OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

D03042

Evaluation of industrial and infrastructure methodology and practical experience

by T. E. Kuhn*

Introduction

This paper owes much to research carried out by the author during 1963—1964 at The Brookings Institution, Washington, D. C., while on leave-of-absence from the University of California, Berkeley. The work was supported by a generous grant from the United States Agency for International Development (USAID). Clell C. Harral, Grace Finne and Ellie Steinberg participated. Wilfred Owen and Edwin T. Haefele were in charge of the Brookings research programme, which emphasized the role of transport in economic development. The contributions of those mentioned, as well as of the USAID and World Bank officials, are gratefully acknowledged. In accordance with ancient tribal customs of the academic community, the author gladly accepts full responsibility for all shortcomings of the ideas presented here and claims no credits.

Fundamentals and definitions

Development planning, with project evaluation as an important component, is a scientific information process that enables executives to make rational decisions, that is, informed choices among meaningful alternatives. The end purpose is the efficient allocation of scarce resources among competing ends. Development analyses are essentially means-ends comparisons: if a specific action is taken, a particular result will probably follow. The scientific task is confirmation or rejection, on the basis of evidence, of various hypotheses that forge logical links between causes and effects. The causes are the means that can be employed (inputs, resource allocations, costs and actions of various types), and the effects are the desired ends (outputs, objectives, revenues and results of various types). On the basis of this definition, the scope for development analysis is indeed great: any action that generates recognizable, if not measurable, input and output streams can be evaluated. This includes such widely diverse projects as expansion of an educational system, industrial plant modernization, marketing of tropical fruit, eradication of infectious diseases, and rural electrification.[1]

Decision-makers (executives, policy-makers), whoever they may be in a given society, are effectively in command of policy instruments (means of action) and must articulate and pursue policy objectives (goals of action). Analysts (planners, experts, consultants) act as advisers to the decision-makers, adopt their viewpoint and are bound by their range of action. This particular framework of reference is crucial in project evaluation.

Of the many theories and hypotheses that the analysts could conceivably spin, only those that relate possible development actions to desired development objectives are of interest. All other relationships enter into the analyses as passively endured environmental circumstances. The potential success or failure of the relevant actions is analytically tested with the aid of success criteria (evaluation standards, decision-making guides). The old view, that economic theory by itself could

* University of California, Berkeley, USA.

[1] See, for example, R. N. McKean, *Efficiency in Government Through System Analysis*, New York, John Wiley and Sons, 1958, for a list of programmes carried out by the United States Federal Government which lend themselves to performance budgeting (physical performance contrasted with money costs) and benefit-cost analysis.

generate self-evident success indices such as maximization of profit or of the benefit-cost ratio, begged basic questions. Whose profits? Whose costs? What exactly is meant by benefits? The newer view is that success criteria do not arise out of the thin air of abstract reasoning, but are quite clearly derived from the ultimate goals that are to be pursued. This view puts great emphasis on determination of the objectives in the first place.

It is now also generally recognized that there are several species of development objectives, such as maximization of national product, better income distribution, more employment, education, health, promotion of national culture, internal and external security, knowledge of the universe, and so on. Further, these objectives are typically incommensurate (possibly quantifiable, but no common measure exists), conflicting (attainment of one objective impairs that of the others), or complementary (mutually helpful). The old idea in economics of a unique optimum based on a single maximand or minimand, such as money income or cost, has to be discarded on these grounds alone. More promising is the concept of social and economic achievement surfaces that stretch in as many dimensions as there are incommensurate objectives. The so-called efficient surface would embody the best possible compromises between conflicting objectives: more health versus more mobility; more production versus more leisure; and so on. It is clear that only top national executive bodies, such as parliament or the cabinet, can resolve these crucial issues. Analysts, however, can provide most valuable information on trade-offs between different social and economic achievements. Optimization then has this meaning: a rational compromise among several conflicting objectives on the basis of good information.

For analytical convenience the smallest, discrete unit of decision-making that generates both inputs and outputs is defined as a project. Physical size and technical properties are irrelevant: launching of a $100 million industrial complex or a $500 equipment purchase can both be regarded as projects. Analyses and decisions themselves consume precious resources, and therefore projects should be of such minimum size that the gains from better executive judgement exceed extra costs.

At the lowest, or microeconomic, level, analyses relate to proposed projects. The information on the projects passes from the information suppliers, the analysts, to the decision-making information users, typically in well-documented confidential report form, and comes under the trade names of technical and economic feasibility study, benefit-cost analysis, project evaluation, pre-investment survey, engineering-economy review and the like. The present paper is primarily concerned with these basic analytical building blocks.

At the highest, or macroeconomic, level, much research goes into the preparation of social and economic development plans for entire regions and countries. Such plans ideally embrace all projects, branches of activity, sectors and the public as well as the private sphere, with the time horizon for analysis and action programmes extending to at least five years. As is known to those with practical experience in national planning, there are difficulties in fitting the individual project building blocks into the macroeconomic framework and vice versa. The sequential planning and annual reconciliation of project phases, annual government budgets, five-year programmes and plans of ten or twenty years' perspective are not easy to accomplish.

Important characteristics of development analyses

Several important characteristics common to all development studies should be noted at the outset. These are discussed below.

Action orientation

The only meaningful test of any proposed means-ends chain is practical effectiveness: Will the scheme work as specified? This is a most refreshing feature. It quite properly forces the analyst to "put up or shut up" in his work. For example, general complaints about the alleged inefficiency of governmental institutions in area A or the supposed laziness and greed of the trade unionists in industry B or the hopeless ignorance of management in sector C are empty talk. Vague dissatisfaction does not constitute a legitimate analytical problem, which implies possibilities for remedial action. It is the responsibility of the analyst to come up with definite means-ends recommendations, for instance, administrative reforms in the first case, progressive labour incentive schemes in the second, and a management-training programme in the third.

The need for a comprehensive systems approach

It is very important to consider analytically any suitable action, however unorthodox, as long as it brings desired results. Here the analyst must have the mental agility to look beyond his own professional bailiwick, perhaps by enlisting the support of other talent. It has often been found that highway specialists come up time and time again with highway construction solutions to the most diverse urban, location and transport problems. Likewise, there are economists who never progress beyond the incredibly naive "marginal cost must equal marginal revenue" answer to all of mankind's ills.

In project analysis, a comprehensive systems approach must be adopted, with the criterion again being simply the effectiveness of means in relation to ends. Thus the raising of incomes in a declining farming area, as a

specific end, may be accomplished in any of the following ways, singly and in combination: new harbour, better highways, more truck competition hence lower rates, irrigation scheme, co-operative marketing, storage and processing arrangements, agricultural credit, direct government subsidies, tax concessions, teaching of new cultivation methods through extension programmes, strengthening of local government and so on. The real limitations to action are too often imposed by the lack of imagination of decision-makers and anaiysts and not by given natural conditions. Fortunately, the growing recognition that many scientific disciplines often contribute to the solution of real life problems has had a liberating effect upon professional thought processes.

The essential element of choice

Choice is absolutely fundamental to project evaluation. The presentation to the decision-maker must always contain alternatives to various courses of action, all designed to achieve the desired end, among which he can choose. In fact, a "no alternative" proposal is not a reasoned recommendation but an ultimatum. It is important to note that the economist, in putting down costs, is compelled to consider alternative forms of resource commitment, for the true costs of one course of action—the opportunity costs—are the benefits foregone from the next best course of action. Traditionally, the enjoyment one could have obtained from many different things in the market, appraised by the price yardstick, is taken as a measure of cost. Thus the cost of one dollar simply implies ten newspapers, five containers of ice cream, two units of electricity and so on. Numerous alternative consumption offers, made under specified competitive conditions, are necessary to give meaning to the term "cost of one dollar".

In many situations, especially in the public sector and in development work, perfect market conditions will not apply, and the automatic registration of cost figures is not possible. Then the analyst has to generate his own opportunity cost estimates, namely, by synthetically designing meaningful alternatives. Thus the true cost of a social welfare programme, for instance, may be the foregoing of a university expansion programme. Often the analyst may have to work with several economic, financial, social, political and ethical value dimensions simultaneously—an intellectually demanding feature of modern public-sector studies.

It is axiomatic that the quality of decisions rises with the number of alternatives that are available to the decision-maker. But analytical blueprints for choice, and even the exercise of choice, cost time and resources. The shrewd observation has been made that even use of the competitive market is far from costless.[2] How many potential choices are then, in practice, necessary to guarantee a good decision? It seems that at least three alternatives, including the "do nothing" alternative, are the bare minimum for sensible decisions. Unfortunately, in field work "take it or leave it" proposals that permit no comparisons and give the policy-makers no leeway predominate. Analysts may think that anything beyond these crude, binary "accept or reject" choices is intellectually too strenuous, but in fact it is usually possible for analysts to come up with a respectable number of alternative solutions, including secondary design and location variations. Pierre Massé, for example, describes a model for choosing from thirteen different electric power plants—thermal, hydro, gas turbine, tidal power etc.—certainly a rich selection.[3] A development study in which the author participated[4] offered for its main action proposal, a $25 million road project, a total of eight alternatives including five choices of location and several engineering design and construction options. Further subvariations involving the time dimension through project postponement or advancement are also always possible; options are not a scarce commodity in project evaluation.

Determination of ends, limitations of monetary indices for welfare

What is the end purpose of these elaborate exercises in analysis, decision-making and resource commitment? There is agreement that the exercises must somehow result in a recognizable improvement of society's well-being, but from that point on the discussion proceeds to areas where the issues are not clear-cut. What is meant by improvement? Must everybody be better off? Can there be some losers, provided they are outweighed by the gainers? Are all members of society to be included, no matter what their initial status? Must the rich, for example, invariably be made richer? And how should welfare be interpreted? In the psychic sense? Are psychic sensations measurable? And are interpersonal comparisons in this sphere possible?

These formidable questions have agitated many fine minds for decades. Originally it was thought that the yardstick of money income, for individuals as well as for countries, could serve as a proxy for the recording of private and social bliss sensations. But then, after unsuccessful wanderings through the intellectual maze of so-called welfare economics, it was recognized that the distribution of income among members of society—

[2] R. H. Coase, "The Nature of the Firm", *Economica*, New Series, Vol. IV (November 1937), pp. 386—405.

[3] P. Massé, *Optimal Investment Decisions: Rules for Action and Criteria for Choice*, Englewood Cliffs, N. J., Prentice Hall, 1962.

[4] Stanford Research Institute, *A Ten-Year Highway Program for Honduras*, report prepared for the Government of the Republic of Honduras, Central America, under the auspices of the International Development Association, Tegucigalpa, Honduras, and Menlo Park, California, 1963.

and, one may add, among this generation and succeeding ones—definitely required ethical judgements. As one writer put it: "It is not enough to find quantitative expressions for (economic) policy standards—the standards themselves must be ethically attractive."[5] As a further difficulty, how was account to be taken of the flow of bliss and anti-bliss sensations that simply do not generate any money price signals in the market? What about air pollution, for example? Or leisure? Or opportunities for creative activities? Or the supply of sunshine and fine beaches? Other technical flaws in GNP and money-income statistics, as standards of international and interpersonal welfare comparisons, were noted.[6]

Today the earlier, heavily money-oriented views have largely been abandoned. Those who still cling to them may ask themselves whether money income is the only or even the most important welfare factor in their lives. Or, to bring international *per capita* income comparisons into perspective, they may estimate how much additional income would induce them to move permanently from, say, the shores of the Pacific or Mediterranean to some northern metropolitan slum set among belching smokestacks.

In recent years much of the intellectual steam has gone out of unadulterated "GNP growthmanship". The modern view still regards money income as an important indicator of success but insists that it must be supplemented by many other moral and social criteria. With it has come great interest in all the diverse objectives society might pursue apart from money-income maximization, ranging from the collective wish to extend average life expectancy, through the intention to give everybody a better education, to the desire to render foreign aid to less fortunate people elsewhere.

Conclusions

Means-ends comparisons are the essence of project research and economic development planning. Meaningful analyses of this sort simply cannot be undertaken by economists and technicians without prior instructions on the ultimate objectives that are to be attained. Properly stated objectives are indispensable for the determination of operational goals and constraints, for measurement operations (especially on the benefit side) and for the application of preference orderings and related decision rules. Decision-makers may often find it difficult at the outset to formulate goals precisely without knowledge of the potential courses of action. Here the analyst may become the economic psychiatrist of the subconscious collective mind by exposing clearly the various trade-offs, for example, between higher money incomes, military preparedness, educational achievements and social welfare standards. While the policy decisions are ultimately anchored to deeply rooted values of society, the rendering of scientific information as such can be regarded as an unequivocal ethical good.[7]

To sum up, the purpose of development planning, including project evaluation, is to provide scientific information on the effectiveness of the available means of action in relation to stated ends in a given social-institutional environment. This formulation cuts across all national and ideological boundaries. To be sure, there can still be honest differences on development objectives. There is scope for discussion on what constitutes a good life in various cultural environments. "One man's meat is another man's poison", as the saying goes, and even the choice of development means—which are essentially alternative ends foregone—is open to reasonable debate. But once the means and ends are determined, the development analyses themselves are quite impartial and neutral.

Practical lessons from fundamental ideas

What are the practical lessons to be learned from the fundamental ideas described above? A developing country that wants to invigorate a socially and economically backward area may be taken as an illustration. First it is important to understand the general setting for development planning; determination of the terms of reference for the analysis then follows logically.

Chief elements of development planning

Ultimate objectives

In the particular example chosen, the ultimate objectives would be improvements in the well-being, broadly interpreted, of the people living in the area. Neither industrialization, transport improvement nor increased agricultural output as such are true ends; they are merely specific technical means to achieve higher-level objectives.

Decision-makers

The top executive body of the developing country is in charge, but if international assistance is sought for the development scheme, other decision-making agencies will enter the picture, for example, the United Nations,

[5] D. Braybrooke, "Farewell to the New Welfare Economics", *The Review of Economic Studies*, Vol. XXII (1954—1955), pp. 180—193.

[6] W. J. Barber, "A Critique of Aggregate Accounting Concepts in Underdeveloped Areas", *Bulletin of the Oxford Institute of Economics and Statistics*, Vol. 25, No. 4 (November 1963), pp. 293—308; D. Usher, "The Transport Bias in Comparisons of National Income", *Economica*, New Series, Vol. XXX, No. 118 (May 1963), pp. 140—158.

[7] C. W. Churchman, *Prediction and Optimal Decision: Philosophical Issues of a Science of Values*, Englewood Cliffs, N. J., Prentice Hall, 1961.

the Organisation for Economic Co-operation and Development (OECD), the World Bank, foreign aid organizations of wealthier countries, or perhaps a consortium formed by several of these. Again, both public and private interests can participate, for example, an entrepreneur willing to start a plant in the area and a government industrial development bank ready to back him financially. Further, several ministries may take part in area development decisions, e. g. industry and commerce, transport, agriculture, and social services. Each may have its particular set of lower-level objectives that at worst may relate to departmental "empire building", that is, maximization of staff, budget allocation or prestige for the particular ministry. When several decision-makers are involved, it is advisable to define the development objectives clearly at the outset and reconcile those that may be conflicting.

Analysts

The analysts can be planners, civil servants, university personnel, consultants, scientists and technicians of all descriptions. Their functions are best described as those of professional problem-solvers and advisers to the executives. When distinct project studies are being tackled, their duties should be spelled out precisely through terms of reference, a task that requires a surprising amount of thought.

The analytical framework

The true scope of decision-making powers, and hence of the analyses, is most conveniently defined along these lines:

(a) Geographic and jurisdictional limitations (the country? one region or area? one industry or government department?);

(b) In the social-economic dimension, by the group of people and economic organizations of concern (entire community? owners and management of just one entreprise? all farmers? the public sector only?);

(c) In the time dimension, by the intertemporal scope of the decision-makers (five years? ten years? for the expected life of the present government only? to include just the present generation? or future generations as well?). This definition alone raises some profound issues;[8]

(d) By the decision-maker's range of action and instruments (what are his legal powers? fiscal? financial? managerial? regulatory?).

In this example, as in all development and public-sector work, the analytical scope will extend as far as the general public interest does. The boundaries of the study will therefore include all economic and social groups within the area or country; the time horizon will stretch far into the future; and the arsenal of instruments for action at the disposal of the decision-makers will probably be quite impressive.[9]

Sample terms of reference for area development study

Given this general setting, sensible instructions by fictitious decision-makers to the development analysts might include the following points (the fictitious instructions are in italics, followed by explanatory comments).

The problem

The Government of Mesalia regards the relatively low average standard of living and the poor quality of public services in the Aliveri area as an urgent problem.

Note that factual background material on the problem obviously exists, for example: *(a)* a special study of the Aliveri area that caught the Government's attention; *(b)* routine *per capita* income data, unemployment rates and similar statistics on area-by-area basis; and *(c)* performance indices for social services such as number of doctors and hospital beds per 100,000 population, kilometres of paved and gravel roads related to surface area, population and motor vehicles. This and other evidence[10] should immediately be studied by the analysts in order to grasp the problems that have to be solved.

Objective

The chief objective is, within ten years, to bring living and social service standards in Aliveri up to the national level anticipated at that time.

This statement of objectives provides a great deal of analytical guidance: *(a)* existing social-economic disparities between Aliveri and the rest of the country are mostly quantifiable and largely known; *(b)* long-range projections for the national economy to 1975 and beyond, prepared by the central planning office, can

[8] Many distinguished economists have written on the so-called "future generations problem", income distribution, the roles of interest and social rates of time preference. Among them are Samuelson, Abba Lerner, Koopmans, Myrdal, Marglin, Margolis, Galenson, Leibenstein, Tinbergen, Krutilla, McKean and Hirshleifer. The literature on these subjects is vast, but nobody seriously interested in them should neglect to read O. Eckstein, "A Survey of the Theory of Public Expenditure Criteria", in *Public Finance: Needs, Sources, and Utilization* (Universities-National Bureau Committee for Economic Research, J. M. Buchanan, editor), Princeton, N. J., Princeton University Press, 1961, pp. 439—494, and discussion comments, pp. 495—504.

[9] H. B. Chenery, in an important article, "Development Policies and Programmes", *Economic Bulletin for Latin America*, Vol. III, No. 1 (March 1958), provides a comprehensive inventory of contemporary development tools and shows the variables that can be controlled by their use. The choice of policy instruments is generally much greater than is realized.

[10] There is a good discussion of various indices which portray "the quality and texture of life as 'end product'" in the book by N. S. Buchanan and H. S. Ellis, *Approaches to Economic Development*, New York, The Twentieth Century Fund, 1955, pp. 5—21.

be utilized; and *(c)* the gap between likely economic and social achievements in the Aliveri area and in the rest of the country if no special actions are taken—something that can be researched—defines the magnitude of the desired development task, and the statement that the gap should be closed within ten years defines the required minimum development speed. Unfortunately, such precisely stated policy directives are rarely encountered in field work. Analytical work suffers when executives do not clearly state what they want.

Means of action

Any of the policy tools at the disposal of the Government of Mesalia suited for the task may be deployed, including direct public investment in industry and infrastructure, as well as encouragement of private inititative through tax relief and other incentive measures. Participation of the International Consortium Bank (ICB), under favourable loan conditions, will be sought.

This statement is also most instructive. A thorough inventory of existing, legitimate policy instruments is called for, including a broad review of laws and regulations governing private ventures in depressed areas (ranging from tax holidays and fast depreciation schedules to low power rates and cheap public land). Consultations with the appropriate ministries will disclose exactly what they are able to do. Participation of the International Consortium Bank means that, for portions of the programme, particular action tools and decision criteria have to be taken into account such as: *(a)* investment in specific projects of a minimum size only, following outside feasibility studies carried out according to ICB specifications; *(b)* projects must be financially self-supporting, given life-spans and interest rates applied by ICB in comparable cases; and *(c)* projects should help the foreign-exchange situation of the country, i. e. lead to import substitution or to increased export.

Since the government statement does not exclude other suitable means of action not specifically mentioned, the consultants are given an excellent chance to come up with some effective recommendations that the Government, being concerned with many other things, may not have considered. It should be noted that the Government obviously desires maximum participation of ICB.[11] The scope for this organization, subject to its well-known, specific "rules of the game", should be worked out first by the analysts. The remainder of the programme would then have to be taken on by domestic organizations.

[11] Most developing countries have agencies whose chief job is to utilize the manifold forms of foreign assistance to the utmost; this is how it should be.

The study area

The study area is defined as the Aliveri River Basin, delimited by the surrounding watersheds. Field work should emphasize this geographic area, but transport and commercial interchanges with other parts of the country and the outside world if significant for social and economic development should also be investigated.

This statement concentrates the analyst's efforts on a limited area without eliminating attention to possibly important external economic relationships. Dangers in field work are: *(a)* consultants sit in the national capital and try to solve specific area problems with the aid of fairly meaningless macroeconomic statistics; *(b)* they get so absorbed by purely local problems that they lose sight of broader regional and national interactions; and *(c)* although they start off with the specific area of interest, under the influence of the ubiquitous "everything depends on everything else" syndrome, they get drawn into ever wider, more complex and expensive general research.[12] Obviously, a sound compromise has to be struck in the study terms of reference between an overly inclusive and a too restricted geographic scope.

The above terms of reference, it would seem, define the purpose and boundaries of the analytical task for area development very well. Additional instruction might relate to study length, deadline for submission of final report, fees (if outside consultants are employed) and the assistance collaborating government agencies can provide. There is no doubt that the initial frame of reference, more than anything else, determines the final results.

Sample terms of reference for industrial project

By way of contrast to the broad area development problem, instructions for a specific industrial project study may now be drawn up. There is no suggestion that one type of problem statement is intrinsically superior to the other—it is just that they differ in purpose and scope. Greatly simplified fictitious sample terms of reference might run something like the following:

The Mesalia Industrial Development Bank, a joint public-private institution, has received an application for financing a petrochemical plant at Aliveri, complete with a satisfactory analysis of the potential demand for the products.

The general objectives of the bank, as well as the criteria applying to projects of this type, are stated in detail in the relevant legislation. They include in particular:

(a) Economic and financial viability, taking into account,

[12] Transport experts, although starting out from a small problem of connecting highways, may easily be seduced into general development planning work. This is natural because the interactions between transport and the total economy are strong. However, it is more efficient to work down from the general to the specific, or for the transport man to join forces with the other development economists.

however, general government inducements available to all forms of industrial activity;

(b) Preference for projects that can be located in depressed areas, that will absorb unemployed workers, or that will convey other broader economic and social benefits.

Although the applicant has submitted fairly detailed technical proposals, possibly desirable modifications in design, phasing of construction work, scale of plant and production, marketing operations and other relevant aspects of the scheme should definitely be investigated. The suggested Aliveri location should also be examined.

In this instance there are two decision-makers: *(a)* the private promoter, who presumably wants to run the new plant at a profit (the analysts, as a very first step, should consult him and read his proposals carefully); *(b)* the Mesalia Industrial Development Bank, whose scope and interests are wider, but certainly not as comprehensive as those of the Government. This is a much tighter framework than in the previous case; many aspects that are definitely included in the comprehensive area development study are now external and hence ignored. The analytical task is correspondingly easier and the range of action recommendations more restricted.

It should be noted, however, that apart from the fact that the application relates to petrochemical production, with a product demand study to back up this big first decision, all other technical, location and marketing choices are left open. This gives the analysts ample opportunities for the presentation of meaningful alternatives—the very basis for making optimal decisions.

Examples of poorly defined terms of reference

In past research and planning work, the author has come across numerous terms of reference for international project studies that definitely biased the analysts' research and findings, to the distinct disadvantage of the decision-makers. To cite just two glaring examples:

1. A recent case involved the transport problems of two areas separated by a narrow body of water. The social and economic usefulness of a link had already been established. Sensible instructions to the engineering and economic consultants would have been: "Investigate the best means of moving people and goods between the two areas." Instead, the experts were asked to study a very specific bridge proposal, thereby needlessly excluding ferries, tunnels, causeways or floating pontoons.

2. Instructions for a port study went something like this:

"Conduct such investigations as may be necessary to determine and recommend a technically and economically sound long-range port development plan. Construction recommended for initial implementation shall be so planned as to afford a port facility that will serve most efficiently and economically present and projected future traffic."

The terms of reference might have been written more objectively as follows:

"Conduct such studies as may be necessary to determine whether it is technically and economically sound to recommend" etc.,

and then conclude with:

"If construction is not deemed advisable at the present time, state what other measures may be initiated so as to afford . . .".

This would at least have left the accept/reject option for the port proposal as such, plus a variety of alternatives within the port technology.

Project terms of reference are often too specific and practically dictate the solutions: "Determine the economic and technical feasibility of a plant at Midcity for the production of 1 million gadgets per annum." The consultant naturally finds the gadget project (or road, or port, or irrigation scheme) economically and technically feasible. The client has obviously already made up his mind on the matter and just needs respectable, outside confirmation. Only a consultant of exceptionally staunch character, impervious to unpopularity and loss of income, will disappoint him. It is illuminating that in the entire professional career of the author, he has come across just two feasibility studies that did not recommend the initial proposals they were supposed to test rigorously; it so happens that the author had a hand in the setting-up of one of these. Although other circumstances are to blame as well, a great part of the trouble is probably due to badly defined terms of reference.

Other studies are unnecessarily vague: "Examine economic conditions in the XYZ region." Here the decision-makers appear to be vaguely dissatisfied. In all likelihood a general fact-finding expedition by consultants will be mounted. But unless it is geared to distinct possibilities for action, the final report will probably contain the usual "further research should be undertaken" platitudes.

In conclusion, one can only urge that great care be taken when the all-important frame of reference for development studies is set up. If necessary, broadly oriented professional help should be enlisted for this purpose. The operations research literature, which is strong on the subjects of determining true objectives and spotting genuine problems, can also be consulted with profit.

Methodology for Project Evaluation

Efficient resource allocation is the main theme of project evaluation. In the economics literature, some of the numerous works on investment theory and capital

budgeting are particularly relevant,[13] but as yet there is no agreement on the appropriate methodology. An attempt will be made, therefore, to suggest theoretically sound procedures capable of practical application, without getting drawn into complex abstract debate.

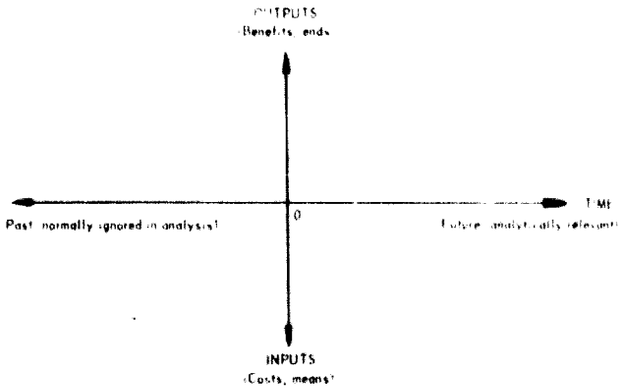
Elementary notions

All investment analyses, including project studies, consist of systematic juxtapositions of properly dated input and output series, as previously defined. The analyses are meant to provide guidance for decision-making and are consequently exclusively oriented towards the future, for a decision once irrevocably made becomes past history—dead, irrelevant and taken as granted for the next round of analyses and decisions. As a former professor of the author vividly put it: "It is of no economic significance whatsoever whether a flat piece of ground which lends itself to highway or factory construction was created yesterday by bulldozers or a million years ago by glaciers." Jevon's dictum "bygones are bygones" indeed applies; committed resources no longer represent opportunity costs and should be ignored.

Figure 1 shows an effective way of looking at the past and the future, at means and ends, and may serve to portray complex economic patterns conveniently. Zero defines the analytical starting point: the world around taken as given, no fresh resource commitments yet, the date set at exactly the contemplated time of action.

Figure 1

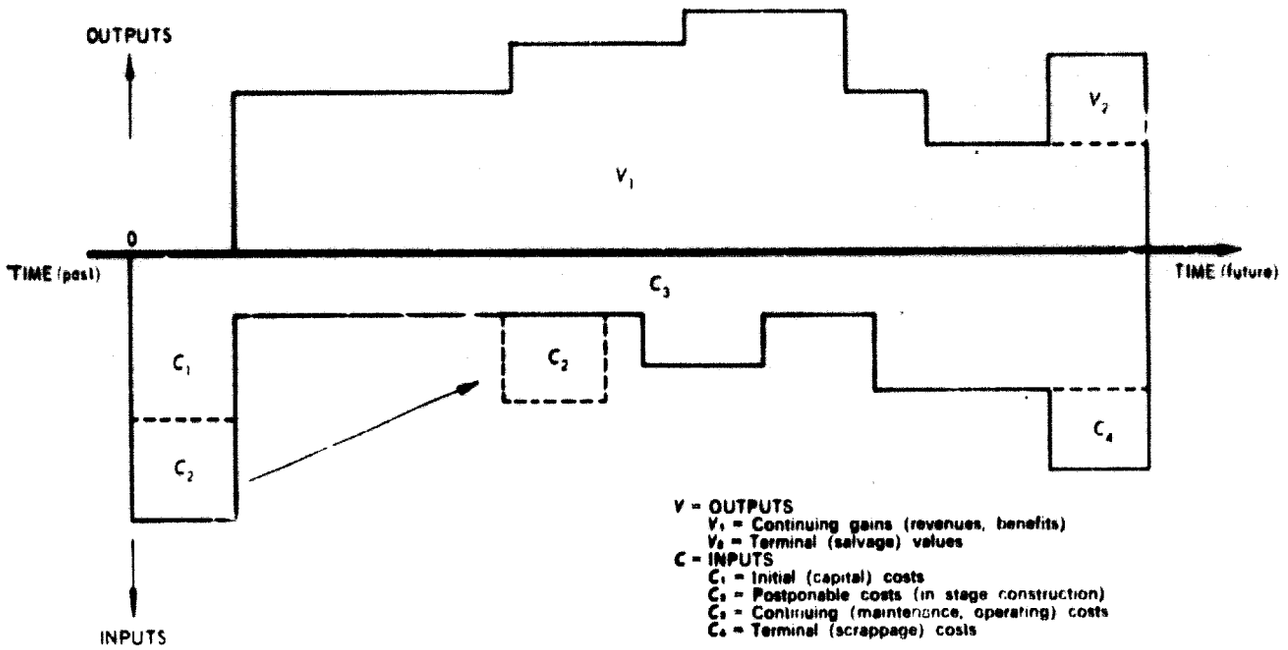
BASIC PORTRAYAL SCHEME FOR PROJECT ANALYSIS



Along the horizontal time axis, everything to the left of the origin is irrelevant past; to the right, potential future events are faithfully recorded. By convention, benefits and costs—measured in some meaningful way—are shown upwards and downwards, again starting from zero. In the case of predictably repetitious series, the past may indeed have a message for the future and should then be included in such a time chart. Figure 2 illustrates the graphic portrayal of a complete project life history. The literature speaks of benefit-cost profiles, or input-output streams. The data can also be recorded in tabular form as is shown in table 1.

Figure 2

CONTINUOUS INPUT AND CONTINUOUS OUTPUT PROBLEMS



[13] See F. and V. Lutz, *The Theory of Investment of the Firm*, Princeton, N. J., Princeton University Press, 1951; Massé, op. cit.; McKean, op. cit.

Table 1

TABULATED PROJECT LIFE HISTORY AND DISCOUNTING TO PRESENT VALUES

(1)	*(2)*	*(3)*	*(4)*	*(5) = (3) − (4)*	*(6)*	*(7) (5) × (6)*	*(8)*	*(9) (5) × (8)*
End of year	*Analytical time*	*Revenues or outputs (V) (million dollars)*	*Costs or inputs (C) (million dollars)*	*Net revenues (net costs) (V—C) (million dollars)*	*Discount factors[a] at r = 0.03*	*Present values of net revenues (net costs) (million dollars)*	*Discount factors[a] at r = 0.08*	*Present values of net revenues (net costs) (million dollars)*
1965	t_0	0	0	0	1.0000	0	1.0000	0
1966	t_1	0	5.00	(5.00)	0.9709	(4.8545)	0.9259	(4.6295)
1967	t_2	0	5.00	(5.00)	0.9426	(4.7130)	0.8573	(4.2865)
1968	t_3	2.00	1.00	1.00	0.9151	0.9151	0.7938	0.7938
1969	t_4	3.00	1.00	2.00	0.8885	1.7770	0.7350	1.4700
1970	t_5	5.00	1.00	4.00	0.8626	3.4504	0.6806	2.7424
1971	t_6	5.00	1.00	4.00	0.8375	3.3500	0.6302	2.5208
1972	t_7	4.00	2.00	2.00	0.8131	1.6262	0.5835	1.1670

[a] Calculated from formula $DF = \frac{1}{(1+r)^t}$, or taken from standard mathematical tables.

	Total present values for project life		
Interest rate, *r*	**0**	**0.03**	**0.08**
Net revenue (loss)	**$ 3.0 million**	**$ 1.55 million**	**($ 0.222 million)**
Policy advice	**Accept**	**Accept**	**Reject**

Four possible formulations of investment problems

For expository convenience, four broad formulations of investment problems can be recognized. The first three have received much, possibly even undue, prominence in economic theory.[14] To the writer, the fourth is of greater practical interest.

The point input—point output case

Here the resource sacrifice is concentrated at one point of time, with consumption occurring subsequently also in one period. One may think of seeding, followed later by harvesting. There are two variations to the point input—point output theme. In one, the time interval between seed and harvest, i. e. the investment period, is fixed. In the other, the interval can be varied. Usual examples are trees that grow and wine that mellows in the barrel, with some discretion as to when consumption of wood or beverage is to take place.

The continuous input—point output case

One may think of raw materials that pass through various processes and eventually emerge as finished products that are then consumed all at once. Input timing is usually assumed to be variable within limits.

[14] See especially Lutz, op. cit., and Massé, op. cit., chapter 1.

The point input—continuous output case

Investment is concentrated at a single point of time, whereas output is spaced over a more or less lengthy period. Machines that are installed once and then render service for a long time are supposed to represent this case.

The first and third formulations seem rather contrived and out of touch with reality. They assume that production is timeless and costless after the first input. This is hard to believe: crops have to be watered and tended until they are ripe; in the mellowing of wine there is the continuing cost of labour, premises and barrels; and machines have to be provided with motive power and must be housed and maintained. These two problem formulations do not have much practical significance, and even the second case is formulated rather restrictively. In most investment decisions in the real world—those involving factories, machines, buildings, infrastructure projects, research and development programmes—the analyst is confronted by continuous inputs generating continuous outputs.

The continuous input—continuous output case

It is perhaps not surprising that this empirically most important case has not received much attention in the literature, for it is conceptually difficult and mathematically unwieldy to handle. It possesses a number of elements—inputs and outputs of various types and magnitudes, their respective timing, the length of the

time span, different value scales—which singly and in combination create not just one but several investment planning issues. They may be thought of as variations on the main theme of continuous input—continuous output.

These themes can be explained conveniently with the aid of figure 2. In this time graph, total outputs are shown by area (I), subdivided into continuing gains, revenues or benefits (I'_1) and terminal, or salvage, ones (I'_2). Total inputs are indicated by area (C), subdivided into initial, or capital, costs (C_1); costs that may conceivably be postponed under circumstances of stage construction or "phasing" (C_2); continuing costs (C_3), and terminal, or scrappage, costs (C_4). It is quite unclear what is accomplished by the usual distinctions between capital costs (expenditures on physically durable objects such as machines and buildings) and operating and maintenance costs (devoted to physically more ephemeral objects such as wages and fuel). What matters in investment analysis is when resource sacrifices and output enjoyments occur in a project's life history and their magnitudes.

It is easy to see that the analyst may be called upon to study many different input-output problem variations, created basically by the following:

(a) Choices as to volume and timing of the input and output streams, independently and relative to each other;

(b) Technical-economic options affecting the internal composition of the inputs (labour, machines, materials etc.) and outputs (product mixes;[15]

(c) Possibilities that outputs (social services, consumer goods, national defence) and inputs (money costs, social sacrifices) should be measured on different scales of value.

As a general rule, when confronted by continuous input-continuous output problems it is most expedient to treat each input-output stream configuration as a distinct project. Investment analysis then consists of systematic comparisons of these discrete project proposals, using rational evaluation guides for selection purposes.

Prominent continuous input-continuous output problem approaches

Given input and output streams of the type sketched in figure 2, different methods of evaluating them, using distinct criteria of success, are found in the literature. The more prominent variants are discussed briefly below.

Pay-off, capital-recovery period, or capital turnover rate problems

Here the question is how long does it take to recoup initial costs from revenues. The length of the capital-recovery rate is supposed to be a success indicator: a project that takes six years would be preferred to one that takes ten. This test unreasonably neglects the performance of assets beyond the recoupment period. For example, the six-year project may fall to pieces immediately afterwards, whereas the ten-year one may be serviceable for another fifty-year span and may therefore be preferred. Further, initial costs are singled out, and continuing costs are ignored for no good reason. In this way, the problem formulation is a throwback to the point input—continuous output case, which, as observed, is not a very realistic one.

Capital-output ratio problems

In this formulation the attempt is made to maximize outputs in relation to initial inputs. A project that promises to deliver the maximum output per unit of initial input would be preferred to all others. Occasionally, this performance criterion is also called the product-capital ratio.

In retrospect, it is difficult to account for the popularity that this particular analytical device enjoyed a few years ago. After all, the definition of "capital" is quite shaky and why should the continuing streams of inputs be eliminated from the calculations after the initial resource-commitment close? The only possible explanation is that it was presumed that capital resources were the only scarce factor. But such *a priori* reasoning is very dangerous in field work, for it prejudges vital issues the analysis is supposed to solve. Again, the formulation of the capital-output ratio problem, by ignoring cost streams, is a throwback to the point input—continuous output case.

Capital-intensity problems

Capital intensity can conveniently be measured by the ratio of initial costs to continuing costs, the latter preferably discounted to present values (see below). For brevity one can refer to the "ratio of initial costs to future costs", as stated by Lutz.[16] The higher the ratio, the more capital-intensive the project. It is usually presumed that the output stream stays constant as costs are substituted and vice versa. It is then argued that developing countries, as they are short of investment funds, should always select less capital-intensive projects than the more industrialized countries.

It is not at all obvious what is achieved by this particular formulation. If the assumption of constant output streams holds true, the problem is clearly that of cost minimization. The question then is: What mix of initial costs to continuing costs is most advantageous? To answer this question, an interest rate or social rate of time preference must be applied to the input streams. To take one extreme, at a zero rate of interest, initial costs count

[15] A. K. Sen, *Choice of Techniques: An Aspect of the Theory of Planned Economic Development*, Oxford, Basil Blackwell, 1962.

[16] See Lutz, op. cit.

just as much as later continuing costs. Zero interest in effect wipes out the time dimension as an economic factor. It unrealistically favours immediate heavy consumption sacrifices for the sake of possibly very late output benefits. However, as the interest rate rises, less and less analytical weight is given under the usual discounting or compounding procedures to the later cost streams relative to the initial ones. It follows that less capital-intensive projects become more attractive as the interest rate goes up, and the more capital-intensive projects show their merits as the rate goes down, always assuming *ceteris paribus*.

Viewed as one aspect of cost minimization, concern with capital intensity makes sense. Even so, the inherent assumption of output streams that stay constant with changes in the initial capital cost versus continuing cost proportions is rather restrictive. Further, it is inadmissable to associate automatically all projects in less developed countries by *a priori* reasoning with the desirability of low capital intensity and hence high interest rates.

Staging or construction-phasing problems

The staging or construction phasing problems are very similar to the previous ones. The question is asked whether it is advantageous to build a project all at once to full capacity, with an outlay of the entire initial cost, or whether a portion of the cost can be postponed until it becomes, say, the second construction phase (postponable cost). An example might be the construction of a highway with four-lane capacity immediately or construction in instalments, with two lanes initially and the second set a few years later.

If the output stream is supposed to be the same, regardless whether there is all-at-once or stage construction, the problem is one of straight cost minimization. Again, the interest rate is strategic: a high rate favours stage construction, a low one, all-at-once work. Large setting-up expenses (bringing men and machines to the site), or construction economies of scale in general, mean that the cost of the second construction phase will be larger than the postponed portion of the initial cost. All-at-once work would then probably be advantageous. Innovation, expected improvements in technology and high uncertainty in general, on the other hand, would favour staging. These different factors should be carefully weighed in project analysis.

Postponement and advancement of suitable input portions should always be tested on paper in order to arrive at the best timing pattern. But few field analysts are aware of phasing possibilities, and empirical knowledge of the subject is quite inadequate.

Various input mix and timing problems

Once again, as the output stream is assumed to remain the same when different configurations of inputs are being tested analytically, this is a cost-minimization problem. A special problem is the best composition and timing of the input components that together serve to produce output. Typical questions are: Is a hydroelectric or a thermal plant design more advantageous? Should a proposed bridge be built of masonry, laminated timber, steel or pre-stressed concrete? Should relatively more labour or more machinery be used on the job? Is rapid construction, involving more severe engineering and management problems, or a more leisurely pace more advantageous? Once the costs of various input components are known, as well as the technically best ways of combining them and the interest rate, these questions can be answered unequivocally. The solving of input mix and timing problems requires particularly close collaboration between engineers and economists.

Various output mix and timing problems

Output mix and timing problems are analogous to the questions discussed in the preceding paragraph. It is assumed that the input stream configuration is given, but that different output types may be produced at various points in time. Briefly, this becomes an exercise in output maximization. Typical questions are: Should there be a great volume of lower-quality output, or higher-quality production in smaller amounts? What kinds of products should be produced at what times? Market research expertise, in addition to engineering and economic skills, is required to solve output mix and timing problems.

Complex input-output mix, timing and multiple value scale problems

These problems combine features of those discussed in the two preceding paragraphs, the restrictive assumption that input and output streams will not affect each other is discarded. For every configuration of costs there may be a different output stream and vice versa. Typical questions are: Is it worth while to sacrifice more inputs to gain more outputs? Will earlier yields of outputs pay for the additional inputs needed to hasten production? By what losses in outputs would possible savings in operating costs be accompanied? Often there will be several scales of value; for example, output may be measured in physical terms (number of schools constructed, acre-feet of irrigation water provided, health service coverage achieved), but inputs in market values. This complicates analysis. Appropriate success criteria are cost minimization, output maximization, or in combination, maximization of net outputs if both series are commensurate.

Treatment of the time dimension

Various economic events such as input doses and accruals of outputs are typically spaced irregularly over time. Mere inspection or aggregation of the input and

output streams yields no definite prescriptions for sensible action. As Pierre Massé says: "The difficulty is that, physical appearances . . . notwithstanding, one franc available right now and one franc available ten years hence are two different economic goods, as different as an apple and a pear available at the same time. They can neither be compared nor directly added."[17] Resource allocation decisions consequently become a form of "arbitrage in time", and investment, in the final analysis, "not an end in itself but rather a process for distributing consumption over time".[18]

Somehow the basic common-sense notion must be accommodated that a franc received or sacrificed today should count more heavily than a one-franc transaction five or fifteen years from now. Mathematically this is generally accomplished by the application of the well-known discounting or compound interest formulae. Briefly, dated input and output streams are reduced to simple (present or future) value terms, which are then compared. If both series are commensurate, projects with outputs greater than inputs are accepted; those that do not meet this test are rejected. Among acceptable projects, those that promise maximum net outputs are selected. When several scales of value exist—monetary plus other—more complicated procedures apply, as will be explained later. The technical literature should be consulted for further details. A few special points are of interest here.

Equivalence of discounting and compounding

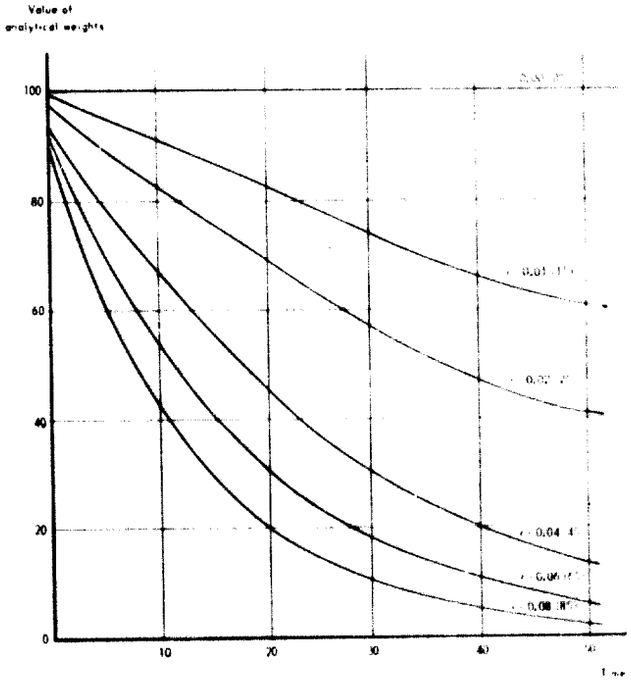
The discounting method works backwards, as it were, from the future to the present. Results are therefore inputs and outputs in present terms. Compounding works in the opposite direction, with the date of project expiration being the chosen period in terms of which all inputs and outputs are valued. Results are inputs and outputs in future terms. Both procedures lead to identical project choices and policy prescriptions. It is sometimes thought that discounting has unique merits of its own. This is an error. Given the same input and output data, discounting the present values accomplishes nothing that cannot be done just as well by compound-interest calculations to terminal values.

Differential weighting of future events

Both methods essentially assign declining analytical-statistical weights to future events. This weighting is a function of the interest rate and the total project time span. At a zero interest rate, inputs and outputs expected in the year 2015 count just as much as those of the present time. But, given an interest rate of 4 per cent, the weight (or value) is reduced to 14 per cent five decades from now. And applying a rate of 8 per cent, the weight declines to a mere 2 per cent (see figure 3).

Figure 3

ANALYTICAL WEIGHT OF FUTURE INPUTS AND OUTPUTS AT VARIOUS POINTS OF TIME AND USING DIFFERENT INTEREST RATES



The rapid shrinkage of importance of inputs and outputs during the first few years should be noted. As the time horizon expands to infinity, the analytical weights will gradually approach zero for any positive interest rate. Such are the powerful effects of compound-interest mathematics.

In figure 3 it can also be observed that changes in the length of the time horizon and in the level of the interest rate are partial substitutes for each other. For example, raising the interest rate from 4 to 8 per cent has about the same effect on analytical weights as cutting the time horizon from 40 to 20 years. Likewise, using 8 per cent instead of 1 per cent is equivalent to shrinking the time horizon from 40 to as little as 5 years. Putting it another way, inputs and outputs in the year 2005 assessed at 1 per cent will exercise the identical influence on final analytical results as the same inputs and outputs in 1970 appraised at 8 per cent, assuming *ceteris paribus*. Practitioners, it seems, are often not aware of these interrelationships.

Choice of interest rate

The interest or discount rate is a most strategic project-selection device; the higher its level, the more

[17] Massé, op. cit., pp. 8—9.

[18] J. Hirshleifer, "On the Theory of Optimal Investment Decisions", *The Journal of Political Economy*, Vol. LXVI, No. 1 (February 1958).

projects will be "rationed out". How, then, should the level be selected? At first it was thought that any project could, as it were, generate its own internal rate of return, the rate that exactly equates the discounted or compounded input and output series. The project-selection criterion would then be "maximize the internal rate of return". However, serious problems arose with this analytical artifact: *(a)* some series generate not one, but several internal rates of return;[19] *(b)* for mutually interdependent projects of the type encountered in systems or networks (see below), the rule "maximize the project internal rate of return" simply breaks down; *(c)* any internal rate of return implies that funds can be reinvested elsewhere at exactly that rate, and this would be the case by coincidence only.

Similar objections must be raised against maximization of the benefit-cost ratio, a project-selection guide often advocated in the public-sector literature. The current view is that the input-output appraisal rate must somehow be determined outside the project framework. There are two schools of thought on how this can be done. One school views time preferences as a competitive market phenomenon, with people trading present for future dollars at a certain rate. Thus, adherents of this school would use the market rate, or range of rates, for project planning. This approach is particularly applicable to shorter-range, purely commercial transaction, it seems, where money market phenomena do indeed furnish some guidance for the future. Other writers, and among them are highly regarded economists such as Eckstein, take a rather broader view of what they term "social rates of time preference". They suggest that the capital market is "rife with rationing, ignorance, differential tax treatments" and so on, and is therefore blatantly imperfect.[20] Fundamentally they believe that investment changes consumption patterns over time. Consequently, the choice of interest rates for economic development work is essentially a matter of value judgements, leading to redistribution of income among different generations of people.

For purely financial analyses, as in the example of the petrochemical plant, the first view is correct. But for broad social and economic planning purposes, for instance, in area development, one surely must subscribe to the second school of thought. It stands to reason that all the analytical devices that express time preferences—time horizons, salvage values and scrappage costs, high or low input and output estimates, and especially interest rates—should ultimately be tailored to the results society wants to obtain. The interest rate then becomes a deliberate planning device: high rates will be used to encourage consumption and discourage investment, low rates to achieve the opposite effect.

Towards the infallible decision guide for project evaluation?

Starting from the very simple idea of means-ends comparisons, which are really at the bottom of project evaluation, the discussion has become more and more complex as various real-world circumstances have been introduced. The question arises whether a universal, foolproof decision guide for project evaluation can be devised. The answer is that the nature of the problem, as visualized in the initial terms of reference and research design, directly determines the success and decision-making criteria.

This proposition can be elucidated by studying table 2, proceeding from top to bottom: the analytical scope is widened from the single, completely independent project (surely a rare case in practice), through the project bundle (sectoral programme, system, network), to the all-embracing national or regional economy (simply the sum total of all projects and programmes). At what point on the vertical scale the analysis should be set depends entirely on the decision-maker's viewpoint and instructions. The individual entrepreneur would be concerned only with his petrochemical plant project. The Ministry of Industry (Petrochemical Division) or the National Association of Chemical Producers would probably adopt a middle position and a strictly sectoral approach. National and regional development planners would employ comprehensive analyses, in accordance with the outlook of the executives to whom they report.

Similarly, table 2, proceeding from left to right, shows that the comprehensiveness of research and measurement operations increases. At one extreme, only market value (monetary) revenues and costs are taken into account. This would suit the requirements of the profit-maximizing entrepreneur, that famous figure in economic science fiction. His place would be in the top left-hand corner. Multiply him over and over again, and a society would emerge that would engage exclusively in monetary transactions and would be guided by maximization of market value Net National Product (NNP) or Net Regional Product (NRP) (bottom left).

The right-hand column, by contrast, incorporates any number of broad social and economic values without excluding the monetary ones. In the case of single, completely independent projects (top right), possible success indices include simple goal achievement ("malaria can be eradicated"), cost minimization or requirement approach[21] ("by choosing carefully among

[19] See the important articles by J. Lorie and L. J. Savage, "Three Problems in Rationing Capital", *Journal of Business*, Vol. XXVIII (October 1955), pp. 229—239; Hirshleifer, op. cit., especially pages 348—351.

[20] Eckstein, op. cit.

[21] McKean, op. cit., uses this term.

Table 2

APPLICATION OF DECISION CRITERIA

Scope of analyses	*Possible indices of success*	
	A. For single projects	
Project	Net revenue maximization	Simple goal achievement
	Maximization of benefit–cost ratio	Cost minimization, requirement approach
		Output or benefit maximization
		Maximization of net social and economic benefits
	B. For project bundles or systems	
Project bundles, Sectoral programmes, Systems, networks	Net revenue maximization for project bundle Examine all project combinations Test interdependencies	Maximization of net social and economic benefits for project bundle examine all project combinations Test interdependencies
	C. For the economy as a whole	
Economy, national plan	Maximization of net money income growth Test combinations and interdependencies	Maximization of net social and economic benefits, subject to achievement of society's multidimensional goals
	Comparisons of potential NNP's or NRP's	Comparisons of potential "states", as described by social and economic planning accounts
Comprehensiveness of research and measurement operations	Market value subsystem	Comprehensive set of social and economic values

several ways of doing it, malaria can be eradicated in the cheapest and most convenient way"), output maximization ("the most malaria eradication that can be achieved per dollar"), or combinations of these. The most ambitious planning, research and measurement approaches are to be found at the bottom right of the table. This is the analytical box into which the comprehensive area development effort of the previous example properly belongs. Comparisons of various "states" of achievement that might be brought about by appropriate actions in the Aliveri area of Mesalia would be called for. The decision-makers must choose among these, on the basis of ethical and other standards. Presentations by the analysts of so-called social and economic planning accounts, including evidence on the effects of income distribution (or benefit incidence), would definitely facilitate their difficult task.[22]

One may conclude that there can be no single, infallible decision guide that suits all circumstances in development work. If all inputs and outputs are entirely measurable on the common monetary scale, then maximization of net outputs (or net revenues, gains, benefits etc.) can be the "counsel of perfection", as McKean[23] puts it; it incorporates cost minimization and output maximization in any case, and it can be stretched to apply to interdependent project bundles

[22] These are just some highly compressed and provisional thoughts on a subject that is still largely in flux. John S. MacDonald, of the United Nations and the Corporación Venezolana de Guyana, is the author of some stimulating unpublished papers. Available relevant sources include writings by: W. Isard, *Methods of Regional Analysis: An Introduction to Regional Science*, Cambridge, Mass., The M. I. T. Press, 1960, especially chapters 4 and 12; A. Wubing and G. B. Baldwin, *Measuring the Benefits of an Agricultural Feeder Road: A Hypothetical Example*, Washington, D. C., Economic Development Institute, 1963; W. E. Cushen, "A National Management Worksheet: An Aid to Strategic Planning", *Canadian Operations Research and Operations Research Society of America Joint Conference*, May 27, 1964. A draft chapter in a book manuscript of the author (J. E. Kuhn, *Investment Planning for Social and Economic Development*) is devoted to the proposed social and economic planning accounts. This seems a most promising approach to development problems, but perhaps other techniques can be devised.

[23] McKean, op. cit.

as well as to the entire economy. But as soon as other social goals and values intrude, as they surely will in most development work, broader criteria are called for.

Demonstration cases

It will be helpful at this point to round out the preceding methodological exposition with some practical, if fictitious, examples of project evaluation. The petrochemical plant proposal will illustrate the predominantly financial analysis of a single, independent project, using the simple success criterion of net money revenue maximization (at the top left in table 2). The area development scheme may be taken as the prototype of a comprehensive public development effort, evaluated according to broad policy criteria (at the bottom right in table 2).

Petrochemical project—research phases

Consultants have been retained by the Mesalia Industrial Development Bank to test the technical and financial feasibility of the Aliveri petrochemical plant proposals in accordance with the terms of reference mentioned previously. They may proceed with their research along the following lines:

(a) *Input and output series.* The best possible information on the costs and benefits series generated by different plant configurations must be obtained. Input and output values, in the first instance measured in monetary terms only, are recorded month by month and year by year exactly as they are expected to occur. Realistic salvage values and scrappage costs must be put down.

(b) *Technical design, engineering cost estimates.* This phase will largely be the responsibility of engineers. It embraces research on suitable production processes, equipment, plant layout, scale of operations, physical lives of project portions and many other technical aspects.[24] The crucial end result, from the point of view of investment analysis, is to obtain precise and well-documented cost estimates for the various components of the plant, with dates attached to the input sequences. Physical quantities as well as unit prices must be shown, for example: "five stainless steel pressure tanks type 437 at $14,000 = $70,000 total cost". In this way checks and adjustments for price changes can easily be carried out. A breakdown between foreign-exchange and domestic-currency costs is also required. Close collaboration between engineers and economists is essential for the preparation of sound cost estimates.

(c) *Market study.*[25] Here the talents of demand forecasters and market researchers are needed. The end purpose is to determine potential product sales over time, specified both in terms of prices fetched and quantities disposed of. If this has not already been accomplished, it is highly advisable to begin with a market study for the sector as a whole (here chemicals or petrochemicals). Such a study broadly delineates present and future demand for the product group, factors favouring or retarding demand growth, international trade aspects, competition with related products and so on. Inquiries can subsequently narrow down to the specific market shares that the proposed plant might capture. Distinctions should be made between potential demand for final consumer products (generally responsive to changes in price, income and sales efforts) and for industrial materials and other intermediate products (more closely related to over-all macroeconomic developments). Product quality as well as changes in tastes and technology must be taken into account throughout.

First research results

Suppose that the facts of this greatly simplified demonstration case are as follows:

(a) The engineers advise:

(i) A promising type of petrochemical plant could be constructed during the years 1966 and 1967 at a total initial cost of $10 million, covering design, supervision, construction and contingencies. Of this total, $5 million is payable on 31 December 1966 (t_1), and the other $5 million on 31 December 1967 (t_2).

(ii) Physical life of the facility is five years after its completion, i. e. the project expires on 31 December 1972 (t_7). There are scrappage costs (dismantling, site clearance) of $1 million.

(iii) Continuing costs (operation, maintenance, administration) are $1 million per annum, always payable on 31 December of each of the five production years to make calculations simple.

(iv) All inputs are measurable in market value terms; there are no non-market costs.

(b) The market researchers, in conjunction with the engineers, advise:

[24] For further details, as well as illustrative cases, see United Nations, *Manual on Economic Development Projects*, 1958 (Sales No.: 58.II. G.5) especially chapter III, "Project Engineering", pp. 55—99.

[25] See ibid., chapter II, "Study of the Market", pp. 11—54.

(i) The plant will yield no outputs during 1966 and 1967 and will go into productive operation 1 January 1968.

(ii) Expected product sales, assuming most suitable pricing, marketing strategy etc. are $2 million in 1968, $3 million in 1969, $5 million in 1970, $5 million in 1971 and $3 million in 1972. Revenues are always collected on 31 December of each year.

(iii) As a firm estimate, $1 million can be realized from project scrappage (sales of salvaged materials and equipment, disposal of site) on 31 December 1972.

(iv) All outputs are measurable in market values; there are no non-market gains.

(c) The financial experts advise that:

(i) The plant entrepreneur could obtain loans on the open money market at 8 per cent interest per annum.

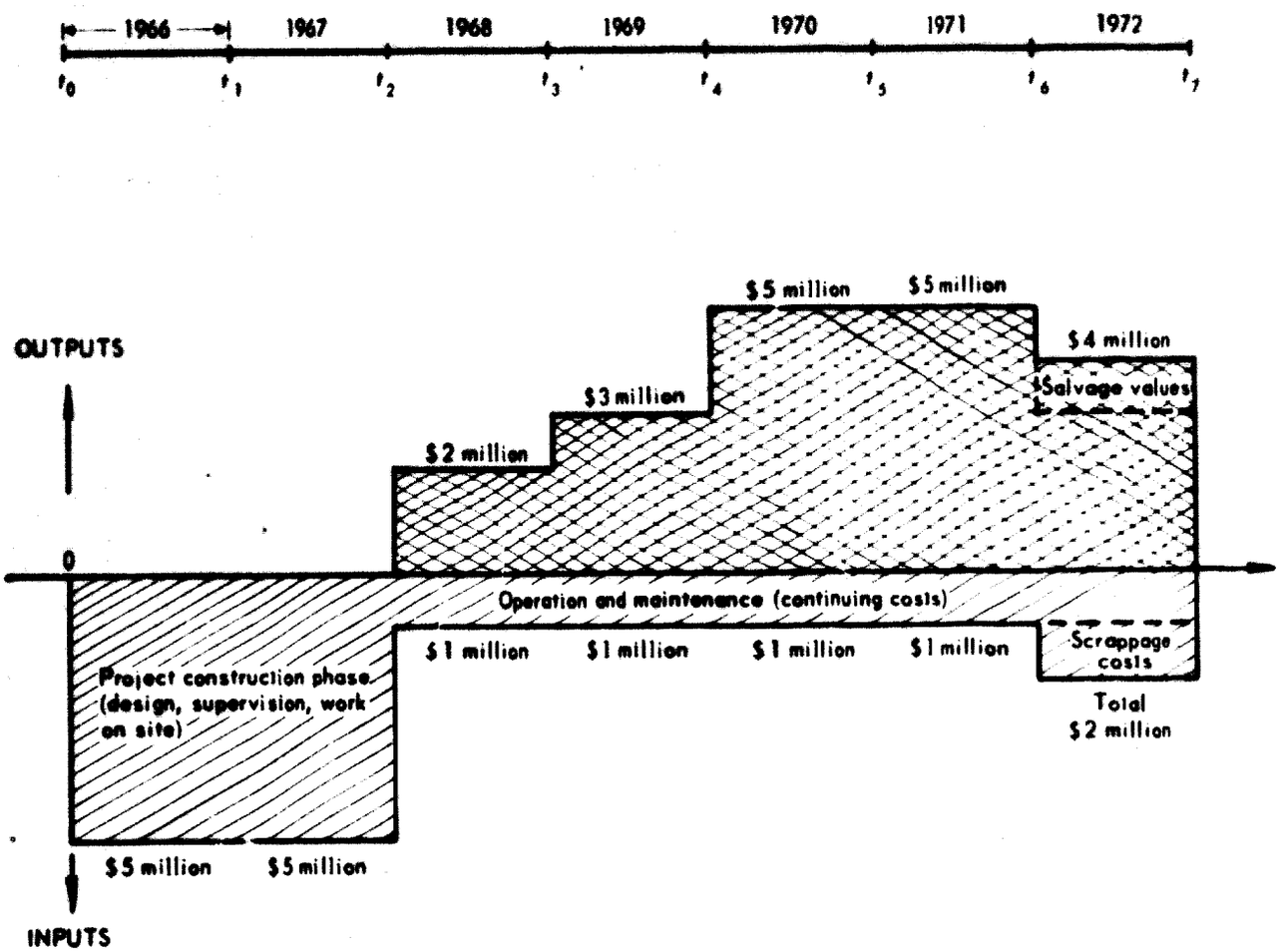
(ii) The Mesalia Industrial Development Bank might grant a more favourable loan at 3 per cent interest per annum. After consultation with the two decision-makers, it is decided that these rates should be applied alternately for purposes of project screening. There are no limits on the total size of the loan.[26]

Evaluation

The research results, which look a little complicated in words, should as a first step be recorded systematically in tabular form (see, for example, table 1) or in the form of a time chart, such as figure 4.

Figure 4

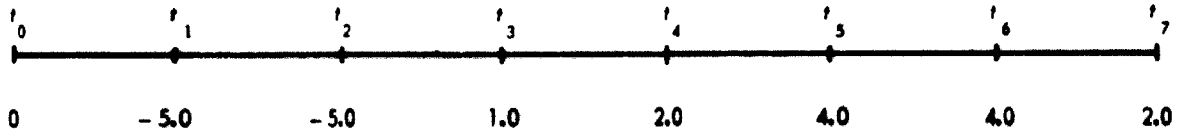
TIME GRAPH REPRESENTATION OF PROJECT EXAMPLE

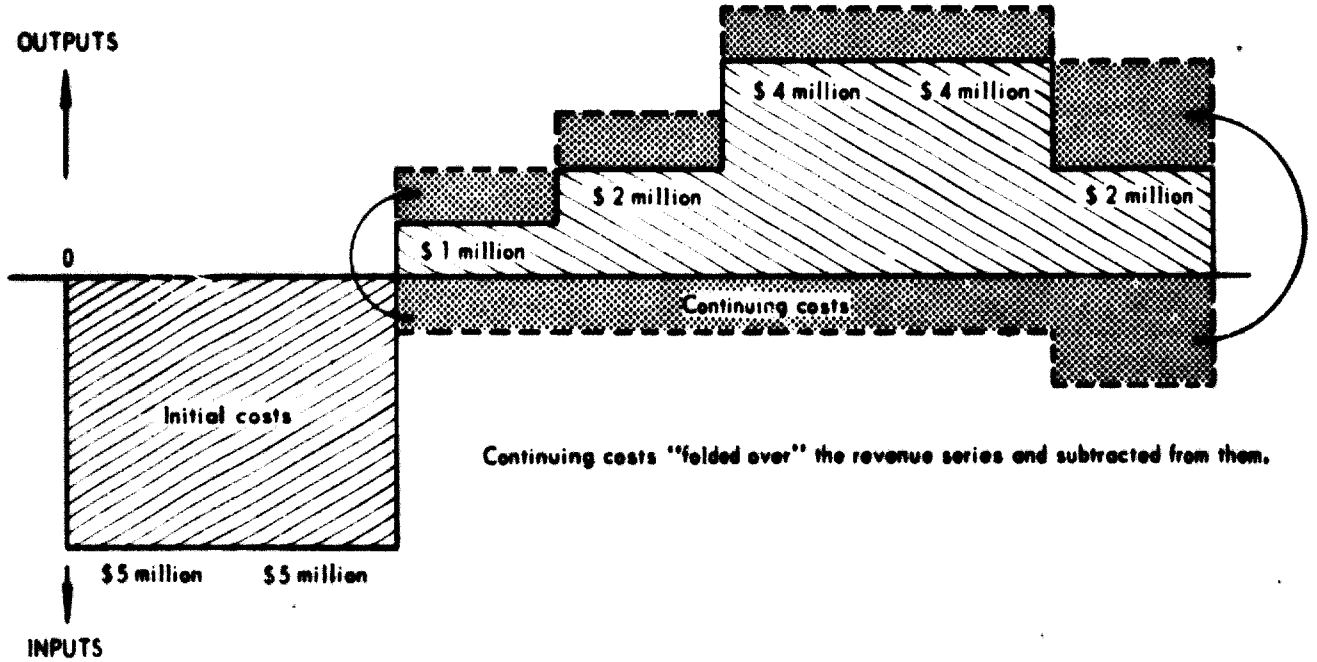


[26] This is an important condition. It eliminates the so-called "budget problem", which is prominent in the public-sector literature. Briefly, it calls for possibly sub-optimal maximization of revenues in relation to rigidly rationed investment funds. In investment theory of the private firm, similarly the rate of return on the entrepreneur's own capital (assumed to be given) needs to be maximized. (See Lutz, op. cit., pp. 15—42.) Either way, rigid input constraints do not make much sense.

Figure 5

RECORDING OF NET VALUES FOR DISCOUNTING





Continuing costs "folded over" the revenue series and subtracted from them.

(Note: This is only possible when both the inputs and the outputs can be measured entirely on the same market-value scale).

Using initially $r = 0.03$, the output and input series are then discounted[27] in the following way:

$$V = \frac{2.0}{(1+0.03)^3} + \frac{3.0}{(1+0.03)^4} + \frac{5.0}{(1+0.03)^5} + \frac{5.0}{(1+0.03)^6} + \frac{4.0}{(1+0.03)^7} = 16.249.$$

$$C = \frac{5.0}{(1+0.03)^1} + \frac{5.0}{(1+0.03)^2} + \frac{1.0}{(1+0.03)^3} + \frac{1.0}{(1+0.03)^4} + \frac{1.0}{(1+0.03)^5} + \frac{1.0}{(1+0.03)^6} + \frac{2.0}{(1+0.03)^7} = 14.6969.$$

[27] The following literature should be consulted on the correct discounting formulae and procedures: E. L. Grant and W. G. Ireson, *Principles of Engineering Economy* (4th edition), The Ronald Press Co., 1960; Lutz, op. cit.; Massé, op. cit.; or Kuhn, *Public Enterprise Economics and Transport Problems: Berkeley and Los Angeles*, University of California Press, 1962.

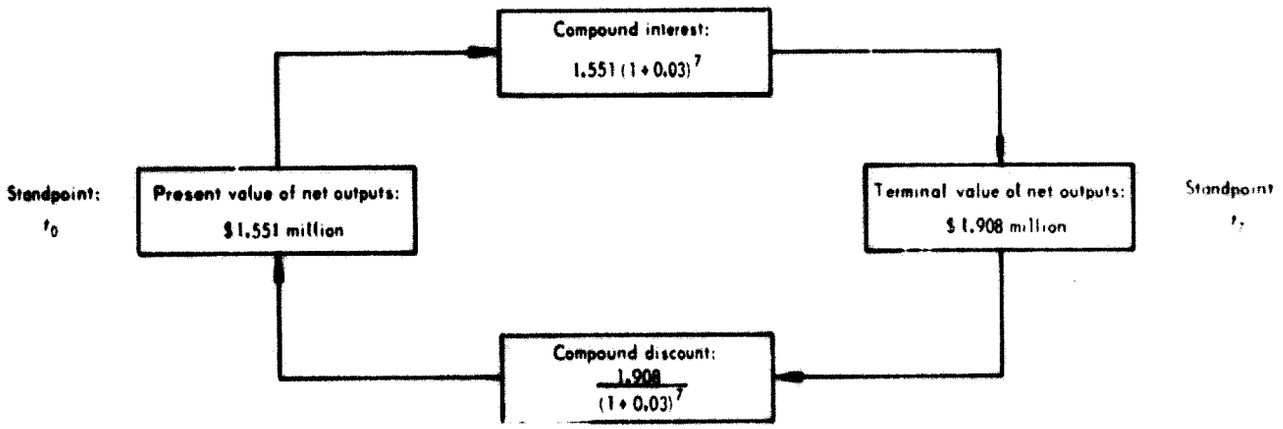
For computational convenience (as shown in table 1) the appropriate discount factors can be taken directly from standard mathematical tables.

The net gains $(V—C)$ from this project, if assessed at an interest rate of 3 per cent, are thus $1.552 million. Under these circumstances, policy advice is to accept the project. This means that if the petrochemical plant entrepreneur borrows money at 3 per cent per annum from the Mesalia Industrial Development Bank, invests it and generally runs the plant as recommended by the consultants, he can wind up the project at the end of 1972, cover all his costs, repay all his debts, and still realize net revenues of over $1.5 million in terms of the present time, that is, 31 December 1965. It should be emphasized that interest payments and amortization are taken care of automatically by the discounting calculations described here. If, on the other hand, the input and output series are assessed at an interest rate of 8 per cent, then a net loss of $0.222 million is incurred. Under these circumstances the project should be rejected, since it does not meet the fundamental principle

Figure 6

COMPOUND DISCOUNT (PRESENT VALUE) AND COMPOUND INTEREST (TERMINAL VALUE) CALCULATIONS

Assumption: $r = 0.03$ (3%)	PRESENT VALUES t_0 Standpoint	YEARS							TERMINAL VALUES t_7 Standpoint
		t_1	t_2	t_3	t_4	t_5	t_6	t_7	
OUTPUTS	16.248	0	0	2.00	3.00	5.00	5.00	4.00	19,984
INPUTS	14.697	5.00	5.00	1.00	1.00	1.00	1.00	2.00	18.076
NET OUTPUTS (NET INPUTS)	1.551	(5.00)	(5.00)	1.00	2.00	4.00	4.00	2.00	1.908



(Assumptions: *(a)* Outputs and inputs occur at end of years indicated; *(b)* interest rate, $r = 0.03$).

that outputs must at least be equal to inputs. In case of choices among several alternative project proposals, design and scale variations, the proposal that maximizes net revenues at the given interest rate should be selected by the decision-makers. As pointed out before, when more project options are evaluated in this fashion, executive judgement becomes sharper, and the final decision approaches true optimality.

Methodological observations

Possible analytical simplifications, as well as further embellishments, can now be introduced.

Simplification

When both the output and input streams are measurable on the same monetary scale (as in this case), unnecessary calculations can be eliminated by simply discounting the net values of the two series, for instance by 3 per cent:

$$V-C = -\frac{5.00}{1.03^1} - \frac{5.00}{1.03^2} + \frac{1.00}{1.03^3} + \frac{2.00}{1.03^4} + \frac{4.00}{1.03^5} + \frac{4.00}{1.03^6} + \frac{2.00}{1.03^7} = \$1.55 \text{ million}$$

This is equivalent to the cost series being "folded over" the revenue series and processing the remainders only (see figure 5). In economic writings,[28] the net series are often recorded consecutively as negative (cost) or positive (revenue) values. Starting with year t_0, the results here would thus be written simply as: 0, −5.00, −5.00, 1.00, 2.00, 4.00, 2.00.

Compound interest and discount calculations

It has been argued before that present and future values are mirror images of each other, as it were, and that there is no special magic to one calculation method or the other. Both indicate whether a project with given sets of inputs and outputs is economically viable when a particular interest rate is applied. Figure 6 demonstrates how net present and future values from the petrochemical plant can be converted into each other and can be switched around in time by means of the usual formulae. If desired, any year between the present and the remote future, for instance, the midpoint or perhaps year t_6, can also be chosen as an analytical viewpoint. Consequently, the terms interest rate and discount rate

[28] See, for example, Hirshleifer, op. cit.

are logically one and the same and can be used interchangeably.[29] Both, in effect, attach identical analytical weights to economic events occurring at future dates.

It is at times difficult to decide what the physical life of a project should be. Buildings and machinery could theoretically be maintained and rebuilt *ad infinitum*, and the right-of-way of a road never wears out physically. In these cases it is possible to postulate infinite project lives and calculate the present values of never-ending input and output streams. However, it is surprising how little difference the lengthening of life-spans from 50 to 100 years or to infinity makes when interest rates of, say, more than 4 per cent prevail. This can be confirmed by checking the relevant discount factors in a book of mathematical tables.

As with all predictions, no one series of project inputs and outputs will be absolutely correct. The basic condition of uncertainty is ever present. The analyst can render an important service by assigning probability weights to the input and output values. The decision-maker wishes to know the right joint risk attached to both series taken together: hence the probability distribution of costs and revenues combined (i. e. of the present value of future net revenues) needs to be worked out.

Much has been written on the subject of shadow-pricing—the systematic purification of input and output values in order to turn them into genuine economic quantities. For example, in many less developed countries foreign exchange is severely rationed, and the rates are pegged at an artificially low level. If such unduly low rates were used in project analysis, then investment proposals with relatively small foreign-exchange input requirements and/or high foreign-exchange earnings potentials would be penalized—surely an undesirable result. Introduction of a realistic rate (i. e. the one that would prevail without exchange restrictions) would lead to much better project-selection results. Various inputs, especially labour, are often undervalued or overvalued and corresponding adjustments should be applied. It stands to reason that tax and subsidy distortions must also be removed.

Conclusion

Purely financial analyses of commercial and industrial ventures, such as the fictitious petrochemical plant, are really quite straightforward. With the exception of shadow-pricing, the relevant economic methodology is well established and non-controversial. Provided the time preference or interest rate is given, discounting techniques can easily be mastered and used in the field. A number of worth-while additional features can be grafted onto the basic method. If both the input and output series are entirely measurable on the same monetary scale, maximization of the present value of net revenues is the correct success criterion. It yields unequivocal solutions to the following problems: *(a)* acceptance or rejection of single projects; *(b)* selection of the best project from several proposals; and *(c)* selection of the best project bundle from combinations of mutually interdependent proposals. However, as soon as multiple objectives and incommensurate scales of value are admitted—conditions to be expected in development field work—many complications arise. Some of these will now be discussed briefly with the aid of the area development example.

Aliveri area development scheme

The study terms of reference clearly showed that the national Government is determined, for good reasons, to press forward vigorously with social and economic development in the backward Aliveri area. This sort of broad problem setting—one that is encountered over and over again in many parts of the world—unfortunately strains contemporary know-how to the utmost. No formal economic and social development theory exists to guide the field worker, and although much practical experience has been gained here and there during the last ten or twenty years, it has not yet been distilled and adequately organized for general application.

Thorough treatment of the subject is quite impossible within the scope of the present article. However, for purposes of discussion, the roles of the Aliveri development planners may be imagined and the main phases of their work sketched. It may be assumed that only agriculture, industry and infrastructure are of interest.

Defining the problem and clarifying the objectives

A thorough analysis of the existing situation in the Aliveri area is a useful first step. Chief problem components may be:

- *(a)* Agriculture in this predominantly rural area suffers from low productivity, lack of markets and poor transportation.
- *(b)* There are as yet no industrial or other employment opportunities that would absorb surplus agricultural labour.
- *(c)* The quality of infrastructure and social services is well below the national level.

Ample statistical and other factual evidence to support these points can be amassed.

The desired direction, impact and speed of the governmental development effort can fortunately be easily deduced from the study terms of reference.

[29] This brings up a slight disagreement with Massé, who writes: "We shall use the expression 'discount rate' instead of 'interest rate' whenever we shall be concerned with economic calculation rather than about financial transactions. A borrower and a lender agree on an interest rate, while a decision-maker uses a discount rate." (Massé, op. cit., p. 14.) Massé's distinction is elusive.

Inventory of potential instruments for action

It is worth while to understand the institutional setting and to explore all possibilities for action, however unconventional. Examples are:

(a) In agriculture, public investment in irrigation; land reform; encouragement of new farming methods through education (extension programme), by example (pilot plant) or through direct financial encouragements (easy loans, cash subsidies);

(b) Establishment of a petrochemical plant in the area, by means that have been previously discussed;

(c) Direct government investment and encouragement of private initiative through diverse devices in the fields of transport, electric power, telecommunications, housing, education and so on.

Individual project study phase

The merits of each of these potential sets of actions should initially be investigated separately. What are the benefits and costs of irrigation in the Aliveri valley? What are the prospects for land reform? Is there a pay-off from further mechanization on the farm, from crop rotation, from use of fertilizers? In transport, are new penetration roads required or technical improvements of the existing network? Is rapid electrification desirable? If yes, should hydroelectric power sources be exploited or should a thermal plant be built?

Theoretically any one of these questions needs to be answered by a full-fledged project report. In practice, some of the proposals will be so obviously sound that they need little deliberation. For others, earlier studies will suffice. Often reports have been piled upon reports over the years, but with little action to show for them. Integrated area development planning can be an excellent medium for unearthing some of these buried treasures of knowledge and putting them to work.

Testing of interdependencies

The testing of interdependencies is a most challenging study phase, one for which there is little theoretical guidance. In the example taken, the following competitive and complementary relationships might be explored:

(a) Agriculture will compete with industry for use of land, labour and other scarce resources; on the other hand, the proposed petrochemical plant would supply farmers with cheap fertilizers;

(b) The industrial plant depends heavily on good infrastructure services (labour, highway transport, telecommunications, housing for employees, education and recreational facilities). At the same time it will, up to a point, pre-empt funds that might have been devoted to agriculture and social services;

(c) The whole public sector both gains and loses from agricultural and industrial schemes. Greater prosperity in the Aliveri area will boost government revenues, cut down on unproductive unemployment benefit payments and the like and therefore expand the scope for worth-while infrastructure improvements. At the same time, as many a local government has found to its chagrin, getting a big industry established may have its drawbacks: industrial wastes have to be disposed of; air pollution results; the local water supply and transport systems may prove inadequate. It is important to explore whether the community as a whole gains or loses. There will be strong interactions within the public sector: irrigation might be combined with a hydroelectric power scheme; highway improvements would inhibit railway transport.

The analytical goal is to come up with a combination of projects that will maximize social and economic advancement for the Aliveri area as a whole.

Sequences, time schedules

For physical reasons many of the schemes will have to be tackled in sequence, for instance, land reform first, construction of penetration roads next, followed by rural electrification, farm mechanization and introduction of new crops. Limitations of finance, manpower, contractors and materials will also prohibit crash programmes. Consequently, sensible priorities and progress schedules must be worked out. Critical-path methods and similar techniques will prove helpful, as will formal investment analysis of the type described earlier.

Evaluation, choices

Gradually, alternative sets of proposals will emerge that will differ somewhat in their ultimate effects. The one may speed industrialization and absorption of the unemployed, but agriculture and the social services may get short shrift. Another may create a model infrastructure in Aliveri, complete with paved roads, good water supplies, excellent housing and modern schools, but the growth of private disposable incomes may be disappointing. Depending on the importance attached by the community to these different types of achievement, a vigorous search must be undertaken for the optimal compromise programme. Marginal trade-offs should be brought to the attention of the decision-makers; for example, the interesting fact that an additional $1 million would buy any of these: schools for 1,000 children; 50 kilometres of main highway or

250 kilometres of penetration road; or 10 per cent expansion in the capacity of the petrochemical plant and hence additional employment for 30 people.

Final recommendations

All this analytical work will culminate in precisely worded, well-documented alternative sets of proposals for action, complete with suggestions as to when the various steps should be taken. The one set of policies which in the opinion of the analysts best accomplishes the stated objectives of the decision-makers should be singled out. The other proposals should, however, also be presented, since they are the only benchmarks against which the soundness of the recommendations can be measured. If such or similar procedures are followed by the analysts, there is every chance that sensible executive decisions can be made, leading to speedy progress in development.

Conclusions

Two extreme development planning problems have been presented: a self-contained, profit-making industrial project and a comprehensive social and economic improvement scheme for an entire area. Both require efficiency of resource allocation, and both analyses rely on elaborate means-end comparisons. There are, however, great differences in the decision-makers' objectives, study terms of reference and in the whole array of analytical techniques employed.

After years of struggling with problems of infrastructure and comprehensive planning, the author is of the firm opinion that industrial project evaluation is a much easier task: the framework is tighter; inputs and outputs are commensurate; the analytical procedures are well-established; and the criteria of success are unambiguous. If one had the choice between evaluation of a highway and a petrochemical plant, one would choose the latter any time. There are, nevertheless, compensations in infrastructure work. Experts are very scarce in this field, and yet huge resources are pumped into it regularly. In most developing countries, transport alone regularly absorbs between one third and two thirds of all public investment funds. There is also the somewhat doubtful consolation of working in a rather "safe" field. As Hirschman points out,[30] it is difficult to prove that transport and other infrastructure ventures are failures. Success or lack of success of an industrial plant, on the other hand, is for everyone to see. Follow-up checks on project performance will be discussed later.

Project planning and execution: state of the art

In 1964, at the Brookings Institution, a team of experts, including the author, tried to determine the state of the art of contemporary international project analysis.[31] The team examined 81 field reports relating to development problems of approximately 40 countries. Most of the reports were confidential documents prepared by consultants. Just to obtain them was a major feat, since there is no library or documentation centre anywhere in the world that stocks such material. Of these 81 studies, 33 were general economic development and transport planning surveys; 42 were transport project evaluations covering highways, ports, railways and airports; and the remaining six dealt with power and telecommunication schemes.

The team reviewed 20 of the 81 studies in great detail, emphasizing methodology, in accordance with a survey format that was specially developed for the purpose. These selected studies comprised roughly 5,000 pages of print, including many tables, engineering drawings etc. They cost about $4 or $5 million in professional fees to prepare, not reckoning staff and executive time of the clients for these efforts, mainly international development agencies, as well as counterpart contributions of the developing countries in question. Altogether over $2 billion worth of investments was proposed in the reports, including such projects as a $475 million power scheme for Africa and a $135 million highway network for a Latin American country. The remaining 61 studies, although read entirely, were analysed in less detail, since they corroborated the conclusions drawn from the selected group of reports.

Since that time the author has seen other reports of this type and, indeed, has made use of them. He has also had opportunities to speak to development officials and planners in the field and to look at USAID, Greek and other international data on project planning and execution speeds, including so-called disbursement patterns.

To conclude the present article, the author would like to convey briefly his impressions on the current status of project planning and execution gained in various ways.

Time lags in the investment process

There is general interest in slippages, or time lags, in project planning and execution. Tinbergen urges analysts to take account of them,[32] and OECD, among other international agencies, has commented on the undesirable "growing lag between fund commitments

[30] A. O. Hirschman, *The Strategy of Economic Development*, New Haven, Yale University Press, 1958, p. 84.

[31] The results of this research are described in more detail in a forthcoming Brookings Institution publication (Clell G. Harral and Tillo E. Kuhn, *Transport Planning in Developing Countries*, Washington, D. C., The Brookings Institution).

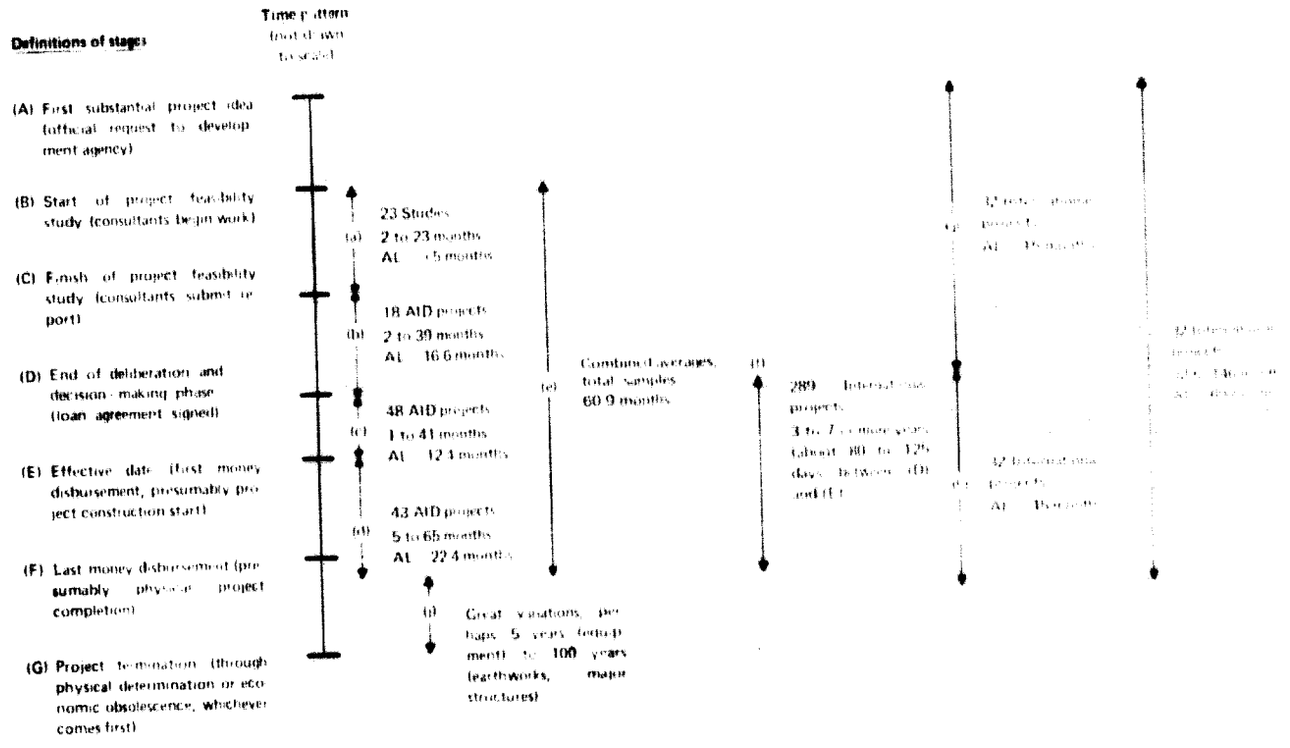
[32] J. Tinbergen, *The Design of Development*, published for the Economic Development Institute, IBRD, by the John Hopkins Press, Baltimore, 1958, p. 15.

and disbursements".[33] Apart from a recent internal report of a development agency on its experiences with disbursement delays, little factual information has been published on the subject.

The investment process is a highly complex phenomenon. It is important to understand the chain of events that typically takes place from the first notion that an investment opportunity exists until the project is completed and goes into production. Figure 7 sketches the principal stages of this process. The chain starts with the first substantial project idea (A), usually an official request to a development agency. Various consultations follow. If the proposals *prima facie* look promising, a decision to launch an investment analysis will be taken. After framing the terms of reference for selecting personnel and so on, the analysts will start their field work (B). After they have submitted their report (C), there will be further involved deliberation phases, culminating in a formal decision to go ahead with the project (D). For international schemes, this is signified by the signing of a loan agreement. For purely domestic projects, allocation of funds represents the same step. All sorts of time-consuming contracting, land acquisition and engineering design phases follow, leading up to the first money disbursement (E) and physical construction work. At point (F) the project is completed and then produces until it expires at (G), either through physical deterioration or through economic obsolescence, whichever is first.

Figure 7

TIME CONSUMED IN DIFFERENT PROJECT PLANNING AND EXECUTION PHASES



The principal stages of this process. The chain starts with the first substantial project idea (A), usually an official request to a development agency. Various consultations follow. If the proposals *prima facie* look promising, a decision to launch an investment analysis will be taken. After framing the terms of reference for selecting personnel and so on, the analysts will start their field work (B). After they have submitted their report (C), there will be further involved deliberation phases, culminating in a formal decision to go ahead with the project (D). For international schemes, this is signified by the signing of a loan agreement. For purely domestic projects, allocation of funds represents the same step. All sorts of time-consuming contracting, land acquisition and engineering design phases follow, leading up to the first money disbursement (E) and physical construction work. At point (F) the project is completed and then produces until it expires at (G), either through physical deterioration or through economic obsolescence, whichever is first.

Empirical evidence

With the kind co-operation of USAID and with supplementary data from another international development organization, the author was able to stitch together various pieces of evidence on time taken up in this complex process of investment. A great variety of schemes was covered: a sugar mill, airport runway construction, aluminium plant expansion, several highway projects, purchases of railway equipment and automotive parts, a pulp and paper mill, and many others. The results are summarized in figure 7. It is exceedingly difficult to collect complete project histories, and one is reluctant to draw inferences from the available small dossier of cases. There are more plentiful data on disbursement patterns, owing to a thorough study of 289 cases by an international development agency (see item [f] in figure 7). No solid evidence seems to exist on productive life-spans of various types of projects, from physical completion (F) to termination (G). This is a very serious gap in knowledge. All manner of assumptions on project life-span are made by field

[33] Organisation for Economic Co-operation and Development, *Development Assistance Efforts and Policies: 1963 Review*, Paris, September 1963, pp. 25—26.

Table 3

POSSIBLE FACTORS UNDERLYING PROJECT EXECUTION SPEEDS

	Disbursement speed		
	Slow	*Medium*	*Fast*
Project types	Multipurpose Mining Development banks Ports Irrigation	Power Roads	Equipment in general Industry Railways Agricultural machinery
Number of loans surveyed	57	135	97
Average three-year disbursement rate (percentage of loan value paid out after three years)	29–49%	about 60%	80–99%
Possible explanatory factors for slow disbursement speed	*(a)* Technical complexity; lack of pre-engineering. *(b)* Many sub-projects; project interdependencies; sequencing requirements; programme loans in general. *(c)* Complicated financing arrangements; several lenders. *(d)* Shortages of local currency. *(e)* Limited absorptive capacity in less developed country; administrative weaknesses; red tape. *(f)* New projects; first loans granted to developing countries; general lack of experience.		

SOURCE: Staff study of an international development agency.

analysts, ranging from perhaps five years for a frail piece of equipment up to the 67 years for a power plant. Since assumed life-span can greatly influence the outcome of project investment studies, the subject should definitely be investigated from the engineering and economic points of view.

Disbursement patterns

Turning to the study of 289 project cases, it must be emphasized that money disbursements do not necessarily closely follow the work schedule. In fact, there is often a trickle effect at the end, for instance because small amounts are held back pending final acceptance of the work although the project is really completed. Unfortunately, no data exist on actual physical project execution speeds. Payment experiences are all there is to go by.

The study provides valuable insights on the factors that may contribute to project speed or delay (see table 3). The completion of ports, irrigation and mining projects tends to be rather slow—perhaps five years or more—largely because these projects are technically difficult. By contrast, certain types of projects involving industrial plant, machinery and agricultural equipment take less time, usually under four years. Power and road projects are in the middle range. Again, general development and multipurpose schemes, which are composed of various subprojects, naturally take much longer than single projects, which are often fully designed before a decision is made. New ventures are more difficult to execute than expansion or modernization of existing schemes. Interestingly, sizes of projects do not seem to influence execution speeds significantly. But there are differences between projects launched in developed and less developed areas, probably indicating relative absorptive capacities and administrative efficiencies of the countries concerned. There may be differences in time lags between internationally financed projects (the category discussed here) and purely domestic ones. Research on this point would be interesting.

Comments and conclusions

It is interesting to note the very long lead times—five to eight or more years from project idea to project completion—with which one has to reckon in the development field. It will take additional years until the project produces fully and its beneficial impact is felt by the economy at large. It is also interesting to speculate how long it might take a somewhat backward economic system to adjust to major development shocks such as electrification, big improvements in transportation, or introduction of a large new industry. And still further years will go by until investment costs are paid off. Everything points to very long time horizons in development work, probably thirty years or more.

The following conclusions on time lags may be drawn:

(a) The investment planning process itself rather than shortage of foreign exchange, or of capital in general, or of skilled personnel—may often be the serious bottleneck in economic development.

(b) Technology, planning and decision-making impose a rather stately, slow pace; perhaps the investment process, like nature, cannot be rushed.

(c) The frequent failure of grandiose development plans to live up to expectations may partly be due to the extremely long gestation periods between idea, plan, decision, action and harvesting of results. This is a most significant aspect, and it should definitely be studied further.

(d) The design phase of infrastructure construction projects is usually so long that they are unsuitable for short-term, anti-cyclical pump-priming purposes unless they can be prepared in advance and put on a public works shelf.

(e) The time dimension is analytically most important. Lags are inevitable, and the economic planner clearly has to recognize them. Instantaneous economic recipes, all those methodological constructions that do not incorporate the time dimension, simply cannot be used for practical development tasks. Unfortunately, a good proportion of the economics literature seems to consume time.

Study lengths and costs

It appears that project evaluation itself generally does not consume excessive amounts of time in relation to the entire process of planning and executing projects. Understandably, there are great variations in study length—the observed range among a sample of 23 studies is from 2 to 23 months—largely because the technical-economic scope of the field research efforts differs greatly. Detailed locational studies, soil borings and design work, for example, are quite time-consuming. Reconnaissance reports, which emphasize economic appraisal, can be completed much faster. It is possible that in some fields research is unnecessarily rushed relative to the deliberation and decision-making stages. A study period of five or six months for appraising a $50 or $100 million investment would appear to be too short.

Study costs are obviously related to the size of the object, the complexity of the problem and above all to the engineering inputs that go into the research work. Purely economic studies tend to be cheap. From a rather small sample, the author observed the following variations in study costs as a percentage of proposed total investments:

(a) River basin economic survey in Africa—0,03 per cent;

(b) Electric power study in Africa—0,03 per cent;

(c) Port development in Asia—2,27 per cent;

(d) Detailed technical report on specific road and bridge project in Latin America—5,52 per cent.

From limited observations one may regard 0,5 to 2,0 per cent as a typical range.

It should often be possible first to carry out a quick and reasonable economic reconnaissance study, with permissible cost-benefit estimate tolerances of up to 50 per cent. Even on the basis of such rough first evidence, it would often be possible to rule out obviously unsound projects without getting drawn into cumbersome and expensive engineering work. Only if the economic reconnaissance results give grounds for optimism about the project should one proceed to further field study commitments. This particular technique for saving research and planning resources was successfully used by USAID, with the advice of the Brookings Institution, in the case of an East African highway proposal. At very low cost it was possible to reject the project outright.

Methodological weaknesses of development studies

After reading through the various field studies, one is forced to conclude that many of them suffer from serious methodological defects. Sometimes the defects are quite obvious: use of disreputable analytical techniques, fantastic benefit estimates, common arithmetic errors. In other cases the observer has to be extremely alert to discover significant mistakes that are hidden under a welter of assumptions and technical verbiage. It would be too space-consuming to offer detailed critiques in this article, but a few commonly found shortcomings should be mentioned:

(a) Many studies fail to integrate the specific project proposal with the general physical and economic discussion. In a highway report, for example, numerous pages were devoted to geology, climate, GNP trends, land values and similar subjects. None of this information was specifically related to the proposed project. At the same time, important investments contemplated in the project area were not covered.

(b) Quite obvious project interdependencies are often neglected. One study almost completely ignored the effects of a proposed new road on existing water, rail and air connexions for the same route.

(c) With few exceptions, field studies treat the time dimension inadequately. The typical report, apart from cursory references to interest rate aspects, ignores time. By claiming benefit flows right from the start, many reports imply that project implementation—from financing and the turning of the first shovel of dirt to full operation—can be achieved instantaneously. This bias results heavily in favour of the particular project.

Drastic efforts, perhaps through personnel training or issuance of manuals, will be necessary to achieve competent treatment of the time dimension.

(d) There is much confusion about decision criteria. Most popular among consultants is the benefit-cost ratio, a device of doubtful validity. Perhaps the time has come to settle once and for all the old controversies between maximization of rates of return (*I/C*, internal rate of return) and net benefit maximization (*I-C*), a superior guide in the author's opinion. Going beyond the purely monetary realm, judgements of income distribution shifts as well as of other non-market value effects of particular actions must somehow be reconciled and integrated with the traditional financial and economic criteria. This is a difficult subject, but also one on which field personnel need guidance.

Reliability of study results, biases

There are a few organized, scientific attempts to compare anticipated project performance, as claimed *ex ante* by the consultants, with actual *ex post* performance. Four aspects may be considered: *(a)* cost estimates; *(b)* benefit or revenue estimates; *(c)* conclusions drawn by the analysts from these two series and other evidence; and *(d)* the alleged effectiveness of means implied by the final recommendations for action.

It should be fairly easy to compare estimated versus actual project costs. It is common knowledge that engineering consultants almost always underestimate the construction costs of a project. Strangely, very little documented evidence on this point exists. In the Brookings research mentioned previously, the author came across the following discrepancies: *(a)* highway construction—actual cost $27.4 million, estimate $16.0 million; *(b)* highway construction—actual cost, $47.0 million, estimate, $19.5 million; *(c)* airport improvement—actual cost, $2.7 million, estimate $1.5 million; *(d)* highway construction—actual cost, $8.0 million, estimate, $5.3 million. And in Greece the following extreme cost over-runs were observed:

(a) Construction of Hotel Mount Parnis, Attika—original cost estimate about $9 million, final costs said to be about $30 million;

(b) Irrigation scheme at Iliki, Plain of Thebes—anticipated costs $4 million, actual costs about $7 million;

(c) Nitrogen fertilizer plant at Ptolemais, northern Greece—original cost estimate $39 million, final costs $80 million.[34]

Some of the figures cited here have been disputed but there is little doubt that initial project appraisals and cost estimations were weak.

[34] *Stochos*, Athens (May 20, 1965), pp. 30–33.

At the same time, it should be pointed out that in Greece, as probably everywhere else, for every troublesome project there are several satisfactory ones that do not attract so much attention. To mention but one good example in passing, the planning and execution of the new smelter of Aluminium of Greece at Saint Nicholas, Gulf of Corinth, a so-called turn-key scheme carried out by a French company, were most impressive. The costs of this project, which with a total investment of $120 million (including all infrastructure works) represents the biggest single development effort in the country, are quite close to original cost estimates. Execution speed has been remarkable: studies began in 1960; contract negotiations, land acquisition and clearance, dock construction etc. followed; structural steel went up in the spring of 1964; and the entire plant went into operation in the winter of 1965. The location of the plant—a sensitive matter because of the proximity of Delphi and other precious historic and natural resources—was well chosen, and provisions for housing, schools, social services and recreation are exemplary. There will be regular employment for about 800 workers, 93 per cent of whom will eventually be Greeks. A good proportion of these, through the company's fine training programme, will literally have been transformed from shepherds and other rural labourers into skilled mechanics. A good many lessons can be learned from the Saint Nicholas project. Perhaps a case study should be carried out to highlight the ingredients of success. Of interest is also Healey's quantitative examination of cost revisions of Indian irrigation and other projects.[35] He finds that the major cause of these revisions is inadequate geological and technical investigation of the projects in their initial phases.

In some instances poor cost estimates may be due to inflationary price increases occurring between project study and execution, but one could very easily allow for this by constant dollar adjustments. More insidious is the fact that project consultants often assume the role of deliberate project promoters, through the simple expedient of submitting artificially low cost and/or high benefit estimates. It should be possible to eliminate these practices through penalty clauses in consulting contracts. The author has no knowledge of the quality of money revenue estimates in commercial and industrial project studies. However, some infrastructure project reports come up with some quite ridiculous benefit claims. One study attributes benefits equivalent to several times the GNP of the entire country to just one highway investment! It is often alleged that particular projects can deliver growth contributions of 400 per cent—implied by a benefit-cost ratio of 5 to 1—when the economy as a whole is expected to grow at only 30 or 40 per cent

[35] J. M. Healey, "Errors in Project Cost Estimates", *The Indian Economic Journal*, Vol. 12, No. 1 (July-September 1964), pp. 44–52.

over the planning period. These are highly suspect results.

Briefly, three errors are commonly found in benefit analysis:

(a) *Benefit-attribution errors* – the particular sector, for example transport, rapaciously claims the growth in the production of goods and services generated by the entire economy.

(b) *Double-counting errors* – a number of sectors may indulge in double-counting of growth effects. For example, highways claim the same benefits that agriculture, industry, power, health and education are already crediting to their particular investment schemes.

(c) *Benefit-valuation errors* – studies may arbitrarily convert non-market effects (leisure time, smoothness of automobile ride etc.) into market values. At the same time, they may pass off important market or non-market costs (accidents, air pollution) as insignificant or immeasurable. The highway sector is notorious for such practices. Other sectors may be less adept at such practices and get less attention.

Any of these erroneous analytical operations can introduce enormous distortions into investment analysis, leading inevitably to poor resource allocation decisions.

Many of the troubles plaguing contemporary benefit-cost analysis can be traced to basic bookkeeping errors. These could be eliminated by the use of so-called social and economic planning accounts that have been proposed by the author and others. Practical experimentation with these analytical devices, in collaboration with good sectoral, regional and macroeconomic studies, would be most desirable.

Generally, practically all studies err on the optimistic side. Vicious incentive links can partly be blamed. Many supposedly neutral, outside consultants have direct monetary interests in having a project accepted. If they can show the scheme to be technically and economically feasible, a juicy engineering design and construction contract may come their way. Likewise, government departments have a natural tendency to push the projects in which they are particularly interested. Highway departments in the United States and elsewhere – one of the biggest spenders of public money these days – are well-known for the passion with which they bulldoze and pave anything in sight. And it has been said that dam building is the *raison d'être* for the United States Bureau of Reclamation and that its zeal to discover reasons against building a dam is conspicuous by its absence. Observers suggest that the Bureau is always prone to exaggerate the potential benefits and discount the potential dangers of any dam project anywhere.

Some institutional reforms seem to be needed, so that project advocates are not also project beneficiaries and adjudicators of the project proposal. Further, it is most desirable to provide the high-level decision-makers with adequate means for reviewing the sometimes complicated project reports, either through well-trained staff or through expert, outside project evaluation "auditors". It is a sad truth that few government departments and international agencies have the time to read voluminous consulting studies, let alone discover shoddy methodology and faked field data. It is an illusion that entrusting a problem to outside, independent consultants automatically produces good results – quality control through expert advisers who are mentally one step ahead of the experts retained for the job is definitely needed.

In conclusion, there is a great need for improvements in the theory and practice of project planning. The United Nations will undoubtedly continue to make contributions in this field. Development and investment problems of great significance for public welfare will have to be solved in the years to come. It is important to put the best analytical tools in the hands of planners and project evaluators as quickly as possible.

10.7.74