PUBLIC INVESTMENT ANALYSIS AND ITS RELEVANCE TO DEVELOPMENT PLANNING IN THE LDC'S

By

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PREFACE

My intention is to put together material learned from several courses and from library research into a paper which is able to satisfy the Plan B requirements for the M.S. degree, and at the same time, having relevancy to problems in my home country and other less developed countries.

In a sense the paper covers more issues than is usual for a Plan B paper. As a result some of the issues are not dealt with as adequately as they might have been in a Plan A thesis. Secondly, the paper includes some regions of economic analysis (e.g. benefit-cost ratios for disinvestments as well as for investments, user costs, resource mobility, and the non-pareto effects of forced taxation for government expenditure) which have not yet been properly treated, or are still very controversial within the economics profession.

Nonetheless, I feel this effort was worthwhile, and I hope that at some later stage in my career it will be possible to do some more research on these problems.

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CHAPTER I

Introduction

Over the past two decades public investment analysis has increased considerably, both in theory and practice. This can be observed from the vast amount of literature which is now available in this field compared to the inter-war period, and the use being made of benefit cost analysis and other related investment analysis in decision making for the allocation of public resources.

Public investment analysis in the form of benefit cost analysis was first explored by a Frenchman, Jules Dupuit, towards the middle of the 19th century.[1] The first systematic attempt to apply benefit cost analysis to public economic decisions seemed to have occurred in the United States, however. This occurred in the field of water resource development. In 1936 the Flood Control Act was passed, requiring that benefits to whomsoever they accrued

[1] Jules Dupuit, "On the Measurement of the Utility of Public Works," first published in Annaies des Ponts et Chaussée's, Sér. 2, No. 8 (1844); English translation in International Economic Papers, No. 2. London: MacMillan, 1952.

be in excess of the estimated costs.[2] This act, however, did not lay down any rule on the criteria to be used in assessing benefits and costs.

Since there were many agencies administering water resource projects, it was natural for different evaluation criteria to develop, each agency using the criteria which best suited its purposes. In 1946 the Federal Inter-Agency River Basin Committee appointed a Subcommittee on Benefits and Costs, for the purpose of achieving uniformity in the standards and criteria employed in plan formulation and evaluation. This committee's proposals were published in 1950 in the "Green Book."[3] Though there was disagreement with some of the proposals, it made way for more work to be done in improving the criteria used in evaluating projects, and for greater consistency in the methods used.

Since then there has been other official documents in the U.S. to improve project appraisal, such as: Budget Circular A-47 issued in 1952 [89]; The Senate Document No. 97, 87th Congress [77]; and The Analysis and Evaluation of

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[2]Flood Control Act of 1936, Section 1.

[3]Proposed Practice for Economic Analysis of River Basin Projects, Report to the Federal Inter-Agency River Basin Committee Prepared by the Subcommittee on Benefits and Costs, May 1950. "Green Book"

Public Expenditures; The PPB System, Joint Economic Committee 1969 [50]. These by no means include all the official documents in this field, but they do give an indication of the interest which is being devoted to improving Public Investment Analysis.

As stated above, benefit cost analysis started in the United States in the field of water resources, but it has since been extended to highways, health, education, etc. It is also being used in many countries. The rapid rise of public investment analysis over the past two decades is due to several factors. A few of these will be considered briefly.

In the early 1950's Baumol's publication, Welfare Economics and the Theory of the State,[4] created considerable influence on professional economists. Baumol saw the need for a criterion which could isolate those public decisions which would increase society's welfare from those which did not. Alongside with this was the impact of the Keynesian type of economics which rejected the idea that Government should have merely a laissez-faire approach;

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[4]Cambridge: Harvard University Press, 1952. This work drew on some earlier work in welfare economics, such as that of J. R. Hicks, N. Kaldor, T. Scitorsky, et al.

instead it was argued that the Government could, and should play a major role in the economy through monetary and fiscal policies.

With all these new ideas, economists started paying more attention to the public sector than they did previously. Economists began examining the characteristics of free market operation, isolating those conditions under which social costs and benefits differed from private cost and benefits. They started showing up the conditions under which the free market mechanism would fail to produce certain worthwhile products, and if it did produce them, they would not be produced in the proper amounts. Various characteristics of "public goods" were identified and also the reason why the market mechanism failed to produce them.

Of importance also was the rapid growth of the public sector in most countries in the post-war period. According to Prest and Turvey, "The central government, local authorities and public enterprises such as nationalized industries accounted for 45 percent of gross fixed investment in the United Kingdom in 1963, compared with 33 percent in 1938."[5] Similar trends could be shown for

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[5] A. R. Prest and R. Turvey, "Cost Benefit Analysis: A Survey," Economic Journal, December, 1965, p. 685.

many other countries, but this does not seem necessary to bring out the point. With this rapid growth of the public sector, it became more important for improved forms of analysis to be developed for the public sector if resources were to be properly allocated. One may feel that there is no need for the public sector analysis being any different from that of the private sector, but as will be shown later, many of the problems properly tackled by the public sector can not be handled by the private sector.

McKean, in his book,[6] feels that the rapid development in recent years of such techniques as operations research, systems analysis, etc. have contributed largely to the increase in systematic economic analysis to public expenditure decisions. There seems to be little reason if any for doubting this claim.

Occurring simultaneously with the developments mentioned above was the interest shown by economists in the 1950's to the 1960's in the field of economic development and growth, with special emphasis on the low income countries. National economic development planning became very important in these countries striving for the betterment of

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[6] R. N. McKean, Efficiency in Government Through Systems Analysis, New York: John Wiley and Sons, 1958.

their socioeconomic conditions. Developing projects became an integral part of these development programs. There was great need, therefore, for improved criteria for choosing among alternative public investments. The various concepts that were developing in the field of public expenditure, such as the appropriate discount rate, valuing of public goods, the criteria for evaluation all became useful to the development planners.

From the above discussion the reader may get the idea that too much is being claimed for benefit cost analysis and other criteria in the allocation of public resources. Benefit cost analysis like most other tools has its limitations, and if badly used can give disastrous results, but it does have much to offer in resource allocation. This point will be discussed more fully in Chapter III.

The Proposed Study

This paper will be developed largely from library research. Chapter I attempted to give the general setting of public investment analysis, its history and development very briefly. Chapter II will deal with the need for Government Intervention in an economy trying to improve its

social and economic conditions. In developing this chapter consideration will be given to the performance of the market mechanism in the allocation of resources under the conditions of perfect competition and some conditions of static economics. Then many of these assumptions which tend not to exist in the real world will be relaxed. Given these imperfections it will be shown that under these conditions the market mechanism is unable to do a good job of changing the ownership pattern of resources, and also in the proper allocation of such resource use.

Chapter III will be a review of literature on some of the aspects of public investment analysis. No attempt will be made to discuss all the relevant aspects in this field, but it is hoped that the more important and controversial aspects of public investment analysis will be dealt with. Some of the areas that will be discussed are: forms of investment criteria and their limitations; time and interest; risk and uncertainty; benefits, costs, and their pricing; and budgetary constraints.

The fourth chapter will be devoted to development planning. Here a brief look will be given to what is considered development planning and the need for it. The qualitative and quantitative aspects of planning will be

discussed. The quantitative aspects will be a discussion of the various planning techniques. This will cover: macroeconomic models; input-output models; sectorial models; and simulation models.

Chapter V will deal with the role of project analysis in the development program. This chapter will be a form of bringing together project analysis and development planning. A brief summary and conclusion will then be Chapter VI.

CHAPTER II

The Need for Government Intervention

Our basic economic theory is based on the price system, where price is an indication of the supply and demand situation in the market. This price system is what we depend on for the allocation of the use of resources. Under certain assumptions of static economics and perfect competition, this market mechanism does perform a fairly good job of allocating resources. These assumptions will therefore be stated, and a look given at the performance of the price system under these conditions.

The Assumptions of Static Economics

The definition of static economics which will be used here is taken from Glenn Johnson.[1] "The term static

[1] Glenn L. Johnson, Unpublished 401 Production Economics Course Outline, M.S.U., 1968. From Frank H. Knight, Risk Uncertainty and Profits, Boston: Houghton-Mifflin, 1957.

economic theory has a variety of meanings. Hence, when one tries to outline the assumptions underlying static economics a rather specific definition of static economics is required. The theory usually considered when the word static is used is a theory of a given number of economic variables. An exact relationship, as used herein, is one which has a standard deviation of zero. In a theory of exact static relationships, the magnitudes of certain variables can and are permitted to change as the theory is used to explain changes which occur when the value of one or a set of variables is changed."

The assumptions fall into three categories: (1) those which make the system static with respect to: (a) production functions, (b) consumption functions, and (c) institutions; (2) those which eliminate random elements, and (3) those concerning motivations.

(1) Those Which Make the System Static

(a) Assumptions which fix the production function of the economy.

(1) The state of art is assumed constant, i.e. the total production of any given set of productive factors remains fixed.

(b) Assumptions which fix the utility functions of the economy.

(1) Tastes, habits, customs (i.e. everything affecting utility functions) are assumed fixed.

(2) The ownership pattern for resources and, hence, the equilibrium distribution of private real incomes is assumed fixed.

(3) Population is assumed constant.

(4) Utility functions are independent among people, i.e. jealousy and "copying" of tastes and value systems are absent.

(c) Assumptions which specify the institutional set-up of the economy.

(1) Government is assumed fixed.

(2) It is assumed that goods and services are sold in a market where both producing and consuming individuals and groups can make their choices free of force or coercion,

but with consumers subject, however, to limitations imposed by their real incomes.

(3) Non-firm and non-household groups are assumed fixed.

(2) Those Which Eliminate Random Elements

(a) It is assumed that persons and groups making up the economy possess perfect knowledge. This assumption implies perfect foresight.

(b) It is assumed that the persons and groups making up the economy are rational.

(3) Those Concerning Motivation

(a) Consumer units (or households) are assumed to be motivated to maximize the satisfaction derivable from their real incomes.

(b) Producer units (or firms) are assumed to be motivated to maximize money profits.

The Assumptions of Perfect Competition

For perfect competition to exist the following conditions must hold:

(1) Smallness of Size of Producers and Consumers

Any economic agent in the market must be so small relative to the market as a whole, that it cannot exert a perceptable influence on price. This means that any individual consumer is so unimportant that he cannot enjoy any special privileges from sellers. From the point of view of producers, each producer to be so small that he cannot perceptibly affect market price by changes in its output.

(2) Homogeneous Product

The product of any one seller must be identical to the product of any other seller. This assumption is closely related to the first.

(3) Free Mobility of Resources

This third assumption is that resources should be mobile. Labor, for example, must be mobile among jobs and geographically.

The Performance of the Market Mechanism Under Static Economics and Perfect Competition

Under the above discussed assumptions the price system can be depended on for the allocation of resource use, but no change or very little in the ownership pattern of resources. Under the assumptions the producer can operate such that marginal cost is equal to marginal revenue. Marginal costs and marginal revenues will be equated everywhere in the economy. When this is not so, then resource owners will move their resources from areas where marginal revenue is low relative to costs, to areas where marginal revenue is higher relative to costs. In equilibrium, therefore, marginal costs will be equated with marginal revenue everywhere in the economy, granted this may be very elusive. Consumers likewise will be making any necessary adjustment in their consumption of goods and services in order to maximize their satisfaction subjected of course to their budgetary constraints.

From the above, we could achieve a "pareto optimum" for the economy, that is no one could be made better off without making someone else worse off at the same time. This is not to say that a pareto optimum is impossible

without perfect competition, since such a condition could be achieved with perfectly discriminating monopolists, but it is difficult for a monopolist to achieve perfect price discrimination.

With various forms of imperfection in the market it is quite natural that market prices need not reflect social costs. Even if the assumptions that have been discussed so far hold, the market mechanism would still fail to produce certain goods which the people want, due to the nature of the goods, for example when there is an exclusion problem. This problem of exclusion will be dealt with in more detail in the chapter. As noted previously, the market mechanism will do very little to change the pattern of resource ownership. The market mechanism is also unable to adequately deal with various forms of externalities. Because of these and other reasons which will be discussed in this chapter it is necessary to have government intervention.

The Exclusion Problem

Certain products have the characteristic of non-exclusion, i.e. if they exist for one consumer they exist for all. Such goods will not be produced by the price system, or if produced they will not be produced in the

desired amounts. Under these conditions, consumers will not be motivated to reflect their true demand for the product, knowing that by the masking of their demand they may avoid payment. A good example of such a product is national defense. It becomes vital that government produce such goods. This is not to say that once such goods are provided by the government then all the problems involved with their production are solved. There will be the problem for example of evaluating the benefits. One possible means of evaluating such benefits, however, is to see the extent to which the public is willing to be taxed for the product.

There is also the related problem posed by some products. This is the characteristic of marginal cost being zero for some group. To use an example from A. Schmid,[2] "Air quality control has this characteristic in that the cost of the smoke stack control does not increase as residents of the airshed change. The marginal cost of another residential consumer of the resulting air is zero." If pricing is such as to cover total costs, some user who has positive utility and who adds nothing to extra costs

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[2] A. Schmid, Benefit Cost Analysis in One Lesson, Ag. Econ. Misc. No. 1969-11.

will be excluded. Even if it were possible to exclude this user it would be wasteful to do so. Pricing at marginal cost would make it impossible for the firm to recover its investment in producing such goods. Here again the need for government intervention becomes very important.

Externalities

Externalities may be regarded as the impacts of the action of some individual or group of individuals without these impacts having any effect on the first group causing these impacts. There has been much written on externalities, but there seem to be no consensus of opinion on their classification. It seems reasonable to say, however, that externalities can be broadly classified into pecuniary externalities, and technological (non-pecuniary) externalities. Before discussing these externalities, it may be worthwhile to make reference to some good contributions to the literature on this topic.[3]

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[3]See J. E. Meade, "External Economies and Diseconomies in a Competitive Situation," Economic Journal, March, 1952, pp. 54-67. J. Buchanan and W. C. Stubblebine, "Externality," Economica, November, 1962, pp. 371-384. Tibor Scitovsky, "Two Concepts of External Economies," Journal of Political Economy, April, 1954, pp. 143-151.

Technological Externalities

These are externalities where the output of one firm affects the production functions of another, and there is no compensation for this. These externalities are regarded as external economies or diseconomies, depending on whether the externality is beneficial or harmful.

Many examples of technological, external economies and diseconomies have been cited in the literature. Meade's apple and honey example is now quite famous.[4] To use another example, if there are two factories located along a stream, one upstream, the other downstream. If the factory upstream pollutes the river with its by-products, while the factory downstream has to use this water at added expense because of the pollution from the upstream factory, then, this is an external diseconomy. If, on the other hand, the factory upstream had to use the water, and in so doing removed many impurities, thus making the cost of production of the factory downstream decrease, then this is an external economy.

The problem, then, is how should these externalities be treated? The example just discussed seems rather

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[4] J. E. Meade, op. cit., pp. 56-61.

easier than others where there are many people being affected by many others. There is no easy solution to this externality problem. Some people argue that in order to maximize the economy's welfare government should subsidize those firms creating the external economies, while taxing those creating the external diseconomies. This may be an effective way of internalizing some externalities.

Government may use prohibition to prevent the occurrence of certain externalities. This may be a poor approach however. Forced government regulations may be quite effective if the cost of maintaining such regulations is not prohibitive. It is difficult, however, to make a definite statement on how internalization should be achieved through the use of force and change in resource ownership. Various measures may be used with different degrees of effectiveness depending on the particular externality. This is not to say that each time an externality problem is faced it would have to be treated differently from the others. This is not the case since their common properties should make them very similar.

Pecuniary Externalities

Pecuniary externalities are those affecting prices of products or inputs caused by the action of firms or consumers. If, for example, a real estate development agency decides to expand its house building program, this could be significant enough to cause the price of cement to increase. This could cause the cost of production of other firms using cement to increase. This then could be regarded as a pecuniary diseconomy for these firms.

Where the action of one firm affects another firm because of increases in the price of its inputs or a reduction in the price of its products it is necessary to examine whether such effects should be accounted for. If the firm adversely affected can make adjustment in its investment, this should create no problem. If the firm has fixed resources and undergoes some reduction in rent on these resources this need not be regarded as a loss to the economy. If the firm is forced out of production, however, and the fixed resources were such that they had zero or negative salvate values, then this may be a loss to society. In other words, the benefits gained from the firm causing the externality should be balanced against the

benefits lost from the firm forced out of production with no alternate use for its resources.

If there is some form of integration among industries with better information on the effects of one industry's actions on another then such externalities could be better predicted, and their effects could be evaluated before action is taken. The more decentralized is the economy, the more difficult it may be to obtain such information and achieve a better coordination of activities, however.

Free Mobility of Resources

If the market mechanism is to do a good job in the allocation of resource use, there is need for such resources to be freely mobile. With such mobility, prices can be used as a guide for bringing about equality of private and social costs and benefits, since resources could be moved from areas of low returns to areas of higher returns.

For resources to be mobile it means that ownership of resources should not be monopolized. It should also be fairly easy for firms to enter and leave any industry.

Labor should also be mobile among jobs and geographically. Quite often these conditions are absent.

The question of monopoly power will be dealt with later in the chapter, also the free choice of jobs. The question of immobility of resources due to fixity of assets is quite another problem. According to neoclassical economies the fixity of an asset depends largely upon its expected useful life, thus, physical fixity is the important factor. It is assumed that the entrepreneur can purchase more of an asset and dispose of unwanted quantities at the same price, that is, acquisition and salvage value being equal.

Glenn Johnson [ ] however defines a fixed asset as one for which the marginal value productivity in its present use neither justifies acquisition of more of it, nor its disposition. This definition of a fixed asset does not depend on the life of the asset but with its usefulness. In agriculture for example because of high transportation costs there may be a wide disparity between acquisition and salvage values for farm inputs. There may also be this wide disparity between acquisition and salvage value for farm labor.

The acquisition cost of an individual engaged in farming is the opportunity cost of the income foregone by

not entering another occupation at the time he entered farming. It is therefore the income others are earning in another industry with similar ability. The salvage value of farm labor is the earnings that are available to farm people outside agriculture.

People who have worked in agriculture for a long time may become somewhat specialized in their skills and so their salvage value outside of agriculture would be very low. In periods of high unemployment the salvage value of farm people outside of agriculture may be virtually nil.

Because of these wide disparities between acquisition costs and salvage values there may be a high degree of resource fixity, and so there may not be easy shifting of resource use with even considerable price changes. Under such conditions it may be necessary for the government to aid in resource reallocation and use. It may aid in job training for example.

Income Redistribution

Under the free market system a certain distribution of income will result according to the ownership pattern of resources and services. If the market is working at its best, then rewards will be determined by the demand and

supply for the products or services the individual produces, and the amount he produces. As Weisbrod noted, persons with low productivity in value terms will earn little regardless of whether the low productivity is due to lack of skill, lack of effort, or low demand for the skill.[5]

It follows that people with very little capital, having only their services to offer, and possessing poor education, very little skills, poor health, etc. would receive very little from the market system. It may therefore be necessary for the government to bring about some forms of income redistribution through changes in resource ownership. Such changes may include changes in: monopolistic power; knowledge; skills; property; and technology. Income redistribution may also be effected by the internalization of previous externalities.

There are some who feel that income distribution should not be in the realms of economics, but it has very important effects on the economy. Not only will a change in the pattern of resource ownership affect the country's

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[5]Burton A. Weisbrod, "Collective Action and the Distribution of Income: A Conceptual Approach," The Analysis and Evaluation of Public Expenditures: The PPB System Vol. 1, pp. 177-197. A compendium of papers submitted to the Subcommittee on Economy in Government of the J.E.C. 91st Congress, 1st Session, 1969.

national income, but if the income distribution within a country is very skewed, this may create considerable discontent among its people which could lead to economic and political instability.

If the case of education is considered, few people would consider education for the masses as undesirable. If everyone had to pay for all the education received, then only a small percentage of the educated in most countries would be. This again shows the need for income distribution.

Not only is the need for income distribution important when the market mechanism is working perfectly, but quite often it is not. Because of imperfect knowledge, many persons may be bypassing jobs which they are capable of doing, and which would be more rewarding. There may also be biases based on race, religion, or sex, which prevent people from being employed in certain jobs which they are capable of doing. Government may not be able to do a better job of providing information, but they can certainly use force or coercion to overcome some of the biases mentioned above.

Some views on the manner in which income redistribution should be achieved may be found in these

references.[6] The decision making on income redistribution is best left to the political process, but the economist can be very valuable by showing the politician the means of achieving certain goals, and the consequences of choosing one means over another. If, for example, there are two projects A and B, with A giving 500 units of quantifiable benefits while B gives 480 units at the same costs, then if the decision maker chooses B over A, he should at least be saying that he valued the redistributive effect of B over A to the extent of at least 20 units.

Increasing Returns

Under conditions of increasing returns, oligopoly and monopoly are likely to develop (again a problem of resource ownership). Under these conditions the consumer may be "exploited." Exploited being used in the sense here that consumers pay more for the marginal product than its marginal cost of production, and both the price of the product is higher, and the quantity produced is smaller than would be the case of perfect competition (negative excess capacity).

[6] Burton A. Weisbrod, op. cit., pp. 177-197. A. Allan Schmid, in the same volume, pp. 579-591.

With such conditions existing in the real world, it is necessary for the government to have some regulartory power over monopolies so that consumer exploitation can be reduced, with the aim of increasing the welfare of the society. It may also be necessary to have laws like the anti-trust laws in the United States to overcome various forms of collusion in oligopolies.

Summary

The discussion on the need for government intervention by no means covered all the reasons for intervention but it is hoped that the more important ones were discussed. It should also be borne in mind that government intervention as used here was not meant to replace the market mechanism, but rather to complement it where it was unable to do a good job in allocating resources, and to make needed adjustments in resource ownership.

CHAPTER III

A Review of the Literature on Benefit Cost Analysis

As we mentioned earlier, there is a large volume of literature today on benefit cost analysis. It would therefore be impossible to review any significant amount of the literature which is now existing in this field in a paper of this nature. Secondly benefit cost analysis draws on many fields of study, such as: welfare economics, public finance, resource economics, production economics, consumption economics, and industrial organization, and market structure. Technological changes also have great impact on B/C analysis. This therefore makes it necessary to leave out many important aspects of benefit cost analysis. It is hoped, however, that some of the most important and controversial aspects of benefit cost analysis will be dealt with.

Forms of Investment Criteria and Their Limitations

The government (or private firm for that matter) faced with limited resources must seek out adequate criteria for choosing among alternatives, if it is to maximize returns from its given resources. As it is difficult in finding a perfect solution to most problems, so it is with finding a criterion for decision making in public investments. It becomes necessary therefore to have some flexibility in the choice of criteria, so as to achieve one's objectives in the most economical way, given the existing constraints with which one is working to achieve such objectives.

In comparing projects, the "Green Book" mentions at least three possibilities: (1) compare the differences between benefits and costs; (2) compare the rates of return on investment; and (3) compare the ratio of benefits to costs which is their recommended basis for project comparisons.[1]

The ranking of projects by comparison of the differences between benefits and costs should be rejected

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[1] Subcommittee on Benefits and Costs, op. cit., p. 14.

since this will favor large projects, but not necessarily efficient projects.[2] Ranking projects by their benefit-cost ratios or by their rates of return may give completely different results, depending on the relationship between their capital and operation and maintenance costs. Eckstein clearly demonstrates this point with an example.[3]

Eckstein's example is that of a chain of supermarkets with an investment of $10,000,000, $100,000,000 sales per year, with $5,000,000 operating profit on these sales. A 3 percent interest rate was used for the investment.

The benefit-cost ratio for this investment would be rather poor, annual benefits being $100,000,000, annual costs $95,000,000, thus B/C = 1.05. A crude rate of return calculation would show the investment to be very profitable, with an income of $5,000,000 per year on an investment of $10,000,000, i.e. a 50 percent rate of return. He makes the assumption that the stock of goods turn over ten times per year, thus tying up an average of $10,000,000 in

[2]Project here is considered to be a proposal for capital investment to develop facilities to provide goods and services.

[3]Otto Eckstein, Water Resource Development, Harvard University Press, Cambridge, Massachusetts, 1965, p. 54.

inventories. At the 3 percent interest rate this would amount to $300,000 so the crude rate of return would now be 47 percent. The rate of return on all fixed capital would now be 25 percent.

The project discussed above is then compared with an investment in an hydroelectric project, requiring $20,000,000 in investment, with annual revenues of $1,500,000 and annual expenses of $300,000, again using a 3 percent interest rate. The average rate of return will be 1,200,000/20,000,000, i.e. 6 percent, while the benefit-cost ratio will by 1.6. Using the benefit-cost ratios the hydroelectric project is preferable to the supermarket, i.e. 1.6 to 1.05, while the supermarket looks much better than the hydroelectric project using relative rates of return, i.e. 25 percent versus 6 percent.

This crude example clearly demonstrates the importance of the criteria used for choosing among alternatives. It is necessary therefore for the investment criteria to be adopted to the type of projects and the policy objectives. When projects need large amounts of investment capital, with fairly small operating and maintenance costs, and capital availability is a limiting factor, then the rate of return will tend to be a better criteria to use.

On the other hand where operating and maintenance costs tend to be the critical factor then a form of benefit-cost ratio may be best for achieving maximum returns.

According to Eckstein, "the benefit-cost ratio, like any investment criterion, is suited only for certain kinds of investment decisions. The economic nature of the costs must be reasonably uniform; there must be no extreme variations of capital intensity. The benefits must be uniform at least at the conceptual level and must have roughly equal degrees of uncertainty. And the life spans of the projects among which choices are to be made must be of the same order of magnitude."[4] This seems to be restricting the use of B/C analysis too much, but this point will be taken up later.

The Benefit-Cost Ratio Versus the Average Rate of Return

The following is Eckstein's treatment of these two investment criteria.[5] B = benefits received annually, as defined by agency practice; C = costs per year, including the charge on capital; K = fixed investment; O = operating,

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[4] Ibid., p. 55.

[5] Ibid., pp. 56-57.

maintenance, and routine replacement costs incurred annually; i = interest rate; r = rate of return; and T = amortization period.

The present value of total cost would thus be:

$$\sum_{t=1}^{T} \frac{O}{(1+i)^t} + K,$$

The present value of total benefits is

$$\sum_{t=1}^{T} \frac{B}{(1+i)^t},$$

and the benefit cost ratio is

$$\sum_{t=1}^{T} \frac{B}{(1+i)^t} \left[\sum_{t=1}^{T} \frac{O}{(1+i)^t} + K \right]^{-1} \qquad \text{----------(1)}$$

Converting the ratio to an annual basis by dividing numerator and denominator by

$$\sum_{t=1}^{T} \frac{1}{(1+i)^t},$$

we get

$$\frac{B}{C} = \frac{B}{O+K \left[\sum_{t=1}^{T} \frac{1}{(1+i)^t} \right]^{-1}},$$

and letting

$$\left[\sum_{t=1}^{T} \frac{1}{(1+i)^t}\right]^{-1} = A_{iT},$$

making $\frac{B}{C} = \frac{B}{O + A_{iT}K}$ ----------(2)

The rate of return, r, is defined by the equation

$$K = \sum_{t=1}^{T} \frac{B-O}{(1+r)^t} \quad \text{or} \quad K = \frac{B-O}{A_{rT}}, \quad \text{----------(3)}$$

where $A_{rT} = \left[\sum_{t=1}^{T} \frac{1}{(1+r)^t}\right]^{-1}$

From (3) we get

$$B = A_{rT}K + O, \text{ and so } \frac{B}{C} = \frac{A_{rT}K + O}{A_{iT}K + O}$$

solving for A_{rT}, we get

$$A_{rT} = \frac{(B/C)\ (A_{iT}K+O)\ O}{K} = \frac{B}{C}\left(A_{iT} + \frac{O}{K}\right) - \frac{O}{K}$$

or

$$A_{rT} = A_{iT}\left(\frac{B}{C}\right) + \frac{O}{K}\left(\frac{B}{C} - 1\right) \quad \text{----------(4)}$$

If there are no current costs, that is if O/K = 0, the two criteria coincide, then (4) becomes $A_{rT} = A_{iT} \left(\frac{B}{C}\right)$--(5) If the benefit-cost ratio is equal to 1, the two criteria again coincide.

Eckstein then demonstrates graphically the effect of different O/K values when ranking projects by benefit-cost ratio as against the rate of return. Figure 1 is a reproduction of this graph.

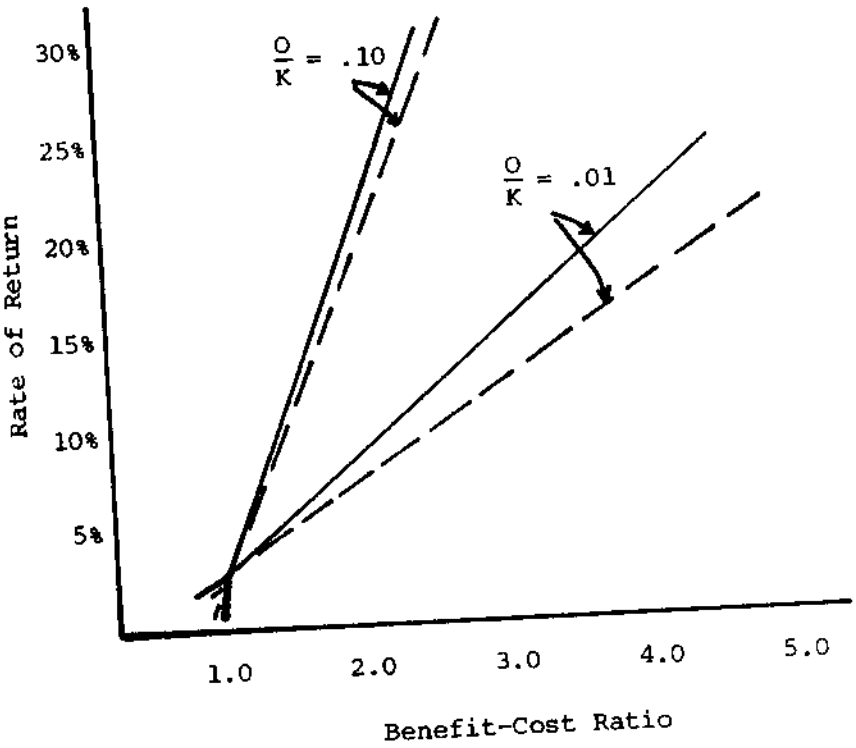

Figure 1

Source: O. Eckstein, Water Resource Development, p. 59.

Figure 1 demonstrates that the benefit-cost ratio is particularly favorable to projects with low values of O/K, i.e. where most of the cost is on initial investment and where year by year expenses are minimal. Eckstein also argues that, "if capital is rationed* but all other resources are available in sufficient quantity at their market prices, then the selection of those projects which have the highest rate of return on capital will lead to the production of the greatest future economic value stream. Similarly if any one factor of production is rationed while all others are variable, the optimum result is obtained if the highest rate of return is obtained on that factor."[6]

The discussion so far has developed as if there is only one benefit-cost ratio. This is not so, there are two popularly used ratios. The ratios are as follows:

$$\text{Ratio (1)} = \frac{\sum_{t=1}^{T} \frac{B}{(1+r)^t} - \sum_{t=1}^{T} \frac{O}{(1+r)^t}}{K}$$

*Capital rationing as used here refers to agencies having fixed budgets with which to operate.

[6] Ibid., p. 61.

$$\text{Ratio (2)} = \frac{\sum_{t=1}^{T} \frac{B}{(1+r)^t}}{K + \sum_{t=1}^{T} \frac{O}{(1+r)^t}}$$

As can be observed, the first formula deducts the present worth of operating and maintenance cost from the present worth of gross benefits and thus uses net benefits for the numerator with capital investment being the denominator. In the second formula gross benefit is used as the numerator with capital expenditure plus operating and maintenance costs as the denominator.

As would be expected, these two formulae will produce different benefit-cost ratios for the same project. The first formula will usually give higher ratios. A simple example will demonstrate this point. Suppose there is a project with 30 units of gross benefits, 10 units of capital cost, and 5 units of operating costs. The first formula would give a benefit-cost ratio of 2.5, i.e. $\frac{30-5}{10} = 2.5$, while the second formula would give a ratio of 2.0, i.e. $\frac{30}{10+5} = 2.0$.

It is important to not only consider the ratios of projects, therefore, but to see how the ratios were arrived at. The difference between the two formulae can be used

advantageously, however. If the project is one which will need large amounts of operating and maintenance costs and this will be a critical factor, then the second formula would be a better criteria to use in evaluating the project. This I think is important in my home country (Jamaica) where it may be relatively easy to obtain capital for investment through loans, etc. but the generation of operating and maintenance costs can be a real bottleneck. Similarly if a project is able to generate its own operating and maintenance costs, but capital is in short supply then the first formula may be the better one to use.

MeKean advocates the maximizing of present worth, i.e. maximizing present value of gains minus the present value of costs. When there is no capital rationing, he recommends investment until the "internal rate of return"[7] from incremental investment is no higher than the market rate of interest, but he recognizes the problem created by this method when there are mutually exclusive projects.[8] With no capital rationing the market rate of interest will

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[7]The internal rate of return is that rate of discount which makes the present value of the projects receipts stream equal to the present value of its cost stream, or in other words the rate of discount which makes the present worth zero.

[8]R. M. McKean, op. cit., pp. 76-77.

then equal the firms marginal internal rate of return. The firm would therefore be maximizing its present worth. With capital rationing the marginal internal rate of return may be higher than the market rate of interest, but the firm would still be maximizing present worth given its constraints.

According to McKean, "the firm's investment committee or the government agency should assume that the capital invested is not to be liquidated, that net receipts are to be reinvested and that maximum return over the period under consideration is to be sought. In these circumstances the test should be maximum present worth for the given investment budget when streams are discounted at the marginal rate of return."[9]

This criterion recommended by McKean faces problems, however, since some of the assumptions are not likely to be met in most cases. Many government projects are such that the benefits are not collected by the government, and for all practical purposes, one must rule out the reinvestment of such project benefits. Marglin makes the point that the government cannot ensure that the aggregate consumption benefits of a public investment program are

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[9] Ibid., pp. 84-85.

reinvested at a rate of return equal to the marginal internal rate of return to provide consumption in the time pattern desired by the government.[10]

McKean himself recognizes the fact that if net receipts cannot be invested at the marginal internal rate of return, then the internal rate of return will not lead to the correct decisions. This aspect of the problem should not be ruled out, because quite often certain early investment opportunities may give very good returns, but once these have been undertaken returns from other projects may decrease, though the opposite could occur also.

McKean also recommends ranking by the internal rate of return, proceeding down the list of projects until the budget is exhausted. He discourages the ranking of projects by the average rate of return, however, and he uses some examples to show how using average rates of return could be misleading.

The internal rate of return is favored by some people since it overcomes the problem of choosing a discount rate in projects evaluation, and as will be seen later in this chapter this is one of the real big problems

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[10]Stephen A. Marglin, Public Investment Criteria, The M.I.T. Press, 1966, p. 51.

of benefit-cost analysis. The International Bank for Reconstruction and Development, for example, uses this criterion for ranking most of its projects.

Bain considers two criteria, either find a set of projects which has the greatest possible excess of aggregate discounted benefits over aggregate discounted costs when the funds available for current capital investment are fully applied, i.e. maximize $\frac{V-O}{K}$

where: V = present value of the future gain stream

C = present value of the future cost stream
(C = K+O)

K = capital cost

O = present value of the operating cost stream,

or alternatively secure with available investment funds the project set affording the greatest possible ratio of discounted aggregate costs. Maximize V/C. Bain prefers the second method of the two, but feels some form of combination of both may be better than either.[11]

Krutilla and Eckstein recommend carrying out projects only if V > C, and to the point where $\Delta V/\Delta C > 1.0$

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[11]Joe S. Bain, "Criteria for Undertaking Water Resource Developments," The American Economic Review, No. 2 (May 1960), pp. 311-315.

assuming no budgetary constraint. When choice must be made between public or a private project, or different design configurations for the same project, then choose the proposal which offers the higher V/C ratio.[12]

Margolis using the following definitions and assumptions:

$\overline{S}$ is a fixed government allocation for water resources development which is constant over time.

α is the ratio of operating costs to capital and is constant over time.

β is the ratio of benefits to capital and is constant over time.

Assuming a perpetual life and a social rate of time preference, r, and the present value of benefit is:

$$V_B = \frac{\beta}{(\alpha+r)} \quad \frac{\overline{S}(1+r)}{r}$$

The present value of investment is:

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[12] John V. Krutilla and Otto Eckstein, Multiple Purpose River Development, John Hopkins Press, Baltimore, 1958, p.

$$V = V_B - V_C = \left(\frac{\beta}{\alpha+r} - 1\right)\left(\frac{\bar{S}(1+r)}{r}\right)$$

The investment option, given a constant appropriation, is a choice among a set of projects with different degrees of capital intensity, α, the ratio of operating costs to capital. Under these circumstances one must maximize the present value with respect to α. The maximization conditions for the present value is:

$$\frac{\beta}{\alpha+r} = \frac{\partial B}{\partial \alpha}$$

So maximize V - C.[13]

In summarizing the criteria problem, it can be said that there are many suggested criteria for use in project evaluation and ranking. The benefit-cost ratio and the internal rate of return seem to be the most popularly used ones. They both have their limitations and favorable points, and they should be used according to the existing conditions and policy objectives rather than accepting any one blindly. As we discussed on page , the internal rate of return becomes meaningless unless the returns can be

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[13]Julius Margolis, "The Economic Evaluation of Federal Water Resource Development: A Review Article," The American Economic Review, XLIX, No. 1 (March 1959), pp. 96-111.

reinvested, and at the marginal internal rate of return. Similarly it was shown on page that different b/c formulae will give different ratios, and their relative merits depend on the constraints with which one is working.

Before leaving the criteria problem, it may be worthwhile to note these few additional limitations of benefit-cost analysis. Benefit-cost analysis is investment orientated and deficient for dealing with disinvestment. Benefit-cost analysis employs primarily the static which is inadequate for appraisal of non-market adjustments.

Time, Interest, Risk, and Uncertainty

At the onset it was intended to separate time and interest from risk and uncertainty, while being cognizant of their close interrelationship, but in going over the literature their close interrelationship seemed so accentuated that it was decided to introduce them under one broad heading.

This close relationship is demonstrated by the following statement. "The values attached to benefits and costs at their time of accrual can be made comparable only after conversion to an equivalent basis for time and degree

of certainty of occurrence. Interest and discount rates and risk allowances provide a means of giving monetary expression to differences in the time and certainty of occurrence of benefits and costs."[14]

Time must be regarded as a very important factor in economic analysis and must be treated as such. Interest rate is the factor used to equate the benefits and costs occurring at different time periods. As mentioned above, however, the interest rate is also used in overcoming uncertainty. The subcommittee, though granting the need for risk discounting in the interest rate, feels that certain types of rish should not be handled by the interest rate, and the interest rate should be used primarily for the time factor.[15]

On this question of the time factor Kuhn pays attention to the fact that a high interest rate will heavily penalize projects with long delays in their benefit accrual. He notes also that the timing of

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[14]The Subcommittee on Benefits and Costs, op. cit., p. 21.

[15]Ibid., p. 21.

projects can be very important.[16] This timing of projects is important not only between projects, but within projects.

Risk an Uncertainty

If risk and uncertainty are regarded as degrees of knowledge situation with known and unknown probability distributions of their outcomes respectively, then one can agree with the Subcommittee on Benefits and Costs in converting risk into annual amounts, either through insurance or some other appropriate allowance. For example, where losses from floods, storms, etc. can be estimated with reasonable assurance, then their damages could be deducted from benefits, or the means of overcoming such losses added to costs.

Although Eckstein does not make a distinction between "risk and uncertainty,"[17] he states that: "Within

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[16] Tillo Kuhn, Public Enterprise Economics and Transport Problems, University of California Press, Berkeley and Los Angeles, 1962, pp. 111-114.

[17] There is a large amount of literature on risk and uncertainty, but it is treated differently by most authors, see for example: Frank H. Knight, Risk Uncertainty and Profit, Boston: Houghton-Mifflin, 1957. C. O. Hardy, Risk and Risk Bearing, Chicago, Ill.: University of Chicago Press, 1923.

the benefit-cost framework risk adjustments can be injected in at least three ways: (1) by shortening the period of analysis; (2) by including a risk factor in the interest rate; and (3) by making safety allowances on the cost or on the benefit side."[18] It is fairly safe to say risk is being used here for uncertainty as defined above, then this treatment of uncertainty is similar to the "Green Book's" recommendations.

(a) Period of Analysis

On the question of the life of the project, the subcommittee recommended an upper limit of 100 years for the economic life of the project, even if the physical life of the project could go beyond this period. This they justify because of the great uncertainty involved in predicting the remote future. Benefits and costs possibly offsetting each other, because of the low present worth of such benefits, and the fact that the benefit cost ratio will not change significantly by benefits accruing beyond the 100-year period.[19]

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[18] Eckstein, op. cit., pp. 82-83.

[19] Subcommittee on Benefits and Costs, op. cit., p. 25.

U.S. Budget Circular A-47 limited the project life to 50 years, so does the Agency for International Development. The 50-year period is now being used by most U.S. water agencies in their project evaluation, but there is an indication that they may start using 100 years.

McKean disagrees with the setting of a specific cut-off date. He argues that this is implying that while uncertainty up to that point can be reflected by multiple estimates, but beyond that point it suddenly becomes so overwhelming that estimates can be discounted to zero.[20]

Eckstein devotes some attention to the effect of cut-off dates on different types of projects. He demonstrated graphically that capital intensive projects with low O/K ratios are more affected than others. Figure 2 and Table 1 show the extent to which the benefit cost ratios of projects of different economic lives are depressed by this form of risk allowance. He uses a ratio of 2.0 if the projects were credited with their benefits to their full economic life.

Eckstein analysis shows that this type of uncertainty adjustment will not deal with the uncertainty of projects with economic lives shorter than the period

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[20] R. M. McKean, op. cit., p. 75.

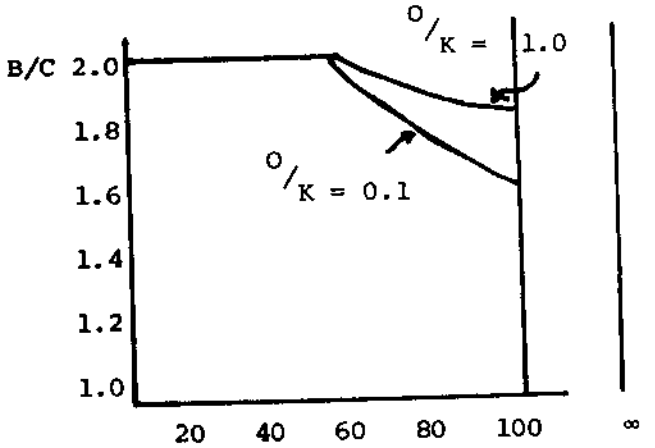

Figure 2

Source: Otto Eckstein, Water Resource Development . . ., p. 84.

TABLE 1

EFFECT OF LIMIT ON PERIOD OF ANALYSIS ON A BENEFIT-COST RATIO EQUAL TO 2

Expected Economic Life	Resultant Benefit-Cost Ratio	
	O/K = 0.01	O/K = 0.10
50	2.0	2.0
60	1.87	1.95
70	1.78	1.93
80	1.72	1.91
90	1.68	1.89
100	1.65	1.88
	1.55	1.85

Source: O. Eckstein, Water Resource Development, . . . p. 84.

chosen as the cut-off point. At the same time it penalizes projects with economic lives longer than this cut-off date. This he figures could lead to the establishing of structures to last just to this cut-off date when more could have been gained from making them more durable. Usually capital is amortized over the project life on a sinking fund basis.

(b) Adding a Risk Premium to the Risk Free Interest Rate

Most writers advocate adding a risk premium to the risk free interest rate in order to overcome uncertainty. Eckstein shows the effect of a 1/2 and 1% risk premium on projects of different economic lives which would have a benefit-cost ratio of 2.0 if there were no adjustments for risk. Figure 3 and Table 2 show these effects.

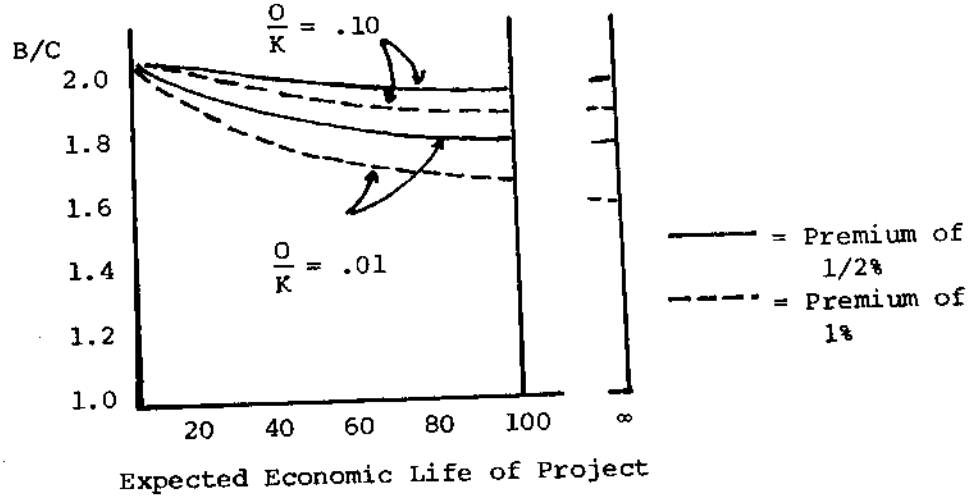

Figure 3

Source: Otto Eckstein, Water Resource Development . . ., p. 87.

TABLE 2

EFFECT OF RISK PREMIUMS ON THE BENEFIT-COST RATIOS OF TYPICAL PROJECTS WITH DIFFERENT ECONOMIC LIVES

Economic Life	Risk Premium			
	1/2 Percent	1 Percent	1/2 Percent	1 Percent
	(O/K = 0.01)		(O/K = 0.10)	
0	2.0	2.0	2.0	2.0
10	1.95	1.91	1.97	1.95
20	1.92	1.84	1.96	1.93
30	1.90	1.80	1.96	1.92
40	1.87	1.75	1.95	1.90
50	1.85	1.72	1.95	1.90
60	1.84	1.69	1.95	1.89
70	1.82	1.67	1.94	1.88
80	1.81	1.65	1.94	1.88
90	1.80	1.63	1.94	1.87
100	1.79	1.62	1.94	1.87
	1.75	1.56	1.92	1.85

Source: Otto Eckstein, Water Resource Development, . . . p. 87.

As can be seen from Figure 3 and Table 2, the risk premium adjustment affect all projects, so it is better than using a cut-off date. The method also penalizes capital intensive projects more heavily and this is good since large fixed investments are more risky than projects with small investments and lower operating costs, since operating cost is variable and so could be stopped if the project fails. This is assuming other things equal.

Haveman recommends using different risk premiums in discounting benefits and costs where their uncertainties are different enough to warrant such a measure.[21] This seems to be quite sensible since there is no reason why benefits and costs must necessarily face the same degree or type of uncertainty.

(c) Contingency Allowance

This third method of making adjustments for uncertainty is very popular. This is usually done by adding a certain percentage of the estimated cost so as to use a larger cost figure or deduct a certain percentage of the benefits.

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[21] Robert Haveman, Water Resource Investment and The Public Interest, Vanderbilt University Press, Nashville, Tennessee, 1965, p. 172.

Various decision rules may also be used when dealing with uncertainty. The "Laplace Principle" may be used for example when dealing with outcomes with no known probabilities. Under such conditions equal probabilities would be assigned to all the possible outcomes. The method faces the problem of one not including all the possible outcomes.

Wald's maximin strategy may also be used. This is a rather conservative decision rule. The optimistic approach to this is the maximax strategy. One may not want to use either of these extremes, and the "Hurwicz Principle," may be used to incorporate both. Here optimism is measured on a scale α (from zero to one) and this α and $(1 - \alpha)$ values are used for multiplying the various maximum and minimum outcomes.

The Savage Principle of minimizing the maximum regrets may also be used. The analyst should leave the decision making to the politician, so he should only indicate the results of different decision rules to the politician and leave the choice to him.

The Interest Rate to Use

So far the importance of incorporating time and risk in the interest rate has been discussed, but no

attention was devoted to how an interest rate figure should be arrived at. As Eckstein rightly put it: "The choice of interest rate for design and evaluation of public projects is perhaps the most difficult economic problem and yet one of the most important ones faced in this field."[22]

The Subcommittee on Benefits and Costs recommend a rate which approximates the interest rate on long term government bonds 2-1/2 percent when the "Green Book" was written.[23] Eckstein, however, points out that the government bond rate does not necessarily reflect the social cost of capital employed in government projects.[24] He makes note of Keynes distinction between "borrowing risk" and "lenders risk."[25]

It is generally agreed that lenders risk in government bonds is virtually nil, since the credit worthiness of the government is largely dependent on its taxing power and the whole political stability of the country. This is not the case with the borrowers risk, however, since the

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[22] Otto Eckstein, op. cit., p. 94.

[23] Subcommittee on Benefits and Costs, op. cit., p. 24.

[24] O. Eckstein, op. cit., p. 95.

[25] J. M. Keynes, General Theory of Employment, Interest and Money (1936), p. 144.

risk of a project failing could be fairly high, but this is not taken into account in the bond rate, so this factor should be added to the bond rate in order to arrive at the social cost of capital invested in projects.

It has also been suggested by some that the rate of interest used for the private sector should be used for the public sector, based on the notion that taxes used for financing public projects should earn the same rate of return as private investments, and similar interest rates would be able to aid in achieving this goal. Eckstein notes that much of the taxes are paid by households and the alternate use of such taxes may be to a large extent consumption expenditure. This means that government taxes will not displace investments to the extent of the tax.[26]

Eckstein recommends tracing the capital used for public projects to its source, and hence to its opportunity cost. He argues that the tax from business will cause decline in private investment depending on the availability of investment funds in relation to the firms investment opportunities. The rest of the business taxes would tend to reduce the funds in the general capital market. For taxes derived from households, he figures that one could

[26]Otto Eckstein, op. cit., p. 97.

look at the interest rates at which households operate in their market transactions.

Using this line of research advocated in the preceding paragraph, Krutilla and Eckstein in an empirical study concluded that the rate of interest should be between 5 and 6 percent.[27] Eckstein, however, notes that if some weight is given to the welfare of unborn generations, and if the possibility of a different income distribution is considered, then the interest rate could be quite lower.[28] Due to the fact that a high interest rate penalizes projects with large capital investment and long time periods in the realization of benefits, Eckstein advocates the use of a rate of interest lower than the 5 or 6 percent for government projects, since they would fall into this category. He also argues that the private market is not well geared for such projects and so the public may give up an area for which it is best suited. He also notes that the individual may be willing to borrow at high interest rates for consumption while willing at the same time to give tax for investment for future generations since this is a collective effort. Eckstein is, however, aware of the

[27] John V. Krutilla and Otto Eckstein, op. cit.

[28] Otto Eckstein, op. cit., p. 99.

fact that if the interest rate is too low it could cause the implementation of bad projects.

Eckstein sums up the problem thus: "I propose the following compromise which is designed to preserve the long-time perspective of the federal program, yet would assure that only projects are undertaken in which capital yield as great a value as it would in its alternative employments. Let the government use a relatively low interest rate for the design and evaluation of projects, but let projects be considered justified only if the benefit-cost ratio is well in excess of 1.0."[29] He advocates the combination of low interest rate and high benefit-cost ratio such that it corresponds to a rate of return of 6 percent. Figure 4 depicts this principle.

The discussion has been confined to only a few writers and by no means covers all the major ideas on the proper discount rate to use for government projects. I could not leave this topic, however, without referring the reader to some very good contributions by other writers who were not covered in the discussion.[30]

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[29] Ibid., p. 101.

[30] See J. Hirshleifer, "Investment Decision Under Uncertainty: Applications of the State-Preference Approach," Quarterly Journal of Economics, Vol. 80 (May

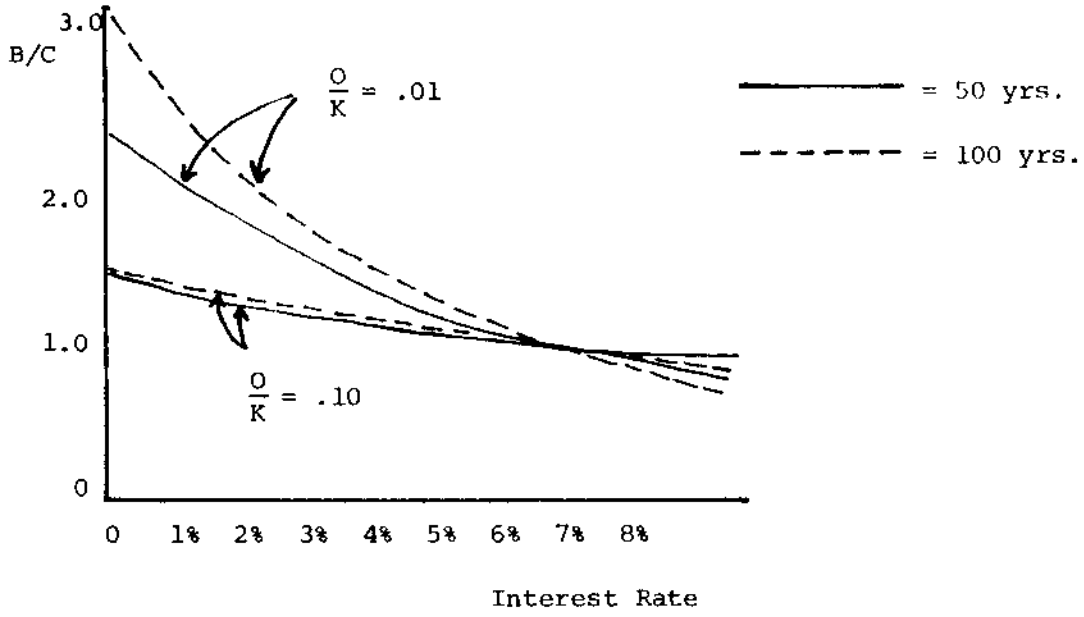

Figure 4

Source: Otto Eckstein, Water Resource Development . . . , p. 102.

The review of literature showed that there is no general agreement on the rate of discount which should be used for government projects. This is a very important factor, however, since it could determine whether a project is or is not implemented. Eckstein's suggestion of using

1966). J. Hirshleifer and D. L. Shapiro, "Treatment of Risk and Uncertainty," The Analysis and Evaluation of Public Expenditures: The PPB System, Vol. 1, Joint Economic Committee, Washington, 1969, pp. 505-530. W. J. Bamoul, "On the Social Rate of Discount," American Economic Review, Vol. 58 (Sept., 1968). M. S. Feldstein, "The Social Time Preference Discount Rate in Cost Benefit Analysis," Economic Journal, Vol. 74 (June, 1964). S. A. Margiin, "The Social Rate of Discount and the Optimal Rate of Investment," Quarterly Journal of Economics, Vol. 78 (May, 1964). K. J. Arrow, "Discounting & Public Investment Criteria" in A. V. Kneese & S. C. Smith, eds., Water Resources Research (John Hopkins University Press, 1966).

an interest rate so as not to penalize long term projects but using a benefit-cost ratio high enough so as to make sure that a 6 percent rate of return is achieved seem to have some merit.

The literature reviewed did not deal with the fact that government expenditure financed through taxes is a non-pareto better adjustment, since the taxpayers are forced to pay such taxes. This aspect of the problem will not be tackled in this paper, however.

Benefits and Their Evaluation

A major portion of the controversy surrounding benefit-cost analysis today is centered around what benefits should be included in the analysis and how the benefits should be valued. Generally benefits have been divided into primary (direct) and secondary (indirect) benefits. There has been differences in the definitions of primary and secondary benefits, and also differences in their use by agencies. Some agencies and large organizations such as the I.B.R.D. (World Bank) do not include secondary benefits in their analysis, while others do. This makes it quite possible for different agencies analyzing the same project to arrive at quite different

results even if they are using similar interest rate and investment criteria.

Benefits Defined

In the Senate Document No. 97, various types of benefits are defined as follows:[31]

(1) Benefits: Increase or gains, net of associated or induced costs, in the value of goods and services which result from conditions with the project, as compared with conditions without the project. Benefits include tangibles and intangibles and may be classed as primary or secondary.

(2) Tangible Benefits: Those benefits that can be expressed in monetary terms based on or derived from actual or simulated market prices for products or services, or, in the absence of such measures of benefits, the cost of the alternative means that would most likely be utilized that provide equivalent product or services.

(3) Intangible Benefits: Those benefits which, although recognized as having real value in satisfying human needs or desires, are not fully measurable in monetary terms, or are incapable of such expression in formal analysis.

(4) Primary Benefits: The value of goods and services directly resulting from the project, less associated costs incurred in realization of the benefits and any induced costs not included in project costs.

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[31] 87th Congress, Senate Document No. 97, pp. 8-9.

(5) Secondary Benefits: The increase in the value of goods and services which indirectly result from the project under conditions expected with the project as compared to those without the project. Such increase shall be net if any economic non-project costs that need be incurred to realize these secondary benefits.

The "Green Book's" definitions of primary and secondary benefits are fairly similar to the definitive above.[32] In it, primary benefits are considered to be the value of immediate products or services of a project and are readily measurable in most cases. These benefits being able to be evaluated at the first point in the chain of effects of a project where the products or services have an actual or estimated market value, but the most likely alternative cost of production of the product or services may also be used. These primary benefits attributable to the project being the gross primary benefits less associated costs.

Secondary benefits are regarded as the values added over and above the value of the immediate products or services of a project, such as those resulting from subsequent processing. It is considered unnecessary to consider secondary benefits in the successive steps in project

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[32]Subcommittee on Benefits and Costs, op. cit., p. 34.

formulation unless the net secondary benefits attributable to a project are appreciable as compared to the primary benefits.

Evaluation of Benefits

Evaluation of benefits is sometimes very difficult because of the difficulty involved in reducing all benefits to a common denominator. Arriving at a common denominator is particularly difficult when dealing with what is popularly regarded as intagible benefits. A flood control project which will save the loss of hundreds of human lives yearly, for example, will be difficult to assess its value. Quite often the policy maker may attach some value to such benefits but may be unwilling to state them. This is not a problem unique to project analysis; quite often, for example, judges have to make decisions on how much damages to award for the loss of a human life through accidents.

If the policy maker is willing to build a project which saves ten lives at a cost of $1000, then he should at least be saying that he values a life at a minimum of one hundred dollars.

In evaluating benefits and costs the "Green Book" recommended using prices estimated as they are expected to

be at the time when costs are incurred and benefits received. That is, applying prices current at the time of investigation to project investment costs when they are to be incurred shortly after the project authorization, while benefits and other costs would be expressed in terms of a price level expected to prevail at the time when these benefits and costs would be expected to occur.[33]

In arriving at future prices the "Greenbook" recommends using the average price level expected over the life of the project. Thus, requiring consideration of population growth, technological developments, changes in consumption patterns, levels of employment, amount of foreign trade, possibilities of substitutes and alternative sources of supply, and monetary and fiscal policy. Note is made of the difficulties involved in making such projections but they were regarded as necessary. A national projection could be made and agencies make certain adjustments according to regional deviations from the national average.[34]

McKean disagrees with the "Green Book's" recommendation of using current prices, since benefits and costs would be calculated using undeflated prices. Thus, if

[33]Subcommittee on Benefits and Costs, op. cit., p. 17.

[34]Ibid., p. 18.

gradual inflation was anticipated by the analysts, the benefits would be blown up relative to costs, because the bulk of the benefits would be realized after most of the costs were incurred. He used an example to emphasize his point, showing that if the price level rose from 100 to 300 by the time benefits occur, then it would be incorrect and misleading to say benefits were trebled.[35] The "Green Book's" recommendation of making projections is certainly commendable, but McKean's point of inflating benefits is very important. Using current prices present some form of a dilemma for the government. If the rate of inflation is projected, it could aid in the timing of project construction, by showing up how much could be saved by going ahead with certain projects now as compared to delaying them for a few years. On the other hand, the government may not be willing to say that it expects a certain rate of inflation to continue since this may even help in removing it from power.

Another aspect of benefit evaluation which could lead to erroneous decisions is using the cheapest alternative cost of producing an output. This method if properly used can really help in putting a price on benefits which

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[35] R. N. McKean, op. cit., p. 181.

are difficult to price otherwise, but it can easily be wrongly used.

McKean is fully aware of this when he states that, "there is considerable danger of going astray, however, when we shift to a task which is not definitely scheduled. The door is then open to counting as gain the cost of the cheapest alternative way of performing an unjustifiable task. Consider, for example, a project that supplies water to soils so poor that they can yield little or nothing even with irrigation. . . . If we estimate benefits to be minimum cost of supplying an equivalent amount of water to these lands by some other means, benefits may appear to be great, yet the whole operation may be practically worthless."[36]

Non-Marginal Changes

One of the major problems faced in evaluating project benefits occurs when the project or the whole program bring about major non-marginal changes. Under such conditions the prices of inputs and products may change significantly when comparing the "before" and "after" situation of

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[36] Ibid., p. 179.

the project or program. This type of situation is very likely to happen when there are large investment projects in less developed countries, and more so when the economy is small.

Large investment projects may increase production by so many units that the price per unit of the product falls considerably when the new product is marketed. If this additional output is measured by this new price it will not measure the value which consumers attach to it. This would be under-valuing the project benefits. On the other hand using the old price would be over-valuing the project benefits.

According to McKean, "the extra output contributed by the lumpy investment should really be multiplied by an average price between the amount for which the first extra units could be sold and the price for which the last units could be sold. The product of this multiplication approximate the amount that consumers would be willing to pay for the additional output.[37]

Prest and Turvey argue that when the demand curve is linear an unweighted average of the before and after price will suffice; but more complicated techniques being

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[37] Ibid., p. 169.

necessary for other forms of demand function, when they are known.[38] The problem is not as simple as this, however, because we are now facing an elusive demand curve. We are now not dealing with a movement along the demand curve, but rather with a new demand curve.

According to I. M. D. Little [59] a simple consumers' surplus criterion is valid only if the good is independent (or any substitutes are produced at constant marginal cost), and if price is everywhere equal to marginal cost. Since this is not likely to be the case there may be a great deal of producers' surplus elsewhere which may not be readily measurable, and may undo the consumers' surplus anyway. Because of the uncertainties associated with consumers' surplus it is difficult to say whether this criterion will do a better job of dealing with non-marginal changes than the usual profitability criterion.

Secondary Benefits

Although the treatment of primary benefits still need some improvements the treatment of secondary benefits is by far more controversial and has need for more unanimity in treatment.

[38] Prest and Turvey, op. cit., p. 691.

One of the major areas where there is need for improvement in dealing with secondary benefits is the tendency for over or double counting of such benefits. To cite an example of such double counting, in an A.I.D. report on the Lake Chad Basin, direct irrigation benefits were (rightly) calculated as the net increase in value of agricultural production after an allowance was made for the increased cost of production (associated costs) other than the cost of water. They went on to add, however, that in addition the community and the nation would receive benefits due to the increased food available, the increased prosperity of the project farmers, etc.[39]

McKean in his book devotes considerable attention to such double counting. He makes the point that irrigation projects have sometimes been given credit not only for the imputed value of water (that is, what farmers could pay for it) but also for the value of the crops made possible by the water, the value of the livestock made possible by the crops, and the value of the milk products made possible by the livestock.[40]

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[39] Potential Irrigation Development, Lake Chad Basin, Nigeria. Report prepared for A.I.D. by U.S. Bureau of Reclamation.

[40] R. McKean, op. cit., p. 151.

What McKean says may seem to be overemphasizing the point, though it is not inconceivable that such overcounting has been done. McKean seems to feel quite strongly about double counting, however. At another point in his book he had this to say. "There is no denying that the subject is confusing. Successive payments are undeniably gains to the recipients, and it is easy to slip into regarding them as net gains to the nation . . . . First to be counted are the values attached to the new output by those who purchase from the farmers. To these are added the incomes generated as the farmers take their receipts and pay them out to others. Also, as expenditures to build the project become incomes to laborers, cement producers, and steel fabricators, these incomes are included among the benefits. Right before our eyes, the farmers costs, the project costs, and a good many other costs have suddenly turned into gains."[41]

To overcome such errors in counting benefits the Special Task Force Report to the Water Resources Council recommend the classification of project benefits according

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[41] Ibid., p. 157.

to their objectives.[42] These benefits according to objectives are divided into: (a) National Income benefits; (b) Regional development benefits; (c) Environmental benefits; and (d) Well-being benefits. This report considers it unnecessary to term benefits as primary or secondary, instead the benefits could be regarded as contributions to the given objectives.[43]

Using the conventional terminology of secondary benefits the report suggests that such benefits can only contribute to the national income objective if there were either unemployed resources and the project brought them into employment, or if there are economies of scale in production in the industries involved.[44] Unemployed resources as used here also include underemployed resources and cases where fully employed resources are better used as a result of the project.

This treatment of secondary benefits seems to be quite good, where benefits are just a transfer from one

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[42]Report to the Water Resources Council, By the Special Task Force, Procedures For Evaluation of Water and Related Land Resource Projects. U.S. Water Resource Council, Washington, D.C., June 1969, p. 30.

[43]Ibid., p. 28.

[44]Ibid., pp. 42-43.

region to another they would not be counted as additions to national income (eliminating much of cause of double counting) but could be counted in the regional benefits. If the society, however, regards regional development as important than even a pure transfer of resources may be making some contribution to the national objective of regional development, though this could not be regarded as an addition to national income.

Schmid and Ward tested the recommendation of the Task Force Report on a particular project.[45] They give a very good summary and recommendation of the issues raised by the Task Force Report. Among some of these conclusions are: They commend the report for suggesting a more explicit display of multiple product effects, and the indirect effects of the project at the regional level.

They emphasize the need for great care to be taken when dealing with employed resources, so as to distinguish those effects which are only changes in economic activity and those which are truly benefits to anyone. Thus, only

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[45] A. Allan Schmid and William Ward, A Test of Federal Water Project Evaluation Procedures with Emphasis on Regional Income and Environmental Quality: Detroit River, Trenton Navigation Channel. Agricultural Economics Report No. 158, April, 1970. Dept. of Ag. Economics, M.S.U., East Lansing.

net gains in wages and profits should be accounted for. This would avoid the mistake of neglecting the opportunity cost of an employed person or the use of other resources.

There may be some indirect income gains to a region (even if at the expense of another region), but these they argue can't be stated with confidence. Using regional multipliers may inflate such benefits. They figure, however, that indirect income benefits are simply a poor way to make income transfers.

The point is made that the inclusion of benefits to unemployed resources will direct more of the water program budget to projects in the poorer regions, while weighting of indirect income to employed resources will direct more of the budget to the richer more industrialized regions, since they are more self-contained economies and thus, retain more of the indirect benefits.

Note is made of the point that helping geographic areas of low income should not be confused with helping poor people, since projects in poor areas need not help the poor people in that area. The effect of the project on income distribution should be made as explicit as possible.

They (rightly) feel that more attention must be given to assuring that individual project analyses will

make sense when put together in programs. The individual project is therefore an inadequate perspective from which to operate.

In evaluating project benefits it is also important to guard against not allowing for an adequate time lag before estimates are made for full project benefits. When one is dealing with a heterogeneous situation (example crop yield with different soil fertility) care must be used in order to arrive at a representative figure for the aggregate, otherwise benefits could easily be overvalued.

In concluding, I would say secondary benefits should be included in the project analysis and be given as much importance as primary benefits. In the more developed economies where there is very little unemployment, the deletion of secondary benefits may not be very important, but in most of the less developed countries unemployment is fairly high, and the inclusion of such secondary benefits derived from the employment of these unused resources could play a vital part in development.

Costs and Their Evaluation

Generally speaking, project costs and their evaluation is not as problematic and controversial as is the

case for benefits. Since in many projects a major portion of the project cost occurs at the investment stage, the problem is more one of estimation quantitatively, rather than deciding what price to use. It may be worthwhile to note, however, that while in the construction stage a project could be such that it brings about non-marginal changes, causing similar problems as discussed under benefits valuation. In some instances also projects are planned for in advance before the start of the project, and here again there is the problem of projecting prices.

Definition of Costs

Senate Document No. 97 gives the following definitions of costs.[46]

(1) Project Economic Costs: The value of all goods and services (land, labor, and materials) used in constructing, operating, and maintaining a project or program, insterst during construction and all other identifiable expenses, losses, liabilities, and induced adverse effects connected therewith, whether in goods or services, whether tangible or

[46]Senate Document No. 97, op. cit., p. 11.

intangible and whether or not compensation is involved.

(2) Installation Costs: The value of goods and services necessary for the establishment of the project, including initial project construction; land, easements, rights-of-way, and water rights; capital outlays to relocate facilities or prevent damages; and all other expenditures for investigations and surveys, and designing, planning, and constructing a project after its authorization.

(3) Operation, Maintenance, and Replacement Costs: The value of goods and services needed to operate a constructed project and make repairs and replacements necessary to maintain the project in sound operating condition during its economic life.

(4) Induced Costs: All uncompensated adverse effects caused by the construction and operation of a program or project, whether tangible or intangible. These include estimated net increases, if any, in the cost of government services directly resulting from the project and net adverse effects on the economy such as increased transportation costs.

Induced costs may be accounted for either by addition to project economic costs or deduction from primary benefits.

(5) Associated Costs: The value of goods and services over and above those included in project costs needed to make the immediate products or services of the project available for use or sale. Associated costs are deducted from the value of goods and services resulting from a project to obtain primary benefits.

The Special Task Force Report to the Water Resource Council agrees with the above definitions of induced and associated costs, except for the fact that the definitions should not be limited to primary costs, but should rather apply to all objectives.[47]

From the foregoing definitions of costs one can see that it is necessary to include all the relevant costs associated with the project. While there is a tendency for overcounting of benefits, when dealing with cost there is a tendency to write off some costs as not important. This should be avoided, and effort should be made to account for

[47]Special Task Force Report, op. cit., p. 35.

all aspects of the project if it is worth the effort to do so. The procedures discussed for evaluating future benefits should also be used for estimating operation and maintenance costs.

CHAPTER IV

Development Planning

Over the past twenty years development economics and development planning have taken on major significance in both academic and non-academic circles. Today most of the less developed countries have some form of national development plan. Though these development plans usually possess certain common features, such as some of their policy objectives, they do differ widely from country to country.

According to Arthur Lewis, "a development plan may contain any or all of the following features: (1) a survey of the current economic situation; (2) proposals for improving the institutional framework of economic activity; (3) a list of proposed government expenditures; (4) a review of major industries; (5) a set of targets for the private sector; (6) a macroeconomic projection for the whole economy."[1]

[1] W. Arthur Lewis, Development Planning. George Allen & Unwin Ltd., 1966, p. 23.

The diversity of development plans is also expressed by experts in a United Nations' publication. "There are in the real world no completely planned and completely unplanned economies; planning is obviously a matter of degree. In the countries of the region, the degree of planning varies widely. Thus, there is on the one hand the centrally planned economy in mainland China . . . where most labor, material and equipment resources are allocated by the government to the production units, which dispose of the major part of their products according to central direction. On the other hand, there is the predominantly private enterprise economy of Japan, in which planning means chiefly projection by the government of economic activity (including that of government) and the influence of the government on the rate of growth through fiscal and monetary policies. In between these two extremes, come the other countries of the region with different shades of 'mixed economy' . . . ."[2]

Demas defines planning as "the formulation and execution of a consistent set of interrelated measures

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[2]United Nations, Economic Commission for Asia and the Far East, "A Decade of Development Planning and Implementation in the ECAFE Region," Economic Bulletin for Asia and the Far East, Vol. XII, No. 3, Dec. 1961. Taken from G. Meier, Leading Issues in Development Economies. Oxford University Press, 1964, p. 423.

designed to achieve certain specific economic and social goals."[3] Demas then goes on to say if planning is so defined, then, its most important goal in any underdeveloped country is to achieve as rapidly as possible transformation of the economy, and the possibility of such transformation in turn requires structural and institutional change.[4]

Structural changes he considers to be major shifts in the composition of output, the distribution of the labor force, the composition of exports and imports; the forging of linkages between economic sectors; the raising of productivity in lagging sectors and regions; increasing the savings ratio; and above all changing the direction of investment. While institutional changes are required to create new types of markets, new incentives, new skills, new instrument for mobilizing resources, new attitudes, and increased mobility and responsiveness of factors of production to price and income opportunities.[5]

From the foregoing it is quite clear that when anyone talks about a development plan it will not be clear and

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[3]William G. Demas, The Economics of Development in Small Countries with Special Reference to the Caribbean. McGill University Press, Montreal, 1965, p. 120.

[4]Ibid., p. 120.

[5]Ibid., pp. 120-121.

precise to everyone unless he defines what he means. Development planning as will be discussed in this chapter is within the context of a decentralized economy, and Demas's definition is fairly close to what is being considered as development planning here.

The extent of development planning in any country is largely influenced by its stage of development; the availability of statistical data and their reliability; the availability of professionals to make the plans, and of good administrators to execute them. Not only will these factors affect how much emphasis is placed on planning, but they will also determine the planning techniques used.

Development plans in terms of duration may be classified into three categories: (1) perspective plans, usually covering a time period of twenty to thirty years. These plans tend to create a certain degree of continuity, and are very important if planning is not to be done on an ad. hoc. basis. They must be flexible, however, so that as reiteration is done they can be modified to suit changing conditions. (2) Medium term plans are usually about five years in duration. They are more detailed than perspective plans, and are also more of a working plan. (3) Short-term

plans, these usually take the form of annual government budgets. These plans are usually more detailed than the previous ones, and are also usually subjected to less changes.

The Importance of the Qualitative Aspects of Planning

A great deal of the literature on development planning is devoted to programming techniques (quantitative aspects), but the qualitative aspects of planning are of equal importance. Lewis is aware of this face when he makes the following statement.

"The recent trend towards putting more figures into Development Plans has unfortunately tended to obscure the fact that what matters in planning is not mainly figures but mainly policy. It is possible to write a good Development Plan which is mathematically completely consistent, but which will nevertheless achieve nothing, because policies are lacking."[6] It is therefore necessary to create the proper environment for development, if the development plans are to meet any degree of success.

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[6] W. Arthur Lewis, op. cit., pp. 22-23.

From the foregoing it can be seen that the qualitative aspects of planning should be given as much priority as the quantitative aspects. This is even more so the less developed is the country, since it may lack the necessary data for certain quantitative analyses, and changing attitudes etc. may be most important in overcoming some of the real bottlenecks to development. It may be worthwhile to note also that quantitative techniques can be of major help to the decision maker (the politician) but they cannot replace him. This may sound trivial, but some people get so involved with their techniques that they figure that quantitative methods can solve all the problems.

Planning Techniques

Development planning today relies heavily on the use of "economic models."[7] To quote from a United Nations Bulletin, "Development programmes relies on the existence of a certain number of interrelationships in the economy. . . . The soundness of a programme will depend largely on

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[7]An economic model is being regarded here as an organized set of relationships that describes the functioning of an economic entity. Such an entity could be a firm, a region, or a country.

whether and to what extent the relevant relationships have been taken into account in formulating it."[8]

The models used in development planning usually consist of the following:

(1) a specified set of objectives, such as maximum income, full employment, or reduced balance of payments deficit.

(2) a set of instrument variables, related to the policy measures that a government intends to use to achieve its objectives. Such variables may be levels of savings, production, and investment by sectors.

(3) Other variables, not directly affected by government action, but which are necessary for adequate analysis of the economy, such as consumption of individual commodities, and prices of commodities and of productive factors.

(4) Economic relationships, in the form of equations containing the variables mentioned above. Such

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[8]United Nations, Department of Economics and Social Affairs, "Use of Models in Programming," Industrialization of Productivity Bulletin, 4, April, 1961.

equations may describe the behavior of an economic entity in terms of a response of one economic variable to change another variable, example a consumption function, a production function, an accounting identity such as demand having to equal supply.[9]

The models popularly used for development planning are:

(1) Aggregate Models

(2) Sectorial Models

(3) Input-Output Models

(4) Linear Programming Models

(5) Simulation Approach (this may incorporate various forms of the models listed above).

Before discussing these models, it is worthwhile to note that in any economy, a combination of several types of models may be used successfully rather than using only one type of model. Depending on the availability of data and

[9]The discussion of these variables draws from the Industrialization & Productivity Bulletin 4, op. cit.

state of the economy certain models may be better suited than others. One of the great advantages of using a combination of models is that they can be used to check the consistency of each other, and may also be used to strengthen each other's shortcomings.

Aggregate Models

These apply to the entire economy, dealing with production, consumption, investment, etc. as single aggregates. Aggregate models are popularly used to determine possible growth rates in national income, the volume of domestic savings, exports, imports, and foreign capital required to carry out a given program.

The following are the relations most commonly included in aggregate models:

(1) A consumption income (or savings income) relation;

(2) A production function, relating national product to input of capital and labor;

(3) An import function relating input requirements to the level of national income or its components;

(4) A certain number of constraints or limitations on resource use, such as, demand for labor cannot exceed supply; investment cannot exceed domestic savings plus net import of capital; imports cannot exceed foreign exchange earnings plus net receipts from foreign loans and grants.

Due to the fact that investment capital is usually regarded as one of the major limitations to development in the less developed countries, the Harrod-Domar model is popularly used as a form of a macro model. This model will determine the maximum growth achievable from the rate of investment and its productivity as measured by the capital-output ratio. The model can also be used to indicate the extent to which it would be possible to achieve full employment of labor.

Macro models need not be as limited as the Harrod-Domar model, however. All the limitations to growth can be entered into the model and a solution to the set of simultaneous equations is arrived at, which determines the rate of growth given these constraints.

One of the problems with aggregate models is that one tends to see only the forest but loses sight of the trees. Aggregate models provide a fairly adequate basis

for the use of general policy instruments, but they do not furnish a check on the consistency of the results in specific sectors and of particular public projects. Aggregate models tend to be less demanding in their data requirement when compared with other models, e.g. inter-industry models. They may, therefore, be more practical for countries with little statistics.

Sectorial Models

Sectorial models are fairly popular among countries attempting their first development plan. The general tendency has been for various ministries to select projects from their sectors and send them up to some central planning unit which must make the final development plan. This "bottom up" approach has tended to cause inconsistent plans, because each sector tends to make their decisions independent of other sectors. Such sectorial programs tend to be a collection of projects also. These are some of the reasons why many people are against such programs.

This need not be the case, however. In developing a sectorial model, it is necessary for the unifying planning body to identify key sectors in the economy. Once these sectors have been identified, an evaluation must be

made of alternative projects or production techniques within each sector. In order to formulate consistent sector plans, analysts in the different sectors should use similar accounting prices, e.g. foreign exchange, capital, etc. should be priced according to their scarcity.

After initial sector calculations have been made, then it is necessary to revise the objectives and sector and project selection. Plans should be modified until they are consistent.

If sectorial models are properly constructed, then they can be very effective in economic development. They provide a basis for assessing the effects of likely technological changes, and changes in the product mix within each sector. They usually make more use of technological and economic information than aggregate models. Sectorial models need not therefore be inconsistent, and lead to inefficient plans.

Input-Output Models

An input-output model like a linear programming model is a rather specific form of an inter-industry model. Input-output models have been adequately treated elsewhere so the major theoretical aspects will not be discussed.

Input-output models analyze explicitly the relationships among different sectors of the economy. For development planning the economy is subdivided into 15 to 30 or more production sectors with about 5 to 6 sectors of final use. The levels of final use are usually determined outside the model and the demands for intermediate products and imports are determined from the solution of the model.

The Inter-Industry Accounting System

The basic accounting system of an input-output table can be presented as shown in Table 3. Production activities are grouped into sectors, each sector appearing twice as a producer of output and again as a user of inputs. Each row indicating the output of a sector which is either put to intermediary use (used for production by other sectors) or consumed as final demand. Final demand consisting of investment, private consumption, government consumption and exports.

Each row shows the inputs that have been purchased by a sector from other sectors. The total intermediate inputs used by one sector the balance of which total production adds up to the total primary inputs. Thus, the

TABLE 3

THE ACCOUNTING SYSTEM OF AN HYPOTHETICAL MODEL

	Purchasing Sectors					
	Intermediate Use		Final Demand	Total Production	Import	Total Use
	Sectors	Total Intermediate Use				
Producing Sectors	X^{11} X^{12} ---X^{15} X^{21} X^{22} ---X^{25} " " --- " " " --- " X^{51} X^{52} ---X^{55}	W^1 W^2 " " W^5	Y^1 Y^2 " " Y^5	X^1 X^2 " " X^5	M^1 M " " M^5	Z^1 Z^2 " " Z^5
Total Intermediate Inputs	U^1 U^2 ---U^5	W	Y	X	M	Z
Value Added	V^1 V^2 ---V^5		V			
Production	X^1 X^2 X^5					

Source: United Nations, Development Programming Techniques, No. 6, ECAFE. Bangkok, 1967, p. 27.

payments for primary factors of production (land, labor, and capital) equal the sectorial value added. All payments are accounted for, and adding up the final uses will give the approximate gross national product.

The Assumptions of the Model

The following are some of the basic assumptions of an input-output model.

(1) One production function for each sector.

(2) A given product is supplied only from one sector.

(3) There are not external economies or diseconomies.

(4) The demand for input is a function of the level of output only.

(5) Linear relationship between inputs and outputs.

(6) Relative prices remain constant.

The model is solved by setting up a matrix and then the matrix is inverted. The solution to the model aids in the allocation of the investment required to achieve the production levels in the program, and it provides a more

accurate test of the adequacy of available investment resources.

The input-output model is particularly applicable to economies that have achieved a certain degree of industrial development, thus, having a substantial volume of inter-industry transactions. Regional input-output models can be used for exploring the implications of development programs for the particular region concerned as well as for the whole economy. Because the model is built on an interdependent system, it provides mutually consistent values for the most important economic magnitudes such as: total output; intermediary demand; final demand and value added. It, therefore, gives a precise degree of interdependency among the various sectors of the economy.

From the assumptions of the model, one can see that it has several limitations. The model is unable to deal with non-linear relationships and price changes. The model is also static, looking at the economy at one period in time, but not able to trace the interrelationships through time. Old industries which are becoming inefficient and should be phased out, but still showing large multiplier effects would tend to be favored over new industries which have not yet developed supporting services thus having a

small inter-industry multiplier even though this new industry may be better for the transformation of the economy in the long-term perspective.

Input-output models also make heavy demand on statistical data, and professionals. Such models are, therefore, not very suitable for real backward underdeveloped economics. Some of the limitations discussed in the previous paragraph may be overcome by using a dynamic input-output model.

Linear Programming Models

Basically a linear programming model consists of three components: (1) An objective or set of objectives; (2) alternative methods or processes for attaining the objectives; and (3) a set of restrictions or constraints.

The Objective Function

The objective function can take many forms. For development planning some of the popular objectives are: Maximization of Gross National Product; maximization of consumption; and minimization of unemployment. The model could be set up so as to maximize GNP subject to the constraint that unemployment does not exceed five percent of

the labor force. Or, the policy maker could choose to maximize real GNP subject to restrictions on the rate of price inflation.

The Alternatives

In contrast to input-output models, linear programming models can use several alternative techniques of producing the same commodity, also alternative uses can be made of resources. The economy is broken down into several sectors, each sector possessing their own production, investment, and in some cases import and export activities.

The Constraints

A number of economic and technological constraints must be met by the optimal program. These constraints specify the limit upon the availability of primary resources (land, labor, capital and foreign exchange) over the planning period, and minimal sectorial goals for production and investment. Below are some examples of such constraints:

(1) The level of each sector's production cannot exceed its capacity level, which is the sum of the initial capacity and the additional capacity created by

sectorial investment minus capacity eliminated by sectorial disinvestment during the relevant period.

(2) The total demand for all goods produced by a sector must equal the total production of the sector plus imports.

(3) The total value of imports cannot exceed the value of exports by more than the maximum deficit permitted.

(4) The demand for labor cannot exceed the available labor force.

(5) The percentage of employed workers to the total labor force must exceed a certain percentage.

The solution to the linear programming model consists of finding the most economical way of achieving the given set of objectives. Linear programming models make heavy demands in their data requirement. Not only do they need detail sectorial information, but they also need detailed information of the industries within sectors. Like input-output models, linear programming models are unable to deal with non-linear relationships unless the model is modified. It is doubtful if such models will be used

extensively in development planning in the less developed countries, since it calls for a certain degree of sophistication which may not be available.

Simulation Models

Clarkson and Simon regard simulation as a technique for building theories that reproduce part or all of the output of a behaving system. This system can be an aggregate of the behaving units, an entire economy or a particular unit.[10] According to Orcutt, "simulation is a general approach to the study and use of models. As such, it furnishes an alternative approach to that offered by conventional mathematical techniques."[11]

The definition of simulation which will be used for this paper is one furnished by Hayenga et al. "Computer simulation is a systems analysis tool which utilizes subject matter theory, certain mathematical structures, programming logic, and empirical analyses to condense a

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[10] P. Clarkson and H. Simon, "Simulation of Industrial and Group Behavior," American Economic Review, Vol. 50, December 1960, p. 920.

[11] Guy H. Orcutt, "Simulation of Economic Systems," The American Economic Review, Vol. 50, December 1960, p. 893.

complex system into a mathematical formulation duplicating the essence of the real system."[12]

The systems analysis approach attempts to isolate and formulate into a mathematical model those sectors and components of the economy and those physical, biological, economic, and social relationships within them which are most important in affecting the development effort. This approach in the development context emphasizes those relationships that can be affected by or are vital to the evaluation of development policies. The model is used for analyzing alternative development strategies and assisting in the critical resource allocation decisions.[13]

Simulation Methodology

Using Halter, et al. model here, simulation is regarded as an iterative problem-solving process. This is depicted by Figure 5.

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[12]M. L. Hayenga, T. J. Manetsch, and A. N. Halter, "Computer Simulation as a Planning Tool in Developing Economics," American Journal of Agricultural Economics, December 1968, p. 1755.

[13]A. N. Halter, M. L. Hayenga, and T. J. Manetsch, "Simulating a Developing Agricultural Economy: Methodology and Planning Capability," American Journal of Agric. Economics, Vol. 52, May 1970, p. 275.

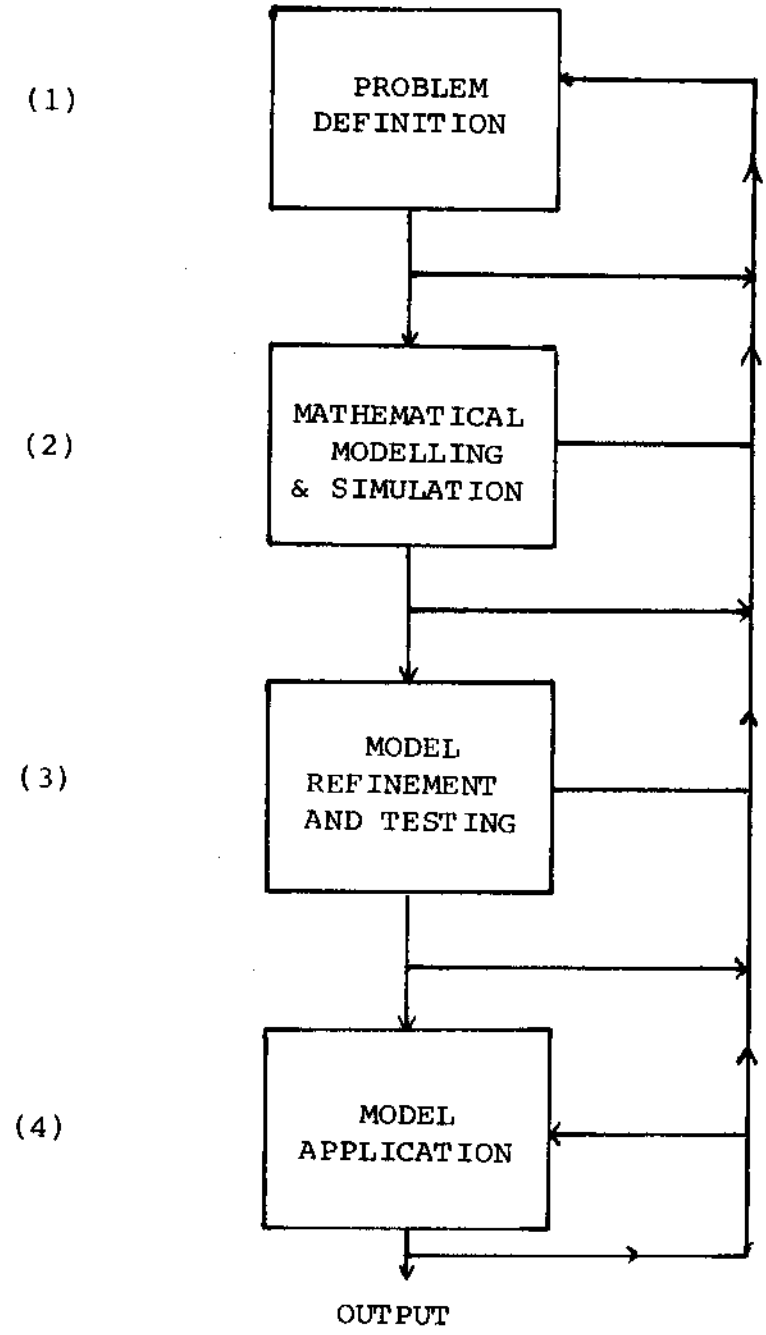

Figure 5.--Computer Simulation as an Iterative Problem-Solving Process.

Source: A. N. Halter, M. L. Hayenga, & T. J. Manetsch, "Simulating a Developing Agricultural Economy: Methodology and Planning Capability," American Journal of Agric. Economy, Vol. 52, May 1970, p. 272.

As shown by Figure 5, simulation involves problem formulation, mathematical modeling, refinement and testing, and execution. The arrows indicate the importance of the iterative process. Problem definition very briefly involves specifying the functions and mechanisms of the system, the appropriate system performance, and the alternative means available for achieving the objectives.

The mathematical form of the model may be represented as follows:[14]

$$\psi\ (t + 1) = F\ [\psi(t),\ \beta(t),\ \alpha(t)]$$

$$\Theta\ (t) = H\ [\psi(t),\ \psi\omega(t),\ \alpha(t),\ \beta(t),\ \gamma(t)]$$

$$\pi\ (t) = G\ [\psi(t),\ \alpha(t),\ \beta(t),\ \gamma(t)]$$

where:

ψ = a vector (set) of variables that defines the state of the simulated system at any given time. Typical state variables might be production capacities, land allocated to various activities, prices, population by subgroups, levels of technology, etc.

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[14] Ibid., p. 275.

$\psi\omega$ = a vector of variables that describes the state of the system in the real world.

$\alpha(t)$ = a set of parameters that defines the structure of the system, e.g., technical coefficients, etc.

$\beta(t)$ = a set of exogenous variables that influence system behavior, e.g., world prices, weather, etc.

$\gamma(t)$ = a set of policy variables that can be controlled to alter the system's performance in various directions, e.g., investment alternatives, tax policies, etc.

$\Theta(t)$ = a set of intermediate output variables that measure how well the model of the system $\psi(t)$ corresponds to reality $\psi\omega(t)$, e.g., residual sum of squares, R^2, etc.

$\pi(t)$ = a set of output variables which measure the systems simulated performance, e.g., profit, income, rates of growth, per capita income, foreign exchange earnings, etc.

The first equation is a difference equation formulation of the system model which describes the state of the system and subsequent performance at discrete points in time. The second equation applies in the model refinement and testing stage. The third equation is relevant in model application when the performance of the system is simulated over time under various policy alternatives.

Sensitivity analysis may be used for testing and refining the model. Sensitivity analysis can be used to test the impact of changes in model parameters upon the model behavior. Such testing can indicate what data are most important in affecting the model behavior, thus, establishing priorities in data collection; it also shows programs and policies which may significantly improve the performance of the system.

The Advantages of Simulation

(1) Simulation allows a degree of complexity to be handled that would be impossible if inferences could be drawn only by standard analytical techniques. In other words, simulation techniques make possible the effective study of models

containing large numbers of components, variables, and relationships of almost any desired form.

(2) Simulation approach makes it possible to carry out sensitivity analyses on a model. The model can be run many times with the value of parameters being altered between runs. The resulting variations in time path of endogenous variables can be observed and related to the corresponding alterations of parameters. After finding out how sensitive these results are specific differences in the size of parameters, the investigator is in a much better position to decide where to apply additional research effort in parameter estimations.

(3) Simulation techniques permit specific implications of models to be determined. By so doing, they make it possible to carry out testing at various levels of aggregation, ranging from the level of individual components up to the level of highly aggregated phenomena such as national income.

(4) Simulation or closely related Monte Carolo studies can be useful in supplementing or extending modern multivariate statistical techniques of estimating

parameters in operating characteristics. In effect, these techniques enable operating characteristics to be fitted to bodies of data by systematic trial and error procedures. This may become of great importance when dealing with various kinds of non-linear relationships for which other methods of estimation are either unknown or too costly.

(5) Mathematical simulation and system analysis offer an interdisciplinary approach for interrelating the different aspects of complex problems to see the consequences through time of alternative policies and programs.

(6) Simulation provides the research worker with a convenient way of getting around the intractable problem of reducing many objective functions to a single desired outcome.[15]

(7) Simulation has much to offer in the designing of nonexistent systems.

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[15]The first four advantages were taken from Guy H. Orcutt, op. cit., pp. 900-901. While the fifth and sixth were taken from Glenn L. Johnson, "Relevant Rural Development Research for West Africa," paper presented at a Seminar on Research on Agricultural Development in East Africa, MSU, June 9-14, 1968, pp. 25-26.

The Major Disadvantages of Simulation

(1) Simulation needs trained personnel which may be rather limited in the country.

(2) There must be ready access to high speed digital and analogue computers.

(3) Simulation approach when compared to the models discussed can be very costly to set up initially. The fact that the model can be used over and over again by making slight adjustments of the parameters, etc. should be borne in mind however.

CHAPTER V

The Role of Project Analysis in the Development Program

Little and Mirrlees seem to sum up quite well what I intend to achieve in this chapter when they say, plans require projects and projects require plans.[1]

From the point of view of the importance of projects they say, "If a plan is to be consistent and feasible a lot of self knowledge is required. If this self knowledge is to be gained, the critical appraisal of projects which have already been constructed should not be neglected. But one cannot be satisfied with a plan which is merely consistent and feasible . . . unless one strives continuously to direct one's investment to those sectors where it would yield the most benefits to the economy, and within sectors to projects which yield most, one will certainly end up with a plan which is very far short of what could be

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[1] I. M. D. Little and James A. Mirrlees, Manual of Industrial Project Analysis in Developing Countries. Vol. II. Development Centre of O.E.C.D., Paris, 1969, pp. 58-59.

achieved. Thus if the division of investment between different sectors of the economy is to be rational it is essential that the costs and benefits of many different projects in each sector should be assessed on a comparative basis."[2]

On the question of projects requiring plans, Little and Mirrlees note that the best economic appraisals of projects cannot be made without a plan. They figure that to choose the right projects one must have an estimate of the demand for its products, and in order to know the estimated domestic demand one needs to have some idea of how the economy will develop. The development of the economy in turn is influenced by the government's plan and policies. On the supply side, analysis of the real cost of the project requires knowledge of the strength of the scarcities which are operating and will operate in the economy.[3]

According to Stolper, "The lease of any development program is an action program consisting of well thought through projects. What distinguishes the comprehensive approach from a mere list of projects is, first, that an attempt is made to relate the various projects towards each

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[2] Ibid., p. 58.

[3] Ibid., pp. 59-60.

other; secondly that an attempt is made to take indirect effects into account; thirdly, that an attempt is made to relate policies for both the public and the private sector to the projects; and finally, that an attempt is made to make the various projects feed into each other in timing, manpower planning, size, and so forth."[4]

A group of United Nations experts commented on the role of project analysis in planning as follows: "The majority of the decisions taken by governments to implement development programs apply to individual commodities and projects, and an overall development plan is of only limited value unless it can be translated into these more specific terms."[5]

Haveman and Krutilla using a form of Leontief input-output analysis did an excellent job of showing the effects of the construction of several types of projects on the economy. In their model the construction of a project is assumed to impose two primary kinds of demand on

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[4]Wolfgang F. Stolper, "Comprehensive Development Planning," paper presented for the Economic Commission for Africa in Addis Ababa 1962. mimeographed. In Gerald Meier, Leading Issues in Development Economics, Oxford University Press, 1964, p. 494.

[5]United Nations, E.C.A.F.E. Formulating Industrial Development Programs, Development Programming Techniques Series No. 2, Bangkok, 1961, p. 31.

the economy for on-site labor which represents direct factor demands and for materials, equipment, and supplies which result in withdrawal of factors through the several rounds of the production sequence generated by the final demand.[6] Table 5 below is a brief sketch of their table.

Haveman and Krutilla claimed the purpose of their study was to present a method of analysis and to discuss a body of data essential for the evaluation of the social cost of public expenditures in an economy with unemployed resources. Secondly to investigate the structure of demands imposed on the economy by the construction of various kinds of water resource projects.[7]

From this study they were able to make the following conclusions:

(1) In considering water resource development as a stimulant for the economy, the policy maker must distinguish the several different kinds of projects. There being substantial differences in the structure of demands imposed upon the economy and each project type tend to stimulate quite different parts of the economy.

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[6]Robert Haveman and John Krutilla, op. cit., p. 17.

[7]Ibid., p. 35.

TABLE 4

CONSTRUCTION COST OF VARIOUS TYPES OF PROJECTS ALLOCATED TO INDUSTRIAL AND OCCUPATIONAL CATEGORIES (000 DOLLARS)

Categories	Large Earth Fill Dams	Power House Construction	Large Multipurpose Projects	---	Total
Industry & Input-Output Study Sectors					
Agriculture, Forestry & Fisheries					
Manufacturing					
Transportation & Warehousing					
:					
Total Material, Equipment Etc. Cost					
Occupation					
Professional, Technical Etc.					
Craftsmen, Foremen, Etc.					
Operators & Kindred Workers					
Laborers					
Total On Site Labor Cost					
Total Project Cost					

(2) In addressing the needs of an economy with a given pattern of unemployment, the gross employment generated by a project is not the only relevant policy variable. Different types of projects impose their demands on widely different categories of labor.

(3) In forming policy, decisions should be based on the pattern of gross output and total labor demands. Restricting information to the bills of final demand and on-site labor only lead to erroneous judgments. The indirect production and off-site labor demands generated by the bills of final demand are fully as large as the demands for direct production and on-site labor, and they form a significantly different pattern.[8]

Since the majority of the less developed countries are faced with the problem of overcoming regional and national unemployment such analyses of projects could contribute greatly to the economy's development.

From the foregoing, one can see the importance which must be attached to project analyses in any development program. Benefit cost analysis can therefore make a

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[8] Ibid., p. 36.

significant contribution to the planning process, by using it in project selection. For such project appraisal and selection to be meaningful, however, there must be proper coordination between various public agencies, and between the public and private sectors of the economy.

Coordination between agencies is sometimes more easily said than done, however. Different appraisal of individual projects could be done in order to help solve this problem. A project could be appraised for example showing a particular benefit-cost ratio if certain other projects are constructed, or if certain other conditions are met. Another analysis could be made of the project assuming that only some of these conditions are met. The central planning body would then be in a better position to handle the interdependence between projects and sectors, since he would be better able to see what set of projects will give the greatest return.

The timing of projects should also be given importance in their appraisal. This could be taken care of to some extent by the different appraisals of particular projects. In this way one could show the benefits to be gained by building projects simultaneously or in building some projects before while others follow.

Some people recognize the importance of inter-industry studies, but yet regard the inclusion of secondary benefits (indirect benefits) in benefit-cost analysis as not important or unnecessary. This I think is very inconsistent. By the inclusion of indirect benefits, one is able to obtain a fair amount of the cross-sectional effects of a project on the economy, and in so doing one may be able to get a great deal of information without even setting up formal inter-industry studies. One should be careful, however, of not making the mistake (as some agencies do) of counting only the positive secondary impacts of the project, but at the same time disregarding the negative impacts.

CHAPTER VI

Summary and Conclusion

Public investment analysis and development planning have grown considerably during the past twenty years. This has been due to several factors: Keynesian type of economics advocating the role of government in using monetary and fiscal policy in order to factor economic development, and present unemployment; economists started isolating cases where the free market mechanism would not be able to do a good job in resource allocation, and of even more importance the need for government to change the pattern of resource ownership. These factors led to a large increase in the public sectors in most countries.

With the public sector accounting for a large amount of most countries' investment, and with its ability to guide and influence non-public investment, it was quite natural that public investment analysis and planning took on added significance. It, therefore, became necessary to search for appropriate criteria to use in the allocation of

such public funds given the policy objectives and constraints at any point in time.

On the question of the choice of criteria the interest rate to use, and the adjustments to make for risk on uncertainty there has been little unanimity among prominent economists and public administrators. Some of the criteria advocated are: the benefit-cost ratio; the internal rate of return; and the Social Marginal Productivity (SMP) criteria.

As was discussed in the paper, no one criteria will lead to the most efficient use of resources for any given condition, so it is necessary to be pragmatic and use the criteria which will give the most efficient use of resources given one's objectives and constraints.

Deciding on the correct interest rate (that is if one can be so precise as to state a correct interest rate) for discounting benefits and costs of development projects is a rather difficult problem. The interest rate used should reflect a certain degree of risk discounting, and should also reflect to a large extent the opportunity cost of capital. Under such conditions, it is unlikely that the interest rate used could be so low that it permits bad projects to be constructed. Since many public projects

benefits are not maximized before a considerable time lag, one needs to be careful also in not using an interest rate so high that such vital projects for the countries' development are made to look bad, and thus, not constructed.

The use of a contingency allowance for project costs seems to be a practice to be commended, because even when great effort is put into estimates of costs there is still a tendency for costs to be underestimated. This seems to be prevalent in the less developed countries, and this may be due to the lack of skills, or lack of experience of people involved with implementing the project. Cutting the life of the project arbitrarily may discriminate against certain projects unnecessarily.

Development planning cannot be meaningful if it is orientated only around the public sector. The government must set policies and targets designed to influence the private sector into making their needed contribution to the development program. Planners should try not to have conflicting objectives, though this is a problem faced quite regularly. The maximization of national income and full employment, for example, may be very inconsistent in the short run. Under such conditions, one may have to

settle for a certain degree of unemployment or a reduction in the growth of national income.

Various planning techniques may be used. Aggregate models may be used for estimating what percentage of income is necessary to be invested in order to achieve a certain rate of growth, they can also be used for roughly estimating the magnitude of foreign exchange gap which is likely to develop, and also to show up the real limits of the investment program and may be best able to account for all the indirect repercussions of the investment programs.

Inter-industry models may be used quite effectively for showing up the interrelationships between the various sectors of the economy, and are able to show up many micro-level problems which the aggregate model is unable to show. These models may also be used for regional planning. Inter-industry models may be somewhat limited, however, because of lack of data, limited amount of industrialization and the restrictive assumptions on which they are usually based.

Sectorial models, if well coordinated, may be very good for development planning but quite often this coordination between sectors is very lacking and this may lead to inconsistencies in the overall development plan.

Whatsoever the planning technique used, they must all incorporate a certain degree of micro-level planning if the plan is to be meaningful. Selection of the best set of projects which can add to the development objective is therefore a vital element in the development program. Benefit-cost analysis may be used effectively as a criteria for such projects selection.

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