P&P - Appraisal and Cost of Projects II

THIS FILE IS CLOSED AS OF

DECEMBER 1968.

FOR FURTHER CORRESPONDENCE SEE:

1969 - 1971.

RECORDS MANAGEMENT SECTION
February 1969

P.B- Project Appraisal

Mr. W. Baum December 20, 1968

W.A. Wapenhans

Comments on "Deployment of Computer Simulation for Project Appraisal"

1. The paper on "Deployment of Computer Simulation for Project Appraisal" by Mr. Reutlinger of the Economics Department has been reviewed by several people in the Agriculture Projects Department. A meeting was held involving Messrs. Freidgut, Schumacher and Hendry to discuss Mr. Schumacher's written comments on the Reutlinger paper, and there was general agreement that these comments reflected the reaction of this group to Mr. Reutlinger's proposal. These comments are attached hereto for your information.

2. The discussion went a bit beyond the actual points raised in Mr. Schumacher's comments, and the major conclusions may be summarized as follows:

a. To the extent that Mr. Reutlinger has in mind the development of all-purpose computer simulation for complete project appraisals, this would be an unrealistic objective for further work at this time.

b. Within projects, however, there are certain activities that lend themselves to similar analysis as between projects, and work might be done to develop models for such specific aspects. Examples of this would include such things as operation of irrigation systems, breeding models for livestock, feeding models for livestock, and so on.

c. Models that have already been developed in this department, and referred to in Mr. Schumacher's attached memos, still require documentation to make them more widely usable. As a result of experience to date it appears that it would be better to use outside consulting services for programming since this would provide the necessary documentation to go with the program, and would also be less costly than has been the case in the work done within the Bank thus far.

d. In the development of new models for specific aspects, the technical assumptions built into the models are critical to acceptance of the models by technicians. It would, therefore, seem desirable that such models be developed within the technical departments with assistance from the Economics Department.

cc: Messrs. T. Freidgut
A. Schumacher
J.B. Hendry
S. Takahashi

JBHendry:thad

P+P - Project Appraisal

FORM NO. 59
(2-55)

CROSS REFERENCE SHEET

COMMUNICATION: Memo

DATED: December 20, 1968

TO: Mr. Baum

FROM: Mr. Knox

FILED UNDER: ADMIN. - Services - Data Processing

SUMMARY: Proposal for use of Computer Simulation in Project Appraisal

Pr P. appraisal + Cost of Projects

Mr. D. S. Ballantine December 19, 1968

Klaus Bahr

Comments on Proposal for Application of Computer Simulation for Project Appraisal, Based on a Draft Discussion Paper (Schlomo Reutlinger)

1. The paper suggests that application of sensitivity analysis by use of computer techniques could improve project appraisal by:

(1) rationalizing data collection and processing;

(2) rationalizing the decision process through making all assumptions explicit; through allowing for alternative assumptions and alternative structures of the project to be worked out; and thereby increasing and detailing the number of possible choices, i.e. increasing the chances for the relatively best choice to be picked;

(3) making project evaluation and review (during and after implementation) much easier, thereby providing for transparency of investment policies and for their efficient, continuous reformulation.

2. The paper implies that this can be achieved by (1) using model techniques, and (2) using the rate-of-return as main appraisal criterium. Whilst the latter is not (yet) applicable to education investment decision-making in the Education Projects Department, the application of computer models is a proposition which merits investigation.

3. In this context computer simulation (i.e. making experiments by use of a mathematical model which makes the logic of a project explicit) takes the form of computer assisted sensitivity analysis. This means that the effects on project objectives of changes in the basic assumptions and parameters of the appraisal model can be determined in an experimental way.

4. Contrary to the project fields Reutlinger has in mind (roads, irrigation, high dams, ports, etc.) education is a huge industry for which there is no consistent theoretical or conventional system of values and relationships defining the socio-economic interdependencies of this industry with the other sectors of the socio-economy. Education appraisal projects, therefore, cannot count on consistent (and detailed) market studies and straight-forward economic evaluation. However, detailed investigations of the education process in relation to specified objectives and of related money-costs are possible. In this area computers would be very useful. Since national education systems have certain basic structures, production objectives, input characteristics, and features of operation and organization in common it might be possible to construct a basic model, which could be adapted to individual cases (countries and projects).

5. Present appraisal procedures could, perhaps, be improved by tests for consistency and optimality (in the sense of least cost solution) through computerisation in fields like: (1) cost implications of the choice of standards (e.g. class size, floor space per pupil, number of cause-option, etc.); (2) consistency of complementary elements of the project, and consistency of the project plan with complementary development proceeding in the education system at large (e.g. successive stages of the education process, developments in pupil enrollment and teacher training); (3) consistency of enrollment plans, financial programmes, and employment projections.

6. My conclusions with respect to education projects are:

(1) Reutlinger's proposal is not applicable as it stands. Adopting conventions applied to projects in other sectors of development economies would neglect the special nature and function of a country's education system.

(2) The increasing work load of the Department and also the increasing complexity (because of software elements) of education projects will very likely necessitate rationalization and standardization of procedures (from identification through appraisal and supervision).

(3) Use of models and computers would seem desirable. Ways and means should be investigated of how to construct operational models and how to employ computers for our basic data retrieval and processing work. Computer simulation or computer assisted sensitivity analysis would then be a matter of course.

KBahr:gc

P.S. In preparing these brief notes I have consulted with Messrs. Blakey, van Dijk, Koulourianos, Lethem who had an opportunity to read Reutlinger's draft paper.

FORM NO. 57 | INTERNATIONAL DEVELOPMENT ASSOCIATION | INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT | INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

TO: Mr. S. Takahashi DATE: December 18, 1968

FROM: A. Schumacher

SUBJECT: Comments on "Deployment of Computer Simulation"

Current Simulation Programs

The Livestock Division is using a number of simulation models in its project appraisal work. There are three models "on the shelf" for livestock appraisal work. These are a breeding/fattening model, a breeding/weaning model and a straight fattening simulation. The first two have been revised so that they now incorporate risk and sensitivity analyses. Mr. Husain also worked out a system so that each of the simulations can be aggregated for securing an over all economic rate of return thereby throwing up a risk profile on a project basis (Tanzania Green Cover).

The Livestock Division also has devised a simulation model for determining cash flows and the rates of return to participating banks when one or more of these banks is used as a channel for IBRD/IDA lending to the livestock sector. This program was conceived originally by J. Andreu and devised by myself and Edwin Kumsher of the Computer Services Division. This simulation was used extensively on the Uganda Livestock and Costa Rica Agricultural Credit Projects.

I also understand that Mr. Renato Rossi has been working through a number of his farm plans on the current Mexico report using various simulation models. Perhaps eventually it would be possible, time and funds permitting, to work out in connection with specific project appraisals simulation models for dairy and sheep production. We are also continually revising our livestock simulations which have been used on the Brazil, Uganda, Tanzania and now on the Zambia Livestock Projects.

Problems

During this work on simulation many problems have arisen. The most important problem is that it is vital to have the closest cooperation of the technical specialists in devising the actual make up of the simulation model. Messrs. Gerring, Fransen and Schafer-Kehnert were extremely helpful in providing and checking the information required for the formulation and revision of these livestock models. (attached are Tariq Husain's comments on this subject) The second problem is that there are many other aspects of livestock project appraisal equally or more important than simulating a herd development projection. By far the most important problems in my brief experience to date have been devising suitable channels for the lending operations and organizing or strengthening the executing agency or agencies responsible for carrying out the project. Therefore, in this light, I am working less now on further refining the basic livestock simulations and more on finding suitable programs which would enable our livestock and agricultural credit institutions to

greatly improve both their accounting systems and the data provided to management for policy decisions. You will recall that I mentioned this subject briefly during staff meeting (December 16). I have attached the first results of this work as reported in AFC's most recent progress report on KE-105.

Conclusions

I would question the need for "a center" located in the Economics Department devising simulation models on various projects. I would suggest that it could be very beneficial if certain interested members of the Economics Department could participate more fully in project appraisal work and could, as a result of such participation, devise realistic suggestions for improving our project analysis and follow up. In this connection, Mr. Gittinger of the EDI has discussed with me in very general terms a possible presentation to this summer's Agricultural Projects course, of two lectures (with appropriate case study material) on sensitivity, probability and risk analysis as applied to a specific project, such as Tanzania or Zambia. Therefore, it would be most helpful if someone from the Economics Department (preferably Mr. Reutlinger or Mr. Husain) could work most closely, possibly on the Zambia Livestock Project where our data would be fairly good, with the Livestock Division in analyzing the particular problems of applying simulation models to these projects. In this fashion, it would be possible to obtain a good appreciation of the specific problems incurred and benefits obtained in deploying such an approach.

Finally, it would also be very helpful to the work of the Livestock Division if someone in the Economics Department could make an inventory of all simulation work completed or on-going on livestock done in universities both in the United States and overseas. Such an inventory of work would better able us to assess the current state of both simulation, linear and dynamic programs and systems analysis existing at the moment in the livestock area.

ASchumacher/mjt
IBRD

cc: Messrs. Stoops/Fransen
Friedgut/Palein
Gittinger (EDI)

P & P - Appraisal of Proj.

December 17, 1968

Professor Pearson Hunt
Edmund Cogswell Converse Professor of
Finance and Banking
Graduate School of Business Administration
Harvard University
Boston, Massachusetts 02163

Dear Pearson:

I greatly enjoyed seeing you again in Boston last week, and it was a pleasure to meet your wife. Thank you both for your kind hospitality.

You will recall we had a short talk after dinner about financial analysis and the new approach you are developing. I said it would be interesting for us and perhaps for you to see what you thought of the way we conduct financial analysis in our project appraisals. I have spoken with Mr. Baum, Associate Director, Projects, and with Mr. Rovani, Financial Adviser, Projects. They have agreed that it would be useful for me to send you two of our reports, one on the Second Railway Project in Taiwan (1967), and the other on the Ghana Power Project of early 1968. You will note that these are confidential documents between us and the member governments, and I would ask you to treat them on this basis as being for your personal use only.

If you feel so disposed, and taking into account your imminent journey to Europe and Israel, we would be glad to have any initial reactions from you, and then see if there is anything further that might be done. The easiest way might be for you to call in at the Bank when you are in Washington after your return from abroad. At that stage, I would like you to meet Mr. Rovani who is responsible for guiding the Bank's financial analysis work.

I hope you have a good journey. Alison and I send you our best wishes for Christmas and the New Year.

Yours sincerely,

Bruce M. Cheek
Deputy Director
Western Africa Department

Reports No. TO-601a China
TO-629a Ghana
P-605 Ghana.

12-18-68
Reports Desk.

cc:Mr. Rovani

BMCheek:hpb

Mr. A. David Knox December 11, 1968

C. R. Dickenson

Proposed Amendments to the Summary of Information Needed for Telecommunication Project Appraisals

It was suggested that, if the Summary in question is to be reissued, it would be advantageous if this were done in loose-leaf form so that it may become a supplement covering the special telecommunications aspects and associated with the small black reference book covering appraisals in general.

With regard to the actual amendments and additions, I would propose as follows:

Paragraph A. Information about the Borrower

A sentence should be added before the final sentence in subparagraph 2 worded as follows: "The adequacy of the planning organization and arrangements for review of plans as projects progress should be examined, and proposals made for any changes which may be necessary".

Paragraph C. The Telecommunications Market

A further sentence should be added at the end of the paragraph: "Consideration should be given to the possible effects of the project on other means of communication already in existence, particularly insofar as profitability of such service may be affected with possible prejudice to the financial viability of the organisation as a whole."

Paragraph D. Description of the Project

The following new sentences should be inserted after the first sentence: "The description of the project will normally include any additional provisions outside of those to be financed by the Bank which are necessary for effective use of the plant which is proposed for Bank financing. The description of the project may also include consultancy services where these are proposed. The appraisal team should make a review of the Borrower's development program as a whole in order to confirm that this is a balanced one both from the geographical standpoint and in relation to the various services provided, i.e. long-distance, local, telex, etc. The question of possible standardisation should be examined as related to filling existing installations to capacity, extension of existing installations by additional new units, or in regard to the network as a whole." and then read on "The description of the project ...

Paragraph G. Estimated Cost of the Project

An addition should be made worded as follows: "Possible foreign exchange conversion problems and the effects of any future devaluation should be considered. Where alternative proposals involving different foreign exchange costs are under consideration, present value cost studies should be related to the free market rates of exchange."

Paragraph J. Operating Organization

An additional sentence should be added: "The number of employees should be considered in relation to numbers employed in other developing countries facing similar conditions and at a similar stage in their development, and as related to wage rates applying and the labor cost per telephone. Training programs should also be considered in relation to outside educational facilities, academic levels reached and the adequacy of such both from a quantitative and a qualitative standpoint."

Paragraph K. Tariffs

An additional sentence should be added to the first paragraph: "In many countries preferential tariffs or special services are provided for government departments. Details should be obtained and the position clearly set out in the appraisal." An addition should be made to paragraph 2 as follows: "In reaching its conclusions on the tariffs proposed, the mission should bear in mind the following general principles:

(a) Tariffs can frequently with advantage be cost related but the relationship should be reasonably broadly based and in the case of local, long-distance and international telephone networks must be interrelated.

(b) Development of all networks and systems should as far as possible be based on a requirement for financial viability over the life of the plant and as related to the opportunity cost of capital in the country in question.

(c) The need for subsidization of any service either by the administration/rate payers or by direct subsidy from government should be carefully examined and brought out in the report.

(d) Charges for services should not be placed at such a high level that they adversely influence development or affect the operation of the economy, and the use of high rates as a rationing factor should be carefully examined.

(e) The basis on which installation fees or the purchase of bonds is required from new subscribers should also be considered and brought out in the report."

Paragraph L. Financial Aspects

At the end of the first paragraph, the following sentences should be added: "In general, considerations should be related to modern commercial accounting systems even though the administration operates within a government budgetary system. The position on accounts receivable should be carefully examined and related to how many months' revenue this constitutes. Possible proposals for mechanized accounting should be examined, particularly as related to use in other functions of management."

After paragraph L, a new paragraph should be inserted:

M. Economic Aspects

The possible economic aspects for consideration in relation to the telecommunications operation will in the main fall under the following headings:

(i) A review of whether an adequate allocation of national resources for telecommunications is being made as related to the GNP and/or national savings;

(ii) an investigation as to what extent the order of priorities proposed for telecommunications development is related to economic considerations;

(iii) an examination of the tariff structure and possible effects of existing and proposed tariffs on the economy;

(iv) an examination of the balance of payments position as related to the essential telecommunications needs;

(v) the adequacy and efficiency of existing services and their present effects on the economy;

(vi) the sources of funds to be provided for the program;

(vii) the likely economic benefits of the project.

CHD:sl

cc: Messrs. Vasudevan, Meier

ops Files
for P- Appraisal & Cost of Pr.

Dr. Ed. Mason

December 9, 1968

A. D. Spottswood/Samuel Lipkowitz GDS

Outline for Historical Development of Project Appraisals

1. We have prepared the attached outline on the historical development of project appraisals as a basis for discussion as to how you would like us to proceed.

2. The outline is only illustrative of the factors that have affected project appraisals and it is not intended to be exhaustive or complete. We hope, however, that it will serve to obtain your approach to the research required and the degree of detail you like to have.

3. After you have read the outline please let Mr. Spottswood know when it would be convenient to discuss it with you. (Extension 2683).

Enclosure:

ADSpottswood:mw

P&P - Appraisal & Cost of Proj

Mr. Warren C. Baum

December 6, 1968

Herman G. van der Tak

Proposal for Deployment of Computer Simulation for Project Appraisal

1. The attached draft working paper, prepared by Mr. Reutlinger outlines the substantive features of the application of computer simulation to project appraisal work. Briefly, the proposals are to (a) write up clearly models used in evaluating various types of projects, (b) have the model programmed for computerized calculations, (c) use preliminary data to determine the relative merits of investigating various project features and to determine the most relevant data gaps, (d) determine the economic benefits using alternative project designs, and finally (e) obtain the most likely estimate of benefits as well as the likelihoods of other estimates (risk) based on probability distributions of events and parameters affecting the project.

2. The proposed procedures do not aim at sophisticated optimization models or systems analysis for complex projects. They are merely intended to improve and facilitate currently used appraisal methods for standard types of projects. The same models and simulations, but using updated information, would serve at several stages of a project's life: at pre-appraisal, during appraisal and for ex post evaluation.

3. The general idea behind these proposals, the need for both streamlining and improving the project appraisal procedures, is not new and has been discussed for some time. Their implementation will require a systematic effort. A team of two to three persons from the Projects and Sector Studies Division would lead in constructing the models, demonstrate their usefulness and advise on problems of implementation. They would work in close cooperation with the Projects Departments whose active participation is required. Their subject experts will have to assist in developing the models for the various types of projects and will have to use them in practice, and possibly adapt them for a particular project. Eventually, we would expect that many people in the Projects Departments will have learned how to use and adapt simulation models. The division's involvement would then become limited to advising on special problems and to using these models for special research and follow-up studies.

4. We are looking forward to discussing these proposals further with you and your colleagues,

Attachment

cc. Messrs. Kamarck
Stevenson
Reutlinger/deWeille/Thias

HGvdTak:bso

Draft

December 6, 1968

DEPLOYMENT OF COMPUTER SIMULATION FOR PROJECT APPRAISAL

Economics Department

Sector and Project Studies Division

Prepared by: Shlomo Reutlinger

Tentative Draft

Table of Contents

I. Introduction

1. The purpose of this paper is to suggest adoption of a new format for presenting economic appraisals of projects and to suggest additional analysis of project appraisals. None of the proposals are new to persons generally familiar with operations research tools. The paper is intended, however, to impart a basic understanding of the proposed analytical procedures to those unfamiliar with jargon used in the operations research literature. Since application of some of the proposed analytical procedures would probably result in more speedy and less costly appraisals and others would improve their quality, the fact that they are not more used suggest at least that the methods are not widely understood. Yet, the proposals are simple: (a) write up clearly the algebraic relations of the model used in deriving a measure of the project's benefits, (b) have the model programmed for computerized calculations, (c) use preliminary data to determine the relative merits of investigating various project features and to determine the most relevant data gaps, (d) determine the economic benefits using alternative project designs, and finally (e) obtain the most likely estimate of benefits as well as the likelihoods of other estimates (risk) based on probability distributions of events and parameters affecting the project. Translated into the language of operations research, the recommendations are simply an advocacy of using simulation and stochastic simulations in routine project appraisal work.

2. Rationalization of project appraisal procedures has been going on for a long time. We have come far in accounting for the benefits and costs, and in doing so we have uncovered a whole host of problems: how to measure benefits and costs, how to estimate physical responses to project activities and how to predict prices and costs. We hope to make progress on all these problems through improvement in our theories explaining physical and social relationships, and through improvements in data collection and their statistical interpretation.

3. Interestingly enough, however, our attempts at rationalizing have led us to a new phase in project appraisal: a clear recognition that knowledge of costs and benefits, let alone future costs and benefits, is likely to remain incomplete and at best a matter of probability judgments; and that what we need, therefore, are appraisal methods which take this fact explicitly into account and do afford as rational a judgment of a project's merits, <u>given whatever knowledge we do possess.</u>

4. As quantitative appraisals of a project's merits become accepted standards and as it is more and more realized that such appraisals involve a large number of judgments about events and parameters which at best are subjectively determinable predictions, it becomes also necessary to require a clear presentation of how and on the basis of what assumptions costs and benefits have been estimated. A more formal statement of the model used in the analysis facilitates such a presentation.

5. The proposals detailed in this paper have grown out of a variety of experiences. First, the paper represents an attempt to point out the practical feasibility of applying the general ideas presented in an earlier, more theoretical study of measuring the impact of uncertainty

about project related events on the rate of return estimates.[1/] Second, recent applications of systems analysis in the appraisal of several projects suggest valuable generalizations.[2/] Finally, the quest for a more adequate and systematic presentation of factors considered in making rate of return calculations is the result of difficulties encountered by the author and others when asked to comment on project appraisal on the basis of presently available information in appraisal reports.

1/ See S. Reutlinger, "Techniques for Project Appraisal Under Uncertainty", IBRD Report No. EC-164.

2/ These applications were pioneered by L. Pouliquen and E. Jaycox on transportation projects, and T. Husain and A. Schumacher on a livestock project.

II. "Formal" Project Models and Their Uses

Definitions

6. This paper is about the application of computer simulation on mathematical models in project planning and appraisal. A good general definition of simulation and model is given by Shubik.[1/]

> "A simulation of a system or an organism is the operation of a model or simulator which is a representation of the system or organism. The model is amenable to manipulations which would be impossible, too expensive or impractical to perform on the entity it portrays. The operation of the model can be studied and, from it, properties concerning the behavior of the actual system or its system can be inferred."

7. This very broad definition then suggests that, in fact, any planning activity, including project appraisal always is a simulation on a model. Indeed, a model could be simply a logical abstraction in the mind of a person or a physical structure reduced to scale and devoid of detail. Simulation could be an abstract manipulation on the model retained in the mind of a person or a physical manipulation on the three-dimensional structure.

8. The definition of computer simulation on mathematical models is much more restrictive. A mathematical model is a statement of relationships between variables which conforms to well specified rules of logic. "Computer simulation is a numerical technique for conducting experiments on a mathematical model."[2/]

1/ M. Shubik, "Simulation of the Industry and the Firm", American Economic Review, L, No. 5 (December 1960), pp. 908-919.

2/ T. H. Naylor, et al, Computer Simulation Techniques, John Wiley & Sons, New York, 1966.

Reasons for Constructing a Mathematical Model and Computer Simulation

9. It has been pointed out already that practically all planning is synanomous with simulation on a model. Certainly, major capital projects which take years to be constructed and many more years to yield benefits cannot be manipulated themselves for the purpose of knowing their benefits. All such projects' effects must be inferred form calculations (or simulations) on a model.

10. A concise mathematical statement of the model conforming to rules of logic does not necessarily and under all circumstances improve the model nor facilitate its use. Certainly, some aspects of a project might be more readily studied by observing physical models like the ones usually contructed by engineers and architects. For other aspects, it is too difficult and costly to construct a mathematical model or inadequacy of empirical knowledge may curtail its usefulness.

11. There are no exact rules for setting up good models. The same applies to mathematical models. Generally, there is some benefit from disaggregation if it results in better projections of the aggregated variable of interest. For instance, it is quite clear that if one's objective is to estimate the internal rate of return of a project it is useful to have a model of how the rate of return is related to annual net benefits. Whether to project total revenues from sales of a commodity on the basis of prices and physical quantities and a "model" relating these to total revenue or to project revenues directly without a "model" would depend on whether prices and quantities can be better predicted than total revenues directly. It would not make much sense to construct a model relating production to weather, if weather cannot be predicted and/or the relationship between weather and production is not known.

12. To the extent that any model can and should be developed, however, the construction of a mathematical model and computer simulation are useful because:

(a) such models can be used as very specific "terms of reference" to what data and assumptions should be or have been considered in the appraisal;

(b) such models can be easily adopted for computer calculations;

(c) The general model can be then used for quick and inexpensive investigations of the effects of changes in the project on the desired benefits;

(d) the model can then be used to identify the more sensitive information gaps,

(e) the model can then be used to make an appraisal of the likelihoods of obtaining various results from the project, and

(f) the model and the clearly specified assumptions about the behavior of variables and parameters will provide a good basis for ex post evaluations of the project.

Construction of Mathematical Appraisal Models

13. Any project generates many types of costs and benefits. An appraisal cannot take into account all of them nor can the actual costs and benefits be actually observed. Hence, cost-benefit analysis is simply the construction of a model capturing anticipated major occurences and analyzing them. Possible shortcomings of present appraisal

procedures are not necessairly the result of inadequate models used in appraisals. Some models may be gross abstractions of what actually is likely to transpire during the course of a project, yet may be the "best" ones feasible in view of the state of available information and appraisal objectives.

14. The difficulty with most currently used models is that they are often not clearly or fully stated. Component parts of the model are scattered throughout an appraisal report, while it has become standard procedure to show the "super-structure" of the model in the form of an annex table, giving series of annual costs and benefits and the internal rate of return estimate. It is usually difficult to find out how these costs and benefits are estimated and on the basis of what assumptions. An analagous situation would be if an architect presented a matchbox glued to a cardboard and, separately, a shopping bag filled with models of doors, windows, ornaments, etc. to a panel of judges charged with assessing the beauty of a proposed building. Obviously, the judging would be very difficult and the effect of making small changes in the components of the building on the final appearance and beauty could not be easily ascertained.

15. A mathematical model as used in the context of this paper is merely a precise statement of the logic used and the basic premises or assumptions used in appraising a project. Such a model does not require accurate quantitative information, nor does its deployment guarantee accurate quantitative estimates. The following illustrations are intended to illustrate the technique for constructing a mathematical model.

16. A project model can be extremely crude and simple or very refined and complex. An extremely crude model would be a statement that

to determine the internal rate of interest it is necessary to find the rate, r, which makes a prescribed number of discounted net benefits sum up to zero. Or in algebraic notation:

$$(1)\ \begin{cases}\text{Choose r such that} \\ \sum \left[(1+r)^{-t} \times \boxed{\text{Net Benefit (t)}}\right] = 0\end{cases}$$

$$\text{where } t = 1, 2, \ldots, \boxed{n}$$

This project appraisal model would then consist of an explicit statement of n annual benefits (negative or positive) and their relationship to a derivation of their benefits.[1/] This is obviously an extremely crude model. However, for a case in which no data on specific inputs or outputs or prices can be obtained or in case of a project which is extremely small or similar to previously analyzed projects, this crude model may be the "best" one for the purpose.

17. An expansion of the very crude model may look as follows:

$$(2)\ \begin{cases}\text{Choose r such that} \\ \sum \left[(1+r)^{-t} \times \text{NET BENEFIT (t)}\right] = 0\end{cases}$$

$$\text{where } t = 1, 2, \ldots, \boxed{n}$$

$$(3)\quad \text{NET BENEFIT (t)} = \text{REVENUE (t)} - \text{COST (t)}$$

$$(4)\quad \text{COST (t)} \begin{cases} = \boxed{k(t)} \times \text{PROJECT COST} & \text{if } t \leq \boxed{c} \\ = \text{MAINTENANCE COST} & \text{if } t \geq \boxed{c} \end{cases}$$

1/ Variables or parameters which are used as given data without specifying how they are estimated are shown in boxes.

Equation (4) simply states that during the construction period, c, the cost is some proportion, k(t), of the total project cost and thereafter the cost is a constant maintenance cost.

(5) PROJECT COST = STRUCTURES + /CONSULTANTS/ + /ADMINISTRATION/

(6) STRUCTURES = /QUANTITY/ x /PRICE S/

Equation (5) states that the project cost is derived from estimates of three distinct types, say structures, consultant's fees and administrative cost. Equation (6) states that the cost of structures is based on estimates of the number of structures needed and their per unit cost. Then,

$$(7)\quad \text{REVENUE}(t) \begin{cases} = 0 & \text{if} \quad t \le /c/ \\ = ((t - /c/)/ /f/ \times \text{REV FULL DEV} & \text{if} \quad /c/ < t < /c/ + /f/ \\ = \text{REV FULL DEV} & \text{if} \quad t \ge /f/ \end{cases}$$

Equation (7) states that revenue is zero during the construction period, c, increases at a constant rate furing the development period, f, and remains constant from there on. Furthermore,

(8) REV FULL DEV = OUTPUT x /PRICE O/

(9) OUTPUT = /OUTPUT PER FIRM/ x /NUMBER FIRMS/

18. The eight equations presented so far constitute a model which is still not very specific on many assumptions likely to be made in the course of a project appraisal.. However, it illustrates the kind of model which could be prepared in advance of specific appraisals for projects of a similar nature. The purpose here is simply to show what

is involved in preparing a formal statement of a model. Clearly, it is nothing but a concise statement of how a project is being appraised. The use of mathematical language certainly presumes nothing about the preciseness of the quantitative estimates used in the appraisal. It merely codifies the logic used in going about the appraisal. Clearly, no unusual mathematical skills are required to construct such a model.

19. A model identifies the relationships between variables. The basic building blocks of the model are variables and parameters which are used in the appraisal. A listing of these and their values used in the appraisal in conjunction with the model is an important step in presenting the model. In the case of the above eight-equation model data would need to be provided for the following list of items:

/n/, the "life" of the project

/k (t)/, the proportion of project cost incurred in each year during the construction period

/c/, the length of the construction period

/CONSULTANTS/

/ADMINISTRATION/

/QUANTITY/

/PRICE S/

/REVENUE FULL DEVELOPMENT/

/f/, development period, time between end of construction and attaining full development benefits

/PRICE O/

/OUTPUT PER FIRM/

/NUMBER OF FIRMS/

Timing of Model Construction

20. To the extent that there are many similarities in the way projects of a kind are appraised, it may be useful to have a general model on hand prior to specific appraisals. This is similar to saying that one ought to approach such project appraisal with fairly detailed terms of reference. Clearly, some part of the model might not be useable in all projects either because of lack of necessary data or because of irrelevance. Similarly, in other cases it would make sense to agument the model by making further refinements.

21. With currently previaling project appraisal procedures, the terms of reference specify indeed only a very crude model in advance of the appraisal. It is generally expected for almost all project appraisals that an internal rate of return be estimated on the basis of a series of annual net benefits (as outlined in equation (1)). Any further development of the model is accomplished during the appraisal of each project.

22. Preparation of more refined models in advance of appraisals would have several advantages. First, such models, incorporating features generally analyzed in projects of a kind, would serve to alert appraisors to data to be collected and analyzed, if feasible. Second, such models could be used for analyzing a project's merits with preliminary data. Such data may be requested from whoever is in charge of project preparation. Finally, such models, in conjunction with preliminary data, could be used to analyze the sensitivity of the rate of return estimate to specific factors and to identify the relative importance of further field investigations. Similarly, the stage would be set for analyzing the advisability of modifications in the project and related policies.

23. It is likely that in each appraisal some components of costs or benefits are estimated in other than the usual ways. This applies to technical as well as economic parameters. It is then desireable to graft on to the general model a number of equations describing the "appraisal logic" used in the particular case.

Computer Simulation

24. Transcribing a model into a number of concise statements may be useful simply in terms of making it less likely for oversights to occur. It may even turn out that after having invested in the adoption of "formalized" models, they will turn to be instruments for speeding up appraisals and making it less time-consuming for persons who have not been involved in the appraisal to give critical reviews. However, the most important reason for preparing a "mathematical" model is that this provides an opportunity to subject a project to a much more adequate appraisal than would be possible otherwise. This advantage obtains because a mathematical model's deployment is uniquely adopted to calculations on high speed computers.

25. Preparation of the project models (whether to be made in advance or during an appraisal), data collection and determination of the uses to be made of the model is, of course, the sole responsibility of the experts: the engineers, the agriculturalists, the economists, etc. Many of the advantages to be derived from "formalizing" models derive, however, from the ready availability of high speed calculating capacity on modern-day computers. With competent programmers to assist, the model deployment suggestions detailed below should not present any serious technical difficulties.

Sensitivity Analysis

26. Senstivity analysis is essentially an investigation of how and to what extent individual factors and parameters are likely to influence the benefits derived from a project. Knowledge of this "sensitivity" can affect project planning decisions and appraisal in several ways.

27. There are first of all the many factors and parameters which inflence the success or failure of a project, and hence its merits, but which are outside of the control of project design or management. Clearly, the quantitative values of these factors and parameters cannot be known precisely. However, a sensitivity analysis prior to the detailed appraisal of the project could determine the relative value of information to be obtained from additional investigations. Furthermore, when additional precision of estimates cannot be attained, sensitivity analysis, combined with a rough estimates of the extent of uncertainty about various factors and parameters could provide a preliminary estimate of the risk of attaining a lower than anticipated rate of return.

28. Equally important, sensitivity analysis would make it feasible to explore the benefits or costs of many alternative project designs and management features. Using the formulated model one could quickly determine by how much a smaller project, delay in construction or different management features would affect the rate of return of the project. When costs and benefits of alternative design features are not known, it could be at least determined whether additional investigations are worthwhile.

Risk Appraisal

29. Another important potential use of a project simulation model is in estimating the risk or uncertainty involved. In the literature on decision

models one may get the impressions that variables and relations can be classified as known to be with certainty or as being subject to risk or uncertainty. As abstractions these three states can be more or less objectively defined. However, in reality, when one is faced with making appraisals or forecasts, objective measures are not available or unattainable. The appraiser must then make up his mind of what he believes to be the most likely probability distributions of each variable affecting his decision, using whatever related evidence available to him. Practically, this means that he must consider the full range of possible values taken on by the variable and their relative likelihoods. Such information has not and cannot be processed by current appraisal procedures. The estimated rate of return as usually estimated is simply the return, assuming each variable and parameter is going to take on a specified single value. Consequently, the likelihood of getting a lower or a higher rate of return is not appraised, although it is quite certain that the engineer or the price forecaster making the appraisal has in his possession a large amount of relevant information.

30. Uncertainty analysis in conjunction with a simulation model could utilize this information to predict a probability distribution of the rate of return. This appraisal method is called stochastic simulation. Instead of using a set of single values for the variables and parameters, the computer is presented with a set of probability distributions of variables and parameters. The computer is then instructed to pick at random a set of values for each of the variables and parameters, a value having a chance of being chosen according to its likelihood to occur. Based on this selected set of values a rate of return is calculated. Repeating the same procedure a few hundred times, the resulting frequency

distribution of the rate of return is likely to approximate the probability distribution which corresponds most nearly with the objective and subjective knowledge possessed by the appraisors.

31. Having done this uncertainty appraisal, the decision maker first of all can avoid surprises. If he is not willing to take chances he can decide to avoid projects with unacceptable chances of failure, or if he has a choice between two projects having equal average of "most likely" returns he can choose the one with less chances of a smaller return. It is not possible to give a general rule for decisions under uncertainty, but the fact remains that decisions are frequently affected by what are believed to be the likelihoods of varying outcomes and that it is, therefore, desirable to use all available information for estimating these likelihoods.

Ex Post Evaluation

32. Finally, formalization of models will be extremely useful for doing follow-up evaluations of projects. Explicit statements about the variables and parameter assumed to influence the appraisal and their assumed values will facilitate the collection of useful data for testing appraisal practices. Sensitivity analyses and risk appraisal performed during the appraisal will provide the basis for identifying the more important variables to be kept under continuous surveillance. As actually realized values become available, the model with modifications can be used over and over for quick recalculations of the actual benefits.

33. Projects may turn out better or worse than or as anticipated without credit or fault being attributable to the appraisal, as ably

documented by Hirschman.[1/] Hence, useful lessons are more likely to be learned, if we concentrate on re-evaluating our predictions about specific factors and how they relate to the overall success of projects, rather than limit our attention to success or failure of projects themselves, which may be due to unforeeable circumstances.

1/ A. O. Hirschman, Development Projects Observed, The Brookings Institution, Washington, D.C., 1967.

III. Case Illustration: A Highway Project

34. The case study of an actual transportation project is presented here to illustrate the proposals made in the previous chapter. The described project was appraised by Messrs. Jaycox and Pouliquen employing the method of simulation on a mathematical model. Since the purpose here is to illustrate the method rather than to impart a thorough understanding of a particular project, the model discussed in this paper is a somewhat simplified version of the model actually used.

35. The project data used in this illustration are taken from an actual highway project in Zambia. The project calls for the pavement of a 64 mile long road. The project is supposed to be completed in two years. The major measurable benefits consist of road user savings and road maintenance cost savings. The extent of these benefits depends of course a great deal on the estimated traffic volume. The road may result in some induced traffic, but for our illustration we are simply going to neglect this kind of benefit.

36. A conventional project appraisal report would give a table with numbers, as shown in Table 1. The costs and benefits shown in this table are based on best estimates of various items affecting the project costs and the benefits and the schedule of constructing the road. These "assumptions" may be spelled out in other tables or in the text of the report, or very often they are not explicitly recorded.

37. Using the method of more or less "formal" model construction and simulation, one simply writes out explicitly in algebraic form the model used for measuring the rate of return. In constructing the model

Table 1: Highway Project Benefits and Costs

Year	Project Costs	Vehicle Operating Cost Saving (thousand)	Road Maintenance Cost Saving	Benefits
1	954			(954)
2	954			(954)
3		84	88	172
4		90	95	185
5		97	100	197
6		104	107	211
7		112	115	227
8		120	123	243
9		129	133	262
10		139	141	280
11		149	152	301
12		161	164	325
13		173	176	349
14		186	188	374
15		200	202	402
16		215	217	432
17		231	233	464
19		267	270	537
20		287	289	576

The internal rate of return is approximately 12%.

one does more or less what one would do in finding the best route on a road map. One locates the desired, final destination and then identifies the best road leading ot it, working back from road to road to the point of origin. Then in taking the actual trip, one starts, of course, with the road nearest to one's origin. Similarly, in constructing an appraisal model one identifies the final objective, working backwards through intermediate objectives to the very basic data. In instructing a computer (or a statistical clerk) we must proceed in the opposite direction, proceeding from the very basic "input" data with each equation calculating new data obtained from data obtained from previously calculated equations or futher "input" data. If one wants to follow the logic of the model it is a good idea to read a model which is constructed for computer calculations by starting at the end and reading backwards.

38. The flow chart is merely a visual aid, giving a bird's eye view of the model. Each box represents a sub-model which could be deleted or modified to suit particular circumstances. Or else, further sub-models could be added on. For instance, if project costs could vary a great deal with findings from future soil testing, a model might be added on to reflect such functional relationships.

39. The flow chart, model and data used in appraising the road project by the procedure advocated in this paper are presented in the following pages. The data presented in the column of "best estimates" processed through the model would exactly reproduce the results of the conventionally practiced appraisal presented in Table 1.

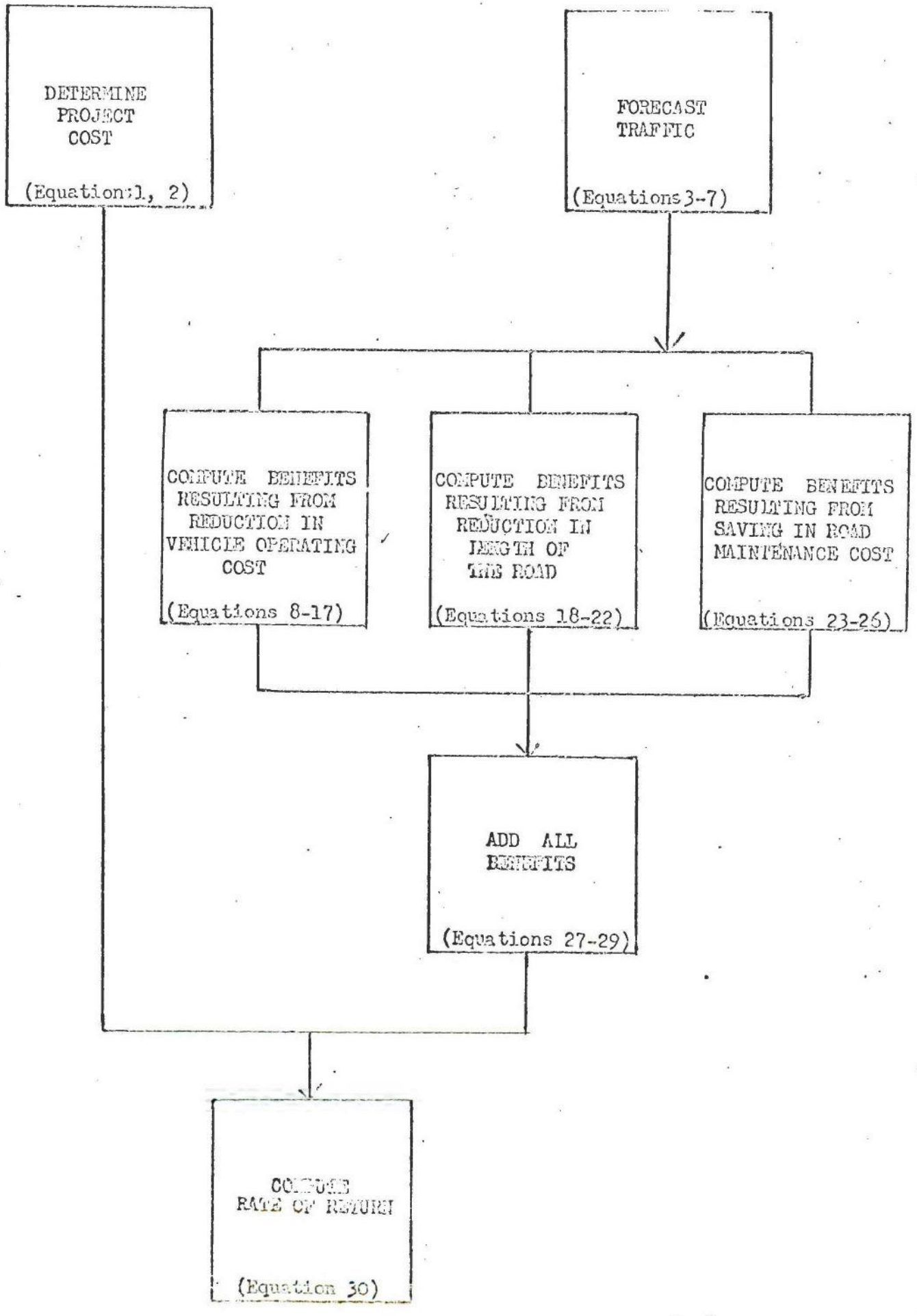
40. It should be noted that the model is actually more general than needed for the specific project, since there are no benefits from

reduction in length of road in this case. This, of course, does in no way interfere with the use of the model. When no / REDUCTION MILES / figures are given, the statistical clerk or computer simply assumes a value of zero and carries out the calculations of benefits attributing zero benefits due to reduction in miles. On the other hand, the model is far from general enough to handle all road appraisals. For instance, benefits from generated new traffic are not included. But it is easy to see how a series of equations could be added to handle these calculations. In practice, one could either have a very general model utilizing only the equations for which variables have non-zero values, or otherwise, one could prepare in advance a series of sub-models or "packages" which would be put together in every case according to the nature of the project.

41. There are basically three ways in which simulation of a model as presented here can improve the appraisal of a project. First, it would be worthwhile to ask how changes in the project would affect the rate of return and if it is advantagous one would proceed to improve the project plan. Second, one would want to know whether it is worthwhile to collect more information and what information should be sought. Third, one would like to know by how much the rate of return would be different if other than the best estimates for the "input" variables were to materialize, and what the probability is of getting a rate of return in a specified range.

(Analysis of the project sensitivities
and risks to be presented in next
draft of paper)

FLOW CHART FOR ROAD PROJECT APPRAISAL



ROAD PROJECT APPRAISAL MODEL

1. (PROJECT COST) = /PAVEMENT BASE/ + /SUBBASE/SHOULDERS/

   + /EARTH WORKS/ + /MORROW MATERIALS/ + /OTHERS/

2. $(COST)_t = \begin{cases} \dfrac{\text{(PROJECT COST)}}{\text{/CONSTRUCTION TIME (n)/}} & \text{if } t \leq n \\ 0 & \text{if } t > n \end{cases}$

3. $(TRAFFIC\ CARS)_t$ = $(1 + \text{/TRAFFIC GROWTH CARS/})^t$ x /INITIAL TRAFFIC CARS/ x 365 days

4. $(TRAFFIC\ TRUCKS)_t$ = $(1 + \text{/TRAFFIC GROWTH TRUCKS/})^t$ x /INITIAL TRAFFIC TRUCKS/ x " "

5. $(TRAFFIC\ BUSES)_t$ = $(1 + \text{/TRAFFIC GROWTH BUSES/})^t$ x /INITIAL TRAFFIC BUSES/ x " "

6. $(TRAFFIC\ TRAILERS)_t$ = $(1 + \text{/TRAFFIC GROWTH TRAILERS/})^t$ x /INITIAL TRAFFIC TRAILERS/ x " "

7. $(TRAFFIC\ SPECIAL)_t$ = $(1 + \text{/TRAFFIC GROWTH SPECIAL/})^t$ x /INITIAL TRAFFIC SPECIAL/ x " "

8. (COST SAVING CAR) = /COST TRAVEL OLD ROAD CAR/ - /COST TRAVEL NEW ROAD CAR/

9. (COST SAVING TRUCK) = /COST TRAVEL OLD ROAD TRUCK/ - /COST TRAVEL NEW ROAD TRUCK/

10. (COST SAVING BUS) = /COST TRAVEL OLD ROAD BUS/ - /COST TRAVEL NEW ROAD BUS/

11. (COST SAVING TRAILER) = /COST TRAVEL OLD ROAD TRAILER/ - /COST TRAVEL NEW ROAD TRAILER/

12. (COST SAVING SPECIAL) = /COST TRAVEL OLD ROAD SPECIAL/ - /COST TRAVEL NEW ROAD SPECIAL/

13. $(\text{OPERATING COST SAVING CAR})_t = (\text{MILE COST SAVING CAR}) \times (\text{TRAFFIC CARS})_t \times \boxed{\text{MILES}}$

14. $(\text{OPERATING COST SAVING TRUCK})_t = (\text{MILE COST SAVING TRUCK}) \times (\text{TRAFFIC TRUCKS})_t \times \boxed{\text{MILES}}$

15. $(\text{OPERATING COST SAVING BUS})_t = (\text{MILE COST SAVING BUS}) \times (\text{TRAFFIC BUSES})_t \times \boxed{\text{MILES}}$

16. $(\text{OPERATING COST SAVING TRAILER})_t = (\text{MILE COST SAVING TRAILER}) \times (\text{TRAFFIC TRAILERS})_t \times \boxed{\text{MILES}}$

17. $(\text{OPERATING COST SAVING SPECIAL})_t = (\text{MILE COST SAVING SPECIAL}) \times (\text{TRAFFIC SPECIAL})_t \times \boxed{\text{MILES}}$

18. $(\text{MILE COST SAVING CAR})_t = (\text{TRAFFIC CARS})_t \times \boxed{\text{COST TRAVEL OLD ROAD CAR}} \times \boxed{\text{REDUCTION MILES}}$

19. $(\text{MILE COST SAVING TRUCK})_t = (\text{TRAFFIC TRUCKS}) \times \boxed{\text{COST TRAVEL OLD ROAD CAR}} \times \boxed{\text{REDUCTION MILES}}$

20. $(\text{MILE COST SAVING BUS})_t = (\text{TRAFFIC BUSES}) \times \boxed{\text{COST TRAVEL OLD ROAD BUS}} \times \boxed{\text{REDUCTION MILES}}$

21. $(\text{MILE COST SAVING TRAILER})_t = (\text{TRAFFICE TRAILERS}) \times \boxed{\text{COST TRAVEL OLD ROAD TRAILER}} \times \boxed{\text{REDUCTION MILES}}$

22. $(\text{MILE COST SAVING SPECIAL})_t = (\text{TRAFFIC SPECIAL}) \times \boxed{\text{COST TRAVEL OLD ROAD SPECIAL}} \times \boxed{\text{REDUCTION MILES}}$

23. $(\text{TRAFFIC UNITS})_t = (\text{TRAFFIC CARS})_t + 2(\text{TRAFFIC TRUCKS})_t + 2(\text{TRAFFICE BUSES})_t + 3(\text{TRAFFIC TRAILERS})_t + 3(\text{TRAFFIC SPECIAL})_t$

24. $(\text{MAINTENANCE COST OLD ROAD})_t = \boxed{a} + \boxed{b} \times (\text{TRAFFIC UNITS})_t$

25. $(\text{MAINTENANCE COST NEW ROAD})_t = \boxed{c} + \boxed{d} \times (\text{TRAFFIC UNITS})_t$

26. $(\text{MAINTENANCE COST SAVING})_t = (\text{MAINTENANCE COST OLD ROAD})_t - (\text{MAINTENANCE COST NEW ROAD})_t$

27. $(\text{TOTAL OPERATING COST SAVING})_t = (\text{OPERATING COST SAVING CAR})_t + (\text{OPERATING COST SAVING TRUCK})_t$
$+ (\text{OPERATING COST SAVING BUS})_t + (\text{OPERATING COST SAVING TRAILER})_t$
$+ (\text{OPERATING COST SAVING SPECIAL})_t$

28. $(\text{TOTAL MILE COST SAVING})_t = (\text{MILE COST SAVING CAR})_t + (\text{MILE COST SAVING TRUCK})_t$
$(\text{MILE COST SAVING BUS})_t + (\text{MILE COST SAVING TRAILER})_t$
$+ (\text{MILE COST SAVING SPECIAL})_t$

29. $$(\text{BENEFITS})_t = \begin{cases} (\text{TOTAL OPERATING COST SAVING})_t + (\text{TOTAL MILE COST SAVING})_t + (\text{MAINTENANCE COST SAVING})_t & \text{if } t > n \\ 0 & \text{if } t \leq n \end{cases}$$

30. Calculate r such that $\sum (1 + r)^{-t} (\text{COST})_t = \sum (1 + r)^{-t} (\text{BENEFITS})_t \qquad t = 1, \ldots, m$

INPUT DATA FOR ROAD PROJECT APPRAISAL

Equation	Item	Best Estimate	Nature of Uncertainty	Probability Distribution
1	PAVEMENT BASE	466,000	Price and Quantity	Discrete:

Probability	Cost
40%	579,000 (6" base)
60%	466,000 (5" base)

Equation	Item	Best Estimate	Nature of Uncertainty	Probability Distribution
1	SUB-BASE/SHOULDERS	311,150	Price, quantity, thickness of base required	Step Rectangular:

(i) If cost of base is 579,000 then:

Probability	Cost Sub-base and Shoulders
30%	150,000 - 240,000
50%	240,000 - 300,000
20%	300,000 - 400,000

(ii) If cost of base is 466,000 then:

Probability	Cost Sub-base and Shoulders
30%	200,000 - 300,000
50%	300,000 - 340,000
20%	340,000 - 440,000

Equation	Item	Best Estimate	Nature of Uncertainty	Probability Distribution
1	EARTHWORKS	92,400	Price and Quantity	Uniform between 46,200 and 92,400.
1	BORROW MATERIALS	15,000	Price and Quantity	Triangular on the range 10,000 to 30,000.
1	OTHERS	1,023,000	Price	Triangular on the range 941,850 to 1,163,500.
2	CONSTRUCTION TIME (n)	2		
3	INITIAL TRAFFIC CARS	41	Statistical Error	Normal: Mean 41, Standard Deviation 3.35.
4	INITIAL TRAFFIC TRUCKS	23	Statistical Error and number of tankers in actual traffic count	Triangular on the range 15 to 35.

Equation	Item	Best Estimate	Nature of Uncertainty	Probability Distribution
5	INITIAL TRAFFIC BUSES	6	Statistical Error	Normal: Mean 6, Standard Deviation 1
6	INITIAL TRAFFIC TRAILERS	15	" "	Normal: Mean 15, Standard Deviation 3.3
7	INITIAL TRAFFIC SPECIAL	nil		Probability 25% — Traffic Level 35; Probability 75% — Traffic Level nil
3	TRAFFIC GROWTH CARS	6%	Forecasting Error	Uniform on range 4% - 8%.
4	TRAFFIC GROWTH TRUCKS	8%	Forecasting Error	Uniform on range 4% - 8%.
5	TRAFFIC GROWTH BUSES	6%	Forecasting Error	Uniform on range 4% - 8%.
6	TRAFFIC GROWTH TRAILERS	8%		Uniform on range 6% - 10%. Growth of truck and truck trailers traffic are fully correlated.
7	TRAFFIC GROWTH SPECIAL			
	Period 1968 - 1972	0		
	Period 1972 on	-20%		

Equation	Item	Best Estimate	Nature of Uncertainty	Probability Distribution
8	COST TRAVEL OLD ROAD CAR	0.0613	Lack of data	Uniform on a -12% +15% range; all fully correlated./1 In addition operating cost of trucks is varied uniformly on a -5%; +10% range to account for uncertainty on size of trucks.
9	COST TRAVEL OLD ROAD TRUCK	0.1076	Lack of data and size of trucks	
10	COST TRAVEL OLD ROAD BUS	0.1516	Lack of data	
11	COST TRAVEL OLD ROAD TRAILER	0.215	Lack of data	
12	COST TRAVEL OLD ROAD SPECIAL	0.215	Lack of data	
8	COST TRAVEL NEW ROAD CAR	0.0479		/2
9	COST TRAVEL NEW ROAD TRUCK	0.0670		
10	COST TRAVEL NEW ROAD BUS	0.1034		
11	COST TRAVEL NEW ROAD TRAILER	0.140		
12	COST TRAVEL NEW ROAD SPECIAL	0.140		

/1 This distribution is artificial and is only geared at getting a correct distribution of the savings from the improvement of the road.

/2 Ignored because variation of savings is fully taken care of by variation of operating costs on old road.

Equation	Item	Best Estimate	Nature of Uncertainty	Probability Distribution
13 - 17	MILES	64		
18 - 22	REDUCTION IN MILES			
24	a	417.0		
24	b	3.6	Divergence of existing data	Uniform between 3 and 5.
25	c	600.0		
25	d	2.25	Divergence of existing data	Uniform between 1 and 2.5.
30	m (life of project)	20	Incomplete analysis	Triangular on range 12 - 25 years.

Mr. Hugh Latimer, Economics Department December 3, 1968

John A. Holsen

Comments upon "Techniques for Project Appraisal Under Uncertainty"

This is a good paper. It should find an interested audience among people who are concerned with the application of statistical methods and computer simulation techniques to the problem of taking uncertainty into account in project evaluation. It should have a growing audience as this is a logical next step in improving appraisal procedures. This treatment of the subject is especially valuable because a careful reader with only a rusty knowledge of statistics will be able to make good sense out of it; he need not be a professional in operations research. The Bank can make a contribution by making this study more widely available. I would rank it high in terms of the measures you suggest in your memo of November 26.

JAHolsen/mrer

Mr. B. Chadenet October 25, 1968

W.A. Wapenhans

Director's Memorandum on Cost Estimate Tables

Reference is made to your memo of October 22, 1968. We would very much welcome the standardization of the tabulation of cost estimates in the body of the report. We take it that this refers to the table to be included in the text rather than annex material.

As far as the example given is concerned, we would like to make the following comments:

(i) The use of sub-totals in the vertical organization should not be excluded especially since the example given does neither include interest during construction nor contingencies. For complex projects, especially those including sub-project activities, this might clarify the presentation.

(ii) Regarding the horizontal organization of the table, we wonder whether the final column giving the amount of the sub-item as a per cent of total cost might not, in some cases 1/, be usefully replaced by a column giving the foreign exchange component as a per cent of the total cost of the sub-item. On this I draw your attention to the cost estimate table used in the Terai Seeds Project, India (copy attached).

(iii) You might also wish to consider whether it would not suffice to have a breakdown in local currency and foreign exchange requirements under the US$ million equivalent column only, while the column giving costs in local currencies would have only aggregate costs for such items. This would reduce the size of the table in the body of the text. A more detailed breakdown giving this information under both currencies could be included in the annex on cost estimates.

1/ Particularly where our financing is tied to the foreign exchange component.

It might also be useful to emphasize in the Director's memorandum that the annex material on cost estimates is prepared in such a way as to enable comparison with the summary estimates contained in the table in the text. The treatment of contingencies, for instance, is a case in point since different allowances may be made for the various work items.

Attachment

cc: Messrs. Evans
Takahashi
Goffin
Bartsch
Darnell
Stoops
Rowe

WAWapenhans:fh

SUMMARY PROJECT COST ESTIMATES [1/]

	Rupees			US$ Equivalent			
	Local Currency	Foreign Exchange	Total	Local Currency	Foreign Exchange	Total	Foreign Exchange
	Rs Million			US $'000			Per cent
Processing Plants							
Buildings	15.6	-	15.6	2,086	-	2,086	-
Mechanical/Electrical Installations	2.2	2.9	5.1	294	381	675	56
Consultant Services	0.2	1.2	1.4	27	160	187	86
Pre-production Administration Costs	0.2	-	0.2	20	-	20	-
Sub-Total:	18.2	4.1	22.3	2,427	541	2,968	18
On Farm							
Land Levelling (by contractors)	19.2	4.8	24.0	2,560	640	3,200	20
Land Levelling (by farmers)	0.4	-	0.4	53	-	53	-
Tubewell construction	3.4	3.8 [2/]	7.2	448	506 [2/]	955	53
Irrigation Distribution System	21.7	-	21.7	2,897	-	2,897	-
Farm Machinery	7.0	39.0	46.0	933	5,200	6,133	85
Spare parts for imported farm machinery	-	9.2	9.2	-	1,227	1,227	100
Surveys	1.0	0.2	1.1	128	23	151	15
Sub-Total:	52.6	57.0	109.6	7,020	7,596	14,616	52
Electrification	4.1	2.0	6.0	545	261	807	32
Total Investment Cost:	74.9	63.1	137.9	9,992	8,399	18,391	46
Fertilizer	-	30.0	30.0	-	4,000	4,000	100
Total Project Cost:	74.9	93.1	167.9	9,992	12,399	22,391	55

1/ Apparent errors due to rounding.
2/ Represents foreign exchange component of equipment already in India.

Mr. Robert Sadove October 24, 1968

V. W. Hogg

Comments on - Director's Memorandum on Cost Estimate Tables

1. My comments on Mr. Chadenet's memo ~~of~~ Oct-22 are as follows:

Project Costs

(Millions)

Item	Local (Prs)	Foreign (US$)	Total Cost (Prs)	Total Cost (US$)	% of Total
1	271.4	29.4	411.5	85.2	45.3
2	105.9	26.3	231.6	48.6	25.3
3	28.2	11.8	84.3	17.6	9.3
4	28.0	1.8	36.6	7.7	4.0
5	101.3	9.4	146.1	30.7	16.1
Total	534.8	78.7	910.1	190.8	100.0

2. I think this 4-column table is all that is required. It says all that is often required, i.e. report readers want to see the total cost easily - this is given under one heading and in local currency and US$. Readers want to know the foreign contribution - often the loan or credit - this is clear. Borrowers want to see the local currency contribution that is also given. In my experience we are not too concerned with converting the local component into US$ or the foreign component into local currency. These two latter are readily obtainable by subtraction.

VWHogg/amd

October 24, 1968

Mr. B. Chadenet

D.S. Ballantine

Director's Memorandum on Cost Estimate Tables

With reference to your memorandum of October 22, 1968, the proposed method of presentation of project costs will be used in all future Education Division reports.

SJGurt:vct

Pl. Acid & Op. files
P.P. Appraisal + Cost & Proj

Messrs. Ballantine, Evans, Knox, Sadove, Piccagli and Rovani

October 22, 1968

B. Chadenet B. Chadenet

Director's Memorandum on Cost Estimate Tables

The presentation of cost estimate tables in appraisal reports has not been handled consistently. A more uniform presentation would have the advantages of making these tables easier to prepare for our staff and easier to review by readers.

The Public Utilities Division has experimented for some time with a table giving the amount of local costs, foreign exchange cost and total costs, expressed both in the currency of the borrower and in US$ equivalents. Here is an example, which also includes a column of percentages:

Items	FRs (millions)			US$(millions)			%
	Local	Foreign	Total	Local	Foreign	Total	of total expenditure
1. Local telephone network (175,000 telephones)	271.4	140.1	411.5	56.8	29.4	85.2	45.3
2. Trunk switching and long distance network	105.9	125.7	231.6	22.3	26.3	48.6	25.3
3. Interwing and international	28.2	56.1	84.3	5.8	11.8	17.6	9.3
4. Telegraphs and telex	28.0	8.6	36.6	5.9	1.8	7.7	4.0
5. Miscellaneous, including government	101.3	44.8	146.1	21.3	9.4	30.7	16.1
Total telephones	534.8	375.3	910.1	112.1	78.7	190.8	100.0

This presentation has the following advantages: it is comprehensive but not difficult to prepare. It is easy to read by Bank staff, who are familiar with US$ equivalents, and it is courteous to our borrowers, who are used to their currencies. I therefore suggest that this 6-column presentation be used unless special circumstances require a departure from it; the column on per cents can be added when useful.

May I have your comments by the close of business on Friday, October 25, so that a Director's Memorandum may be published on the subject.

BChadenet:jfh

Ballantine
Knox
Rovani
Capitali

P.P. - Appraisal & Cost of Proj.

Mr. Chadenet

October 11, 1968

Michael L. Hoffman

Operational Memorandum No. 5.01

In connection with revising some of our Operational Memoranda, I have had occasion, because of cross references, to reread O.M. No. 5.01 on project appraisal. In this memorandum we state that project appraisal in practice involves the investigation of six different aspects: economic, technical, managerial, organizational, commercial and financial. The memorandum contains an excellent outline of how these six aspects should be examined.

I wonder whether the time has not come to add another "aspect" to which appraisers should pay attention. The section might be headed "Non-Economic Aspects." These would include such things as the impact of the project on the sociology of the region and community, its relation to pace and extent of urbanization, the constraints imposed by culture patterns and the project's possible effects on such patterns, possible ecological implications for pollution, climate, etc. Do we not in fact already examine such aspects for many education and agricultural projects? And in others, I have frequently heard statements in the Board and elsewhere that we wished we knew more about such matters than we do.

It seems to me that the present Operational Memorandum does less than justice to the breadth of our current standards of project appraisal and is an inadequate guide to new and junior staff in the light of proposed extensions of our lending activities into non-traditional fields.

MLHoffman/pnn

MLH

September 25, 1968

Professor R. Billingsley
Department of Agricultural
Economics and Sociology
Texas A & M University
College Station
TEXAS 77843

Dear Professor Billingsley:

Thanks for your letter of September 13. I am enclosing a copy of my publication, "Techniques for Project Appraisal Under Uncertainty", which has been issued with some delay. You will note on the back cover a list of our other studies. If any are of interest I suggest you request them from Mr. Ricardo V. Diaz, Reports Desk.

I enjoyed very much meeting with you and your wife and am looking forward to your announced visit here.

Yours sincerely,

Shlomo Reutlinger
Economics Department

SReutlinger:bso

Enclosure

FORM NO. 59
(2-55)

CROSS REFERENCE SHEET

COMMUNICATION: SENIOR STAFF MEETING SSM/M/68-37

DATED: September 24, 1968

TO:

FROM:

FILED UNDER: SENIOR STAFF MEETING

SUMMARY:

PROJECT APPRAISAL UNDER UNCERTAINTY

1. Mr. Kamarck drew attention to the report (EC-164) entitled "Techniques for Project Appraisal under Uncertainty" which had been circulated (SecM68-320), and added that the highway project in Zambia for which the Executive Directors had approved a loan earlier that day was the first to which these techniques had been applied.

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

SecM68-320

FROM: The Secretary

September 10, 1968

PROJECT APPRAISAL

There is attached for information a copy of a report entitled "Techniques for Project Appraisal Under Uncertainty" (EC-164). Additional copies may be obtained upon request from Secretary's Document Office (extension 2158).

Distribution:

Executive Directors and Alternates
President
President's Council
Executive Vice President, IFC
Vice President, IFC
Department Heads, Bank and IFC

Mr. S. Takahashi August 30, 1968

Shlomo Reutlinger

A Note on the Interpretation of High Rates of Return in Current Input Financing Projects

8.27.68

1. The problem discussed in the attached note has come to my attention on several occasions. The note was hurriedly prepared since I am not quite sure that I am on the right track, i.e., if I have correctly identified the underlying questions or if I have left out some important considerations.

2. I should appreciate if you would make comments and/or suggest a forum for discussing the contents of my note. Particularly, I would like to know if it would be worthwhile to dig up more empirical evidence and to draw out further generalizations or suggest particular applications of some of the implied hypothetical statements.

Attachment:

SReutlinger:bsc S.R.

cc. Messrs. A. Stevenson
H. G. van der Tak
W. A. Wapenhans
J. B. Hendry

S. Reutlinger

August 27, 1968

A NOTE ON THE INTERPRETATION OF HIGH RATES OF RETURN IN CURRENT INPUT FINANCING PROJECTS

1. Introduction

1. Project appraisers, particularly in the case of some agricultural projects, seem to be "plagued" with so far unheard of high rates of return estimates in projects whose main components consist of financing current inputs such as fertilizers, seeds and extension services. For whatever reason, very high rates of return seem to be unacceptable to the appraisers and consequently they sometimes seek to contrive a variety of reasons for reducing the rate of return estimate. In a recent IBRD project appraisal report this reduction in benefits was accomplished by including costs incurred prior to project initiation and reducing arbitrarily the number of years for which benefits are incurred. This note attempts to analyze the nature of the "problem" and suggest some solutions.

2. It is not uncommon to find that application of new inputs through making available knowledge and credit can result in a revenue increase of 3 to 5 dollar for every dollar of expenditure for the input. If the lag between the time the cost is incurred and the benefit is harvested is one year and the benefit cost ratio is B/C, the rate of return will be B/C - 1.[1/]

1/ The mathematical derivation is as follows: The internal rate of return is r such that,

(1) $\left[1 + (1 + r)^{-1} + \ldots\right] C = \left[(1 + r)^{-1} + (1 + r)^{-2} + \ldots\right] B$

then

(2) $B/C = \left[1 + (1 + r)^{-1} + \ldots\right] / \left[(1 + r)^{-1} + (1 + r)^{-2} + \ldots\right]$

dividing both the numerator and denominator of (2) by $(1+ r)^{-1}$, we obtain;

(3) $B/C = 1 + r$

and hence,

(4) $r = B/C - 1$

attached to memo dtd 8/30/68 from Ms. Reutlinger to Mr. Tokatlidis.

It is noteworthy that this rate of return is independent of the "life" of the project. For example, if B/C = 4, then the rate of return is 3 or 300 percent.

2. Plausibility of High Rate of Return Estimates

3. A main cause for suspecting the validity of a high rate of return estimate is, of course, the historical evidence. If such investment opportunities really existed why would they not have been explored already, one would be justified to ask. Why would private and public institutions have preferred to invest in projects with much lower rates of return?

4. The burden of proof is then clearly on the project appraisal. One needs to show that and in what way the project really innovates. Is it through introduction of a new technology not previously known? Is it through an institutional innovation which spreads information and encourages farmers to seek credit for new inputs? Or is it through setting up new institutions which make available inputs to farmers in a way previously unknown?

5. For example, it is quite possible that under presently existing institutional arrangements, the only way by which farmers can obtain new inputs is by making their own credit and purchasing arrangements. Given that farming is carried on in many small units, is it not possible that with existing banking and credit institutions and input supplier arrangements, the selling, bookkeeping and collection costs of a $5 fertilizer purchase and loan administration would be 100 percent or more? If to this we add a 50 percent payment default rate, even a 200 to 300 percent rate of return may not be an attractive alternative to other investments.

6. Let us assume, however, that the new project bypasses completely the existing institutional arrangements. Perhaps, the fertilizer is simply distributed to farmers without individual loan contracts and collection is made in the form of a commodity tax on farm products sold by farmers or no collection at all is anticipated in the case of pure subsistence farmers. A high economic rate of return may then indeed be realizable and the historical evidence would not need to invalidate in any way the appraised high rate of return estimate.

7. To sum up so far: it makes sense to question high rate of return estimates on the basis of seemingly contradictory historical evidence. However, it would be erroneous to jump to the conclusion that high rates of returns are always the result of errors of judgment of calculation. In some cases they may well stand up in spite of seemingly contradictory historical evidence.

3. Is a High Rate of Return an Indication of a High Priority Project?

8. Assuming then that we have properly accounted for all costs and that the project innovates in some way (new techonology, information availability or institutional set-up) so as to make historical evidence non-applicable, and that then the rate of return estimate is still high, the question is how to evaluate such projects in terms of investment priorities.

9. There is, as far as I can see, only one reason for not preferring a project with a higher rate of return to one with a lower rate of return, all else being equal, which may be applicable to the interpretation of rates of return from current input financing schemes.[1/] Given limited investment

---

1/ I am fully aware of the weakness introduced into the argument by the "all else being equal" clause. But this is another topic.

capital and lumpiness of investments it may be preferable to postpone a high-return project. It is quite possible that opportunities for current inputs financing projects are limited and that for this reason a country with a fixed capital supply and "lumpy" investments may find it preferable to invest in larger projects having lower rates of return. Otherwise, the rate of return criterion would be applicable, regardless of whether two projects are major capital projects or one is of a current input financing nature.

10. High rates of return from current inputs financing projects are proposed to be discounted sometimes on grounds of incomparable uncertainty between current inputs financing schemes and major capital investments. This is certainly not a generally valid generalization. The uncertainty attached to the benefits from irrigation projects would not seem to be any less than to benefits of fertilizers projects, but with the latter having occasionally the advantage of being revisable in response to newly acquired information.

11. Another possible argument one hears occasionally in favor of major capital investments even if their rates of return are lower is that they take longer to be installed and therefore must be started at once, although their rate of return may be less than that which could be obtained from financing "current" inputs. This would be true only in the case in which (real) costs of such capital projects are expected to increase or their (real) benefits to decline with the passing of time.

12. Finally, one could investigate whether major capital investment projects result in more secondary benefits or have larger multiplier effects than current input financing projects. In the absence of evidence to the

contrary it is highly questionable, however, that valid generalizations could be made on the basis of secondary benefits. In fact it is not all clear that current input stimulating projects have not the edge on secondary benefits as well.

4. Summary

13. (a) High rates of return are indeed suspect unless the project can be shown to introduce in some significant way a major departure from historically experienced situations.

(b) It is possible, however, to encounter current input financing projects with very high rates of returns, even after all returns and all costs are realistically reflected in the appraisal.

(c) The rate of return from a current input financing project (i.e., fertlizer) should be interpreted in the same way as one would interpret the rate of return from major capital investment type project (i.e., irrigation) unless a choice has to be made under conditions of fixed capital availability and "lumpiness" of projects and current input projects are the relatively smaller projects.

(d) One should not a priori expect current input financing projects to be subject to higher uncertainty, or fewer secondary benefits.

P + P - Appr. + Cost of Proj

August 21, 1968

Mr. J. Boyd
c/- Mrs. G. Gordon Boyd
Flat 82,
20 Abbey Road
London, N.W.8, England

Dear John:

Thanks for your letter saying you would take on the tourism job -- you always get the cushy ones!

When you left, I had not yet read your note on appraisal in conditions of inflation. I have now done so, and found it very interesting.

Attached to your note was a copy of a memorandum on "Inflation and Monetary Exposure in Latin America". You refer to it as "a study by ADELA". Those words appear in ink on the copy attached to your note. The paper is not by ADELA, and has no connection with ADELA. It would be embarrassing both to ADELA and to the author (from whom I have the paper on a confidential basis) to have the paper attributed to ADELA. I've made the correction on your original, but if you have a copy of the paper still in your possession, I'd appreciate your returning it to me.

With best wishes,

Sincerely yours,

WD

William Diamond
Director
Development Finance Companies

cc: c/- Hellas Travel Bureau
5 El Venizelou Avenue
Athens, Greece

cc: Mr. Mathew
Mr. Garcia

WDiamond/jm

August 21, 1968

Mr. J. Boyd
c/- Mrs. G. Gordon Boyd
Flat 82,
20 Abbey Road
London, N.W.8, England

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With best wishes,

Sincerely yours,

William Diamond
Director
Development Finance Companies

cc: c/- Hellas Travel Bureau
5 El Venizelou Avenue
Athens, Greece

1968 AUG 23 PM 5:51

cc: Mr. Mathew
Mr. Garcia

WDiamond/jm

P & P - Appr. & Cost of Proj

Jochen K. Schmedtje August 21, 1968

William Diamond

Project Appraisal in Inflationary Conditions

1. Re your draft study on "Project Appraisal in Inflationary Conditions". Attached is a copy of a memo on it from Mr. Boyd (who used to be on our staff), which you might find interesting. I hope it is not too late.

2. I am much interested in the outcome of your study. Is a revision available?

cc: Mr. Kamarck
Mr. Mathew
Mr. Garcia

WDiamond:jm

Project appraisal

Mr. V. W. Hogg

August 14, 1968

E. V. K. Jaycox

Probability Analysis

1. You asked for a memo on the role, costs and limitations of using probability analysis as an analytical tool for project appraisal.

2. The Economics Department is, as you know, writing on this subject generally, using our Zambia/Tanzania road appraisals and Mogadiscio port appraisal as case studies. Mr. Pouliquen, who was involved in these appraisals, is engaged in this write-up with Mr. Reutlinger and others.

3. My thinking on the justifiable uses of probability analysis is, therefore, not fully formulated at this time. As you know there are three phases to conducting a probability analysis: (i) build a model for rate of return analysis, (ii) a sensitivity analysis to test the effect of on the rate of return of varying the assumptions relating to various parameters, and (iii) the probability analysis proper. Each has separate uses; I will discuss all three.

a) Basic Model of Physical, Economic and/or Financial Performance:

Creation of a basic model to account for the interaction of the important variables in the economics or finances of a project or an operation is the first step, and by far the most difficult one. This involves considerable time and, of course, costs money. If this model is to be any good, it should incorporate operational simulations and generate critical input data. Example: the port model we have developed generates the optimum capacity of the port, maximum benefits, point of diminishing returns, timing for expansion, and the cost of handling cargo, from productivity, manpower, ship cost, ship arrival and other critical data. The model incorporates a queueing model. In the case of our road model, optimum initial pavement strength can be assessed and form part of the rate of return analysis. While it takes time to develop these models, once they are available they can be used to handle most of the projects we appraise. The development and use of these models requires systematic thinking about the project concerned; this is one of their great advantages. Understanding the logic of the project is a prerequisite to appraisal, the construction of a model, therefore, can in certain instances be a valuable aid to discipline.

Further, optimizing technology, investment timing, staging, even operational policies, say in a port, are possible using these models as tools.

b) Sensitivity Analysis:

In the (partial) sensitivity analysis of the project used as a preliminary to probability analysis, each variable is given a range of possible values, and rates of return are calculated (using the model) on the basis of the extremes, and on the basis of a 10% or some such variation from the best estimate value. This allows the appraiser to see which variables are most important for the outcome rate of return. We have often been surprised in the case of complex problems involving traffic diversion, limited physical capacity, differential cost savings, etc. One of the biggest advantages of this analysis, is the possibility of saving appraisal time and project preparation time. Assuming pre-existence of the model, projects can be tested for their sensitivity to data uncertainties in the early stages of a feasibility study by the consultants or borrower. Time can be saved in reaching decisions by concentrating investigation on the most critical variables. Even the need for final engineering of some parts of the project prior to appraisal might be handled on an ad hoc rather than blanket rule basis. Appraisal teams could ignore variables which prior analysis has proved to be of low importance for the decision to be made. The importance of pricing policies, employment policies, and operating methods for financial and/or economic results could be tested to see whether lending conditions would be appropriate and worth making an issue of in negotiations. Argumentation on these issues could be backed up by analysis. If the probability analysis step is not to be taken, this sensitivity analysis step must be made more sophisticated to take into consideration correlations between variables. It may be easier in some case to go straight to a full probability analysis.

c) Probability Analysis:

The probability analysis program is very simple and cheap to operate. To do full probability analysis of nine road sections from three different points of view involving a total of 8100 rate of return calculation (Tanzania sections of Tanzam highway) with over 40 variables in each calculation, took approximately 25 minutes of computer time and cost less than $150 at commercial rates in Bethesda. With our own computer the allocable cost would be much less.

The probability analysis allows the appraisal staff to express its entire judgment about the various important variables in the analysis, without a conscious bias to be "conservative" or "optimistic", i.e. without an overt personal risk preference being given and for which there are no guidelines. The results give a much better indication of likely outcome than a single point result. The analysis allows appraisal under conditions of uncertainty, simply by allowing the appraiser to "quantify uncertainty", i.e. to take it explicity into account. This is all very satisfying, but it may not be necessary to the making of the investment decision per se. This depends on what investment criteria we employ. For projects where the criterion to "acceptability" instead of optimisation and conservative estimates yield very acceptable results, the analysis would not be of added usefullness in the sense of leading to a quicker or different decision. When using this criteria, it is only the marginal project or one particularly surrounded by uncertainty that would be analyzed in this way. Mogadiscio and Tanzam are respectively examples. If, however, we are going to do incremental analyses of design features, capacity increments, etc., a more general use of probability analysis would be very helpful. Operating close to the optimum means taking risks and investigating the margin. Optimum timing of investments, for instance, means making them as soon as they would earn the minimum acceptable rate of return given the opportunity cost of capital. Conservative bias may mean being too late on investments, too fat on design standards, faults in stage construction timing and other wastes. Incremental analysis also involves delving into areas where data uncertainty is high. It is here that probability analysis can be particularly helpful. We may then have an apparently paradoxical situation, i.e. in well supplied data countries we would make sound but broad project judgments, but in data poor countries we may have to employ the most sophisticated techniques to make good project decisions.

EVKJaycox/bb

cc: Mr. Chadenet, Mr. Baum, Mr. Geolot

Appr. + Cost of Proj.

Mr. Kamarck August 9, 1968

Michael L. Hoffman

Techniques for Project Appraisal Under Uncertainty

Reading the whole of Mr. Reutlinger's paper on project appraisal under uncertainty confirms my first impression that this ought to make a first class occasional paper. It is clearly written, uses mathematics effectively and not unnecessarily. I do not at all agree with the critic who said that the author was trying to satisfy both the scholar and the practitioner or the one who made his principal criticism that it was not "a discovery of America." It seems to me the author had made it perfectly clear that he is addressing himself to the practitioner. And in my judgment he has succeeded admirably in writing a paper that anybody with the technical tools to do project appraisals at all can understand and adapt to practical situations.

My only criticisms are not of the paper but of the critics. None of them, at least none of those quoted, seem to have grasped what appears to me to be the fundamental justification for attempting a more sophisticated approach to the discounting of uncertainties. In fact, several critics who emphasize that the Bank's project appraisers already "take risk into account" do not seem to have grasped the point, which is made in paragraph 10 on page 12, that if each expert contributes to an appraisal numbers which each one has already discounted for uncertainty factors by some unstated percentage (many of which may be the same factors discounted by different experts), the results given to the project appraiser are likely to be even worse than if no uncertainty discounts had been applied. My guess is that this is probably the situation we are in today, with everyone concerned applying unstated discounts for social, political and other uncertainties, and then producing figures which are thrown together in an appraisal, the results of which are then again discounted for the same factors. In view of the fact that the critics do not seem to have paid much attention to this part of the analysis, it might be desirable to put it up in front as a basic justification for the whole exercise.

It is also distressing to see that we still have in the Bank people who persist in assuming that when an analyst refers to the contribution that a computer can make in the solution of problems, he is claiming that the computer analysis is somehow supposed to remedy deficiencies in underlying data. I should have thought that in paragraph 10 on page 5 the author would have precluded such misunderstandings, but apparently not.

I have pointed out to Mr. Reutlinger a slight error in equation 26.1 on page 73.

MLH

MLH:mmcd

FORM NO. 57 | INTERNATIONAL DEVELOPMENT ASSOCIATION | INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT | INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

TO: Mr. William Diamond DATE: July 18, 1968

FROM: J. G. Boyd

SUBJECT: Draft Study: Project Appraisal in Inflationary Conditions

This is an interesting report on a difficult subject. I have little to quarrel with in the general method of approach, which is to differentiate to some degree between direct financing of projects and indirect financing through intermediaries which creates special problems. With some reservations, I think that the authors' conclusions and recommendations on a number of problems they have selected are sensible for dealing as best we can with the intractable problem of value distortions caused by high rates of inflation. But I take issue with them on the scope of their report, which by-passes (or only touches on) a number of important aspects of the problem of external financing of projects in inflationary economies.

As a result there are, to my mind, several large gaps in the study which leave a number of important areas virtually untouched, which are nevertheless germane to the authors' own objective of studying the effects of inflation only as they affect the evaluation and working of Bank projects. The report is very useful as far as it has gone, but I think it would be of considerably greater use as a guide to project appraisal in inflationary conditions if the following aspects were covered, or more fully covered:-

(a) Other Forms of Financing than Conventional Loans

The report only deals with financing by Bank loans, which is the main activity of the Bank group. However, the problems of inflation are such that other methods of financing which might be more suitable to maintenance of value in inflationary conditions, for instance equity investment or lending with equity features. Even though equity investments may only be suitable for a relatively small number of projects, it is an important field which I think should be covered, not only because it is a prime function of IFC, but because the maintenance of value of equity is an important aspect of loan security and of borrowing power.

(b) Accounting under Inflationary Conditions

The trend of the authors' thinking on direct financing is towards greater emphasis on cost-benefit analysis, shadow-pricing, etc. as the best method of evaluation in inflationary conditions, and less on financial analysis. To a certain degree this appears sensible, with obvious reservations on the rather embryonic state of the art of shadow pricing and other non-accounting techniques. The burden of the argument is that financial forecasting under inflationary conditions is too difficult more than a year or two ahead, and that, at any rate

in direct financing of projects by the Bank, financial criteria should be abandoned in favour of investing in projects which pass economic value tests, provided that these projects are assured "financial viability" by means of Government subsidies in lean years and excess profits taxes in fat years. This may be the only solution practicable for ensuring financial equilibrium in certain cases, but I am not entirely convinced that financial criteria should necessarily be abandoned wholesale, especially as in normal business projections the horizon for any degree of accuracy is rarely more than two years ahead anyway.

In the first place shadow-pricing involves in many cases as much subjective "guesstimating" as forecasting the likely price changes under unstable monetary conditions as a basis for financial evaluation. Second, if financial criteria are abandoned, the logical conclusion is that more projects are likely to be accepted by the Bank using less strict criteria in countries where Governments allow financial indiscipline than where they practice discipline -- rewarding the "bad boys". Thirdly, I see no reason why some effort could not be made to assess financial viability on a theoretical basis in some cases, eliminating unforeseeable inflationary influences from the calculation, if the authors' own belief that, in the long run prices moving at different paces tend towards an original equilibrium holds. This is not to argue that the subsidization solution should not be adopted, however, where appropriate and conditions of great uncertainty exist, but simply to suggest that even a theoretical financial appraisal is still advisable to help sort out the sheep from the goats.

Even more important, perhaps, is that appraisal of projects involves follow-up assessments of progress and performance from accounts. Moreover, accounting costs, prices, cash flows, depreciation, profits, reserves, etc. are all vital elements for measuring the economic value and financial viability of the projects even in inflationary conditions. The central problem of inflation is, in a large degree, the maintenance of value in monetary terms as nearly as possible to "real" values by financial policies and accounting methods suitable for inflationary conditions. It is central to project appraisal and follow-up and I think the report would be greatly strengthened if it were to give considerable attention to this rather immediate problem. ~~I attach a paper on this aspect prepared for ADELA which may be useful.~~ The attached paper is NOT by ADELA. W.A.D.

(c) Value Maintenance

The argumentation of the report is probably the principal reason why the authors are almost exclusively concerned with the problem of the maintenance of value of external financing from the point of view of the project rather than from the point of view of the financing agency. Since most of the Bank's loans are disbursed, paid for and repaid in foreign exchange, the authors take the view that there is no important value problem involved for the Bank. But this is non-proven;

it is not in fact analyzed (only touched on) and an analysis of this could be very useful, with deeper probing of the relationship of the two main elements, exchange rate price changes and internal price changes.

Under inflationary conditions it pays to borrow but not to lend (except at very high interest rates). As regards external financing, the authors point out that exchange rate adjustments tend to lag behind internal price changes, which means that the advantage of the borrower is further increased overtime. Who pays for the differential? I think that the report would be more balanced out if the problem of maintenance of value for the financing agency were given more analysis.

The part of the report of main concern to IFC is Part C, dealing with Bank financing through intermediaries. Apart from the main general points made above, I have the following comments on this section, which I feel gets much closer to the nub of the problem than the earlier parts:-

(i) Subsidization

While I agree that subsidization is a less desirable solution, I do not really follow the authors coolness to this as a solution here compared with their favoring it for direct Bank loans to projects. The same economic and financial distortions are likely. Also in fact many financial intermediaries are subsidized by Governments, even where inflation is not high, and this does help the financial performance of the institution and therefore enhances its attractions to local investors as share or bondholders, and helps to attract local funds.

(ii) High Interest Rates

I think the authors may overrate the admitted disadvantages of this solution. It is a solution which is in fact quite widely adopted by financial intermediaries as the principal means of maintaining monetary value in inflationary conditions (e.g. Colombia, Korea), and has been used for extended periods. The high rates on short-term credit and the lack of long-term funds generally permit its use competitively and does not deter borrowers whose debt burden is being rapidly reduced by inflation, which encourages borrowing.

(iii) Use of Indices

The authors survey of possible indices for use in value maintenance in loan terms appears thorough and generally sound. I agree with the value of using both a general price index and a currency value index. But I think this whole subject needs to be developed further into the practical application of these indices in methods of accounting and value analysis, including cost benefit studies, internal rates of return, and accounting methods under inflationary conditions. In this way the study would be brought more closely into focus from the point of view of project appraisal and follow-up.

(iv) Other Solutions

As previously stated, the route of equity or equity type investment needs to be analyzed in relation to shifts in currency and local price values. Also the question of maintaining loan security and tying the value of loans to land prices, commodites, etc., needs to be looked at. The question of Government guarantees against exchange risk are also not specifically covered, nor methods of shifting the maintenance of value to the borrower. Also accelerated amortization is an important area not covered specifically (except as shortening of loan terms), where the disadvantage of the lender can be off-set by sharing in profits above a certain level, or requiring premature loan repayments. Counterpart loan funds are also an area of some interest where they are loanable without any maintenance of value requirements for imported commodities, and the use of foreign Government risk guarantees.

Attachment

FORM NO. 61-EC
(7-65)

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

CONFIDENTIAL

ECONOMIC COMMITTEE

EC/O/68 - 68

July 8, 1968

Techniques for Project Appraisal Under Uncertainty

1. The attached draft study, "Techniques for Project Appraisal under Uncertainty", has been prepared in the Economics Department by Mr. Shlomo Reutlinger. The study aims at providing a better conceptual framework for cost-benefit appraisal of projects when many project-related events are uncertain. The paper focuses primarily on the feasibility and desirability of conveying uncertainty judgments in a formal and mathematically correct manner. It is suggested that appraisal of the extent of uncertainty in project-related events and evaluation of the probability distribution of a project will largely remain a matter for subjective judgments.

2. The present draft has greatly benefited from discussions and comments on an earlier version. It is intended to distribute the study, subject to final revisions and editing, within the Bank as an Economics Department report.

3. Written comments (two copies) should be sent to Mr. Reutlinger (Room F-1149), with an additional copy to me, by the close of business on July 31, 1968.

C. F. Owen
Secretary

Attachment
Secretary's Department

DISTRIBUTION

Messrs.	Friedman	Adler	Orcutt
	Kamarck	Collier	Sacchetti
	Avramovic	de Vries	Sadove
	Bell	King (B.B.)	Thompson
	Krishnaswamy	Larsen	van der Mel
	Rist	Lipkowitz	Weiner
	Stevenson	McDiarmid	Wright

Mr. Andrew M. Kamarck

July 1, 1968

Jochen Schmedtje

Draft Study, Project Appraisal in Inflationary Conditions

I attach a draft study, "Project Appraisal in Inflationary Conditions", prepared by Mr. Sanjaya Lall and myself. As you will recall, this is one of the studies suggested to us by the Projects Department.

I would appreciate it if written comments on the study could be sent to Mr. Lall by the close of business on August 2, 1968.

attachment

cc (with attachment):

Mr. Stevenson
Mr. Bhatia (10)
Senior Advisers
Group Heads
Division Chiefs
Messrs. Latimer
Sadove
Lipkowitz
Diamond
Wapenhans
Hendry
Stoops
Picciotto

JSchmedtje:es

Mr. J. Andreu

May 27, 1968

Louis Pouliquen

Risk Analysis

1. The origin of my work in risk analysis is a lucky rotation in my assignments which brought me in the Projects Department at a time when some thoughts were given to this method of appraisal of projects. My general background, some experience in the use of computers and in the handling of practical problems made me able to undertake to apply this technique to the port of Mogadiscio project. Later on, this first attempt having proven to be useful and promising I was asked to investigate the technique further and to apply it to a road project which is now being appraised (Tanzania-Zambia road link).

2. The objective of risk analysis is to cope with the general problem of uncertainty in the data used in the analysis of any system - in our case the projects proposed for our financing. The easiest way to cope with this difficulty is to use different data and to see what happens to the conclusion. This method known as sensitivity analysis, and which I have also introduced in my work is very simple but rather inefficient when the uncertainty about the data is so high that the project may vary according to the hypothesis, from a very bad one to a very good one. Risk analysis goes one step further and tries to resolve this difficulty by associating to the outcome of the analysis a weight (or probability distribution) derived from the weights (probability distribution) the appraiser may wish to give to the likely values of the inputs of the problem. Starting from a complete picture of the inputs, risk analysis gives a complete picture of the outputs in a concise form well adapted to decision making. Practically risk analysis is mostly performed by way of simulation and requires an extensive use of computers. By necessity I, therefore, have had to develop computer models both for ports and roads. While in the case of roads this did not raise any difficulty in the case of port it was a much more difficult task which is only partially completed by now.

3. I think that my work has been useful since it has already been used as an integral part of the appraisal of 2 projects and seems to have stimulated attempts to conduct similar analysis in other divisions of the Projects Department. The method has indicated promising prospects for future appraisal and seems to have many side benefits which could justify its use given in projects where uncertainty is not a critical element of the appraisal. Going beyond the direct benefits of risk analysis I would say that my work has also been interesting because it was the first attept in the transportation division to make serious use of quantitative methods. Concepts such as optimization, systems analysis, automatic data processing now seem to be taking roots in the minds of some economists and engineers. Undoubtedly, this is a first step toward better microeconomics analysis and constitutes an extremely interesting development in the work of the Bank. As far as I am concerned the task has been, and still is, a challenging one and I wish that more young professionals would be given the responsibility and the support I have had in carrying it out.

Mr. P. Baitia March 5, 1968

John A. King jak

Casebook on Project Appraisal

In accordance with your request I list below the loan and credit numbers relating to the cases. Numbers starred are credits.

Case 1 - CO 38, 113, 215, 255, 339.

Case 2 - CE 101, 209, 283.

Case 3 - ES 22, 221, 268, 342.

Case 4 - JA 200.

Case 5 - AA 210, 350.

Case 6 - GH 320.

Case 7 - CO 225, 282, 369.

Case 8 - TH 175, 333, 406.

Case 9 - JA 196.

Case 10 - IRN 247.

Case 11 - VE 353.

Case 12 - Not related to anyaparticular loan.

Case 13 - IT 235.

Case 14 - NN 145.

Case 15 - SI 337.

Case 16 - JA 205.

Case 17 - PE 260, 365.

Case 18 - FR 249.

Case 19 - KE 64*, 77*.

Case 20 - EC 51*, 176, 379.

Case 21 - ME 317, 401

Case 22 - IS 265.

Case 23 - JA 248, 302, 357, 374, 413, 460 (principally 357).

Case 24 - ET 31, 166, 35*.

Case 25 - KA 428.

Case 26 - SP 387 (I believe the appraisal report has been translated into Spanish at the EDI. The case also draws heavily on The Economic Development of Spain, a Bank survey mission report, which I understand has been translated and published in Spain.)

Case 27 - PE 116.

Case 28 - CH 83.

Case 29 - IN 71, 159, 456.

Case 30 - CO 345.

JAKing/mt

P.P. Appraisal + Cost of Proj

Mr. J. Price Gittinger

February 27, 1968

H. von Oppenfeld

Draft Project Appraisal Handbook

1. After a somewhat superficial review I agree with your conclusions that this is not suitable for our use and that our preference of the internal rate of return should be noted.

2. I wonder why Mr. Mollett calls the internal rate of return method cumbersome? Instead of netting out investment, annual cost and revenue, he computes present values separately for each series.

3. While the logic and the mechanics of each step are well explained, he could say more about what to include, how to get reasonable data. He could also explain the difference between the financial and economic rate of return, as he does cover shadow cost and shadow prices.

4. Finally, he should discuss the limitations of the internal rate of return (as well as those of the other method) which stem largely from the inadequate knowledge underlying many of our assumptions.

5. I am passing the manuscript on to Shig Takahashi and trust that you will hear from him.

cc: Mr. S. Takahashi

HvonOppenfeld:lkt
IBRD

Dr. Otto Donner

February 1, 1968

Bernard Chadenet B. Chadenet

Project Evaluation

In answer to your inquiry, I am sending you a series of questionnaires which the Bank uses in the process of project evaluation, together with our 'black book.'

You asked also about our methodology. I would refer you to the following studies which may be given circulation outside the Bank:

The Evaluation of Agricultural Projects: A Study of Some Economic and Financial Aspects (EC-128, May 7, 1964)

Economic Aspects of Water Utilization in Irrigation Projects (EC-132, January 22, 1965)

On Estimating the Economic Cost of Capital (with special reference to developing countries) (EC-138, October 21, 1965)

The Economic Choice between Hydroelectric and Thermal Power Developments (World Bank Staff Occasional Papers Number One, 1966)

Quantification of Road User Savings (World Bank Staff Occasional Papers Number Two, 1966); and,

Sector and Project Planning in Transportation (World Bank Staff Occasional Papers Number Four, 1967).

Attachments

cc: Mr. S. Johnson J.J.

RP Appr & Cont of Proj

Messrs. Takahashi and Schaefer-Kehnert January 16, 1968

Risto Harma

Considerations Regarding the Potential Use of Risk Analysis at Project Appraisal

The attached paper makes a useful contribution to the discussion on the potential use of risk analysis at project appraisal because the paper identifies and clarifies some of the issues involved which require examination at trying to adopt risk analysis into Bank use.

RHarma/ljb

Mr. W. Schaefer Kehnert January 18, 1968

John C. Gerring

Risk Analysis for the Tanzania Livestock Project.

1. Messrs. Schumacher and Husain are making satisfactory progress in carrying out the assignment of applying risk analysis to the Tanzania Livestock Project. The problem has now assumed a clearer format and the manner in which a tentative solution would be obtained is also clear. However, considerable programming work remains to be done. The Statistical Services Division of the Economics Department is helping in carrying part of the programming load. The balance of the programming is being done by Mr. Husain.

2. Two of the basic objectives of this exercise are: a) to test the usefulness and adequacy of this method of analysis for appraising livestock projects and b) to create a mechanism which shall facilitate its use given that it is in fact useful. Thus it is important that Messrs. Schumacher and Husain should continue to work together on this project until it is completed and written up.

3. The present arrangement about Mr. Husain's stay with this division is unusual; as of January 15 he is administratively a member of the Economics Department and is on loan to us for a period of about four weeks. That is, he would leave the section on or around February 15.

4. It is expected that the basic programming would be completed within two weeks -- unless unexpected delays occur in the "debugging" (removing the syntactical and logical errors in the programs) of the basic programs. After programming would come the phase of testing the programs on real data. If testing proves that the "programs" are functioning effectively, then actual analysis would be performed. The output from the actual analysis would then be translated into meaningful language. This would terminate the initial phase of the Project i.e. the actual use of risk analysis to provide meaningful answers to real problems. If this is successfully accomplished - which is quite likely - the next job would be to prepare a report to the livestock and credit section explaining the general methodology employed, and pointing out the possibilities and the limitations of the method. It is more important that this report be completed in order to provide an adequate link with possible future applications of the method.

5. It would be very difficult to accomplish all this by February 15. It is therefore requested that Mr. Husain remains assigned to this section till the project is fully completed and documented.

THusain:mem
IBRD

January 12, 1968

Letter No. 25

Mr. Robert Picciotto
IBRD Resident Mission
Post Office Box 416
New Delhi, India

Dear Bob:

It was good to hear from you. The Division, especially the Credit Section, is very active at the moment. The transfer of Horst, Pierre and Paul Coffin leaves quite a burden on the rest of the Section.

Our mission to appraise the Tanzania livestock project proved every bit as difficult as Uganda's, mainly due to the same problems I outlined at the section meeting. But I have a feeling that something constructive may come out of these difficulties and 1968 will bring some improvement in the situation.

But the main point of this note is to pass on to you some of the material on our efforts to refine the livestock program you developed. We managed to get programming help and they are now engaged in refining the program as per the attached memo. This will make it easier for Tarig Husain to incorporate risk analysis into it. He has progressed well so far. We are proposing to subject (1) prices of animals, (2) operating costs, (3) capital costs and (4) weaning and (5) mortality rates to risk analysis and see what kind of results we get. Michel is also going to try some risk analysis on the Papua appraisal.

John, Tarig and I would greatly appreciate any suggestions you might have on our proposed refinements in your program. I should also mention that Jose Andreu is finding a bit of spare time to devise a program for working out cash flows for agricultural credit projects. This will be a most helpful program as we will be able to more quickly approximate the likely return on a participating bank's contribution and thereby adjust the interest spreads if the return is too high or low.

Regards.

Sincerely yours,

A. Schumacher
Agriculture Division
Projects Department

ASchumacher:mjs
IBRD

Mr. A.E. Tiemann

January 3, 1968

J.B. Hendry

Ranch Development Project
Authorization of Computer Time.

1. As you know, we are planning to use Monte Carlo simulation (Risk Analysis) in the appraisal of the Tanzania Livestock Project. In this first effort the plan is to use the Livestock Development Program (developed by Mrs. Angel and Mr. Picciotto for the Brazil Livestock Project) as the basic computational unit for the simulation. In its present format the "Livestock Program" would not be fully adequate for our purposes - that is, a few modifications would berrequired. First, as the Program would be used in conjunction with at least two other programs it would be necessary to convert it into a sub-routine in Fortran IV. This Program, along with some others, would be used frequently by the Livestock Section in the coming months, and the effort put in for its conversion would save staff time in writing appraisal reports.

2. The other modifications in the Program could best be discussed with the programmer who would be assigned to the job, though essentially these would consist of:

a) introducing variable culling rates for cows and heifers in place of the present constant culling rates;

b) introducing an option to use a flexible policy for the purchase of heifers (classified by age), i.e., permitting purchase of heifers from capital funds as well as from operating income;

c) introducing an option to permit purchase of steers (classified by age) during the development period;

d) introducing a Predevelopment period;

e) introducing selective printouts, computations for a few productivity coefficients (i.e., overall mortality rate productivity of stock etc.), and the printout of units (i.e., currency and units of denumeration).

The above roughly outlines the areas where modification would be required.

3. The current version of the Program deals with Breeding/Growing/Fattening phases of development with options for some combinations of the three. In the case of Tanzania we have to deal with a ranch type which

could best be described as a Pure Fattening operation, i.e., buying of lean steers, keeping them on the ranch for a few months and then selling them off. We would like to have a sub-routine which could simulate a pure fattening type operation.

4. We would be doing part of the basic programming ourselves - especially the writing of the main program which shall tie together the outputs from the various sub-programs. The main program would generate the input data for the various sub-programs, would attend to the content and the format of the output from the whole package. There may be other changes not foreseen at the present time that may require some changes in direction, but at this time this is roughly the way we plan to proceed.

5. Programming and technical assistance from your division would be very helpful especially in completing the modifications suggested in Paras. 1, 2 and 3.

JHendry:asl

cc: Mr. S. Takahashi
Mr. D. Stoops

OFFICE MEMORANDUM

TO: Mr. J. Schmedtje

DATE: December 15, 1967

FROM: Shlomo Reutlinger

SUBJECT: Comments - Mr. Chenery's seminar held December 13, 1967

1. Mr. Chenery's seminar talk at the Bank on December 13, 1967 encourages me to think that we ought to give high priority in the Investment planning Division to the refinement of development criteria in addition to or in substitution of the usual rate of return criterion for appraising and evaluating projects.

2. My reasons are as follows: As it seems, the "statesmen" in the economics profession never seem to be satisfied to let a "balanced" point of view prevail. There have been times when the "industrializers" had the upper hand, now the "agriculturalizers" have their turn. At other times we had the "infra-structuralists" wielding power, etc. Now, so it seems, "program aid" seems to pull down the scale so forcefully that "project aid" is threatening to be hurdled off the other side of the scale.

3. There is, of course, more than one grain of truth in what Chenery and the pro-program aid champions are saying. For instance, I agree that aid to a project or a sector cannot be justified, regardless of how well the project or the sector utilizes that aid, if the country through bad policies or bad investments in other sectors fails to mobilize to the task of development. The converse absolutely does not follow, however. Neither is aid so plentiful nor are the good performers (either in an ex post or an ex ante sense) rich enough to afford a careless attitude towards the efficiency with which all resources are being used. Neither a planned nor an ex post high growth rate is evidence that on the micro level all is well. The most effective "checks and balances" for publicly operated projects are careful planning. A thorough review of projects and a requirement that standards with respect to macro-performance be met are both necessary. Neither alone should be taken as being sufficient.

4. In summary, Chenery raised two valid objections to the "project aid" approach (1) that it is inappropriate if the overall program is inadequate and (2) that projects, as conceived now, do not always contribute noticeably to marco-performance. On this second point we might do well to ponder.

SReutlinger:bso

cc. Mr. H. G. van der Tak
Mr. Jan de Weille

McKinsey & Company, Inc.

NEW YORK · WASHINGTON · CHICAGO · CLEVELAND · SAN FRANCISCO · LOS ANGELES
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245 Park Avenue, New York, N.Y. 10017
212 687-3600

December 7, 1967

Dear Mr. van der Tak:

Thank you for your very nice letter of November 8. I have been waiting to write to you to say how much I enjoyed talking to you at the World Bank until I had the final runs of the example that Mr. Reutlinger sent us. I now have the runs and am attaching them to Mr. Reutlinger's copy of this letter.

Again, I found our discussions most interesting and will look forward to getting together with you and Mr. Reutlinger at some later date. In the meantime, all best wishes.

Sincerely yours,

David B. Hertz

Mr. Herman G. van der Tak
Head, Sector and Project Group
Economics Department
International Bank for Reconstruction
and Development
1818 H Street, N. W.
Washington, D. C. 20433

cc: Mr. Shlomo Reutlinger

Form No. 57 | INTERNATIONAL DEVELOPMENT ASSOCIATION | INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT | INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

TO: Mr. L.J.C. Evans

DATE: December 5, 1967

FROM: Messrs. W. Schaefer-Kehnert, R. Harma and M. Palein

SUBJECT: Introduction of Risk Analysis in Agricultural Projects Appraisal

1. Upon Mr. Wapenhans' request, we have discussed the possibility of applying risk analysis to the appraisal of agricultural projects. Our discussion was based on general literature treating of the subject of taking account of risk in project appraisal, on analyses of the method previously made in the Division and on the examination of the Mogadiscio Port Project analysis made by the Transportation Division.

2. After our discussion, we agreed that the most efficient way of assessing the possible obstacles to using the method would be to try it on one or several of our projects. Since it is our understanding that it is the intention of the Bank livestock mission now in Tanzania to collect the basic data in such a way as to make an investment risk analysis possible, we feel that upon their return they should be encouraged to proceed with it. In case this should not be possible, or the data available should be inappropriate, we think that an attempt to apply the new method should be included in the terms of reference of one of the forthcoming appraisal missions.

MPalein/jfc
IBRD

CC: Messrs. Wapenhans
Bartsch
Darnell
Hendry
Stoops

P & P Appr. Cost of Proj.

Mr. B.A. de Vries (through Mr. E.K. Hawkins) Eff'd. December 5, 1967

N.G. Carter

Cost of Project Delay

With reference to my memo on this subject of December 4, there is something that needs to be added.

The striking results obtained when one calculates the cost of project delay are primarily caused by the implicit assumption that the asset in Case A can be used for T-G extra periods. This is a valid assumption if the length of asset life is infinite, however, if it is not, then the delayed project will have T-G extra periods at the end of the stream and thus the difference will be reduced by the PDV of these extra periods.

The factor to be added to the formula for PDV/C is

$$\int_{L}^{L+T-G} re^{-rt}dt = \left[e^{-rL}-e^{-r(L+T-G)}\right]$$

Where L is the normal length of life (starting from completion). The table shows the values in the example, of this factor for various values of L.

L	Factor	PDV/C*	PDV*	ΔPDV
10	.0664	-.0424	-6.36	7.71
15	.0445	-.0643	-9.65	11.00
25	.0200	-.0888	-13.32	14.67
50	.0027	-.1061	-15.92	17.27
100	.0001	-.1087	-16.31	17.66
∞	0	-.1088	-16.33	17.68

As can be seen, the costs of project delay are still substantial even when this factor is taken into account.

*Case B, excludes PDV of flows from T to L as these are common with Case A.

NGCarter:te

Mr. B.A. de Vries (through Mr. E.K. Hawkins) EKH

December 4, 1967

N.G. Carter NC

Cost of Project Delay

With reference to our conversation, I have set forth below what I believe to be a reasonable mathematical representation of the problem you set forth.

The example in your note is arrived at by the particular set of circumstances and project mix that you postulate. The problem should be looked at in terms of one single project and the effects on the present discounted value of its future flow of costs and revenues. Since once the project is finished the profile is the same regardless of the building delays, it is sufficient to look at two cases, one with the normal gestation period, the other with the delay in completion, and compute the differences in the PDV of future flows up to the point of the longer gestation period.

Let us call the gestation period G, and the length of time to the longer period T. We shall call the rate of return r and the interest rate i. The PDV is the sum of the PDV of the revenues and the PDV of the costs. Revenue in the years after completion will be R=rC where C is the total cost. The interest cost up to the end of gestation will be itC/G, where t is the particular time period (in periods since the start). After completion the interest cost will be iC (it is assumed that in both cases the amortization does not begin until after completion and in any case it does not affect the answer). Using the continuous exponential form,

$$PDV = \int_{G}^{T} rCe^{-rt}dt - \int_{1}^{G} \frac{iCt}{G} e^{-rt}dt - \int_{G+1}^{T} iCe^{-rt}dt$$

integrating and expressing the result as a fraction of total cost,

$$\frac{PDV}{C} = \left[e^{-rG} - e^{-rT}\right] - \frac{i}{r^2 G}\left[e^{-r}(1+r) - e^{-rG}(1+rG)\right] - \left[ie^{-r(G+1)} - e^{-rT}\right]$$

Taking the two cases quoted in your note,

A.	r=.08	i=.06	G=3	T=5	PDV/C=.009	PDV=1.35
B.	r=.08	i=.06	G=5	T=5	PDV/C=-.1088	PDV=-16.33
					Total loss	17.68

This result would tend to confirm the results arrived at in your note, that the cost of project delay is indeed large, in this case amounting to about 12% of the total project cost.

NCCarter:te

cc: Mr. Hawkins

3 - Appraisal + Cost of Proj?

Mr. Barend A. de Vries

November 28, 1967

E.K. Hawkins and N.G. Carter

Note on the Cost of Delays in Development Projects

We have looked at your note under cover of the memo dated November 27. We have the following joint comments.

The crucial part is the second paragraph on page 1, in which you list two measures of the cost of delays, one in terms of the output foregone and the other in terms of the return on the completed investment. These are not independent measures but can both be subsumed under the same heading. The appropriate measure would seem to us to be the rate of return on the investment which will automatically take account of output foregone should the construction period overrun the original estimate. Similarly, any increase in the costs of the project which result directly from the delay in construction will also be reflected in the rate of return. This will apply as well to the cost of interest during construction referred to in the last sentence of the second paragraph; this should surely read: "the delay will cause an increase in the cost of interest during construction."

We also have a brief comment on your first paragraph in which you speculate on the reasons for project delays in LDC's. We think that there are many varied reasons why projects are delayed. There is one specific institutional reason, however, why there is a tendency for technicians to project a construction period for a project which subsequently turns out to be unrealistic. This is the fact that with any institution it is always difficult to take formal account of possibilities for delay because of the fear that such projections will reflect back on the people concerned in making the projection. For example, it is well known in the Bank for projects to over run the period originally estimated for their construction in Bank appraisal reports. It is not institutionally possible, however, for this to be taken account of in future projections. In other words, the technician concerned has to go on pretending that a project will take x years to complete even when he knows from past experience that it will take longer than that. It is not permissible, in other words, to project uncertainty.

This can be very easily demonstrated by the inadequacy of the Bank's projections of disbursements. You will be aware that Mr. Goor has derived a statistical method for making disbursement projections which does take account of past experience and which can be shown to give much better projections than other methods still in use in the Bank.

The problem of delays in projects has been handled by a number of authors, particularly in relation to its effect on rates of return: see for example the works of Marglin.

EKHawkins/NGCarter/w

P.P - Appraisal + Cost of Proj.

November 8, 1967

Dr. David B. Hertz
Director
McKinsey & Company, Inc.
Management Consultants
245 Park Avenue
New York, N.Y. 10017

Dear Dr. Hertz:

I wish to take this opportunity to express to you my sincere gratitude for delivering a very interesting lecture to our seminar last Wednesday.

Many participants at the seminar have told me that they enjoyed your talk very much. It is my impression that the seminar was not only interesting, but has provided a stimulus to the participants to try out risk analysis in future appraisal work on Bank projects.

Mr. Reutlinger and I are looking forward to getting together with you again on matters of mutual interest.

Sincerely yours,

Herman G. van der Tak
Head, Sector and Project Group
Economics Department

SR/HGvdT:zmc

cc: Mr. Reutlinger

dcn. Dec. 7, 1967

RECEIVED
GENERAL FILES
COMMUNICATIONS

1967 NOV -9 PM 12:26

P.P - Appraisal + Cost of Proj.

Mr. W.A. Wapenhans

October 26, 1967

Phillip Z. Kirpich

Underestimation of Construction Costs

1. As I mentioned to you the other day, a report that has recently been called to my attention contains information that may be of general interest to the division. The report is entitled "The Role of Uncertainties in the Economic Evaluation of Water Resources Projects" by Edward G. Altouney of Stanford University, August 1963.

2. Using as a basic reference a report of the U.S. Bureau of Reclamation (USBR) entitled "Analysis of Reclamation Projects", October 1955, Mr. Altouney has compared for 103 projects of the USBR the actual cost with the cost as originally estimated at the time of the authorization of the project. It is not entirely clear but this presumably means that studies of "feasibility grade" were available at that time.

3. The actual cost C_a was compared with the estimated cost C_e on three bases: actual cost as it occurred, actual cost adjusted for changes in construction price trends and actual cost adjusted for changes in project planning and structural and engineering modifications. It is the second basis that would be of greatest interest.

4. Projects of all magnitudes were involved as the range in C_a was from $100,000 to over $400,000,000. Mr. Altouney found no correlation between degree of underestimation and size of project.

5. Mr. Altouney found the ratio C_a/C_e to vary from 0.74 to 11.00 with an average of 2.19, that is, the average underestimate was 119 per cent. The median ratio was 1.55; meaning that 50 per cent of the cost estimates were underestimated by at least 55 per cent.

6. Inasmuch as the USBR is a highly sophisticated engineering and construction organization it would seem logical to infer that the degree of underestimation by other organizations would be even greater than that experienced by USBR.

7. Might it not be a good idea to suggest that a similar study be made of construction cost underestimation with respect to Bank-financed projects?

c.c. Mr. Bartsch

PZKirpich:ceo
Bank

P.P. - Appr. & Cont. of Proj.

Messrs. Diamond, Paterson and von Hoffmann October 23, 1967

James S. Raj JSR

Seminar on Risk Analysis in Investment Appraisal

I enclose a copy of a memorandum from Mr. H.G. van der Tak on the above subject. Please designate a total of not more than five members of your respective staffs to attend the Seminar.

Oct. 24, 1967

Enclosure

cc: Circulation (2)

JSRaj:am

Seminar on Risk Analysis in Inv. Appraisal

P.P. Appraisal of a Cost of Proj.

Mr. James S. Raj, IFC
(through Mr. A. M. Kamarck)
H. G. van der Tak

October 24, 1967

Seminar on Risk Analysis in Investment Appraisal

1. Your attention is invited to a seminar at which Dr. D. B. Hertz of McKinsey & Company, Inc. will speak on "Risk Analysis in Investment Appraisal". The seminar will be held at 2:30 p.m. on Wednesday, November 1, in Conference Room 1038.

2. Dr. Hertz's presentation should be very timely, since his experience with applying the "aggregation of probability distributions" approach to actual investment problems in U.S. corporations may help to answer some questions raised during recent discussions of Mr. Reutlinger's theoretical paper and in the course of Messrs. Jaycox' and Pouliquen's application of this method to the evaluation of Bank projects.

3. To ensure an effective seminar we want to limit participation to a maximum of 50 invited persons with a specific interest in the topic. May I ask you to invite up to 5 members of the staff of IFC as you see fit.

JSchmedtje:jln

TO: Messrs. B.B. King, Larsen, Thompson, Weiner, van der Tak — October 24, 1967

FROM: E. O. van der Tak

SUBJECT: Seminar on Risk Analysis in Investment Appraisal

1. You are invited to attend a seminar at which Dr. D. B. Hertz of McKinsey & Company, Inc. will speak on "Risk Analysis in Investment Appraisal". The seminar will be held at 2:30 p.m. on Wednesday, November 1, in Conference Room 1038.

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3. To ensure an effective seminar we want to limit participation to a maximum of 50 invited persons with a specific interest in the topic. May I ask you to invite up to 3 members of your Department as you see fit.

cc: Mr. Kamarck

JSchmeltje:jln

TO: Messrs. Kamarck, Stevenson, J. H. Adler, de Vries, Orcutt, Sacchetti, Balassa, Goreux, Hawkins and Tiemann

October 24, 1967

FROM : H. G. van der Tak

SUBJECT: Seminar on Risk Analysis in Investment Appraisal

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3. To ensure an effective seminar we want to limit participation to a maximum of 50 invited persons with a specific interest in the topic. Corresponding invitations have been sent to the Projects and Area Departments, and IFC.

4. Messrs. Hawkins and Tiemann should feel free to invite up to three members of their Divisions as they see fit.

HvdT

JSchmedtje:jln

Mr. Bernard R. Bell October 24, 1967

H. G. van der Tak

Seminar on Risk Analysis in Investment Appraisal

1. You are invited to attend a seminar at which Dr. D. B. Hertz of McKinsey & Company, Inc. will speak on "Risk Analysis in Investment Appraisal". The seminar will be held at 2:30 p.m. on Wednesday, November 1, in Conference Room 1038.

2. Dr. Hertz's presentation should be very timely, since his experience with applying the "aggregation of probability distributions" approach to actual investment problems in U.S. corporations may help to answer some questions raised during recent discussions of Mr. Reutlinger's theoretical paper and in the course of Messrs. Jaycox' and Pouliquen's application of this method to the evaluation of Bank projects.

3. To ensure an effective seminar we want to limit participation to a maximum of 50 invited persons with a specific interest in the topic. May I ask you to invite up to 20 members of your Department as you see fit.

cc: Mr. Kamarck

Ver

JSchmedtje:jln

P.P Appraisal of Proj

Mr. S. Lipkowitz September 11, 1967

S. Takahashi

Techniques for Project Appraisal under Uncertainty

1. Mr. Reutlinger has prepared an interesting paper on how to handle problems of uncertainty in project appraisal. From a mathematical point of view, use of the probabilistic approach in analysing the behavior of key variables can improve the appraisal. However, as Mr. Reutlinger rightly points out "What matters is only whether an event has important consequences for the outcome of a decision and not how certain or uncertain (how "objective" or "subjective") is the estimation of its outcome". In other words judgments as to which are the "key variables" and how they are related or unrelated to each other are much more important than the method used to take care of "uncertainty" in the analysis.

2. In this connection, we have over the past two years had a number of discussions within the Division aimed at improving our methods for determining economic and financial returns. From these discussions we have started to explore ways of determining the sensitivity of rates of returns to changes in key variables. At present this has taken the form of calculating returns based on several alternative assumptions on key variables such as prices or yields. With computer techniques the analysis could be expanded to give us a better view as to which are the variables which will affect project returns significantly. This would set the stage for further refinement through use of the Reutlinger methods to determine the probability distributions of these key variables.

3. Some of the advantages claimed for the Reutlinger approach such as making explicit what is now implicit and providing decision makers with more knowledge and information could be achieved simply by adding explanatory notes to the rate of return calculations without additional analysis.

4. As pointed out in Mr. Friedgut's memo of September 5, 1967 Mr. Reutlinger's technique could probably be used without adding materially to the work of the appraisal mission since much of the data is already being collected and judgments are being made implicitly if not explicitly on the probability distributions of the key variables. It would be interesting to try out the technique on several appraisals to determine more precisely the amount of work involved and the usefulness of the approach.

cc: Messrs. Wapenhans, Palein, Friedgut

STakahashi:vr
IBRD

Mr. S. Lipkowits

September 11, 1967

V. W. Hogg

'Techniques for Project Appraisal Under Uncertainty' - Paper by S. Reutlinger (June 1967)

1. I only discovered this Paper after my return from home leave. We sent only one copy. After a quick reading I felt it was worth of wider circulation in the Transportation Division. Six additional copies, therefore, were distributed to Messrs. Malone, Muth, Park, Pouliquen, Pusar and Wouters the comments of whom are attached. Messrs. Jaycox and Thalwitz are presently attending Prof. Walters "Quantitative Economics Course". On its completion they should be able to approach Reutlinger's Paper with more freshness than others of us. I will arrange that their comments will be sent to you.

2. The general theme of all the comments, with which I agree, is that the Paper makes an intellectual case for using probability analysis as a tool in some project appraisals. We, in this Division, have a trial case (Somali Port Project) well underway. The work done so far (by Messrs. Jaycox and Pouliquen) suggests that it is worth continuing at greater depth not only because of its immediate value to the project but also for the generally practical lessons and conceptual questions that are emerging. We anticipate having a specific case study report on this available by the end of the year. Mr. Malone considers that a highway case is worth investigating - this we might also do.

3. Paradoxically, the empirical and pragmatic work we are doing brings out one of the main weaknesses of the Reutlinger Paper. That is, it is not aimed at the operational decision makers and project appraisers. The report could undoubtedly be shortened - many people in the Bank are familiar with the elementary principles of probability analysis (coin tossing 'and all') - and made more realistic by using concrete illustrations in transport, agriculture, public utilities and education to bring out the likely benefits from using the approach (the degree of sophistication is another story) and some of the difficulties likely to be met en route. In other words, some discussions of the costs and benefits would be valuable. What, for example, might be the implications for appraisal missions? Does it mean they would have to stay longer in the field? Would the type of staff member we have be suitable, or would they require training? Is it likely to speed up project appraisal and loan operations? Is the project appraiser to be supplied (and, if so, by whom?) with a 'do-it-yourself kit'? Does it mean that project appraisal reports become even larger documents - " the data and information the appraiser used ....should be explicitly presented in the appraisal report and...should be reviewed by the top level decision maker." (S.Y. Park, pp. 1-2)?

4. Mr. Malone questions whether a case may not be made for the use of analogue computers rather than digital ones.

5. If and when a shorter more practically orientated version of the report is prepared, I suggest it should be made available on a wide basis in the Projects Department for general discussion. This could take the form of reading prior to a talk by Mr. Reutlinger to each of the Division's at, say, one of their regular Division meetings.

VWHogg:gh
Bank

P.P. - Appr. & Cost of Proj.

Mr. W. Wapenhans September 8,1967

Michel Paledin MP

Reflections after reading "Techniques for Project Appraisal Under Uncertainty", by Mr. Shlomo Reutlinger

1. Mr. Reutlinger's draft report provides several useful criticisms of the method currently used in the Bank to present return indicators in project appraisals. It also describes methods of improving this by the incorporation of uncertainty in the calculation of returns. The following includes some comments on Mr. Reutlinger's report and an attempt to examine some of its implications for project appraisal.

Shortcomings of the Current Method of Evaluating Project Returns

2. Current indicators can be improved for the following reasons:

(a) Rate of return calculations, to be useful, need to be made on a uniform basis. More uniformity in actual evaluations can be achieved if allowance is made for the appraisors' diverse attitudes towards risk. At present there is no explicit indication of whether the returns have been estimated conservatively or optimistically, making it difficult to make valid comparisons between projects on the basis of their return indicators.

(b) In the process of the aggregation of the various elements of the project's return, the total can be either more optimistic or more pessimistic than the appraisor himself intends them to be (Chapter II, paragraph 28).

3. Decision-making usually requires more information than is contained in a single return ratio, even assuming that the latter has been properly arrived at. In fact current Bank presentations conceal a considerable amount of useful information actually in the hands of the appraisors (Chapter II, paragraph 15).

4. Mr. Reutlinger has successfully illustrated the points 2(b) and 3. But he has failed to emphasise point 2(a), which is also important.

Feasibility of Improving Current Bank Method

5. To supplement the provision of a central value of the indicator by some indication on how the indicator is affected by variations of the factors (Sensitivity tests) would increase the quantity of information made available and would draw attention to the key factors; but this would in effect add little more to what the appraisor normally states in the appraisal report to qualify his evaluation.

6. The incorporation of uncertainty in return calculations would improve appraisal work: more uniformity in approach, greater quantity of information included in the end-result, and a more logical handling of the basic assumptions. In addition, it would stimulate the appraisor's awareness of the problems affecting the project, by increasing the focus on the aforesaid assumptions. The opportunity could be seized of having a record of such assumptions kept and made available for consultation by other staff members who would thus benefit from the accumulated experience of the Bank. The incorporation of uncertainty is theoretically feasible. The practical feasibility, though, remains largely to be ascertained:

A. Theoretical Aspects

7. Mr. Reutlinger has given satisfactory explanations on how uncertainty problems can be handled. He has shown that there is no theoretical impossibility here, whether one actually computes probabilities or has a computer simulate the possible outcomes of a project.

B. Practical Aspects

8. The question then is whether more sophisticated methods would involve (a) the collection of a prohibitive amount of additional data, and (b) an unbearable increase in the staff's workload.

9. It could be useful to distinguish among several stages of increasing efficiency, and at the same time of increasing burden for the appraisal mission:

(a) the appraisor only attempts to make explicit more of the knowledge he normally acquires during the mission. Usually, the appraisor says less than he knows. For example, in the process of deciding whether a given magnitude is conservative, or average, etc., one actually considers alternatives and weighs them. This information is thereafter wasted. Once such information is recorded, someone with experience in probability calculus and economics takes the responsibility of aggregating the data.

(b) the appraisor attempts to obtain more data to ascertain his assessment of probabilities and to narrow the range of his estimates. Someone else then takes over the aggregation job.

(c) the appraisor does the aggregation himself. This may ensure more overall consistency, but involves specialized knowledge and time.

10. Introduction of risk analysis does not necessarily require that more data be collected. More data can be required for any kind of estimates, whether they involve probabilities or not. This question is therefore irrelevant to this discussion. If it is agreed that appraisors, under the present circumstances, do not have either the time and the skill to perform the aggregation work adequately, we are left with alternative (a).

11. This alternative would negligibly increase the burden of work for the appraisor. May be, Mr. Reutlinger could have more systematically illustrated how to introduce probabilities in weighing the possible outcomes of the elemental factors. As regards the aggregation problem, he has unfortunately only provided a simplified and hypothetical example. The degree to which the aggregation problem becomes more complicated as a result of introducing the larger number of variables which must be considered in appraisal of Bank projects remains to be seen. Whether acceptable shortcuts can be used to make the job easier can only be ascertained by attempting to apply the method to at least a few selected typical projects. I suggest that this should be undertaken.

Final Presentation and Interpretation of Risk Analysis

12. The presentation of the advantages of introducing uncertainty, as well as the criticisms about the current method could have been made more striking in the report. The report is also rather weak in showing how measures of risk can be used in making decisions. Chapter IV does not really say much about what one does once the complicated process of aggregation has been successfully carried out.

13. As to the form in which results should be presented to the management, it seems that a relatively condensed set of indicators would provide answers for most of the important questions. This could include (1) the expected value (in the sense used in probability theory), (2) the standard deviation, (3) the probability that the return is less than a given mark, (4) the list of the major factors contributing to the variance of the return. A more complete description would include the distribution of probabilities in the form of a table, or a curve.

Conclusions

14. (i) The current presentation of return indicators can be improved through the adoption of risk analysis;

(ii) the incorporation of uncertainty in Bank projects evaluation is theoretically feasible;

(iii) practical limitation lies in the increased workload. However the additional burden on the appraisal mission could be alleviated by making the aggregation work a specialized job;

(iv) the presentation and the interpretation of the final results can be made very simple.

(v) the management would gain useful information from a presentation which would include risk indicators.

(vi) Mr. Reutlinger's exposition of the problems involved is useful but ought to be supplemented by one or several case studies. The interest of such case studies would be five-fold:

a. Identification of possible limitations that do not appear when using a simplified and hypothetical example;

b. Determination of the extent to which the risk analysis is worth carrying out in the case the appraisal mission only collects a limited amount of additional data;

c. Realistic assessment of the additional workload involved in using the analysis;

d. Determination of the most appropriate division of work among the appraisal team, consultants involved in project preparation, and a specialized Bank team;

e. Determination of acceptable shortcuts and study of the possibility of adapting the method to the requirements of computer processing.

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IBRD

Clearance and cc:

Mr. S. Takahashi

Pol Appr. & Cost Ben. Proj.

Mr. S. Lipkowitz September 7, 1967

Duncan S. Ballantine DSB

Techniques for Project Appraisal Under Uncertainty, Comment

1. It has not so far been the practice in the Education Division to attempt to evaluate the economic justification of an education project on the basis of the economic rate of return (except in the case of a project in Chile involving the upgrading of already employed technicians) because the techniques of measuring the benefits of education have not yet reached an operational stage. Hence, the methods described in the abovementioned study cannot be utilized for our work at present.

2. The economic justification for education projects is at present derived from estimates of both the current and future manpower needs of an economy. Projections of manpower needs depend among other things upon:

- estimates of growth of GDP;
- estimates of growth of total population and labor force;
- estimates of wastage (retirement, death, emigration) within the existing labor force;
- estimates of growth of productivity per man;
- evaluation of the occupational structure in relation to the future level of employment;
- evaluation of the educational requirements for each occupational level.

For some of the projections, probability assumptions are used, e.g., mortality tables, but for the majority of the other elements, it is doubtful whether data derived from the experience of other countries are relevant in a particular case: in other words, for manpower projections there does not appear to be as yet a background of data on which to evaluate the probability of an estimation.

3. This does not exclude the possibility that, when additional knowledge and experience lead us to introduce the economic rate of return as a method of evaluating education projects, the use of probabilities might improve our analysis.

FLethem:rg

P.P. - Appr. & Cost Est. Policy

Mr. W. Wapenhans September 5, 1967

T. Friedgut TF.

S. Reutlinger - "Techniques for Project Appraisal under Uncertainty"

1. You requested a review of the draft report prepared by Mr. Reutlinger based on the following three criteria:

(i) Degree to which incorporation of the method would contribute materially to the value of an appraisal;

(ii) Additional demands incorporation of such an analysis into project appraisal would make on appraisal missions; and

(iii) Possibility of presenting and explaining this technique with relative simplicity in an annex to an appraisal report.

Due to the pressures of time and the specific interest in practical aspects of Mr. Reutlinger's model and its application to project appraisal, I have accepted his presentation of the theory of probability, risk and uncertainty without argument and assumed that his development of the formulae relating to pertinent statistical values is correct.1/

Summary of Conclusions

(i) Incorporation of the method of analysis suggested by Mr. Reutlinger could contribute materially to the value of an appraisal mainly by providing additional information on which to base decisions and by providing a logically rigid framework within which missions would conduct their analyses.

(ii) Adaptation of this method need not entail additional work for appraisal missions. On the contrary, once it has been tested and undergone minor adjustments to adapt it to the conditions met with in the field it could eventually streamline appraisal work and increase mission efficiency.

(iii) There should be no difficulty in presenting and explaining this technique and its results with relative simplicity in an appraisal report.

(iv) Theoretically, the incorporation of uncertainty into analysis of capital investment is not new. The practical feasibility of using the type of analysis suggested by Mr. Reutlinger would have to be tested on a suitable project or projects marked for future preparation or appraisal.

1/ There are some errors in the presentation of the statistical formulae but most of these can be attributed to faulty typing and proof reading.

Material Contribution to Appraisal Work

2. In essence, the paper builds up a case for examining projects in a manner which would:

(a) Force the appraiser to state explicitly his assumptions regarding behavior of key variables influencing costs and returns to the project;

(b) Break down aggregate values usually presented in reports into their major components so that these latter appear explicitly and may remain as information which can be utilized at various stages and levels of decision making (not the least important of which might be supervision missions); and

(c) Require mission members to collect data which would facilitate either formal estimation of probability distributions of values of key variables or allow formulation of subjective "guesstimates" of their distributions. Where information is not always available in the desired form or with the desired accuracy estimates of ranges and possible probabilities should be obtained from specialists or people with specific knowledge relating to the values of such variables.

3. There is no doubt that an appraisal mission must be aware of the assumptions involved in its analysis and also realise what components make up the aggragate values used in cost or income estimates. Presently it is assumed that writers of reports actually go through a stage in their work where these points are set down explicitly, whether they appear in the first or subsequent drafts or not. Where a report does not contain such information, it is easy for both writer and reviewer to gloss over crucial aspects and, through repeated revision and alteration eventually develop analyses which become inconsistent with the original assumptions. In this respect, then, the analytical method suggested by Mr. Reutlinger is of considerable value insomuch as it imposes rigid and precise thinking on the appraiser and also reduces the danger of misinterpretation or enthymematic reasoning which may mislead readers at higher decision making levels. 1/

4. Collection of data on probability distributions of key variables influencing the project is also something which is done, at least intuitively, at present by missions in the field. Otherwise, one would have to assume that cost estimates, yield assumption and projections of prices and production were made on a random basis. Here, too, the author would have the data set down in orderly fashion. No one can argue that having more information on which to make a judgement is not at least as good as having less information. The suggested method of analysing this data supplies one with valuable information in the form of:

1/ There are those in the Bank who consider the value of the calculation of the internal rate of return to be not so much in the final figure arrived at in the calculation but rather in the framework it supplies which forces the appraiser to set down explicitly his assumptions relating to the timing of cost and benefit streams.

(i) Expected values of (present value of) costs and benefits;

(ii) Ranges of expected outcomes within any desired probability limits; and

(iii) Probability that the present worth of a project at any given rate of interest will be zero or negative.

For example, in interpreting the results of his hypothetical project appraisal, he states the following:

> "From a table of the standard normal distribution, we note that the probability of S being less than -0.67 is approximately 25%, hence the probability of getting no positive returns from this investment is 25%. In terms of the internal rate of interest (sic!), R=0 corresponds with a rate of return of 8%, hence the probability of getting less than that rate of return is also 25%. 1/"

(iv) By-products of the above could also include information on the variance and standard deviation of major cost, yield or price components. Such data could contribute much to the understanding of problems which arise in various phases of construction and implementation. They would be of particular importance as indicators for supervision missions regarding points of interest to be studied in the field.

5. Obviously the economists' adage "your analysis is only as good as your data" holds true here. If imprecise information is gathered, or figures are manufactured simply to fill a questionnaire, the whole exercise is futile.

Additional Demands on Appraisal Mission

6. One can study more easily the additional demands which this type of analysis would impose on an appraisal mission by partitioning the mission's work into three phases:

(i) Initial preparation in the office;

(ii) Field work; and

(iii) Analysis of data on return from field.

(i) Initial preparation. As explained in the previous section, the analysis demands explicit specification of assumptions underlying the determination and calculation of major components of cost and benefit aggregates. I believe that some preparatory work should be done in this direction in the initial phase of the appraisal, on the basis of the government submission. Ideally the breakdown of major cost and benefit components should be done at the project preparation stage. The appraisal mission, on the basis of the

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1/ R=0 corresponds with a rate of return of 8% since this was the rate of interest used in calculating the present worth of net benefits.

preparation report could then prepare questionnaires or data forms in anticipation of interviews with appropriate officials in the field. The value of such a procedure would be in the explicit specification of types of data which a mission would have to gather and in the indication of the officials it would be necessary to interview. This amounts to no more than carrying the instructions of Director's Memorandum No.1 1/ one logical step further and will assure a much better organized mission and, consequently, more efficient utilization of the mission's time in the field. Here again it can be noted that the additional work involved relates only to making explicit what heretofore has been implicit in proper preparation of a project mission.

(ii) Field Work. In the field the mission would have to devote some time 2/ to collection of information relating to the probability of certain factors taking on certain values. Again, any mission estimating values, whether based on mean or mode, to be used in an appraisal report, would have to collect actual data or make assumptions and guesses where data is lacking. In a sense, then, this is not necessarily additional work but more in the nature of transfer of work which is usually done in the office, to the field. The obvious advantages of this are:

(a) collection of data in the field will be executed in an orderly fashion and filed on preprepared forms;

(b) where actual data is not available and estimates have been made - this will be obvious from the completed forms or questionnaires and as time passes and the analysis advances the initially distinct boundaries between fact and fantasy in basic data will not be obliterated; and

(c) mission members will be less apt to accept as factual, fuzzy and unfounded estimates palmed off on them by government or other officials who may have special interest in promoting the project or have incomplete knowledge of the subject. A constant demand for past figures and inquiries into factors affecting the value of any given variable should increase the degree of accuracy of any mission estimate, regardless of whether the suggested analytical method is ultimately used.

(iii) Analysis of data on return from field. The amount of work on calculations and data preparation associated specifically with the analysis is directly related to the complexity of project cost and benefit data. The model is based on specification of (individual and) aggregate probability distribution functions of main variables and present worth of the project. This is achieved through utilising probability data collected in the field to calculate expected (mean) values and variances of such variables. If performed by a mission member on a desk calculator this could conceivably increase his work load to some extent. However, I feel that much of the work, if not all of it, ultimately

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1/ DMI, para 3: "It will be made a general practice for all appraisal missions, before going into the field, to prepare a draft outline of their report, ..."

2/ How much additional time would depend on the size of the project and number of important items for which data on probability distributions is considered necessary.

would be handled by the Bank's computer. If it were properly programmed and the data collected systematically the results could possibly be produced by the computer in a form suitable to be inserted directly into a report annex. This could result in the saving of time and effort rather than placing additional burdens on missions.

7. In order to assess fully the additional burden that this type of analysis might place on an appraisal mission the method would have to be given a trial in the field. When a project appears which is deemed suitable for use as a guinea pig Mr. Reutlinger could prepare the necessary questionnaires and data forms with reference to the project preparation documents. These would then be carried into the field by the mission and used to the extent possible. On return to the Bank the system of data collection and the analysis could be reviewed on the basis of the field trial and the method altered to solve problems and difficulties encountered. A few trial missions may be required before the system is sufficiently adapted to agricultural appraisal work to be introduced as a standard procedure. The investment involved, however, could bear a handsome return once the method becomes fully operational.

Possibility of presenting an explanation of the model which would be acceptable to the layman.

8. The idea itself is a simple one. Its theoretical development and the mathematical groundwork which Mr. Reutlinger has layed in order to arrive at the ultimate formulae necessary for the calculations, while important in development of the method, are not indispensable in explaining the advantages of this analysis over analyses employing a single estimate of the rate of return. Once one accepts the fact that figures used in project appraisals are subject to uncertainty, common sense should dictate that any estimates used must be qualified with information relating to the probability of achieving the projected results. Detailed explanations of how the probability distributions are arrived at are a matter of technical interest and are no more needed than the formula connected with calculation of the internal rate of return or a set of multiplication tables to show how a combination of prices and quantities yields a value for total cost or total revenue.

TFriedgut:asl

P&O - Appr & Cost of Proj.

Mr. Vincent Hogg September 1, 1967

P. O. Malone

Mr. Reutlinger's Study on Techniques for Project Appraisal under Uncertainty

1. If, as appears from Mr. Reutlinger's study, the analytical methods of appraising and decision-making have been refined to the stage where it is possible logically to allow for the input in most appraisals being a collection of probability distributions rather than of single-valued functions, then I believe that it behooves us to take the concepts and methods set out in the study seriously. I believe also that the "message" is there and is clear -- that if our methods of appraisal are amenable to such refinement, and we do not refine our methodology accordingly, we will be open to the criticism that our appraisals are at best imprecise, at worst misleading or even wrong!

2. With our present technique we just do not know how far wrong we may be in the assessment of the outcome of a project if all the input data turn out, in the event, "worse" than anticipated; nobody else knows either at this moment (fortunately), but this happy state of affairs may not last for long. As I read Mr. Reutlinger's report, if we recognize the existence of an element of uncertainty (ignorance) in the input data of our appraisal arithmetic, and apply the probability calculus, then presumably we will be aware of the probability distribution of the "solution" (the internal rate of return, or any other criterion) and if we then express this "solution" in terms of a single value, at least we will have an idea of how far in error this single value might be. This is an advance on our present method, but is no more, really, than a variation of the old adage "It's not what you don't know that is dangerous, but what you don't know you don't know!!"

3. To convince myself that we operate under conditions of uncertainty, as Mr. Reutlinger terms it, I listed the main ingredients of the calculation for the rate of return in a highway project appraisal. These are:

i) present traffic
ii) rate of induced growth of traffic
iii) rate of natural growth of traffic
iv) the traffic "mix" (the ration of light vehicles to heavy vehicles
v) the project cost
vi) maintenance costs
vii) vehicle operating costs (for different types of vehicles and different types of road)

All the above are put into the rate of return calculation as single figures but all without exception are estimated, each value representing merely one ordinate in a probability distribution.

4. The mathematics used in Mr. Reutlinger's article are, in essence, those required to combine probability distributions rather than discrete values. Mr. Reutlinger suggests the use of high-speed electronic calculators, that is, digital computers. I feel -- although I stand to be corrected by the experts -- that there may be a case for the use of analogue computers rather than of digital ones. Analogue computers have the advantage that they provide a static display of the parameters involved, (in the case of a highway appraisal, these would be traffic volume, the rate of growth, internal rate of return, etc.) and that one can "play" with the setting of any one or more of the input parameters and observe the effect on the output, (for highway projects, this would be the internal rate of return). In this way, one can get a better "feel" of the variations in input which produce significant changes in output. I think this is a point which might profitably be taken up with Mr. Reutlinger.

5. No matter how the mathematics are carried out, it will still be essential to define, in quantitative terms:

i) the input parameters (e.g., probability distribution of present traffic, of traffic growth, of project cost, etc.);
ii) the output (i.e., the criterion which we are using to "appraise" the project - internal rate of return, benefit-cost, present value of total benefits, etc.);
iii) the mathematical relationship between each of i) and ii) ;
iv) any inter-relationships between the input parameters (e.g., the effect on the normal growth of traffic if the induced growth is greater than anticipated).

To define such parameters and to quantify such relationships would be a useful discipline in itself. The results of such an exercise might well affect the type of information we require and gather on appraisal missions.

6. Obviously a sharpening of our appraisal techniques will take time; however, I believe that it would be useful to make an early start using first a simple model and then attempting step-by-step complexity. Fortunately for us in the Transportation Division the problem is not too difficult, and we do not have to worry about the effects, on benefits, of factors such as rainfall, which must complicate the appraisals of the Power and Agriculture Divisions to nightmarish proportions.

7. To sum up:

i) I believe the article is timely and that it behooves us to try and understand the possibilities of appraisal under uncertainty with a view to improving our technique;
ii) I feel that the calculus of uncertainty may perhaps be more usefully carried out on an analogue computer than on a digital computer;
iii) Irrespective of how we go about the mathematics, we must first define and quantify the relationships between the input and output variables.

8. I personally would welcome a talk or talks on this subject by Mr. Reutlinger; I think a talk would be much more useful to the practitioner than the article which, even in the most charitable terms, is rather "heavy going".

PCMalone/mp

August 31, 1967

Dr. David Bendel Herts, Director
McKinsey and Company, Inc.
Management Consultants
245 Park Avenue
New York, N.Y. 10017

Dear Doctor Herts:

At the time of your visit with me at the Bank, I had promised to send you a draft of my paper on uncertainty analysis. This, somewhat belatedly, I have done today under separate cover.

As you will see when you readi the paper, the subject has been treated neither with mathematical rigor nor in "cookbook" fashion. Like all compromises, the approach taken in the paper has its draw-backs of which I am not in the least quite aware. When I will get around to rewriting the paper I will probably attempt to divide the paper into three parts: (1) A general discussion of what it is all about and what is proposed to be done about it (more or less chapters 1, 2 and 4 of the draft); (2) A mathematical treatment of how probability distributions can be aggregated and why so, based on basic axioms in probability theory, (more or less chapter 3 of the present draft); and (3) how step by step to do it and possibly a case study. In the third part a prominent place should be given to the simulation method worked out by you. I did not elaborate much on this method in the draft, but instead have made available a copy of your paper as complementary reaching to all reviewers.

The paper has been circulating now for some time and the evidence suggests that there is considerable interest in the topic. I would like to take up with you again, therefore, the two proposals we have discussed when we met in June:

- that you would use the data of a hypothetical problem I am presenting on pages 54-56 in the draft of my paper and run it through the computer with your simulation program, and

- that you will lead a discussion with interested persons at the Bank on the subject of your paper and subsequent experiences with simulating probability distributions of the rate of return.

I am looking forward to hearing from you suggestions for suitable dates for a seminar discussion, preferably sometime in October. In the meantime, I would also very much like to hear from you whether you can handle my "hypothetical project" with your simulation program [illegible] whether we could make some adjustments to make it suitable for the computations.

Sincerely yours,

Shlomo Reutlinger

S.R.

SReutlinger:bso

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P & P - Appr & Cost

Mr. Vincent Hogg

August 30, 1967

H. P. Muth

Mr. Reutlinger's Draft Study on Techniques for Project Appraisal under Uncertainty

1. I have read Mr. Reutlinger's study and would like to pass on to you the following brief comments:

2. The study is a reminder that most of our appraisal work is done in a climate of uncertainty. In the great majority of cases each one of the variables in a cost/benefit and rate of return calculation is "guesstimated" by a number of people in consultants' offices, foreign ministries and Bank missions. Our own second-guessing variable inputs transmitted to us by others without comment as to their expected ranges of probabilities compounds possible (and likely) errors.

3. Depending on the number of variables (such as expected increase -- both "induced" and "normal" -- in ADT; road user savings, themselves based on a multitude of variables; axle loads and load factors; construction and future maintenance costs; maintenance savings, etc.) and their ranges of probabilities, our rates of return may conceivably by "way out" in some cases. Mr. Reutlinger's examples -- all based on few variables -- confirm this danger. Moreover, this can be the case with both "marginal" projects and those whose rate of return (conventionally calculated) ranks them as very good. It is by no means more certain that a project with a calculated rate of return of 25% will in reality yield a -- maybe lower but still -- acceptable return than another one for which a mere 15% had been calculated to begin with.

4. We must be interested in any refinement of the tools we are used to working with -- as long as the cost in terms of time and manpower which is spent applying them does not outweigh the benefits to be derived from them.

5. Mr. Reutlinger may not be fully aware that even the mean and variance calculations, which he proposes as amenable to being routinely executed by the project economist without access to a computer, go far beyond the time limits within which the latter is usually compelled to work -- even assuming that he is handy with the mathematical gymnastics involved. It would seem to be both unfair and unwise to have only a part of all projects subjected to this privileged treatment: that would inevitably raise questions as to the quality of projects which -- for whatever reason -- have not been subjected to this procedure.

6. It is possible, on the other hand, to pre-program a routine probability analysis for a number of "standard" projects (highway construction or betterment; railway construction or modernization; port construction or expansion, etc.) and to subject all relevant projects to such

analysis. Non-"standard" projects would have to be dealt with individually, but they in turn could become computer-tested models for future application (e.g., the highway maintenance discussion presently under way in the division).

7. One prerequisite for the procedure sketched under paragraph 6 would be the availability of an economist in the project/transportation staff who is both well versed in the applicability of quantitative tools and who knows the practical problems and difficulties of project appraisal intimately. This staff member's time ought to be devoted to finding the proper tools (including computerization) for the solution of our questions. He would be our chief correspondent with the computer staff.

8. There can be little doubt that an increased awareness of the riskiness of our projects, and any procedure designed to apply similar standards of probability analysis to all of them, would improve the quality of our appraisals. To further improve our awareness of the ranges of probability of individual variables, much more ex post analysis of completed projects would be a necessary complement to any systematic ex ante risk analysis.

9. If we were to routinely apply probability analysis to our appraisal work, the suppliers of data inputs (missions, consultants, ministries, etc.) would of course have to be asked to make appropriate revisions in their procedures: to submit well-founded probability ranges of variables rather than single sets of data, etc.

10. In conclusion, I feel that the Bank can ill afford to have others -- institutions or individuals -- take the lead in a kind of work in which we ought to be leading. With national planning apparatuses getting increasingly sophisticated, our pre-computer techniques of product appraisal may one day no longer be up to par. We ought to take Mr. Reutlinger's paper very seriously, and he should be asked to help us translate his still rather abstract concepts into routinely applicable tools of project appraisal.

HPMuth/mp

P&P - Appr. & Cost of Proj

Mr. S. Lipkowitz

August 30, 1967

A. D. Spottswood ADS

Techniques for Project Appraisal Under Uncertainty

Because I have not had an opportunity to study the paper produced by Mr. Reutlinger except in a very cursory manner, I do not intend to make any comments to Mr. de Weille at the present time. (I am leaving on August 31 for a trip abroad and expect to return October 6.)

From my examination of the study I did not find any discussion of the time it would take to employ all the techniques suggested in the decision-making process. From my experience with the Indus Study I learned the difficulties and the time required to establish a model. It would therefore appear to me that unless the so-called decision-maker had unlimited time in which to make a decision, the techniques suggested would not be very useful.

ADSpottswood:poc

5- Appraisal + Cost of Proj.

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

IBRD Office
FAO Rome

August 24, 1967

Mr. Angus Hone
Ministry of Overseas Development
Eland House, Stag Place
London, S.W. 1, England

Dear Mr. Hone:

Thank you for your note of August 7 forwarding me a copy of your paper on "Economists, Engineers and Project Appraisal". I have read this paper with interest and I am in general agreement and have only two or three comments:

First, concerning your point (A). For agricultural projects I feel that the complementary role to engineers is much wider than that of "economists". The agriculturist with expert knowledge of soils, agronomy and other technical aspects of production, and experience in agricultural administration and services, is equally important in project preparation and appraisal.

I am in full agreement with your point (B). Organisation and management for project execution and operation is of fundamental importance and in most cases in the developing countries is the limiting factor to investment and development.

In the Bank we do normally rely on consultants for engineering aspects of project preparation, particularly if major works are involved. For other than irrigation projects we are relying more and more on specially trained staff for this work, using permanent missions in East and West Africa, and more importantly, the FAO/IBRD Cooperative Program. The main activity of the Program, which now has a permanent staff of 30, is project identification and preparation. The staff work together within FAO as an inter-disciplinary team under single direction. The team calls on the specialized knowledge of the subject matter Divisions as necessary. The Program is working very successfully and its experience has confirmed the essential need for an inter-disciplinary approach in project work. My work with this team has also confirmed my personal view that project work in the sense of preparing feasibility studies of projects for financing, demands special skills and special experience which can only be gained by actual work in this field.

I have not published anything more on project appraisal but hope to be doing so in the not too distant future. Meanwhile, you might be

interested in my article on "Investing in Agriculture" in the September 1966 edition of Finance and Development, which apparently is available to you. The central theme of this article is really the institutional obstacles to investment and measures being taken towards lowering these barriers.

Sincerely yours,

P.A. Reid
IBRD Liaison Representative

PAReid:vr

FORM NO. 57 | INTERNATIONAL DEVELOPMENT ASSOCIATION | INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT | INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

TO: Mr. H. G. Van der Tak DATE: July 27, 1967

FROM: M. Schrenk

SUBJECT: Comments on the Report "Techniques for Project Appraisal under Uncertainty"

1. The subject is a tough one and it is treated on a rather high level of abstraction. This puts anybody, who is trying to comment on the report without being a specialist in this very field, into a somehow awkward position. Any comment and criticism may look amateurish, and be fragmentary, "naive", irrelevant, or simply wrong by sheer lack of competence, or lack of time to dig deeply enough into the mathematical outline. This is why it is so easy to criticize the report, but so difficult to contribute anything seriously on the same intellectual level. However, I suspect that the people who are supposed to be convinced and to accept this new approach are not much better-off than I am. Thus, even naive and wrong statements may contribute to reach the goal of the authors, simply by revealing some "traps" into which the reader of limited competence may stumble and reject the approach precipitately.

2. I appreciate very much the idea and the scholarly approach, adopted to integrate the basic principles of uncertainty of expectations into the "discounted cash flow method". The fundamental theses and the principal conclusions are clearly stated. For example:

(a) Any appraisal of a project, in which more than one independent variable or datum is uncertain, has to be regarded as "poor" without an explicit risk analysis. Any decision-maker, who is not a crazy gambler includes risk considerations into his decision and thus has to be provided with full information about the degree of uncertainty and its implications with respect to the outcome of the action under review.

(b) The common "team approach" (several independent variables or data are estimated independently by experts in the respective field), and the division of responsibility between the groups of project analists and decision-makers enforce to deal explicitly with the uncertainty of expectations. Any trial of an expert to introduce "risk allowances" into the single estimates for which he is assigned, would be an act of usurpation, because it anticipates a part of the final decision, unvisable to the decision-maker. Moreover, uncoordinated risk allowances here and there in a complex calculation lead to a loss of information and to an uncontrollable overall downward bias of the final result.

(c) The concept of the probability distribution type of expectations is quite sensible. The assumption that "subjective probability" of a "non-recurring event" is the standard case as compared to "objective probability", that is to say probability distributions with parameters calculated a posteriori from empirical data collected in a sample of identical events is very realistic. The outlined probability approach can fortunately digest both subjective and objective probability distributions simultaneously.

3.1 Dealing with uncertainty, we face a problem characterized by the following example: An economist has to forecast a specific variable x (say, volume of demand). Applying a certain hypothesis (consisting of a sophisticated formalized procedure of projection, sheer guess, or anything in between) he derives at the time series of "most likely" occurrences of the event $_mx_t$ (t = 1,..n). But he has any reason to lack confidence into these figures. Thus, by modifying the hypothesis (changing some of the numerical assumptions of the projections, using alternative ones, or just introducing other guesses) he tries to pin down his feeling of lack of confidence by giving for each year a"most optimistic" and a "most pessimistic" estimate of the occurrence. Because of the fact that optimistic and pessimistic are undefined with respect to the direction of deviation from the most likely occurrence, it is preferable to replace these terms by "lowest likely" and "highest likely" occurrence, $_lx_t$ and $_hx_t$ (t = 1,..n). "Loest likely" and "highest likely" have to be interpreted in the sense that an occurrence outside this range cannot be excluded logically, but is regarded as being "highly unlikely". For example, it is expected to occur in, say, no more than two out of 100 cases. The range between $_lx_t$ and $_hx_t$ then is the measure of the lack of confidence of the estimating person into $_mx_t$; that is to say, for each year there is a subjective probability distribution existing, the mode and the $\pm$ 3 σ range of which are estimated in terms of $_mx_t$, $_lx_t$, and $_hx_t$. In graphic presentation, there would be a curve over time each for $_lx_t$, and $_hx_t$, $_mx_t$ being somewhere in between the other two; the distance between $_lx_t$ and $_hx_t$ is supposed to grow over time due to reduced confidence into the more remote future. This is the typical situation in any forecasting under subjective uncertainty; it appears with respect to events both of economic and technical nature. If things look less complicated, then it is just by simplifying assumption, for example, that $_mx_t$ or $_hx_t - _lx_t$ remain constant over time. The question now is: how can such a judgment, as represented by these three basic estimates (The H.B.R. article expresses it identically) be transferred into terms of probability distribution?

3.2 Let us assume, that for a certain period the following estimates have been made: $_mx = 130$, $_lx = 80$, $_hx = 150$. If I understand the report correctly, then the following procedure of evaluation has to be applied: (1) Distribute the whole range into several subranges of equal width; if three are chosen, then the first subrange is 80 - 103.3, the second 103.4 - 126.6, the third 126.7 - 150; (2) take the median of each subrange, that is to say, 92.6, 115.9, and 140.2; (3) transform your expectation with respect to just these three hypothetical occurrences into estimates of probability, the sum of which has to add up to 1.

3.3. Nothing is wrong logically with this procedure. However, its application to reality looks highly artificial. The three basic estimates of vivid actual meaning to the estimator, representing his appraisal of a "continuum" (which is the very meaning of the basic concept of probability distribution) have disappeared. Instead, three deliberately looking discrete hypothetical occurrences are defined which have no recognizable real meaning and relationship to the original view; the estimator is then asked to express his feeling of the likelihood (which is an utterly vague concept in itself) by allocating relative weights to these three hypothetical occurrences.

What is even worse is the fact that the most valuable piece of information, namely the "most likely occurrence" is neglected completely. Logically, it should appear again in the probability estimates, but its actual representation is very poor. If the original distribution has a skewness, (that is to say, the most likely estimate is not just in the center of the range) which one should expect to happen normally, then there is a strong tendency to lose it completely during this procedure. This final result will tend to be always a symmetrical or even rectangular distribution; the example in the annex to Chapter III demonstrates this outcome involuntarily. Without digging any deeper into the psychological implications of the procedure, I would conclude that it is a useless tool, because it spoils the available knowledge and understanding of the problem and creats artificially a numerical weakness of the final results which is beyond any control.

3.4 An increase of the number of sub-ranges, aimed at approximating the original character of the expectation as a "continuum" and, at the same time, increasing the accuracy of the results, lead to nowhere. The estimator is hampered by the necessity to estimate the relative probability of all alternative occurrences simultaneously, and, in addition in figures which add up exactly to 1. If looking for more than, say, three alternative occurrences this procedure looks just inconceivable under any realistic circumstances.

3.5 Fortunately, there is no need for this direct transformation into a probability distribution: an alternative, more realistic method is available. PERT and CPM have developed a concept of describing the uncertain estimates of time requirements for specific activities, which uses exactly these three elements: "most likely", "optimistic" and "pessimistic" time consumptions. (It should be stressed that these are technical estimates, conceptualized by engineers; that is to say, economists and engineers obviously think the same way with respect to subjective uncertainty.) In these planning techniques simple formulas have been developed to derive directly reasonable approximations of $_e x_t$, (the mean or "expectation value" of x) and $V(x_t)$ (the variance)by using the three elementary estimates:

$$_e x_t = \frac{{}_1 x_t + 4\,{}_m x_t + {}_h x_t}{6};$$

$$\delta(x_t) = \frac{{}_h x_t - {}_1 x_t}{6}$$

$$V(x_t) = \left(\delta(x_t)\right)^2$$

which are then used for the further calculations. Using the figures of the numerical example, $_e x_t = 125$; $\delta(x_t) = 11.7$; $V(x_t) = 137$.

3.6 The theory leading to these approximations is that of the "beta distribution" which is certainly discussed extensively in the literature about OR and PERT and CPM. The PERT method may have its own deficiencies, but it definitely has the advantage to be based on a more realistic concept of the nature of uncertain expectations. The whole argument against the use of the mode (most likely estimate) and the pessimistic ("conservative") estimates of paragraphs II, 18-28 is logically correct but looks irrelevant. It is based on just the artificial concept of discrete alternative outcomes and not on the more realistic of a "continuum"; therefore, the approaches, discussed and refused legitimately, can hardly be considered as serious methodological alternatives.

4. As stated in para 3, we face the fact that for each independant variable we have an expectation value and a variance for each year (the variance usually growing with remoteness of t from the present point of time). Then we have to calculate the expectation value of the net benefit, for each year (in which quite a number of independant variables may be involved) and the respective variance. And finally we have to add up all the annual net benefits for the expectation of the capital value of the project, and have to calculate it's variance. If any correlations are involved, be it between the independant variables for a certain year or be it over time for a given variable, then the volume of computation work will easily reach a fantastic volume because of the covariances, if I understood the formal presentation correctly. This doubt is exactly the point I want to make: the reader of average skill in elementary mathematics gets lost when he tries to face this crucial question. The numerical example does not help him either. Probably this problem is the reason for simulating the overall variance, as suggested in the H.B.R. article.

5. Neglecting all the prior discussed douts in the method of deriving the parameters of the probability distribution (c.f. para 3) and in the neglection of the time dimension of all the estimates, (c.f. para 3.1, 4), the numerical example has another deficiency. It is of a rather serious nature because any untrained reader tends to understand the approach rather by looking to the example than following through the formal outline. The deficiency is the fact that all distributions (c.f. page 56) are strictly symmetrical; the only exception e_2 turns out to be a typing error and should read +10 instead of -20. The mean or expectation value of a symmetrical distribution is (by definition) equal to both the mode and median of the distribution. Hence no calculation at all is required for achieving the means, they are just the median of the three given figures for each variable. This is a somehow dangerous simplification, it could lead the naive reader to the assumption that such a situation is typical, which is not all the case. (A extended discussion of the skewness of the distributions, as prevailing in reality, would add another dimension to the problem of how to transfer realistically actual estimates into parameters of probability distribution, c. f. para). What is really puzzling are the results of the calculations on page 58 and the conclusions drawn from them. First of all, it appears that some errors have slipped into the calculation (which could

rather be discussed orally). What has to be pointed out here is the fact, that for logical reasons the first and the third, and the second and the fourth case have each to provide identical numerical solutions (which is really the case after eliminating the calculation errors). That is simply because of the assumed symmetrical nature of the distributions: any change in the degree of confidence does not change the means or expectation values of the distributions at all (except in the term Σa^t which is influenced in a more complicated way by the uncertainty of n, this is the reason for the two different solutions). The statement on page 59 consequently is conceptually wrong: If uncertainty were neglected, then the median expectations would have been chosen, and the result would have been exactly the same, the conclusion on page 63 is wrong accordingly. (All further calculations should also be checked for correctness; if the figures of page 58 really prove to be wrong, then the errors will spread all over the rest of the example). To sum it up: the example as it stands now, does not and cannot prove the influence of uncertainty on the mean (expectation value) of the outcome, with the exception of n.

6. I miss the discussion of one of the crucial questions: what is the actual meaning of a certain variance of an expected (mean) outcome for the decision-maker? There is only one brief reference to this question on page 62, which may be clear enough for a scholar in this field, but keeps the average reader lost. First of all, the introduction of S = ... etc. and the whole rest may be correct but is rather undigestable to him. Secondly, the properties of the standard of deviation (which is commonly expressed as β and not S), being the square root of the variance, should be discussed explicitly, for example in terms of alternative deviations from the expectation value and the respective probabilities. In this context, the diagram on page 105 in the attached H.B.R. article, showing the accumulated probabilities over the scale of all possible outcomes, looks very impressive and should immediately be meaningful. This very diagram shows in a nutshell the achievements and the properties of the probability approach to the decision-making problem.

7. The suggested procedure (direct estimation of probabilities by considering only three or two alternative hypothetical outcomes) tends to confuse two fundamentally different cases of uncertainty. In the first case, (the one under discussion in the report) we have a subjective "continuum" of expectation, distributed around a "most likely" value; the actual occurrence is expected to fall anywhere into an estimated range, with decreasing likelyhood departing from the mode. The second case, which is clearly distinguished from this first one, is the incidence of clearly defined alternative course of events. To give an example: there is a subjective probability distribution of the expectation of the future volume of domestic sales of a certain product under given political conditions. But the country under consideration may consider to enter a specific kind of free trade arrangement with its neighbor country. Then we have clearly distinguished alternative set of well defined environmental conditions, leading to completely different probability distribution of sales estimates. With respect to this second kind of uncertainty, the direct estimate of the subjective probabilities of the incidence of the

alternatives is a very sensible and realistic concept. The difference between the two cases is immediately evident, if the final evaluation in the final decision-making is looked at: nobody would seriously think of merging the two alternative course of events, and calculating one mean or expectation value, but would look definitely to the alternative outcomes and their respective probabilities and variances.

8. A computarized model of the investment problem is desirable indeed, but not only for simulating hypothetical outcomes of the venture in order to obtain a probability distribution. Another advantage would be to run a "sensitivity analysis" of the problem, (a formally similar but conceptually different "simulation" approach) as a tool for planning the optimal information effort. This is indicated somehow on pages 50 and 51 of the report, and more explicitly, on page 103 of the H.B.R. article. Simplifying somehow, this approach can be described as follows: (1) The model is formulated algebraically, i.e. the basic equation for calculating the capital value of the project has to be spelled out as far as possible, showing explicitly the effect of all the (estimated) independant variables and parameters; (2) the model is programmed for the computers; (3) without any particular effort, a set of very crude first "guesses" of the values of all the independant input data is prepared; (4) the model is run with this first set of expectation values; (5) one after the other these first crude input data are modified to the "negative" side by changing them successively by certain controlled percentages or amounts. The resulting changes in overall outcome tell a striking lesson: they show clearly which of the input data are the "critical" ones and which are of minor importance and require no more than just this guess. This could serve as the key to allocate the limited time or money for the appraisal of a particular project in such a way that the data exploration is concentrated on the critical ones, in order to keep the overall uncertainty at a minimum. Any improvements of information during the whole process can be fed into the model immediately for continuous adjustment and control.

9. Except from the calculation and conceptual errors discussed in para 3, the example in the annex to Chapter III reveals several typing errors, (rather to be discussed orally) which sometimes are quite embarrassing to the reader. This leads to the suspicion that similar typing errors may have occurred elsewhere, thus a careful scrutiny of all the formulas is recommended.

10. I have the feeling that the authors had something impossible in mind with the report: namely, to satisfy both the scholar in this field, and the practitioner who has never heard anything before about this topic. I am afraid, neither will be very happy. The scholar may prefer a more austere presentation, describing briefly the state of the art, and highlighting the shortcomings and indicating future solutions. The practitioner simply wants to understand the actual achievements of the approach, and how

it fits to his problems and to his view. If the goal is more towards the latter, aimed at "converting" him, I would suggest some editing. The form H.B.R. has developed for that very purpose is somehow exemplary. For the more sophisticated reader, specific annexes may be attached. This shortcoming is especially true with respect to Chapter IV which is definitely too "much" and too "little" simultaneously. The aim to make understandable and acceptable the whole concept of integrating uncertainty into procedures of project appraisal stands for itself and does not require a review of the highly complicated theory of decision-making under uncertainty, including "dynamic programming." A simple hint that maximizing the expectation value (in the case of choice between alternatives) or achieving a positive one (in case of a single yes-no decision) is a poor criterion, and that uncertainty about achieving the expectation values are another dimension in his overall utility function, would be enough for any conscientious decision-maker. He has anyhow to find for himself his "optimum", by means of his very individual "risk preference function", and nobody can relieve him from this problem. The position sketched in this paragraph, is pointed out quite emphatically in paras 1 and 2 of the Summary and in para 2 of the Introduction, saying "the primary purpose of this paper is to present workable procedures of analysis to practicing project appraisers."

cc: Messrs. Walstedt
Reutlinger
Schmedtje

MS/gb

P. P - Appraisal of Project

Mr. Jochen E. Schmedtje

July 21, 1967

A. E. Tiesenhausen and A. Kundu

Techniques for Project Appraisal under Uncertainty: Reutlinger

1. We have read Mr. Reutlinger's paper with quite a bit of interest. He has done a tremendous amount of work in bringing in the probabilistic approach to deal with the project returns under uncertainty.

2. The object of the paper, however, is not very clear to us. Mr. Reutlinger presumably wants to present a feasible method for project appraisal without recommending it as the only method. However, most of the paper deals with his special probabilistic approach and then presents an example. On the other hand, if the object is to present various choices of techniques, then Mr. Reutlinger should do more than just allude to some of the alternative approaches, probabilistic or otherwise, and give a comparative picture of all methods. If he wants to emphasize his method as one of the best, which seems to be the case, then we think the paper would benefit from some reorganising. Specifically, a more logical arrangement of the sections of the paper would be in the order, I, IV, II and III.

3. It is not clear for which audience the paper is intended. In quite a few places, statistical concepts or computer simulation methods, etc. are just mentioned in passing without any rigour. As a matter of fact Mr. Reutlinger's probabilistic approach depends on some of these concepts. The paper would be improved if it were written in general terms with a rigourous mathematical appendix to substantiate his arguments. In this way the paper would have greater appeal to general economists but also be more acceptable to statisticians.

4. The mathematical techniques used in the paper could be presented with greater clarity. For example, references to central limit theorem and joint distribution of annual benefits need to be expanded. One would also like to know not only that a problem could be handled by computer simulation but also the techniques or models for simulation. In these respects, discussions on such concepts as Bayesian "a posteriori" probabilities, and Monte Carlo methods, would be quite relevant. Also a sensitivity analysis would make the worked out example more meaningful by showing the riskiness of uncertain probability assumptions.

5. There are several minor points where terminology could be improved. For example, since Information Theory is an accepted nomenclature in operations research for a specialised field, the title Value of Information Theory on page 77 would be better expressed as "Value of Information" Theory.

6. Mr. Reutlinger's paper deserves wider circulation, but would require some tightening up, especially on the mathematical side. We shall be available to assist Mr. Reutlinger in this connection.

cc: Messrs. Kenwrick
de Vries
King
de Vaille
Reutlinger

AE/ATiemann:ss

P&P - Project appraisal

Mr. Barend A. de Vries July 17, 1967

Vinod Dubey

Note on Appraisal of IFC Projects

1. I am in general agreement with the pragmatic considerations developed in your note of July 14, namely, (a) wherever possible projects should be evaluated on the basis of the price at which products would be bought or sold on international markets; (b) engaged as it is in financing single projects, the IFC will have to accept the general protectionist policy of the country as given.

2. I would suggest, however, that:

(a) it may be indicated that the above mentioned considerations are relevant to all projects taken up by IFC, and not only to projects producing textiles and steel, which happen to be marked by excess capacity in other countries; (b) the idea of a "notional" price to take account of marketing peculiarities (e.g. in the case of sugar) may be presented somewhat differently. The free world market price, representing the alternative cost, would be the relevant one for project evaluation. However, taking account of the "dumping" (restrictive) nature of the world price a higher than usual level of protection for domestic production may be considered acceptable in such cases; (c) the idea, in the last paragraph on page 2 of your note, that a project receiving protection out of line with the general level, would be in all likelihood commercially unprofitable, does not appear convincing; (d) the position of a generally free trading country (lines 2-4, page 3) is not necessarily similar to the point made in the earlier part of the paragraph. A country may be free trading because it does not have a manufacturing sector. A development of manufacturing project in such a case may require a departure from the general protection levels. As you point out on page 2 of your note, the relevant consideration is that protection should not be "grossly out of line with the protection generally received by firms in the same or related industries." (Emphasis added).

VDubey:ryd

cc: Mr. Walstedt

Yellow

Messrs. Larson, McDiarmid, Thompson, Weiner and Fontain
Alexander Stevenson

June 30, 1967

Techniques for Project Appraisal under Uncertainty

The attached draft study "Techniques for Project Appraisal under Uncertainty" was prepared by Mr. Shlomo Reutlinger of our Investment Planning Division.

I am sending you two copies of the draft in case there are any staff members in your Department who you consider would like to read it. We should welcome any comments they may have on the draft.

cc: Mr. de Vaille

RGilmore/AStevenson/ner

Mr. Jan de Weille June 22, 1967

Shlomo Reutlinger S.R.

Simulation Technique for Assessing Probability Distribution of the Returns from an Investment

1. Dr. David B. Hertz of McKinsey and Company, Inc. (Management Consultants) visited here briefly with Mr. van der Tak and myself several days ago in response to an earlier invitation.

2. The topic of our discussion was the simulation technique for assessing the probability distribution of the returns for an investment, which Dr. Hertz has presented in his paper, "Risk Analysis in Capital Investment", published in the January/February issue, 1964, of the Harvard Business Review.

3. Since the publication of his paper, Dr. Hertz has had occasion to apply the simulation technique to the evaluation of a variety of interesting investment problems. Dr. Hertz has stated his willingness to respond to an invitation to present a seminar discussion about this topic to interested persons in the Bank.

4. Dr. Hertz has also kindly offered to compute for us with his program and computer a probability distribution of returns for the hypothetical project described in my paper.

SReutlinger:bso

Mr. S. Takahashi June 21, 1967

R. Picciotto

Simulation Techniques for Project Appraisal

1. At your request, I attended a meeting in Mr. Chadenet's Office on the above subject. Mr. Husain, a Young Professional presently assigned to IFC, made a most interesting expose about the use of simulation in modern decision theory. As illustration, he described a computer program which he designed to test the impact of various operational assumptions on development bank profitability. He suggested that a similar approach might be used in some of our appraisals.

2. We have long recognised that return calculations in appraisal reports provide readers with a rather spurious feeling of accuracy or certainty. At a division seminar, last year, I tried to analyse the sensitivity of rate of return criterion to assumptions made with respect to yields, costs, prices and timing of costs and benefits. Following up on this notion, Mr. Palein, wrote a paper where he argued that we might consider giving ranges of estimated values rather than single "most probable" values in connection with our appraisals. More recently Mr. Reutlinger of the Economics Department prepared a rather sophisticated paper where he suggested that an aggregate probability distribution for the rate of return could be obtained on the basis of probabilistic estimates of the main components of benefits and costs.

3. The logic of Mr. Husain's program is quite general and should be relatively easy to adapt to the requirements of a rate of return calculation. I suggest that we attempt such an adaptation in connection with some appraisals currently underway. One possibility is the Shire Valley Project where the response of cotton yields to rainfall or pesticide application efficiency might be analysed. Another is the Uganda Livestock Project in connection with which it might be useful to test the sensitivity of the herd development model already worked out for Brazil.

RPicciotto:ag
IBRD

cc: Messrs.: Chadenet
Wapenhans
Stoops/Gerring/Schumacher
Manning/Friedgut
Gustafson/Husain

~~Study by ADELA of~~
~~Accounting Methods under~~
~~Inflationary Conditions~~

Antonio García Payseri:ic
May 12, 1967

DO NOT by ADELA.
Ud.

~~August 31, 1965~~

INFLATION AND MONETARY EXPOSURE IN LATIN AMERICA IN INVESTMENT OPERATIONS

1. In areas in which economic instability exists or is imminent, the investments and operations are subject to special circumstances that usually are not found in countries relatively more developed. In order to face those circumstances, special tools and abilities are needed to avoid substantial losses or investments that result in economic disasters. This memorandum tries to explain the nature of such conditions, some of its affects, and some of the protective measures that may be taken.

2. There is no panacea for all the ills of such operations. A remedy that can be desirable in certain geographic areas or for a specific company may not be adequate in other circumstances. Thus, this paper should not be considered as a practical manual for the rapid and easy solution of problems that probably are very complex and unrelated. It only will point out some of the areas that may require special attention or a great deal of consideration. Maybe the best recommendation to an investor is that he should assure himself that any company in which he invests should have a financially highly-qualified management with experience in solving the problems in any situation of economic instability, inflation, or monetary devaluation.

3. The monetary losses are real losses and not only losses in the paper (i.e. accounting losses). Sometime the use of inadequate accounting systems that do not show the losses tend to hide this. If net assets in the function of any constant value are worth less after devaluation, the investor would have lost money, as much as if one of the accounts receivable of the company would have turned a "bad debt". In many cases, these losses not only reduce the value of the investment, but also create serious cash and liquidity problems.

4. The devaluation of the currency may be rapid and continuous (as in the case of Brasil during 1963 and 1964), gradual (on parallel rate as in Argentina) or sudden (Colombia and Chile) depending mainly on the degree of governmental intervention and control and on the reserve banks. However, as time passes by, the devaluation tends to follow the local inflationary rate but only occasionally does it seem to reach it. The apparent instability of a currency during a short period of time in itself is not a good index that could lead us to waive the possibility of a devaluation, because the intervention of the reserve bank tends to distort the situation. Because of this and other reasons, the price indexes are to be valued. The balance of payment, interest rates and other economic indexes usually are more exact in order to follow the possibility and the scope of the devaluation.

5. The majority of the Latin American economies of this time are characteristically inflationary and the risks of monetary depreciation are high. A prudent operational financial management in Latin America should for that reason assume that devaluation will occur and should do its financial planning based on such an assumption. At present, certain countries such as El Salvador and Nicaragua can be considered as exceptions because the cost of living, price indexes and currency have been relatively stabilized for a period of time. However, as the planning is best in a continuing stability, the economy should be carefully watched to determine any symptom of weakness. At the first symptom of a possible devaluation (general increase of prices and indexes of the main articles of export, deterioration of the balance of payment, deficient budgets, political changes that may have a negative effect on the monetary value of the country) it is necessary to enforce appropriate programs for the protection of the capital investment.

6. There is a price to pay in protection against the effects of the devaluation. This price is the increase in the interest rate in the loans in local currency vs. hard currency, the cost of currency sales contracts on futures, on swaps, special incentives, etc. and also, the cost in time and personnel necessary to face the problems. In some cases, the price to pay for the protection is out of proportion in relation to the risks involved. Then it will be necessary to make an evaluation about the possibility of a devaluation and the scope of the losses if the devaluation occurs. It is possible to say, however, that if the risk of monetary losses exists, it is desirable to sacrafice a part of the profits in protective measures in the same way as if buying an insurance policy.

7. Before any definite commitment of investments projects in areas where a possibility of a devaluation exists, this risk should be studied. This study should include:

a) to make a forecast about the probability, scope and opportunity of the devaluation based on the indexes available;

b) preparation of a balance sheet and profit and loss and cash flow projections, taking into consideration the forecasted devaluation;

c) an evaluation of the availability and cost of the protective measures in view of the scope of the possible monetary losses.

8. After an investment is made a constant checking on the financial structure of the company in function of its real value should be made. For that purpose balance sheets and profit and loss statements in local currency is not enough. It will be necessary to complement them with similar statements

but denominated in hard currency or by some accounting method that shows the local inflation and the deterioration of the currency. The exposure to "monetary losses" should be evaluated periodically and when necessary adequate corrective measures should be taken. In Annex I a form is shown for the preparation of a "monetary exposure" statement.

9. There are two types of "monetary exposure": One, which for the purpose of this memorandum we will call the "conversion exposure", deals with measuring the net assets in local currency that would be affected by a change in the value of the local currency. The losses that may result in its relationship with hard currency shall be called "conversion losses". The other called "exchange exposure" tries to measure the liability excess in hard currency. The resulting losses in local currency will be called "exchange losses". Both "conversion exposure" and "exchange exposure" together are called "monetary exposure" and the resulting losses are called "monetary losses".

10. The investor is mainly affected by the"conversion exposure" and the "conversion losses" because these losses reduce the value of the investment in real terms. Although the "exchange losses" are already included within the point of view of the investor in regard to the "conversion losses" the "exchange exposure" cannot be set aside on a financial point of view. The obligations in hard currency, after the devaluation, require a larger amount of local monetary units to be paid. This affects liquidity, cash flow, loan programs in local currency, profits in local currency, local tax payments, the ability to amortize debts and the credit of the company.

11. As it is generally assumed that the fixed assets, taking aside the depreciation, maintains its real value notwithstanding the devaluations, the ideal balance sheet on the point of view of the "monetary exposure" would be

such in which the liabilities in local currency are equal or higher than the assets in local currency and in which the net worth is equal or lower than the added amount of the fixed assets and assets in hard currency. Such a balance sheet is difficult, if not impossible, to reach and even if it existed there would be financial difficulties in an inflationary economy (e.g. the impossibility of obtaining new loans in local currency or to renew the already existing, increase in cost of loans; increase in the cost of depreciation, etc.)

12. The different types of investments (soft or hard loans; convertible loans, purchase of shares, etc.) obviously changes with respect to the degree of the investor's exposure in regard to "monetary losses". However, even the lender in hard currency cannot afford to ignore the problems of exposure. The loan that he makes affects the "monetary exposure", the profitability and the ability to amortize debts in case of devaluation in regard to the company in which the investment has been made. For that reason all the alternatives should be carefully considered and all the possible solutions should be taken into consideration before making a commitment for the investment, including swaps, guarantees for the loans in local currency, contracts for sales' installments (future) of currency and loans in soft currency.

13. Following are a few important points that deserve special attention:

14. Cash in local currency should be maintained at a minimum in accordance with the normal daily operation of the business. The surplus in cash, if it is a temporary one, could be held in hard currency or used to pay debts in hard currency if the cash flow allows it. This should be considered in regard to the necessity of maintaining compensatory balances

in the banks that grant the necessary facilities in local currency and also with other administrative considerations in regard to the handling of cash.

15. The receivables in local currency should be maintained at a minimum. This is one of the more complex problems during the inflationary periods when the pressure on the sellers increase for extension of credit terms. A rational administration of credit and collections is essential. Sometimes it is less expensive to grant special discounts as an incentive for the immediate payment than to absorb the monetary risk of maintaining a considerable number of receivables. It is possible to help some of the main debtors, including with facilities in regard to guarantees for them to obtain special credit facilities from the banks that allow them to make immediate payments. Efforts, in order to sell hard currency, should be developed at maximum. For that purpose tools, such as offering supply contracts in long terms and at stabilized prices or granting special discounts for payment in cash, should not be forgotten. However, sales in hard currency in itself do not preclude the possibility of "monetary losses" because other local assets may be depreciated in function of real terms, setting aside the receivables. It would not be unusual that monetary control is imposed at the time of devaluation in order to obtain that the currency that constitutes an income for export could be sold to the reserve banks at a less favorable rate of exchange.

16. There are different opinions in regard to the handling of the inventories. There is some justification for the assumption that prices tend to increase after devaluation and that for that reason the value of the inventory increases in local currency. In other words that it maintains its

real value. However, this is not an absolute assumption nor completely exact.

- First, the government may prohibit the increase of its prices as part of its monetary action.
- Second, the competitive pressures may be so strong that the increase in prices to cover the devaluation completely may be commercially impossible.
- Third, in the best of cases the merchandise should be sold and make the collection of same before the monetary loss could be considered as recuperated. Thus, the recuperation of the loss is considerably delayed in relation to the devaluation and tends to be forgotten as time passes by.
- Fourth, the policy of fixed prices should be of such nature that permits the increasing readjustment during the inflationary period that invariably precedes the devaluations. After the devaluation it would be impossible to make an increase in prices. If management has not done so within the limits that the competitive pressure establishes it will not have done its job.

Thus it could be assumed conservatively that although the inventories are exposed to "monetary losses" part of them could be recovered.

17. In general it is considered that fixed assets maintain their value in real terms (except, of course, the depreciation). If the accounting is kept only in local currency a tendency could exist to depreciate the fixed assets on the base of its original value in local currency. This is not realistic and should be avoided. A majority of the companies with international experience depreciates its fixed assets on the basis of their original value in hard currency although the tax laws of the country do not accept such

depreciation. The policy to follow to obtain a formal revaluation in the fixed assets in local currency depends on the laws, the taxes and the practices of the country. However, the financial management of the company should readjust periodically the equivalents in local currency, at least in the form of contra accounts.

18. The payables in local currency should be maintained at maximum because frequently they are the less expensive and sometimes the only available source of funds in local currency. The offering of contracts that guarantee to take minimum production quotas, prices and other incentives are some of the methods that may be used to obtain that purpose. Obviously the cost of this operation with that of the other available sources should be compared.

19. In highly inflationary economies the loans in local currency from banks or other sources of financing may constitute a constant worry. Probably they will be very difficult to obtain and if obtainable they will be very costly and unusually could be used for medium- and long-term. It is essential that managgent gives special attention to this sector in order to guarantee the availability of cash and maintaining liquidity.

The relationships with the banks must be carefully cultivated by competent personnel. New ideas and ingenious incentives should be continuously created to obtain that financial institutions do what appears impossible. Probably it will cover all the field of financial management because it comprises the placing of cash in local currency; canalization of remittances; collections and letters of credit; investmen's; special commissions; structure of debts and payment of same; relationships with foreign banks that have special contracts in the region, etc.

Alternatives such as swaps or loans in hard currency should be explored by means of contracts of future sales to obtain loans in local currency. The local insurance companies should be explored with the incentive of giving them the insurance. The costs should be considered in regard to the monetary risk, etc. It would be impossible in this memorandum to discuss in detail all the important factors that occur in the administration of local credits. However, this is a field that deserves special attention.

20. Justification of obligations in hard currency to the suppliers and creditors that contribute to the "exposure" should be examined with a critical view. The possibility of reducing the riks with measures such as contracts for buying currency on future should be considered; substitution for local sources of financing; creation of special reserve funds for exchange fluctuation; etc.

21. The total structure of debts deserves special attention. During the difficult periods local sources of financing could be exhausted and it is probable that the investors are not in favor to commit additional funds in hard currency due to the devaluation risk. Serious liquidity problems may result then. Financial planing include to be prepared, during stable periods, to face this eventuality by obtaning loan commitments by the sources of credit (at a certain price, of course); reserve funds in hard currency; commitments from the suppliers to extend the terms of the purchasers; agreements to make loans at long terms, etc.

22. To the degree that a decision has been made to find foreign investors their profits should be remitted abroad as rapidly as possible if they are not necessary for business expansion. To delay dividend payments by ways of purchase on future of hard currency should be considered. In order to protect dividends against erosion in case that monetary restrictions are imposed alternative investment possibilities for dividends should be developed. Profits in

local currency are not important and should be evaluated in its relationship with hard currency after charging the losses suffered as a consequence of the currency fluctuations. The general yield of an investment is represented by the increase in hard currency equivalent to the net value of the company plus dividends.

23. The business that depends mostly on imported raw materials should plan for the eventual imposition of import restrictions. It is usual that such restrictions scarcely be applied to such import commitments to which a letter of credit has been issued before the restrictions were imposed. Then, the convenience of having a continuous availability of supplies by this method should be considered, at least during the period needed to develop any other alternative source.

24. The quality of the financial management of a company in its most ample concept is of maximum importance. A company in which local financial institutions participate as investors could face better the difficulties that occur in an economic climate than one that does not enjoy this advantage. The board of directors should include people with strong vinculation and influence in the local financial community. The financial executives should have ample experience in solving the problems that have to be faced in operations within the unstable economic climates in Latin America. If a permanent staff that fulfills the above mentioned requisites is not available it would be necessary to appeal to consultants that have the necessary qualifications. What is acceptable is not good enough.

ANNEX I

MONETARY EXPOSITION AND ANALYSIS
(December 31, 1964)

COMPANY XYZ IN THE REPUBLIC OF [illegible]

	Balance in 1000 of $	Conversion losses Exposure	Exchange losses Exposure
Cash in local currency	10	10	
Cash in hard currency	5		5
Receivables in local currency	400	400	
Receivables in hard currency	20		20
Inventory[1]	300	300	
Net fixed assets after depreciation	500		500
Other assets in local currency	10	10	
Other assets in hard currency	2		2
Totals	1,247	720	527
Debts to banks in local currency	100	100	
Debts to banks in hard currency	400		400
Payables in local currency	50	50	
Payables in hard currency	200		200
Long-term debts in local currency	-		
Long term debts in hard currency	100		100
Long position local currency	2	2	
Long position hard currency	20		20
Totals	872	152	720
Total conversion exposure losses[2]		568	
Total exchange exposure losses[3]			193
Net worth	375		
Totals	1,247		

1/ It is assumed that 100% of the inventory is exposed. In certain cases these assumptions may be very conservative.

2/ In case that the peso, national currency of the Republic of W.W is devaluated with respect to the present exchange ratio from 170 pesos per dollar to 210, the net worth of the dollars of the company would be reduced by a conversion loss of US$100,000.

3/ The company XYZ also would suffer an exchange loss of 7,720,000 pesos in local currency. This loss does not increase the conversion loss, it is contained within. It is significat however on the point of view of the local accounting, liquidity and financial management, and could become significant in regard to taxation.

$\frac{170}{210} = \frac{x}{5.68}$

568
17
39 76
568
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84
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126
56
568
460
108

P.S - Appraisal & Cost of Proj.
x Consult - gen

Mr. Warren C. Baum,
Mr. A. F. Geolot, Mr. Peter Engelmann

May 10, 1967

William L. Elsby

PROJECT CONTROL

1. This memorandum is concerned with avoiding the large avoidable increases in engineering cost and the delays which arise on projects between the time that detailed engineering is authorized and the completion of construction.

2. I have examined several projects comprising mainly heavy civil and mechanical engineering works ranging in value between $ 3,000,000 and $ 60,000,000 and estimate the avoidable losses arising during design and construction at between 10% and 50% of the tendered contract price.

3. A general average of the avoidable loss in projects involving mainly civil engineering construction is of the order of 20%. The most unfortunate aspect of this loss is not so much the longer term effects of servicing the capital, as the depletion of funds available for immediate use in development.

4. The losses are mainly due to inadequacies and faults in:

DESIGN PERIOD

(a) definition in detail of the operational requirements of the project. This results in later changes of design - usually on a large scale - which disrupt the contractor's construction procedures. In transportation, port design is probably the most susceptible to this fault because of the number of parties involved in the design;

(b) engineering detailing of the contract documents with resultant later disruption of the construction procedures;

(c) site investigation before design; and

(d) programming and processing the work necessary to identify and detail the facilities required, to obtain legal and financial clearances, to carry out site investigation, to prepare engineering details and to let the contract.

CONSTRUCTION PERIOD

(a) programming of work preparation and execution;

(b) preparing the form of a periodical Financial Review of the Contract Price;

(c) checking of outstanding and anticipated claims for increased payment or extension of time;

(d) the analytical examination of progress against the program and actual costs (including claims) against the original priced Bills of Quantities;

(e) developing in the Consultants' and the Contractor's site representatives the will and skill to eradicate delay and additional cost; and

(f) checking the safety of permanent and temporary works as the work proceeds.

5. It is often argued that these functions are the responsibility of the Consultants and the Contractor and should be left to them. This is not a profitable policy because it does not work, the reason being that self-interest is a major consideration and self-interest does not prompt Consultants and Contractors to regard the objectives of these functions as paramount. The method outlined in the attached Appendix is therefore suggested as a first draft of a method of control which could be prescribed by the Bank for projects during the construction period. I have omitted suggesting methods of control during the design period for the sake of brevity and clarity; these could be considered separately.

6. I believe that a similar method of control could be devised for transportation studies.

7. It will be noted that the control does not ensure that trouble will not arise on any particular project. What it does ensure is that defects in the quality of supervision will be detected and can be remedied and that, in an aggregate of projects, the aggregate of troubles will be minimal.

WLKlsby:vbm
IBRD

Attachment

Conditions to be observed by Consultants appointed as Engineer on a Civil Engineering Contract subject to Bank Financing

1. These Conditions are intended to:

(a) avoid unnecessary delays and increases in cost; and

(b) signal at as early a date as is possible the onset of additions in cost and delays in construction.

"Engineer" means the Consultants' home office, "resident-engineer" means the Engineer's site representative.

RESIDENT ENGINEER

2. The Consultants will provide the Client and the Bank with the curriculum vitae of their proposed resident engineer and will offer the Bank the opportunity of discussing the contract and its supervision with a Partner of the Consultants and the proposed resident engineer, either in the Consultants' home office or the Bank in Washington as may be agreed.

3. The offer of appointment to the proposed resident engineer will be subject to the Client's and the Bank's approval.

4. Upon approval of the offer of appointment to the proposed resident engineer and before the offer is made, he will be shown:

(a) the contract documents;

(b) a schedule of contract details still to be prepared for works not fully detailed in the contract documents;

(c) the unsuccessful tenderers' prices; and

(d) these Conditions.

5. The information described in paragraph 4 will be discussed between the Consultants' Partner in charge of the contract and the proposed resident

engineer and the offer of appointment will be made and accepted on the understanding that excuses or explanations for engineering inadequacy of the works, late completion, or excessive cost, however well founded they may appear, have no monetary value and are therefore useless to the Client.

It is expected that the Consultants will propose a resident engineer whose qualifications, knowledge, experience and salary will be in keeping with this Condition.

6. Subsequent to this discussion the Consultants will make their decision whether or not to offer the appointment to the proposed resident engineer.

7. Upon the resident engineer's acceptance of the appointment, the Consultants will inform the Client and the Bank, stating the salary (including fringe benefits) of the appointment.

CONTRACT DETAILS

8. A master copy of the contract details will be maintained in the resident engineer's office. This will comprise:

(a) the original contract document;

(b) variation orders serially numbered, or their equivalent;

(c) provisional sum and P.C. sum orders serially numbered, or their equivalent;

(d) manufacturers' drawings and specifications;

(e) temporary works details; and

(f) any other detail in the form of drawings or in any other form.

These documents will be maintained so as to form a convenient reference to the work to be executed and payment to be made in interim certificates.

9. All instructions from the Consultants to the Contractor will be copied to the resident engineer.

PROGRAM

10. The resident engineer will collaborate with the Contractor's site manager in the preparation of a detailed program of construction, either in network or bar chart form. The program will include details of the methods of construction and plant to be utilised.

The resident engineer will add to the program the time schedules for:

(a) preparing contract details for provisional sum and P.C. sum works and variations, or their equivalents;

(b) preparing any other details in the form of drawings or in any other form; and

(c) taking any other action required of the Client or the Consultants to facilitate execution of the works (e.g., financial, legal or administrative clearances).

PROGRESS

11. During the course of the contract the resident engineer will maintain progress by:

(a) detailed examination with the Contractor's site manager of progress plotted against the program and the causes for deviations;

(b) obtaining close knowledge of the Contractor's works management directly controlling execution, and their opinions;

(c) frankness with the Contractor, understanding of his problems of organizing and executing at a competitive price, and extending every possible assistance of any kind consistent with the contract;

(d) keeping to the dates for carrying out action required of him and doing all in his power to clear action required of the Client and the Consultants in accordance with the program;

(e) utilising network analysis and/or method study as and when their use would be of advantage; and

(f) strongly resisting the desire to offer the cold comfort of an excuse for delay, as an alternative to prevention or remedy.

12. The resident engineer will recommend to the Consultants the application of the stronger provisions of the contract (Clause 46 of the Conditions of Contract (International) or its equivalent) before it is too late to retrieve the time lost, but only after he has been able to establish with the Consultants the cause of and remedy for delay.

COST

13. The Engineer and the resident engineer will maintain on site a register of outstanding claims from the Contractor for additional payment or extension of time.

At three-monthly intervals of time the Engineer or the resident engineer will request the Contractor to give notice of any claim not on record and will confirm in writing with the Contractor the latter's reply to the request.

14. The Engineer and the resident engineer will prepare a Financial Review of the Contract price at intervals of time to be decided by the Consultants after consultation with the Bank and the Client. The Financial Review will include:

(a) the original Contract price;

(b) adjustments arising due to measured quantities differing from the billed quantities;

(c) increases or decreases arising due to variations;

(d) adjustments to the sums entered in the bill of quantities against provisional sum and P.C. sum items or their equivalents;

(e) increases or decreases arising from escalation clauses;

(f) estimated costs of anticipated future variations;

(g) a list of claims considered valid by the Contractor; and

(h) a list of future claims anticipated by the Engineer and the resident engineer.

Where the prices entered in the Financial Review have not been agreed with the Contractor, both the Consultants' and the Contractor's estimate of cost will be given or stated as not available.

SAFETY OF PERMANENT AND TEMPORARY WORKS

15. The Engineer and the resident engineer will:

(a) check and record the line and level of permanent and temporary works at regular and reasonable intervals of time during and, for as long as is necessary, after construction;

(b) check and record at regular and reasonable intervals of time that no alterations to permanent works have been made excepting as ordered or agreed in writing by the Engineer or resident engineer;

(c) check and record in writing at regular and reasonable intervals of time that no alterations have been made to temporary works which have been approved by the Consultants in accordance with the Contract;

(d) check at reasonable intervals of time normally unseen effects (e.g., soundings for erosion or accretion);

(e) consider in particular hydraulic and soils conditions as the work proceeds. The resident engineer will record in writing his opinion on the status of these conditions and any recommendations he may have for any program of investigation or testing of them; and

(f) arrange special programs for testing and inspection of welding, piling or other operations having a direct bearing on safety.

ROUTINE SUPERVISION

16. The resident engineer will provide check lists or programs for:

(a) inspection and testing not covered by paragraph 15 (f);

(b) the submission by his staff of certificates of inspection before covered works, or covered site conditions are built in;

(c) setting out routines; and

(d) methods and dates of recording information, reporting, photographing, and obtaining and making routine returns.

GENERAL

17. The Engineer and resident engineer will organize the site staff to enable local site engineers to be trained in Consultants' site supervision by partaking in the whole of a resident engineer's functions other than that of giving instructions to the Contractor.

18. The Engineer and/or the resident engineer will make all documents referred to in these Conditions available to the Bank's representatives during their visits to the site and will discuss the implications of the documents with the Bank's representatives.

Mr. Patrick M. Reid May 3, 1967

B. Chadenet B. Chadenet

Projects Department Documents

Further to our telephone conversation on Monday, I am sending you the following documents concerning the preparation and appraisal of projects:

Agriculture

Project Preparation
Beef Cattle Projects
Credit Mechanism

Education

Criteria for Bank/IDA Financing of Education and Training Projects
Brief Guide to Preparation of Education Projects for Presentation to IBRD/IDA

Power

Summary of Information Needed for Power Project Appraisals

Telecommunication

Summary of Information Needed for Telecommunication Project Appraisals

Water Works

Questionnaire for Water Works Projects

Transportation

Highways
Railways
Ports

BC:emcc

Studies - Power Tariffs
✓ cc P. + P. Project Appraisals
Co-operation between
Depts.

Mr. Irving Friedman

May 1, 1967

S. Aldewereld (signed) S. Aldewereld

Research on Power Tariffs

I understand that the Economics Department has plans for research into power tariffs and that the broad idea at present is to try to determine whether the tariffs which our borrowers set are so structured as to result in a reasonably efficient use of capital resources. As you know, the Bank/IDA have not hitherto made any detailed review of tariffs during project appraisals. The practice of the Public Utilities Division has been to draw to the attention of our borrowers any deficiencies our appraisal teams noted in their tariffs and to recommend or, in some cases, to require that they retain consultants to review them. The reason for this approach is that the designing of a proper tariff is a highly specialized and time consuming task and we have always considered that where there were problems specialists should be brought in to handle them.

On the other hand it has always been my position that we should welcome any research by the Economics Department which would enable us to improve the quality of our appraisals. I hope therefore that the Economics and Projects Departments will be able to determine jointly whether any work, which contributes directly to the efficiency of operations, can be satisfactorily done within the Bank.

I stress that this is a matter on which there should be close collaboration between the two Departments since I am disturbed to find that some work has already been done in the Economics Department without the knowledge of anyone in the Projects Department. I would hope that work with such a direct bearing on our operations would not be started before the Economics Department had consulted with the Projects Department.

cc: Messrs. Williams
Kamarck
Chadenet
Knox

ADKnox:mv:mc

P&P - Appraisal + Cost of Proj

Mr. Shlomo Reutlinger April 26, 1967

Bernard Oury

Comments on "Techniques for Project Appraisal under Uncertainty"

You have invited my comments on your draft above referred to. Although such difficult a subject would require a more thorough examination, I could only glance through the text and I can offer the following comments:

General Comments

1. From a general viewpoint this paper is interesting and you have couched in simple terms a very difficult problem, narrowing the topic to mean calculation and variance analysis. The paper may give the impression of a good summary of elementary statistical techniques, although this may not necessarily be detrimental. The addition of a few concrete cases in the major fields of Bank activity could have helped to give a more pragmatic orientation to the study (power, transportation, agriculture, ...).

2. Investment decisions under uncertainty have been the object of a large amount of work with the blossoming of many operations research centers in recent years. Equally important has been the development of corresponding computerized techniques and simulation programs. In this regard, it would give a more "operational" character to the paper if a section could be devoted to the description of existing tools in such cooperative-program-user libraries, as those of IBM and CDC for various types of computers.

3. It would have helped considerably if this first draft of the study had been accompanied by a bibliography of the sources used or books recommended by the author to supplement this introductory paper. Several new publications might be useful, such as William Fellner's Probability and Profit, R.D. Irwin, Inc., Homewood, Illinois, 1965 and D.M. Lamberton, The Theory of Profit, Basil Blackwell, Oxford 1965. Reference should be made also to the work of Frank H. Knight, Risk, Uncertainty and Profit, Houghton Mifflin C., 1921, which remains a most outstanding and fecund analysis in the field. I might also mention the article of J.N. Ryan and A.O Garder, "The Measurement of Dynamic Risk", in the Southern Economic Journal, Vol. 31, No. 3, January 1965.

4. Last but not least, we should be aware that the use and abuse of probability theory to deal with uncertainty in economics has come periodically under attack and that the controversy is open more than ever.

5. From an organizational viewpoint, Chapter IV should perhaps precede Chapter III and I have mixed feelings about the section going from page 13 through 21 inclusive.

6. Regarding the utility concept (p. 78), it is true that the individual's utility function provides a classical example. However, Bank lending operations are aimed at social utility rather than individual utility. The discussion of the social utility function should perhaps enter the picture. Though most interesting is the Swalm's study (p. 82) of US executives, a proper illustration? What would be for instance the utility function of Latin American executives? Similarly, the grain storage example (p. 89) seems to me typical of grain exporting countries rather than of grain importing countries.

Specific Comments

Page 5, para 1: I would prefer "... increase in lending for various kinds of agricultural projects" to "...agricultural and particular kinds of agricultural projects".

Page 5, para 2: Delete "comprehensive reviews are available elsewhere". Give instead a bibliography of a few basic reference books to supplement this introductory review.

Page 6, footnote 1 : Are prices non-controllable?

Page 23, para. 3 : The probability calculus is much older than the "new" mathematics which is primarily a "new" method of presenting mathematical concepts.

Page 25, para. 5 : In agriculture the additional output of a commodity is the product of the number of additional producing units and the additional output per unit.

Page 26, para. 6 : Equations (4) ?? explain symbols.

Page 42 : Equation 20; why minus sign? It should be plus or minus or theoretically plus sign, with the possibility that the estimate of a might yield a minus sign.

Page 62, para. 57 : Are additional yields likely to be "timeless"?

Page 75, para. 44 : "Probability" or "estimate" of 20% to 25%?

cc: Mr. H.G. van der Tak

BO:jln

Mr. S. J. G. Burt April 14, 1967

Cornelis P. van Dijk

Uncertainty and the Economic Rate of Return of a Project

1. Mr. Agnew's proposal to attach probability coefficients to all factors determining the Bank's rate of return calculations has much wider applicability; it can be applied to all our judgments and has the advantage of making it clear that these judgments are in fact nothing more than a choice out of a number of alternative possibilities, based on assumptions which are by no means certainties.

2. Previous studies and discussions have made it clear that our present knowledge of the economic benefits of investments in education is such that the application of rate-of-return calculations to education projects cannot be expected to lead to results which are sufficiently reliable to guide the Bank in its investment policy. Since Mr. Agnew's proposal has a wider significance than the field of cost-benefit analysis, however, it will be worthwhile to raise a few questions as to its general relevance.

3. The theory underlying Mr. Agnew's proposal is formally correct but seems to add another uncertainty to the range of uncertainties we have already: the uncertainty of correctly judging the probability coefficients (or distribution) which should be attached to the various possible outcomes of the different factors. If we are not in a position to judge the probability distribution correctly, it is difficult to see how the application of Mr. Agnew's proposal can add anything to our knowledge.

4. The theory of probability is built on the relative frequency idea, in which the frequency with which reproducible events occur give us a guide to their happening again in the future (e.g. the tossing of a coin or rolling of dice). Here the probability distribution is simple and not open to reasonable doubts. In the reality of economic analysis we are often dealing with factors which are unique (happening in a new situation or reaching values never attained before), non-reproducible and sometimes ambiguous. Here the probability that an event will occur or not occur (with all the shades of grey between these two extremes) is much more difficult to assess, even if we had a great deal of statistical information or the judgments of many specialists. In a great many cases we would simply have to put our hunches in. Here the basis of our judgment of the probability distribution itself is open to reasonable doubt.

5. The logical thing to do would be to add another dimension to the exercise: to calculate the probability that our judgement of the probability distribution is correct. Suppose we had based our judgment about the probability that event X will occur on the opinion of 100 specialists; we now ask what the probability is that the opinion of these specialists is

correct and measure e.g. the number of times they failed to predict correctly in the past etc. etc. The process can be extended ad infinitum of course, and all the way the statistical probability that our final outcome is correct would decrease, our feeling of uncertainty would increase, without leading us to better judgments, with higher probabilities. Our best judgment would still be the best we have, we only feel less sure about it.

6. The question may be raised whether this exercise can add anything to our knowledge or can improve our judgments. If the purpose of Mr. Agnew's proposal is to bring into the open the many uncertainties surrounding our judgments, would it not be sufficient to state clearly on which assumptions these judgments rest, without attaching to these assumptions numerical values which are equally uncertain and of dubious value.

CPvanDijk:rg

cc: F. Lethem

Operational Files

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

OFFICE MEMORANDUM

TO: Mr. Warren C. Baum DATE: April 12, 1967

FROM: Hans A. Adler H.A.A.

SUBJECT: Comments on J. G. Agnew's Memorandum on Handling Uncertainty in Project Appraisal

1. Mr. Agnew's memorandum of March 13, 1967, on "Uncertainty and the Economic Rate of Return on a Project" raises an important and interesting issue. Because our actual procedure in appraising transport projects is somewhat different from that described in the memorandum, it may be useful to outline it. The major difference is that we generally do not make the most probable estimate of costs and benefits but a more conservative one to allow for risk so that our estimate can be compared with the opportunity cost of capital, which is also more-or-less riskless.

2. The most important estimates in the appraisal of transport projects are the costs of the project, the unit benefits, and the traffic. The element of uncertainty is now handled as follows for these three items:

a) In the case of traffic, we do not use the most probable estimate, but a more conservative figure, - one which we regard as almost certain and from which most of the risk has been eliminated. Where the uncertainty is great, we present alternative estimates. We have not made a systematic review of how our traffic forecasts have turned out in practice but a sample review indicates that our underestimates substantially exceed overestimates, especially for roads.

b) As for costs, three distinctions should be made. First, for construction costs of roads, our method was changed in 1964 when we began to insist on final engineering being more-or-less completed; the same is true for land acquisition in countries where this presents a problem. As a result, while our construction cost estimates before 1964 did not allow adequately for risk, they now generally do. In the case of ports, our estimates have aimed at the most probable cost; we have not reviewed in detail, however, how actual costs have compared with estimates. There have been only few railway construction projects. Second, for equipment, we also allow for risk (through contingencies) so that most final costs have been less than estimated. For many types of equipment, firm international prices are readily ascertainable so that the margin of error is relatively small. Finally, it must be kept in mind that the correctness of our cost estimates, in allowing for risk, cannot be measured by merely comparing final and estimated costs; to the extent that final costs are higher because of general price increases, it can also be assumed that

benefits would be higher. On balance, it would seem therefore that our cost estimates make allowance for risk.

c) The probability of error for estimating unit benefits varies with the type of benefit. Lower transport costs from paving a gravel road, reducing distances of travel or replacing steam engines with diesels can be measured quite precisely and the range of probable error is small; many of our projects are fortunately of this type. On the other hand, where we attempt to measure the net value of additional agricultural output, the risk is substantial. We have tried to handle it by making conservative assumptions and sometimes by indicating a range.

3. Unless others outside the Bank have already calculated the probability of error in the types of estimates which we make, the most meaningful way of making such a calculation would presumably be to review our past projects and to develop from them the necessary probabilities. This would be useful only to the extent that we follow in the future the same methods we did in the past; as indicated above, our method for estimating road construction costs was changed in 1964 and our methods for estimating agricultural benefits are also evolving.

4. The overall importance of the issue should also be kept in mind. In a project showing a rate of return of 16 per cent, an error of 10 per cent in either traffic, unit benefits or costs (other than from general price changes) would change the return by one percentage point; in the quite extreme case that both unit benefits and traffic were overestimated by 10 per cent while construction costs were underestimated by 10 per cent, the rate of return would be reduced to 11-12 per cent. This would indicate that a more precise evaluation of risk would be important only for relatively marginal projects.

5. My general conclusion is that the most promising approach to the problem of risk in project appraisal is to continue to review our past projects, as in the case of the Iran roads, the Honduras Western Road, and the Salvador feeder road study now planned by the Economics Department. These will give greater insight into the problems of estimating costs and benefits, including the reasons for errors. After a number of them have been completed, it would be useful to review whether a consistent pattern of error can be determined.

HAAdler:ncp
Bank

Cleared with and cc: Messrs. Carmichael, Hardy, Loven

cc: Messrs. Chadenet, Ripman, Bell, Lipkowitz, Agnew
Messrs. Sadove, van der Tak
All Transport Economists

Op. Files

File

Mr. S.J.G. Burt

April 3, 1967

F

F. Letham

Uncertainty and the Economic Rate of Return on a Project

1. Mr. Agnew's paper appropriately reviews the meaning of the rate of return as computed by the Bank, that is, aggregate estimated costs and benefits of a project are calculated for each year of the project's life and lead to the computation of the internal rate of return.

2. This method does not take account of the varying degrees of uncertainty to which the estimates may be subject. However, to improve on the present practice one should be in a position to estimate the probability distributions of the various factors. In the case of computing a rate of return for education, it would imply estimating the probabilities of costs including foregone incomes by students and the probabilities of benefits (income differentials).

3. It does not seem logical that the computation of probabilities would add some measure of increased likeliness in the results of the rate of return to education. This would only be the case when major objections to the approach will be solved. (See C.P. van Dijk: Comments on Mr. Blaug's Paper).

cc: Mr. van Dijk

FLethem/afw

P+P

Messrs. Ballantine, Baum, Evans and Knox March 20, 1967

B. Chadenet B. Chadenet

Uncertainty and the Economic Rate
of Return of a Project

not attached

Mr. Agnew, whom I asked to review the material which I had been given last year at Harvard about the effect of risks on investments, has written the attached paper, which concentrates on the effect of uncertainties on the economic rate of return of projects.

I am sending you this paper as a "thought provoker." I believe that as our experience accumulates, as more data about our projects is made available, as we become more familiar with quantitative techniques and when a computer is available, we will refine our determinations of the rates of return of our projects.

Attachment

BChadenet:jfe

c.c. Mr. Bell
Mr. Kamarck

FORM NO. 75
(2-60)

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

INTERNATIONAL FINANCE CORPORATION

INTERNATIONAL DEVELOPMENT ASSOCIATION

ROUTING SLIP

Date 2/22/67

NAME	ROOM NO.
Mr. Baum OK 2/23. ucs 2/23	
Mr. Aldrich	

	To Handle		Note and File
	Appropriate Disposition		Note and Return
	Approval		Prepare Reply
	Comment		Per Our Conversation
	Full Report		Recommendation
	Information		Signature
	Initial		Send On

REMARKS

From SCH

OFFICE MEMORANDUM

TO: Messrs. C. Hardy/Warren C. Baum DATE: February 7, 1967

FROM: V. W. Hogg

SUBJECT: Underestimates of Construction Costs

1. We are concerned about this for various and obvious reasons. There is a general suspicion of continued over-optimism relating to prospective costs (and benefits) in much of our operations that history tends to confirm - quite aside from conceptual errors which double-count or otherwise inflate the optimistic estimates of benefits.

2. This perennial overoptimism is not necessarily or always a sign of incompetence or dishonesty. In an interesting paper two French statisticians, apparently, have studied this phenomenon: 1/

> R. Giguet and G. Morlat, "The Causes of Systematic Error in the Cost Estimates of Public Works", Annales des ponts et chaussees, No. 5 (Sept-Oct, 1952), pp. 543-62 (translated by The Rand Corporation T-76, March 24, 1958).

3. It seems they provide 2 major explanations:-

(1) Cost estimates are usually based on the most probable value of an uncertain outcome, but the mean value of the probability distribution exceeds the most probable value. The reason is that there are a large number of independent possibilities of things "going wrong", and, while each may have a low probability, some of them are bound to occur.

(2) Because an accidental underestimate increases the likelihood of a project's being adopted, there tends to be a selection bias towards over-optimism.

4. Do you agree we ask Research Files to request a copy of the Rand translation for possible circulation among our highway engineers?

1/ Source of information, Water Supply; Hirshleifer, de Haven and Millman, University of Chicago Press (1960), p. 165.

VWHogg:gh
Bank

I have no objection - but why focus on the Highway Section? - our record of estimating costs with reasonable accuracy has been good over the past one or two years, & is improving!

Projects + Studies

Form No. 57 | INTERNATIONAL DEVELOPMENT ASSOCIATION | INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT | INTERNATIONAL FINANCE CORPORATION

Appraisal of Projects

OFFICE MEMORANDUM

TO: Files

DATE: January 26, 1967

FROM: H. B. Ripman HBR

SUBJECT: Enquiry from Mr. Thor

Mr. Thor telephoned me yesterday to enquire whether the Bank would consider financing an agreement with a consulting firm in a Scandanavian country which had been entered into with the government of a member country (for example in Africa) for which the African country could not now afford to pay. I told Mr. Thor that this case had not arisen in our experience and that we would consider it on its merits if it did arise. I added that of course we only financed such studies when they were likely to lead to a project that appeared promising from the point of view of Bank/IDA financing.

c.c.--Mr. Williams

HBRipman:pgn

5 - Proj. Appraisal

Mr. Cyril Davies

August 30, 1966

H. B. Ripman
(signed) H. B. Ripman

Amendments to O.M. 5.01 - Project Appraisal

I attach a suggested amendment to para. 4 of this O.M. which would mention the responsibility of IFC for Project Appraisal.

I have taken the opportunity to suggest some minor amendments in other paras., and attach a list of suggested amendments.

c.c.--Mr. Chadenet

HBRipman:pgn

Suggested amendments to O.M. 5.01
Project Appraisal

4. Project appraisal is the responsibility of the Projects Department, *except for industrial, mining and development finance company projects, for which I.F.C. is responsible.*

11. (last words)

to show what proportion of the total *is likely to be* local currency and what foreign currency.

15. (last sentence)

Income and expenditure accounts must be forecast through the period covered by the financing plan, and a cash flow must be *constructed* to make sure that the necessary funds will be available when needed. *The assumptions on which these forecasts are based need careful consideration, and should be specified in the appraisal report.*

18. (third sentence)

A "take or pay" contract is one where the buyer undertakes to pay a *minimum* amount during a period for a given quantity of a product *or service* .....

20. Delete "(e.g. an hotel)" from the third sentence.

Project Appraisal

May 23, 1966

Mr. D. S. Thornton
University of Reading
Department of Agricultural Economics
7 Redlands Road,
Reading
ENGLAND

Dear Sir:

Thank you for your letter of May 17, 1966. I am happy to send you, under separate cover, a copy of the four documents on problems of project appraisal that you asked for.

Yours sincerely,

H. G. van der Tak
Economics Department

HHGvdT:amc

Projects appraisal

COPY

ECONOMIC DEVELOPMENT INSTITUTE

OF THE

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

1818 H STREET, N.W., WASHINGTON, D. C. 20433

TELEPHONE: — EXECUTIVE 3-6360

CABLE ADDRESS: EDI INTBAFRAD

May 10, 1966

Mr. Arthur Karasz
Director, European Office
International Bank for Reconstruction
and Development
4 Avenue d'Iena
Paris, France (16e)

Dear Arthur:

Mike Hoffman has asked me to take care of your inquiry of May 2 regarding some "instructions" for project appraisal which Mr. Beringer wanted. Please find enclosed a batch of material which we have used in the various courses of the EDI. The "memoranda" drafted by a "major international financial institution" are disguised operational memoranda of the Bank. The other papers are outlines which we have used in the Agricultural Course. There is nothing secret about anyone of the papers, but they should not be considered official IBRD documents. I hope that the papers will be of some use to Mr. Beringer.

As you probably know, I hope to be in Paris next week to attend a meeting of the Advisory Committee of the OECD Development Centre and shall probably pay you a visit on May 18.

With kindest personal regards,

Sincerely yours,

John H. Adler
Director

Enclosures

JHA/mwm

cc: Mr. Hoffman

FORM NO. 57 | INTERNATIONAL DEVELOPMENT ASSOCIATION | INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT | INTERNATIONAL FINANCE CORPORATION

OFFICE MEMORANDUM

TO: Mr. Michael L. Hoffman DATE: May 3, 1966

FROM: John H. Adler

SUBJECT: Project Appraisal

I refer to your memorandum of April 25, particularly the last paragraph. But before I get to that, let me say that your memorandum, and indirectly the report on Malaysia, really deals with the broad quest of project versus program loans. At the risk of being considered old-fashioned my sympathies are still heavily on the project side, although I would define the term in a very liberal way. (For instance, I can conceive of the loans to India to finance imported inputs for industry as a fine "project." I also would use the project label to a road improvement scheme which consists of a large number of small bits and pieces along various roads.) I think that the paper on Malaysia reflects too much the annoyance of Peter Cargill with the preoccupations of the Projects Department.

Now as to the concern of the EDI with project evaluation techniques, I think your impression of what we can possibly accomplish here is somewhat exaggerated. In the General Course which, as you know, has participants mostly from Ministries of Finance we can do little more than show them the essential elements of project evaluation techniques and try to convince them that there is an economic dimension to the project selection which they should not overlook. In the Projects courses we address ourselves not to Ministries of Finance, but largely to officials of other Ministries and of development banks. There it would be a serious mistake to pooh-pooh project evaluation techniques. But we do not sell them the idea that the most elaborate techniques of project evaluation are essential to their work. To be sure, we teach them something about discounted cash flows, cost benefit ratios, the critical path method and even about shadow prices. But the emphasis is on balance sheet, profit and loss statements, market studies, cost estimates, etc.---the kind of thing any "generalist" with some accounting, engineering, or even economic background can understand and apply without difficulty.

One other relevant point: we are really not concerned with project evaluation techniques designed to satisfy the requirements of the Bank, or the IFC. Our concern with foreign financing is incidental. We are just as much interested in helping them to appraise and select projects from their countries' internal sources.

I also do not think your concern about our creating a new group of people in Ministries of Finance who become bottlenecks in the flow of projects from spending ministries to sources of domestic or foreign financing is warranted from another point of view. From an organizational point of view we follow the Waterston line which stresses the importance of project preparation and evaluation in the originating ministries or agencies of government.

Dr Adler

Can you help?

Gilhinger's NPA study

MICHAEL L. HOFFMAN

HEADQUARTERS:
WASHINGTON 25, D.C.

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
CABLE ADDRESS-INTBAFRAD

INTERNATIONAL DEVELOPMENT ASSOCIATION
CABLE ADDRESS-INDEVAS

EUROPEAN OFFICE:
4, AVENUE D'IÉNA
PARIS (16e) - FRANCE
TELEPHONE: KLEBER 25-10

May 2, 1966

Dear Mike,

Ch. Beringer is an O.E.C.D. Staff member who is often in close cooperation with us. In a letter to me dated April 27, he enquired whether "there exist recent I.B.R.D. papers containing instructions for project appraisal, particularly criteria and methods for project selection in the agricultural field."

Ch. Beringer would need the material, on a confidential basis, for a job he prepares for O.E.C.D. I would be very grateful for any assistance you could give me in this matter.

With kind regards.

Sincerely yours,

Arthur

Arthur Karasz

Mr. Michael L. Hoffman
Associate Director
Development Services Department
International Bank for Reconstruction
and Development
Washington, D.C. 20433

HEADQUARTERS:
WASHINGTON 25, D.C.

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
CABLE ADDRESS-INTBAFRAD

INTERNATIONAL DEVELOPMENT ASSOCIATION
CABLE ADDRESS-INDEVAS

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With kind regards.

Sincerely yours,

Arthur Karasz

Mr. Michael L. Hoffman
Associate Director
Development Services Department
International Bank for Reconstruction
and Development
Washington, D.C. 20433

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INTERNATIONAL BANK FOR

RECONSTRUCTION AND DEVELOPMENT

SOME THOUGHTS ON THE PROBLEMS PRESENTED BY PROJECT DESIGN AND SUPERVISION

M E T R A

35, Boulevard Brune - Paris

Tel.: 828-53-49

Paris, 7th February 1966

Ref. alphabet.

The present memorandum sets forth some thoughts on the problems facing I.B.R.D. in connection with project design and supervision,* and suggests a series of studies that would enable those problems to be solved.

The following plan has been adopted:

(1) Project design and supervision, the problems that it presents for I.B.R.D. and the types of study that may be considered.

(2) Analysis of the engineering consultants' services available.

(3) Study of the demand for the services of consulting engineers.

(4) Determination of an optimum figure for the cost of project design and supervision.

(5) Summary of results.

---

*T.N.: L'ENGINEERING in the original.

I - PROJECT DESIGN AND SUPERVISION, THE PROBLEMS THAT IT RAISES FOR I.B.R.D. AND THE TYPES OF STUDY THAT MAY BE CONSIDERED.

(1) Project design and supervision

In very general terms, project design and supervision may be defined as the entire range of works and services whereby:

- preparation is made for the decision to undertake a capital project;
- the technical features and cost of that project are decided upon; and
- assistance is provided in the matter of the choice of the firm that is to be entrusted with the carrying out of the work.

The persons or bodies performing the said works and services likewise:

- participate in the choice of the means, and of the planning method, to be adopted for the execution of the project, and
- assume responsibility for the inspection and supervision of the works.

Following this plan, we shall assume that, the decision to undertake the capital project having been taken, the scheme has been drawn up in broad outline. The engineering functions that we shall be considering are, then, the following:

- the carrying out of the final technical survey (for example, the topographic survey, as also the taking of soundings and the laboratory work required for that survey);
- the choice of contractor, and sometimes the choice of the technical equipment (in the case of an electric power-station), following upon a study of the technique to be employed and of the prices asked);
- the sanctioning of payment for work carried out, and the choice of the methods to be used;
- inspection and supervision of the work of constructing the project.

(2) The problems facing I.B.R.D. in the field of engineering consultants' services

Consultants' services are playing an increasingly important part in the carrying out of projects, this being due, on the one hand, to technical development, which makes it necessary for the assistance of specialists to be enlisted, and, on the other hand, to the varied nature of the techniques employed in one and the same project, thus requiring a satisfactory degree of co-ordination between the work of the specialists concerned.

Finally, the services of engineering consultants are also gaining in importance because of the fact that there is growing awareness of the fact that all forms of project preparation are thoroughly worth while. The proportion of the total cost of the works represented by engineering services is already a very large one - it may amount to between 10 and 15% in the case of a dam, for example - and it seems likely that this share of total costs will increase still further during the next few years.

In connection with the projects that it finances, I.B.R.D. is called upon to seek help on a very extensive scale from engineering consultants, and the laying down of the most satisfactory policy to adopt with regard to their services raises numerous problems:

- definition of the fields in which the services of consulting engineers are required:

Here it is a question of being able to specify the types of assistance that it is desirable, if not necessary, for consulting engineers to provide, by distinguishing between the various types of project (certain fields call for a great deal more technical know-how than others) and between the various countries concerned (the parts to be played respectively by the consulting engineer's office and the local Administration will largely depend on the level of competence of the latter.) It will also be necessary to stipulate the standard of the qualifications that the firms of consulting engineers will have to possess to meet the needs of each type of project regarding which they are called upon to render assistance, the point at which their participation should be enlisted, etc...

- Fixing the optimum figure for the cost of the said participation:

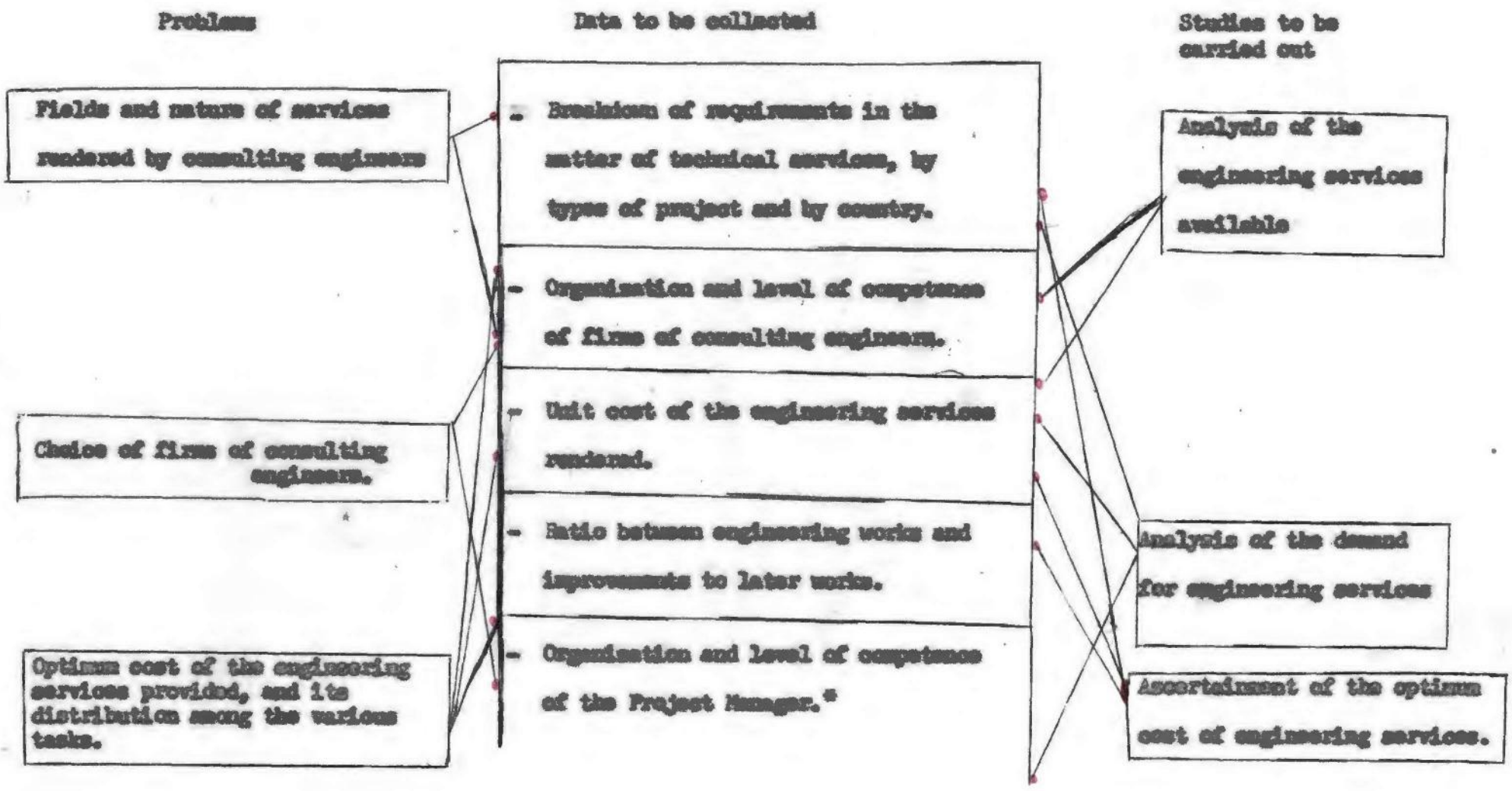
In point of fact, an increase in some consultants' expenses may, at one and other same time, improve the standard of technical reliability and reduce the cost of future works; it is therefore necessary to decide the extent to which consultants should be employed, and in respect of each stage of the work. All of this amounts to a question of finding the right ratio between over-all expenditure and the expenses involved in the provision of consultants' services by spreading these latter expenses in an optimum manner over the various phases of execution of the project, i.e. preliminary technical studies, surveys carried out during the progress of the work, organisation of the planning process, inspection and supervision. The laying down of standards will also be governed by the type of project and country concerned.

- Choice of the engineering offices capable of meeting the requirements of IBRD:

How is it possible to interest the best of these (firms of) consultants and make a choice from among them? In the fields (or the countries) in which there is a shortage of specialists, IBRD could concern itself with the means to be employed to remedy this state of affairs.

Each of the three headings we have just touched upon involves, of course, a great number of other problems, from among which it will be desirable, in collaboration with IBRD, to make a selection depending upon the extent to which the latter has an interest in the solution of those problems (see paragraph V of the present memorandum).

DIAGRAM OF PROBLEMS AND STUDIES



*T.N.: MAITRE D'OEUVRE in the original French

(3) Lay-out of the studies to be considered.

Taking as a starting-point the three groups of problems alluded to above, a schematic table can be drawn up to show the information that would be required to enable these questions to be answered, and such a table is presented in broad outline, in the diagram shown opposite.

The data to be collected may be regrouped into three categories of studies, covering respectively the engineering services available, the demand for engineering services and ascertainment of the optimum cost of those services and Sections II, III and IV of the present memorandum deal with these aspects of the question. Finally, an outline is given in Section V of a study that ought to constitute the preliminary-investigation stage of an enquiry aimed at determining the proper sub-division and precise degree of urgency of the projects to be undertaken.

The services of consulting engineers are made use of in three different spheres of activity, viz.:

- Public Works;

- Agriculture; and

- Industry.

Since the problems arising in the case of each of these sectors present features that are peculiar to these sectors, we shall confine ourselves in the following chapters to an analysis of the engineering aspects of Public Works. It may be possible to deal with the problems met with in the other fields in the course of future studies, if IBRD is concerned about them.

II - SURVEY OF THE ENGINEERING SERVICES AVAILABLE

The purpose of this portion of the study is to inform IBRD of the organizational structure of, and the methods employed by, the various engineering offices, by country of origin and branch of activity. This procedure will, moreover, make it possible to determine how the services provided are developing in the light of the more modern techniques now available. With the knowledge of the scales charged and the periods for each of the types of survey of which the work of consulting engineers consists, it will be possible to determine the proportion of costs assigned to engineering studies in the case of given projects, as also the extent to which this ratio varies with the scale of the project.

During a preliminary phase of this study it would be necessary to collect the data that are essential for making the calculations referred to above.

(1) Collection of data

Information would be sought from firms of engineers in their countries of origin, viz. mainly:

- The United States and Canada;
- Great Britain;
- France;
- Germany;
- Italy;
- The Benelux countries; and
- Japan.

This list could be amended to meet the wishes of IBRD.

This survey would have as its purpose the preparation of a catalogue enumerating the leading firms of engineers by nationality, and grouping them according to branch of activity.

In respect of each of these firms we should provide detailed information regarding:

- its internal organisation;
- its special sphere of activity;
- its level of technical proficiency;
- the qualifications of its staff;
- the countries in which it operates;
- the references it has to show;
- its scales of charges, by country;
- its methods of obtaining information regarding forthcoming projects;
- its financial structure (a special effort would be made to establish any links that might possibly exist between any of the firms studied and the enterprises likely to carry out the projects);

- its turnover (as also the apportionment per country and sector).

The information obtained from engineering consultants' offices would also enable us to determine precisely what staff, equipment and periods of time are required to carry out each of the duties performed by consulting engineers, by type of project and by country.

(2) Analysis of data

We should then have at our disposal sufficient data to allow of a first calculation being made of the cost of engineering functions, as these costs are normally incurred, by country and by branch of activity.

The tasks taken into consideration when calculating prices will here be those which are normally entrusted to one and the same firm of consulting engineers in the case of the projects by IBRD, viz.:

- the technical survey (including the tasks connected therewith);
- price study; and
- inspection and supervision of the works.

By thus delimiting the part played by the consulting engineers we shall be able to arrive at homogeneous results, which will be presented in the form of curves showing (for a given country and for a characteristic type of project) the fluctuations occurring in the ratio between the cost of studies and the cost of the capital investments, in terms of the over-all value of these latter.

We shall thus be able to indicate variations in the cost of studies of the same type, depending upon the country concerned. Such differences are mainly to be ascribed to two basically different reasons:

- physical conditions of work in the country, viz. cost of living, difficulties arising from distance, lack of means of communication, etc..

These factors are responsible for the fluctuations in real terms, in the cost of the studies, and any price increase that such variations may entail cannot be reduced.

- the conditions resulting from the economic and trading policy of the country concerned.

A country's legislation, system of taxation and the trade agreements in force between it and other countries may result in a situation such that the engineering offices of one nationality only have become really established in that country. Since, in this case, there is no open competition, no price-regulating factor is at work.

After having examined closely the various reasons for fluctuations in the cost of studies, we shall attempt to provide a table showing trends in the supply structure of each of the areas covered by the survey, and shall go into the following points connected with the evolvement of engineering offices with the passage of time.

Changes occurring in the various fields of technique:

- changes in the resources employed (type of staff, equipment and methods);
- changes in structure (specialisation and amalgamation);
- cost movements.

We shall also try to determine the extent to which engineering offices seek to become established in new countries, and dissociate themselves from countries in which they formerly operated, as also to ascertain the movement shown by that part of their turnover which relates to work carried out in their country of origin.

Finally, we shall describe the development of methods of obtaining information so far as the contracts financed by IBRD are concerned. Our description may perhaps include suggestions, if it appears necessary to improve the said supply of information.

III - SURVEY OF THE DEMAND FOR THE SERVICES OF CONSULTING ENGINEERS

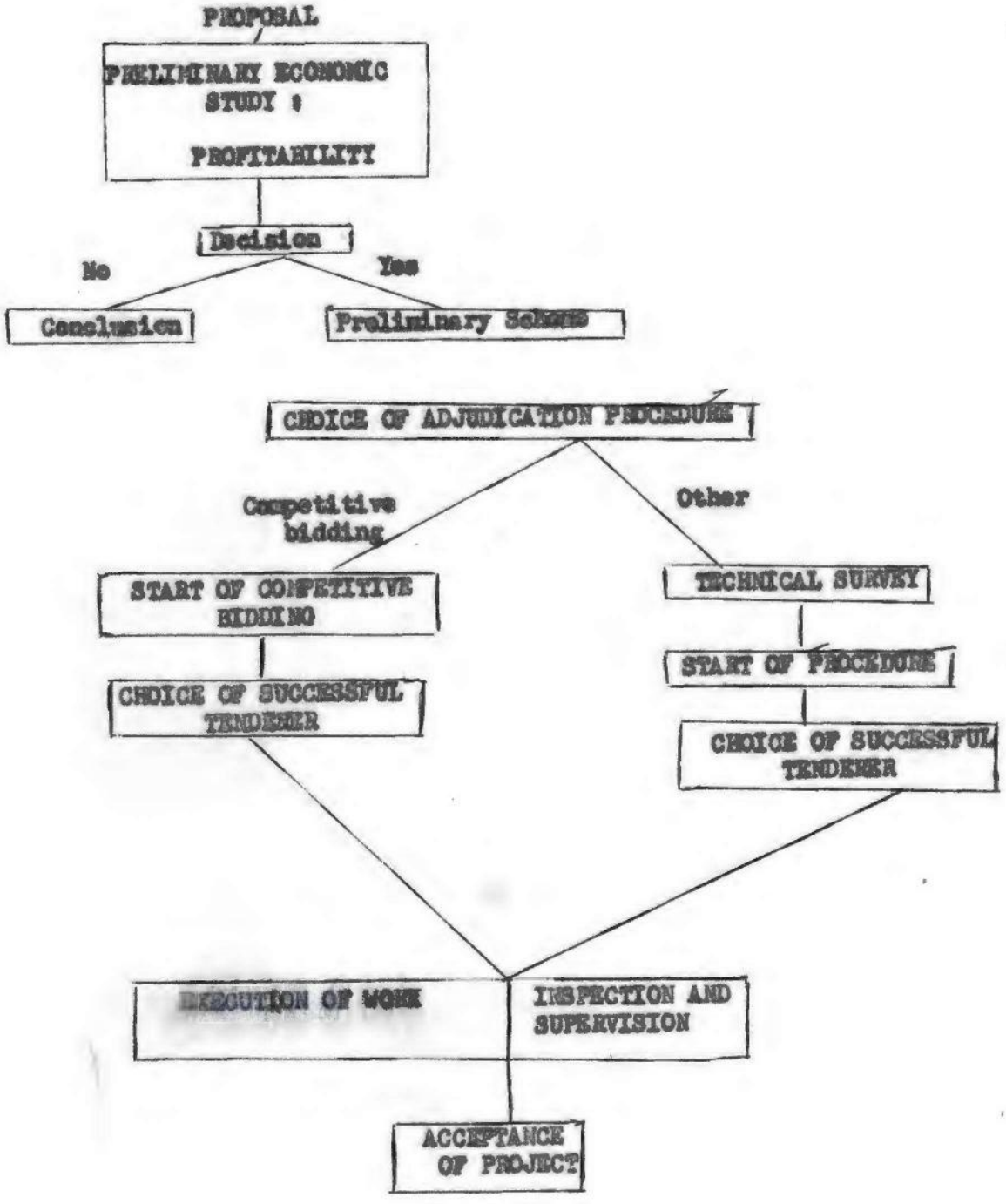
The purpose of this portion of the study is to make a detailed analysis of the machinery available for meeting the present demand for engineering services, in terms of the type of project and of the countries concerned, so as to show:

- the various stages at which it is necessary for the engineers to participate in the execution of a project; and
- the various solutions employed to deal with the problems arising and their effect on costs.

The survey will be conducted mainly in the countries that receive assistance from IBRD, the information being both sought from the Governments of, and from the enterprises established in, those countries. The following points will be examined, by country and by sector adopted for the purposes of the survey:

(1) Nature of the demand

We shall first have to define the limits of the tasks carried out by the consulting engineers, for which purpose we shall examine the successive phases elapsing between the time at which the construction of a project is proposed and the completion of the work:


PROPOSAL
PRELIMINARY ECONOMIC STUDY :
PROFITABILITY
Decision
No
Yes
Conclusion
Preliminary Scheme
CHOICE OF ADJUDICATION PROCEDURE
Competitive bidding
Other
START OF COMPETITIVE BIDDING
TECHNICAL SURVEY
CHOICE OF SUCCESSFUL TENDERER
START OF PROCEDURE
CHOICE OF SUCCESSFUL TENDERER
EXECUTION OF WORK
INSPECTION AND SUPERVISION
ACCEPTANCE OF PROJECT

Apart from the decision that will have been taken regarding the design of the project and the carrying out of the work, all the stages following the proposal, and shown in the foregoing diagram, can be dealt with by an engineering office. In point of fact, the more highly qualified the Project Manager* is, the larger the share in such work he will be able to take.

This being so, the following questions require to be answered:

- Have all the studies, together with the inspection and supervision of the work, been entrusted to one and the same engineering office?
- Does the local Administration participate in the studies?
- Does that Administration itself conduct part of the studies and carry out part of the work of inspection and supervision?

The replies to these questions will enable us to determine the field over which the work of the engineering offices extends, by sector and by country.

Next we must examine the demand-factors that affect the cost of capital investments.

(2) Cost-variation factors

2-1 Drawing up the invitation to tender

The method used in placing contracts for the carrying out of studies may have a considerable effect on costs. As a matter of fact, the choice of the successful tenderer for the contract will largely depend upon the adjudication procedure employed.

The best procedure for use in a given situation will depend:

- on the technical qualifications of the Project Manager; if the latter lacks staff sufficiently qualified to appraise the value of the studies carried out by the firm of consulting engineers, it will be in his interests to employ a procedure enabling him to choose a reliable contractor at whatever cost.

more

A highly-qualified Project-Manager, i.e. one capable of supervising the carrying out of the studies, may on the other hand safely make use of the invitation-to-tender procedure and choose the lowest bidder, unless he has reasons for not doing so.

A Project-Manager with high technical qualifications will also be able to employ the engineering office as a public agency working under his direction.

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*T.N.: MAÎTRE D'ŒUVRE in the original French.
*T.N.: EN RÉGIE in the original French.

- on the volume of work involved; the contract for building a bridge, for example, will almost always be let by public tender when more than a certain amount of work is involved. The firms submitting tenders then play the part of the engineering office, and the same is true in the case of dams.

- on the techniques employed; competitive bidding may well have its attractions in cases where there is a choice between various possible techniques. This is true in the case of a dam or a bridge, but not in the case of a road.

Study of these various parameters will enable us to show what standards should be adopted in choosing the method of placing engineering contracts. When that method has been defined, we shall also have to stipulate the form in which the invitation is to be drawn up.

Thus it is necessary to specify the extent to which the tasks that the engineering office is being asked to carry out will have to be described in detail (in the case of a road, for example, the distance between two consecutive cross-sections should be given, as also the distance between two drillings).

The manner of drawing up the tender will also have to be stipulated in the invitation to tender: lump-sum, breakdown of prices, etc..

2-2 Periods allowed for completion

The periods allowed for completion have an important effect on prices; in point of fact, the means employed will depend upon the time available. In the case of a road, if only a short period is allowed for completion, the topographical survey will be made by using aerial photographs, and will cost more than a survey carried out at ground level.

2-3 Special features of the country in which the work is being carried out:

The relevant points have already been dealt with in the survey of the consultants' services available.

(3) Analysis of results

Our survey of the consultants' services available enabled us, on the basis of unit prices and average periods required for completion, to lay down an average price for each of the phases of the work of consulting engineers.

We are now in a position, on the one hand to define the tasks that the consulting engineers are called upon to perform in each of the countries studied and, on the other, to estimate how far the cost of carrying out those tasks fluctuates in accordance with demand.

Generally speaking, the factors that give rise to variations in price are of two types:

(1) The constant factors: (level of technical proficiency of the Project-Manager, procedures employed for the letting of the contract, conditions peculiar to the country). These determine the framework within which the consulting engineers' tasks are performed, and they have been defined once and for all in the present chapter.

(2) The variable factors: periods allowed for completion and degree of precision with which the surveys have been conducted. Since the periods allowed for completion are determined by the special features presented by any given market, the over-all cost of the capital projects will mainly depend on the degree of precision of the consultants' work.

It will therefore be the purpose of the final portion of the present study to bring a (known) engineering cost and a (probable) project cost into relation with a given degree of accuracy of performance on the part of the consulting engineers, so as to reduce the total amount of these costs to a minimum.

IV - FIXING THE OPTIMUM COST OF THE CAPITAL INVESTMENT

This part of the study is designed to make it possible to determine the effect of the marginal cost of each of the stages of the work of consulting engineers on the cost of the works, with the object of minimizing the factor represented by their over-all cost.

In order to simplify calculation, we shall make the following assumptions:

- For a specific type of project, in a given country, the basic unit tariffs charged by the office of a firm of consultants/determined in the course of the survey of the consultants' services available.

- The adjudication procedure has been decided upon in the manner described in the foregoing chapter (Survey of demand), as has also the precise definition of the tasks carried out by the firm of engineering consultants.

- The periods allowed for carrying out a given task will be average periods. Periods that are too short and which, as we have already seen, involve an increase in cost, are justified only in special cases. We shall vary the time-limits according to the amount of work required, and not in response to an arbitrary wish on the part of the Project Manager.

This being so, the only purpose-variation parameter is the variable quantity we have previously called the "degree of precision with which the survey has been conducted", and it is important to examine this idea closely.

Let us take the case of a road. We shall suppose that a contract has been awarded for the work, following upon the issue of an invitation to tender.

The consultants' office may possibly perform the following tasks:

- Economic and profitability study: It is on this study that the decision to be taken by the employing Authority, so far as the carrying out of the work is concerned, will be based. A bad economic study may lead to the rejection of a profitable scheme, or vice-versa. This study has, however, no direct effect on the cost of the works and is, moreover, generally carried out by the Project-Manager himself, or by a firm other than that which will be carrying out the engineering works proper. For this reason we shall not take this study into account when calculating the optimum cost figure.

- Preliminary project: The amount of information contained in a preliminary scheme may vary widely, and it is essential to stipulate how far the studies relating to a preliminary project are to be carried (preliminary layout, final layout, first drillings, etc.) The cost of drawing up a given type of preliminary project can easily be worked out on the basis of the data collected previously, as can also any increase in cost that may be involved in providing supplementary information.

- Technical survey: This depends in part on the quality of the preliminary design. In fact, if the preliminary scheme hardly exists, there will be a marked increase in the amount of work required to carry out a satisfactory technical survey. We shall, on the other hand, need to measure the increase in cost involved in meeting a request for additional cross-sections or drillings, or for more advanced granulometric tests on the quarry materials, etc..

- Price study: This study may be of a very summary nature in the case of countries where there is open competition and where the firms have different* (countries of) origin, but it should be carried out in much greater detail in countries where the market is distorted by agreements between firms, by protectionist legislation, by bids from concerns having only a limited knowledge of the cost of the work, etc..

  Contrary to what happens in the case just described, the increase in cost involved in carrying out a more detailed survey is difficult to measure, and we shall take into account only two prices per country for this type of study, one referring to a summary study, undertaken for the purpose of establishing an order of magnitude in the matter of price, and the other relating to a more advanced study, conducted with a view to providing a basis for judging the bids submitted, should abnormal conditions prevail on the Public Works market in the country concerned.

- Inspection and supervision: The standard of supervision, and the frequency with which it is exercised, will largely depend on the standard of the technical study made of the contract specification and the schedule of prices.

  If the foregoing studies have been conducted properly, inspection and supervision should be reduced to a mere routine. If, on the other hand, those studies are inadequate, it will be necessary to increase the number of supervisors and the number of inspection visits paid to the site.

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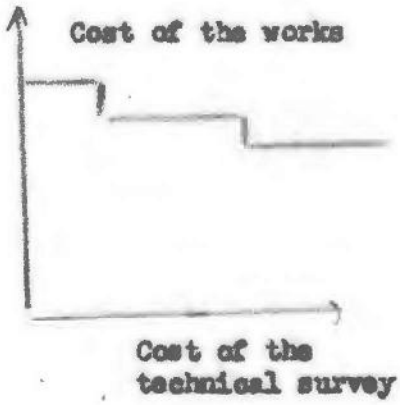
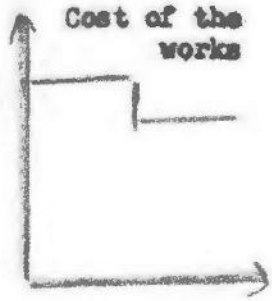
*T.N.: D'origines différentes in the original French - presumably a typographical error.

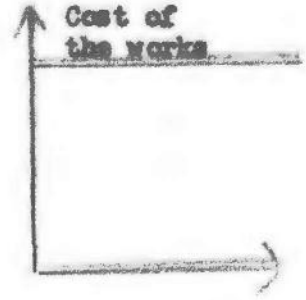
The increased cost resulting from closer inspection and supervision can be easily be worked out, since it is reflected in a specific number of additional man/months.

Thus the cost of each phase of the work of the consulting engineers affects the cost of the succeeding phases, and it also has an effect on the cost of the works carried out. To take an actual case, we shall now consider, by way of an example, the manner in which the cost of the works varies in accordance with the cost of the technical survey.

It is logical to suppose that of the shape of the curve will, in actual fact, be as shown in one of the following examples:

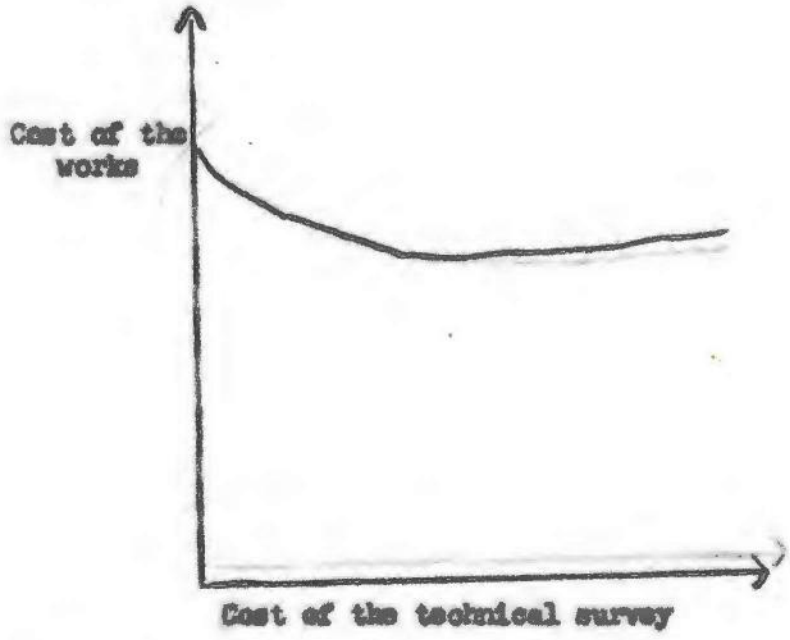






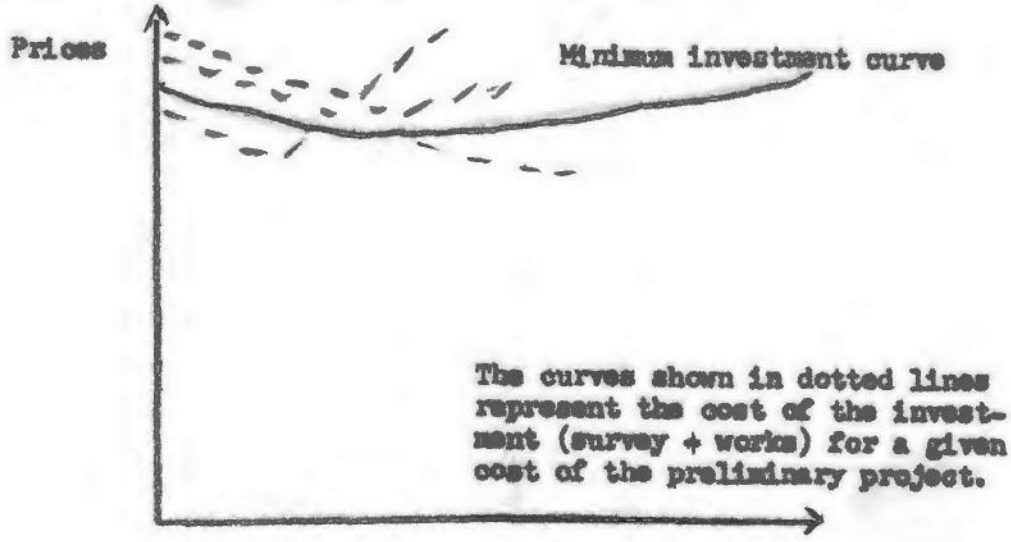
The gaps correspond to the discovery of phenomena (a strip of rocky ground, for example) that can easily be avoided by modifying the layout of the road. Such phenomena, had they not been discovered, would have resulted in an increase in the cost of the works.

In point of fact, we shall base our argument on the probable cost of the works, and not on actual costs. The curve showing how the cost of the works according to the cost of the technical survey will therefore have the following shape.



An an indication, the calculation could be made in the following manner:

(1) Determination of the optimum cost of the preliminary project: To a given cost of the preliminary scheme there corresponds an optimum cost-figure for the whole of the other works falling within the scope of the services rendered by consulting engineers, such as to ensure that the over-all anticipated cost of investment is kept as low as possible. Determination of this minimum figure requires an analysis of the probable cost of the works for a given cost of the surveys. The optimum cost-figure for the preliminary scheme corresponds to the lowest point shown by the minimum investment curve.



Cost of the studies other than the preliminary scheme

(2) Determination of the optimum cost of the other phases of the work of the consulting engineers: The procedure described above will be repeated for each of the phases of the work of the engineers, the assumption being that the cost of the preceding phases is known. The minimum cost of the investment will be established when the optimum figure for the final phase of the engineering services has been determined.

(3) Analysis of results: Taking the foregoing calculation as a starting point, it is possible to determine, by sector and by country, the optimum ratios:

$$\frac{\text{Cost of consulting engineers' services}}{\text{Cost of capital investment}}$$

Comparison of these ratios with the normal ratios arrived at in the course of the second part of the study will demonstrate the advantages secured by employing the optimum plan of action.

SUMMARY

The foregoing chapters give an over-all picture of the problems that project engineering may present for IBRD. The solution of those problems would enable the latter to adopt a more effective policy towards engineering studies, thanks to:

- a better knowledge of the consulting engineers' offices in existence throughout the world, as also of their organisational structure and methods;

- a contract-placing procedure that matched the special conditions prevailing in the various countries and branches of activity;

- a method of determining the specific cost-figure that requires to be earmarked for engineering study purposes, in order that the over-all cost of the capital investment is kept to a minimum;

- forecasts of the probable development of engineering design, as the result of the use of more modern techniques, and of the increasing technical competence of administrations.

On the basis of the above-mentioned data, IBRD will also be able to determine precisely what portion of its budget it should earmark for engineering studies/future years.

We have attempted to describe some means of solving the problems arising, but the preliminary scheme we have submitted should be regarded as a basis for discussion rather than as a definite proposal. From this

angle, it might be useful to define, by agreement with IBRD, the problems that are chiefly responsible for the latter's present anxieties, as also to decide upon the order in which it will be possible to deal with those problems.

V - PRELIMINARY STUDIES

The scheme of studies that we have just submitted should be regarded as setting forth the broad outlines of a basis for the discussion of possible plans to be drawn up in collaboration with IBRD.

Several essential points do indeed remain to be settled, e.g. the precise definition of the sectors that are to be considered, the choice of the countries to which the survey would relate and the order in which the problems would be studied.

This being so, we propose that a preliminary survey should be carried out, with a view to:

- examining the present relationship between IBRD and firms of consulting engineers (methods employed for the placing of contracts, spheres of activity of engineering consultants, ratio of engineering cost to the cost of projects, etc.);

- investigating the problems arising for IBRD from the increasing use made of the services of consulting engineers;

- proposing a grading, in order of priority, of the problems to be studied, such a grading being supported by reasons to justify it; and

- suggesting the studies required for the solution of those problems, a detailed description being given of the methods that would be employed.

In order that this preliminary survey may be carried out, we propose that consideration should be given to the idea of sending a team of two METRA engineers to IBRD for a period of two or three weeks, so as to enable them to consult, on the spot, a few of the more important files on the subject of contracts financed by IBRD and now completed, and to interview a number of IBRD specialists.

They would study, among other things:

- the methods normally employed for placing contracts with firms of engineering consultants;

- the exact duties performed by the consultants, i.e. a precise definition of the scope of the studies, tasks carried out on the site, work performed, services rendered (in particular, do the offices of engineering consultants purchase plant and equipment for the Project Manager?)

T.N.: MAITRE D'OEUVRE in the original French.

- the order of magnitude of the engineering services provided in a certain number of typical cases;

- any difficulties that may have arisen owing to inadequate study or supervision, and their effect on the total cost of the works.

Following upon the above-mentioned visit, work would be done in Paris on the data collected, the results being combined into a report that would be drawn up for the purpose of achieving, to the fullest extent possible, the aims already referred to.

The report would then be submitted to IBRD and, after its conclusions had been discussed, a definitive programme of work, possibly consisting of successive stages, would then be drawn up.

PLAN SUGGESTED

	WASHINGTON		PARIS		WASHINGTON	
	1st week	2nd week	3rd week	4th week	5th week	6th week
Engineer No. 1	Contacts with IBRD Study of files		Writing of the report Preparation of a programme of work			
Engineer No. 2	"	"	"	"		Submission of the report and of the programme of work
Director of studies						

PROBABLE COST OF THE STUDY

Engineers :	55 days at F796 per day	F 43,700
Director of Studies :	5 days at F1,512 per day	7,550
	TOTAL	F51,250

The above-mentioned amount includes neither the cost of travel nor living expenses.

FORM NO. 61.EC
(7-65)

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
.....
INTERNATIONAL DEVELOPMENT ASSOCIATION

Appraisal + Cost Proj

CONFIDENTIAL

ECONOMIC COMMITTEE

EC/0/66 - 9

January 25, 1966

MEMORANDUM

Project Evaluation

1. The attached memorandum "A Proposal for Strengthening the Role of the IBRD in the Field of Project Evaluation", by Arnold C. Harberger, which Mr. Adler referred to at last week's meeting of the Committee, is distributed for information.

2. The memorandum may be discussed at a future meeting of the Committee.

C. F. Owen
Secretary

Attachment

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