of this type is the improvement or the deterioration of the countryside from the tourist point of view.

However, the benefit-cost determination, according to the Sub-Committee, in normal cases, the relative merits of a certain number of projects may be determined satisfactorily by measuring only the costs and benefits

9. United Nations, Op. Cit, pp. 235 - 237

of the projects themselves, that is, excluding the secondary stage. In cases where the associated and secondary costs have special importance or where they vary greatly between projects under comparison, it may be desirable to compare the sum of the secondary and associated costs of the projects with the gross benefits obtained.¹⁰

2. In accordance to social pricing the Sub-Committee recommended to price costs according to the benefits which cease to be obtained from the alternative use of resource, which is the "opportunity costs" problem. In principle, it has to apply an opportunity cost of zero, if in the absence of the project, there would have been no alternative use for the resources. In alternative uses, for normal cases, it is accepted that market prices may be used. However, market prices have to be adjusted in exceptional cases such as pricing labour during period of unemployment.

To conclude this section, it is necessary to say that in practice the application of the above modification and recommendation is limited. In this sphere, United Nations States that "Although the Sub-Committee's report acknowledges the evaluation, in practice they are considered only in very limited form, because of the difficulties of quantitative appreciation".¹¹

10. Ibid., p. 235

11. Ibid., P. 235

V. APPLICABILITY OF BENEFIT-COST RATIO
FOR APPRAISAL INVESTMENT PROJECTS IN
LESS-DEVELOPED COUNTRIES

Now, we turn to the question of the applicability of the technique of benefit-cost ratio for evaluating development projects in less-developed countries.

The limitation of taking into account the indirect effects of a project, and the arbitrary in this method, which indirect effects have to be included and which have to be excluded, has led to a view that the technique of benefit-cost analysis is not appropriate for appraising investment projects in less-developed countries.

In this respect, the conference on problems of economic development by the European Productivity Agency, Bellogie, Italy. June 19th - July 1st, 1960 states: This technique was widely discussed with respect to applicability in less industrialized areas, especially for evaluating resources development programmes. It was pointed out where unemployment or underemployment exists, it is necessary to estimate the secondary or indirect effects of a project since benefit - cost analysis cannot measure these effects very well, it is of little value in assigning priorities as among alternative resource development projects. This is true also in advanced industrial nations, where even in "full employment" periods some unemployment usually exists in some regions.¹²

Another criticism may arise. While in advanced countries, more emphasis is given to the appraisal of individual projects, on the contrary, in less-developed countries which are in the process of structural change, more attention should be given to the programming and sectorial allocation of the investment. This can be derived from the Design of Development, by Professor Tinbergen, especially in his scheme for estimations of the effects on future national income (and consumption) exerted by a program of investment projects.¹³ As a result of this thought, it may say that the technique of benefit-cost ratio as applied in individual governmental projects in advanced countries, like the United States, is not appropriate for appraisal investment projects in less-development countries.

These are the two basic criticisms which may arise. We fell in wrong if we accept them in absolute terms. Thus, the question of appraisal will still need more treatment, especially in accordance to the role of the technique of benefit-cost ratio in the choice between similar projects.

12. OEEC, "Summary of Discussions, "Regional Economic Planning; edited by Walter Isard and John Comberland (Paris, 1961), p.p. 426

13. Jan Tinbergen, The Design of Development (Baltimore: Johns Hopkins University Press, 1958 (The Economic Development Institute). The scheme, p.p. 87 - 90.

Also, this view is expressed by H.C. Bos, "The appraisal of Investment projects, "DEEC, Regional Economic Planning, edited by Walter Isard and John Comberland (Paris, 1961), p.p. 370 - 372.

VI. BENEFIT-COST RATIO AND THE APPRAISAL OF SIMILAR PROJECTS

The process of the appraisal of investment projects may consist of three stages; first, is the choice of the total investment which determines the rate of growth; the second, is the distribution of the total investment between sectors of the economy to increase the production capacities of different sectors to meet the total demand in each sector; then comes the third stage of the choice between projects. This process has to take into account the goals and the interdependence of economic activities.

The technique of benefit-cost analysis provides an effective tool for the choice in the third stage; the choice between similar projects, especially in the area of multi-purpose projects, and in public works such as irrigation projects, road projects and public utilities, not only with a grantee to the goals and the interdependence of economic activities, but also with more efficiency through the criterion of ranking of similar projects.

Benefit-cost analysis provides us with the criterion of ranking of similar projects that prevents, to a great extent, any bias in the calculation of ratios of the similar projects. The economists and engineers, in their estimation of benefits and costs of the projects, use methods which are often subject to errors. For example, price, agriculture output, hydrologic data, and engineering cost cannot be predicted or estimate precisely; they usually are subject to errors. Here the criterion of ranking of similar projects prevents the bias in calculating the ratios. The errors in projection or estimation of prices, agricultural output, hydrologic and engineering cost will affect similar projects in similar ways. Thus, the ratios will tend to be high or low in the same pattern in accordance with similar projects. In this way, there will be no bias in the choice between the similar projects. However, some shadows of bias will prevail as a result of the differences in the composition of benefits and costs of the projects. Nevertheless, the criterion of ranking of similar projects makes the benefit-cost ratio an effective tool for evaluation and decision - making between the similar projects.

This is a merit in favour of the technique of benefit-cost ratio in respect to the process of the appraisal of investment projects.

VII. CONCLUSION

To conclude, though, the technique of benefit-cost ratio is of little value in the process of appraisal development programmes in less-developed countries, at the level of sectors, it is an effective tool of evaluating at the level of individual similar projects.

If fact, the process of appraisal of investment projects in less-developed countries needs to give attention to all the three stages of appraisal process, mentioned in the previous section, and not only to the appraisal at the level of sectors, in order to maximize the utilization of the limited funds available for investment. Benefit-cost ratio contribute in the process at the level of choices between similar projects. Moreover, when one of the corner stones of the plan is a multi-purpose project, the benefit-cost analysis could play a higher significant role in the process of evaluating. The American experience with the technique is of great importance in improving the process of appraisal in less-developed countries. Also, in less-developed countries in which the major productive investments are carried by the private sector, and the governments are responsible for the general ^{and the} infra-structure investments, the benefit-cost ratio is the simplest most practical effective tool for the choice between the government projects, even these projects are not of the same nature.

Finally, it remains an important merit in respect to benefit-cost ratio. This technique allows the economic principles to be applied not only after the planning of the project, but also at every stage of the process of planning and designing the project. Further, it translates the engineering plants into economic terms.

In this respect, the conference on problems of economic development organized by the European Productivity Agency, mentioned before, states:

However, it was agreed that benefit-cost analysis, though of little value of indicating choice between projects, could play a highly significant role in the identification of the best of the many possible designs of a particular development projects. This contribution can be maximized if along with engineer, the economist participates in each stage of design formulation, rather than simply calculate the economic feasibility of a project after the design has become determined and fixed.¹⁴

14. OEEC, op. cit., p. 426

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