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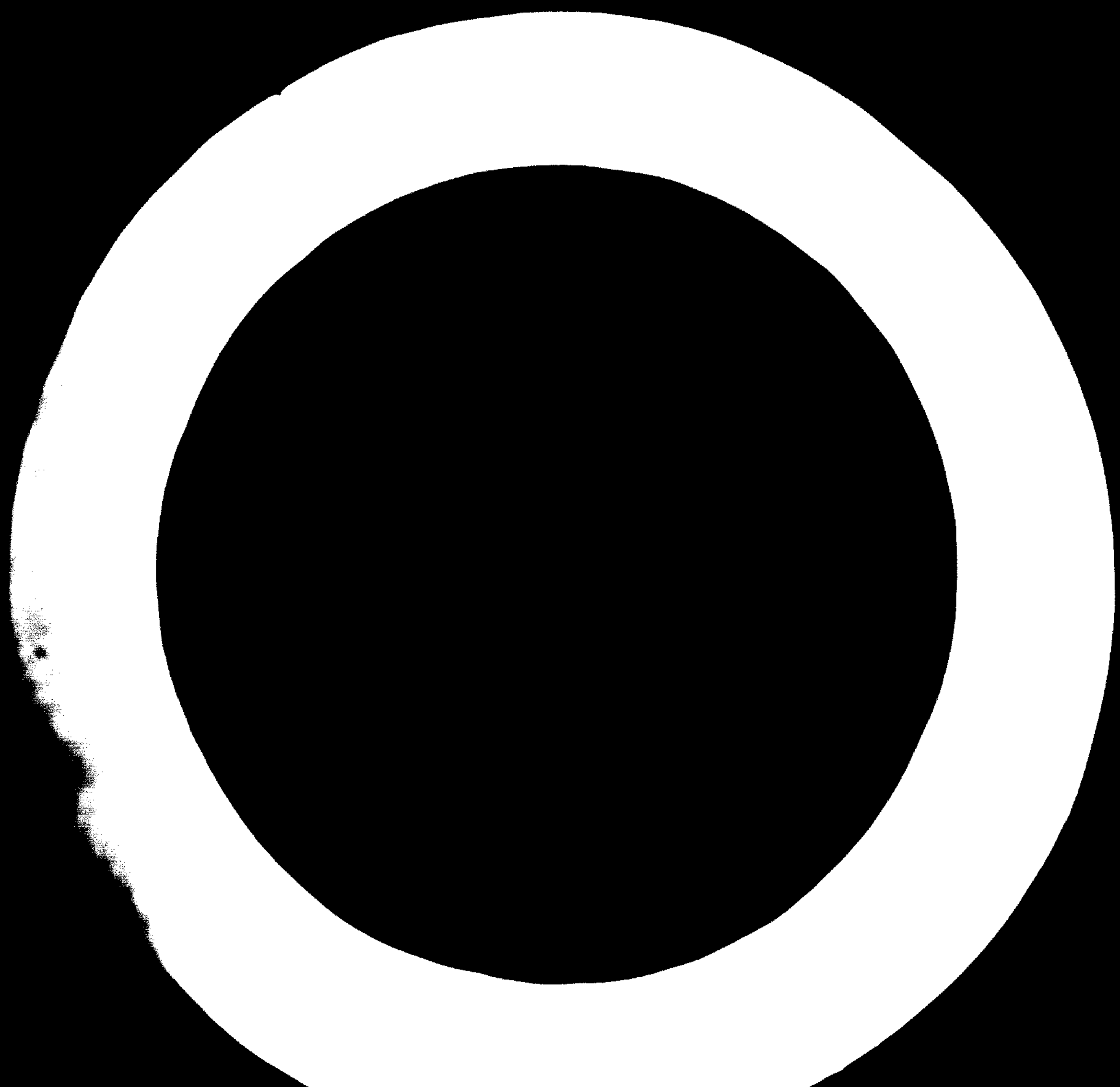
EVALUATION OF INDUSTRIAL PROJECTS

UNITED NATIONS



United Nations Industrial Development Organization

Project Formulation and Evaluation Series, Volume I

EVALUATION OF INDUSTRIAL PROJECTS

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Industrial Project Evaluation held in
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Foreword

The formulation of sound projects is of great importance in industrial development under any economic system. Careful and systematic scrutiny of proposed projects, based on thorough investigation of their economic and technical feasibility, is indispensable in selecting viable projects and in committing financial and technical resources to them. Industrial project evaluation is particularly important in developing countries because limited resources have to be used to maximum effect in accelerating industrial development. For this reason the United Nations Centre for Industrial Development (now the United Nations Industrial Development Organization (UNIDO)) organized the Interregional Symposium on Industrial Project Evaluation held in Prague from [illegible] October 1965. It was the first international gathering devoted exclusively to the consideration of issues and problems in industrial project evaluation.

Participants from thirty developing countries in Africa, Asia, Europe, Latin America and the Middle East attended the symposium on a fellowship basis under the aegis of the United Nations Bureau of Technical Assistance Operations. The participants were all senior officials who had themselves been involved in the process of industrial project analysis or industrial programming in their respective national Governments or institutions. In addition, there was substantial representation of other countries as well as of regional organizations, national financial corporations and planning organizations. Many specialists in the field of industrial project evaluation also attended the symposium as observers.

The agenda consisted of four main items: (a) preliminary steps in setting up industrial projects; (b) considerations in the evaluation of industrial projects; (c) follow-up and supervision of industrial projects; and (d) survey of country experience.

The symposium examined all relevant aspects of industrial project evaluation. The relation of the proposed project to the general strategy of industrial development, essential elements in the preparation of a project, data and other information required, as well as the institutional aspects of industrial project evaluation, were dealt with under item (a). The core of the discussion, examined under item (b), included issues and problems connected with commercial and national economic profitability, interindustry linkages and managerial and technical skills, a survey of current practices and theories in the field of industrial project evaluation, pricing problems, with special reference to foreign exchange and foreign trade considerations, and financial planning and its appraisal. The various procedures and tools required for the follow-up and supervision of approved projects were surveyed under item (c), and the criteria and methods used in industrial project evaluation in developing countries, together with case studies illustrating them and the [illegible] to the [illegible] of industrial [illegible] were highlighted in the course of the [illegible] item (d).[1]

A substantial documentation, consisting of [illegible] papers and [illegible] dealing with [illegible] was available to the participants. [illegible] dealt with country experience and [illegible] of selected information on [illegible] of industrial project evaluation in developing countries. The [illegible] prepared by [illegible] agencies and national [illegible] from the United Nations dealt with [illegible] of industrial project evaluation. The [illegible] covered ample [illegible] highly sophisticated evaluation techniques suited to countries at different stages of development and with different economic systems, and indicating the [illegible] made up by developing countries in this [illegible]. The symposium concluded that the [illegible] documentation prepared for the symposium [illegible] institutions [illegible] published [illegible].

Many [illegible] papers [illegible] have been brought together here [illegible] selection [illegible] taken to ensure that [illegible] aspects of industrial [illegible] evaluation [illegible]. Secondly, [illegible] designed to secure the representation of [illegible] and different viewpoints [illegible]. Finally, an attempt has been made [illegible] balanced view of the principles and [illegible] industrial project evaluation in all [illegible] of the world. Some papers [illegible] have been left out because they [illegible] published elsewhere or because the topic [illegible] adequately dealt with in another paper in the [illegible] volume or because they cover a field extending beyond the limited scope of this publication.

The first paper brings out key issues [illegible] important aspects of industrial project evaluation. The last consists of a selected bibliography prepared by UNIDO which can be used by evaluating [illegible] in developing countries. This bibliography was prepared after the symposium and as a part of the follow-up programme. The second and third papers tackle the problems of relating a project to industrial programming and overall planning. The fourth

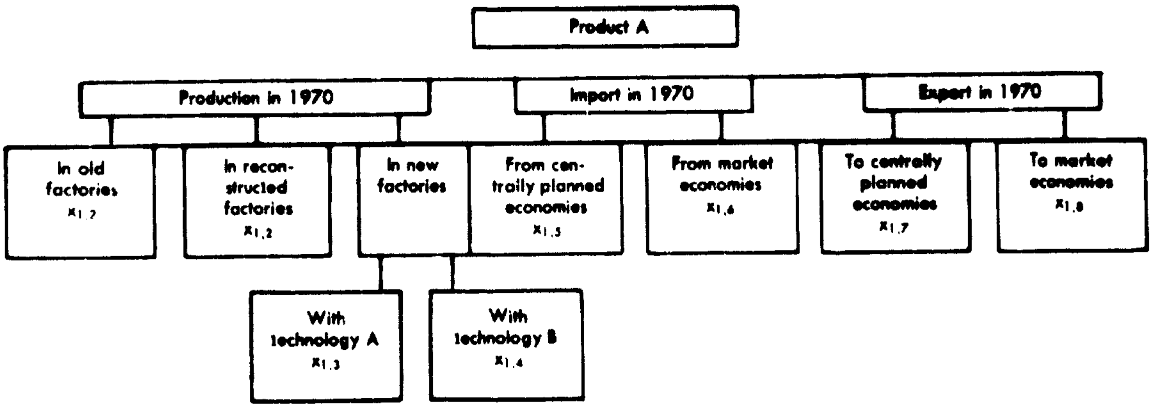
[1] *Report of the Interregional Seminar on Industrial Project Evaluation (Prague 1965)* (United Nations publication, Sales No. 66.II.B.11).

[illegible] the [illegible] economic aspects of project prepara-tion, while the fifth deals with the methods of [illegible] the work of evaluating agencies with a few [illegible] and thorough [illegible]. The seven papers that follow are devoted to an examination of general and specific criteria including commercial and national economic profitability, interdependence among projects, appraisal of the financial plan for the project and requirements of managerial and technical personnel. The criteria of evaluation as well as the methods for their application are covered by this group of papers. The examination of national economic profitability, expressed in terms of various objectives of development planning such as high rates of growth, high employment and balance improvement in balance of payments, creation and redistribution of income, is the most important as well as the most difficult task in project evaluation. Most of the papers in this group are concerned with one or more aspects of calculations of national economic profitability. Paper No. XXVII is a survey of industrial project evaluation in the United States, the United Kingdom and France, and deals primarily with the processes of project evaluation in the private sector. Paper No. XXVIII surveys the literature on cost benefit analysis. The next two papers deal with the issues of follow-up procedures and practices. Finally paper No. XXXI brings out issues and problems encountered in practice in a developing country and which are in many ways typical of the situation in developing countries.

The Prague Symposium established that great scope for improvement existed in the practices and procedures of project formulation and evaluation in developing countries and suggested the organization of training workshops at national or sub-regional levels as the most effective means of dealing with the matter expeditiously. The first aim of such workshops would be to train a nucleus of local personnel who could apply improved practices and procedures.[7] UNIDO has already undertaken a programme of organizing such workshops at the request of developing countries in co-operation with United Nations Development programmes. In addition, the symposium emphasized the need for a manual on industrial project formulation and evaluation which could be used by evaluating agencies and educational and training institutions.[8] UNIDO has already initiated measures for the preparation of such a manual. It is hoped that the experience gained in the training workshops on project formulation and evaluation will be very useful in the preparation of the manual.

[7] Ibid., p. 10.
[8] Ibid., p. 9.

Activity alternatives of product A



Each product, of course, will not be connected with the same activities in every case, but only with those activities which are applicable by economic considerations to the given product. In special cases, such as transportation and communication, special activities are connected, determined by the economic nature of the product.

One sector model in general contains 60-80 activities. The volume of various activities is indefinite, they are the variables of the model. Computations should determine the volume (quantity) of $x_{1,1}$, …, $x_{1,2}$, …, $x_{1,j}$, …, $x_{1,n}$.

The sectoral programme is determined by aggregated activities of a sector model. The programme is the amount of such types of numbers as: $x_{1,1} = 0$, $x_{1,2} = 5000$ etc. In other words: the programme provides targets for all the 60-80 activities.

The determined sectoral programmes will provide an answer to the following questions:

What quantity of each product should be produced in 1970?

What are the projects for which technology should be constructed during 1966-1970 in order to achieve optimum production in 1970?

What should be done with the old capacities existing on 1 January 1966? Are they still worked, or are they being reconstructed or discarded?

What kind and what size of new factories should be built?

What should be exported and imported, in what quantity and to and from which country?

The model deals with the plan prepared by traditional methods as an official programme. The targets elaborated by traditional methods (balance method) represent only one of the possible variants. The model produces more variants and provides an opportunity for simultaneous comparison of a number of alternatives. The programme is an aggregated, complete production, investment, technical development, export-import plan of a sector at the same time. The x values, variables, of course cannot be determined voluntarily. The programme should contain several real limiting factors.

The reality of the programme depends on the reality of the limiting factors. Such limiting factors are, for example: the upper limit of export, capacity limits and technological proportion within the sector. Therefore the elaboration of preliminary studies which we mentioned earlier has a decisive importance from the point of view of realistic model and programme construction, since the limiting factors of a programme should be determined by those preliminary studies. We may draw up a simple scheme of relationships between limiting factors and programme (as shown in the diagram on page 125).

Basic computations on the sectoral level are prepared with linear programming, that is, both limiting factors and function are given in the form of linear equations.

(b) *Sensitivity computations on the sectoral level*

One part of the limiting factors at a given moment is independent of the will of the planners (capacity limits); another part can be changed during the period of calculations (investment funds).

When the optimum programme has been computed, computation of cumulative effects induced by any of the changes in various factors of the model becomes easy. The object of sensitivity computations is to measure the effects caused by changes of one or another factor for the sector's programme as a whole. Therefore, the sensitivity computations play a decisive role in the process of project evaluation as well as in the formulation of criteria for project evaluation. Changing construction expenses, for example, we are able to see the effects of this change on the whole investment activity of the sector; moreover, changes in output, export, import and other factors might be considered also.

To construct a sectoral model may take from one to two years of hard research work. But once the model is ready, computation of a given programme or a sensitivity analysis will not require more than a few hours to accomplish on computers.

(c) *Basic computations on the national level*

The object of these computations is to find the optimum allocation proportions among sectors by mathematical programming. This method is called in the Hungarian literature "two-level planning" or the method of *iteration*. The substance of the method

I. ISSUES AND PROBLEMS OF INDUSTRIAL PROJECT EVALUATION*

INTRODUCTION

The primary purpose of the symposium is to examine issues and problems connected with the evaluation of industrial projects. It is not primarily concerned with issues involved in the formulation of industrial projects, such as market research and demand projections. This limitation is designed to enable the participants to examine intensively the major aspects of the evaluation of industrial projects instead of diffusing effort and the limited time available in covering both formulation and evaluation. The Centre for Industrial Development hopes to take up the topic of formulating industrial projects in its future work programme.

One of the purposes of the substantive documentation prepared for the symposium is to cover adequately all items of the provisional agenda. In addition it is intended to present to the participants the criteria and methods of industrial project evaluation as well as the rationale underlying them both in countries with market economies and in those with centrally planned economies. Finally, an attempt has been made to prepare a comprehensive documentation which can be directly and immediately useful to all persons engaged in the evaluation of industrial projects in developing countries. Forty-two papers dealing with country experience and case studies of individual projects will, it is hoped, provide sufficient information concerning existing practices and problems of industrial project evaluation in developing countries. The documentation deals with simple as well as with highly sophisticated techniques of industrial project evaluation, the latter presented with a view to indicating the possibilities of improving existing practices in developing countries.

Because the documentation is so voluminous, some of the important issues and problems involved in the evaluation of industrial projects are briefly outlined in this paper as an aid to systematic discussion at the symposium. These issues and problems related to conditions in developing countries and are not necessarily pertinent to developed countries. It should be emphasized that they do not constitute an exhaustive listing and that there is no intention of excluding discussion of other relevant topics. Particular topics will have to be examined in the context of the documentation dealing with the survey of country experience and case studies.

It will be useful to examine briefly certain preliminary measures which are indispensable in carrying out the effective and systematic evaluation of industrial projects.

* Paper prepared by the United Nations Centre for Industrial Development.

1. A. Relation of projects to the plan [illegible] industrial development

The importance of this topic [illegible] that practically all developing countries [illegible] suffering from shortage of capital, foreign exchange and skilled personnel [illegible] rational utilization of available resources in order to achieve accelerated economic development. The [illegible] set out below may be dealt with under this item of the agenda.

(a) An industrial project must be [illegible] the context of the development needs of the economy. The essence of the strategy of industrial development lies in the formulation of industrial priorities for a prescribed length of time.

(b) Industrial sectoral programmes, long-term as well as medium-term, are formulated on the basis of industrial priorities embodied in the strategy for industrial development. These programmes include investment and production targets, allocation of resources, know-how and training [illegible] determination of the role of private and public [illegible] policies regarding incentives, finance and technical assistance, balance of payments [illegible] industrial licensing and [illegible] the frame of reference for [illegible] projects.

While the strategy [illegible] and sectoral programmes [illegible] Government has much greater [illegible] former than over the latter [illegible] substitution [illegible] related plants [illegible] supply and demand [illegible] the strategy for [illegible]

(c) A project must be examined [illegible] the economy [illegible] programme [illegible]

(d) Project development [illegible] long and medium-term [illegible] sectoral targets [illegible] projects. On the other hand [illegible] lead to the modification and adjustment of sectoral programmes and the [illegible]

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[illegible]

common unit, that is, to evolve composite criteria, often in the form of synthetic indexes, to resolve these problems.

C. CURRENT THEORIES AND PRACTICES IN THE FIELD OF INDUSTRIAL PROJECT EVALUATION

The theory and especially the practice of evaluation in countries with centrally planned economies and in countries with market economies differ widely.

In both types of economies there exists a wide gap between the theory and the practice of industrial project evaluation. This raises the issue of how to narrow the gap between the two. The field of industrial project evaluation is a relatively new branch of economic analysis and as such still in a formative stage. There appear to be some gaps and unresolved issues, especially in evaluating economies of scale, indivisibilities and the social rates of discount and in the calculation and application of shadow prices.

In countries with market economies there appears to be a large gap between the best and worst practices, showing the need for diffusing knowledge. In countries with centrally planned economies there appears to be a serious difference of opinion in academic circles regarding new and more advanced techniques. The planning agencies are gradually recognizing the necessity of changes in institutional organization for the implementation of new techniques of industrial project evaluation.

The development of new operational techniques seems to be hampered by the limited facilities available for testing new techniques, and the application of newly developed operational techniques is slowed down because computing facilities, availability of trained personnel and the collection and systematization of the required data lag behind the development of new techniques.

D. PROBLEMS OF ECONOMIC [illegible] WITH SPECIAL REFERENCE TO FOREIGN EXCHANGE AND TRADE

Reference has been made to market imperfections and the resulting necessity of adjusting market prices in order to measure social costs and benefits. Adjustment or correction of market prices is especially important in examining the contribution of a project in the form of import substitution and of export promotion and foreign exchange costs.

In estimating national economic profitability, imperfections in market prices are corrected by means of shadow prices. In solving the mathematical problem of maximizing or minimizing subject to constraints, the increase in the optimum value of the maximand, or decrease in the optimum value of the minimand, is made possible by a unit change in a constrained variable. It has been impossible to arrive at perfect shadow prices. Consequently, accounting prices, which represent approximate shadow prices and meet a certain standard of administrative feasibility, are used in practice to correct imperfections of market prices. It should be added that accounting prices may also be used for separate accounting in a large organization which does not buy its input or sell its output in the open market, as in the case of interdepartmental transfers, and thus may be used to construct a set of market values for managers and workers so as to induce them to operate in a manner that accords with defined social criteria.

An important aspect of accounting prices involving high level policy decisions is expressed in giving relative weights to social policy objectives, such as the maximization of return on social capital, reduction in degree of inequality in levels of income, the reduction of regional income variations and expansion of employment.

Since costs and benefits occur at different points in time, involving intertemporal choices in industrial project evaluation, the determination of social time preference, relating values of present and future consumption or benefits, acquires great importance in project evaluation.

It is important to induce decision makers at sectoral and project levels to use centrally established accounting prices for various inputs and outputs and to counteract the undesirable disturbances that may result from using inadequately developed computation techniques.

Another important aspect of accounting prices is the technique used to compute the other parameters needed for making investment decisions. The solution of the dual problem in linear programming maximizing returns from factors in short supply, the use of import-export prices for calculating accounting prices for intermediate and final goods, and iterative multi-stage factor accounting prices are among the techniques for computing these other parameters.

It may be useful to work out net foreign exchange effects and to distinguish three types of projects, such as net export earning, net import saving and net import increasing projects. In working out net foreign exchange flows, both capital and recurrent expenditures and foreign exchange earnings should be taken into account, and the foreign exchange rate, in an over-valued currency, should be corrected through accounting prices. Short run and long run prospects of world markets and expected comparative cost advantages, competitive efficiency over the life span of the project and uncertainties are important considerations in evaluating net export earning projects.

E. APPRAISAL OF FINANCIAL ASPECTS

Accurate estimates of various financial data, such as requirements for fixed and working capital, cash flow estimates and cash balances, are required not only for the smooth construction and operation of an enterprise but also for the correct assessment of the commercial profitability of the proposed project.

The projected balance sheet method and the cash flow forecast method represent two techniques of computing projections of financial requirements. The former shows comparative statistics giving a picture of how balance sheets look at two different points of time without reflecting the cash flow that may

[illegible]

[illegible]

[illegible]

[illegible]

F. Follow-up and [illegible] of [illegible] [illegible]

[illegible]

[illegible] any discrepancy between expectations and performance may be ascribed to errors in estimating costs and benefits, or to applying evaluation criteria, or to [illegible] and other exogenous factors, [illegible] or a combination. [illegible] may require revision of the techniques by which estimates of costs and benefits are made and of methods of applying evaluation criteria. Systematic follow-up would permit the authorities to take remedial measures to rectify errors, or to scrap the project with minimum loss.

[illegible] reports and budgets, and processing of reports are three follow-up techniques which should be simultaneously employed.

In developing countries, problems connected with financing arrangements, delays in completing construction, cost overruns beyond original estimates and weak management are often encountered in the construction phase, while problems connected with technical difficulties in developing production, supplies of raw materials and marketing are predominant in the production phase.

As a condition for providing finance, the financial agency may reserve the right to nominate a director on the board of the company, but may exercise that right only where it has provided a large proportion of the total cost, or when it is found that the operation of the project is experiencing serious difficulties.

The country experience and case studies of projects may be examined in the context of the results and problems stated above.

II. PROJECT EVALUATION AND INDUSTRIAL DEVELOPMENT PROGRAMMING*

INTRODUCTION

The present report deals with the relation between the evaluation and selection of projects and the formulation and application of an industrial development strategy. Since this is a highly controversial subject on which insufficient empirical knowledge exists, especially in the developing countries, the intention here is merely to put forward questions for discussion at the technical level, not to establish evaluation and formulation procedures on a more permanent basis.

Two other limitations must be mentioned. In the first place, attention is focused exclusively on the situation in the developing countries. Most of the comments made would be inapplicable to industrialized countries. Secondly, the specific experiences on which many of these comments are based relate to Latin America. How far the inferences drawn are valid for the developing countries as a whole is a matter for possible consideration by the Symposium.

A [illegible] comment on first the various levels at which industrial development programming takes place in Latin America and the nature of the industrial [illegible] corresponding to each, with special reference to the trend towards the adoption of a middle [illegible] represented by the formulation of sectoral [illegible] present programmes within a more or [illegible] explicitly defined framework of over-all development programming (section A).

Three problems or groups of problems are next [illegible] in the context of the application of [illegible] for the evaluation and selection of projects, [illegible] to industrial programming in developing [illegible] areas:

The role of profitability criteria in the establishment of the sectoral targets in which a given industrial strategy is reflected (section B);

The difficulty of influencing private sector investment decisions in the light of social profitability criteria (section C);

The less reliable character of economic profitability tests in developing countries, and the difficulties resulting therefrom in connexion with the channelling of industrial development (section D).

Attention is drawn to the advantages, in resolving the aforementioned problems, that might attach to the systematic application of sectoral programming with a substantial technological content and based on an integrated approach, the nature of which is explained in section E, and procedures for the application of such programmes are then analysed in some detail, emphasis being laid on the problem of projecting future efficiency levels, which is of basic importance in any project for the modernization of existing industry and is implicit in projects for the establishment of new activities in a given industrial environment, as described in section F. To illustrate the application of such programmes, reference is made, in section G, to a specific example relating to the metal-transforming industry in Uruguay.

Last, after pointing out, in section H, that the usefulness of project evaluation and selection must also be envisaged from other angles, unconnected with investment decisions in the framework of an industrial strategy, the report presents a few considerations on the much discussed problem of the shortage of projects, for which it suggests, in section I, an interpretation differing from that in common currency.

A. INDUSTRIAL PROGRAMMING

An industrial development strategy consists, in essence, in the establishment of priorities for the guidance of public and private investment policy at the level of the major sectors of industry and of the infrastructural facilities exerting the greatest influence on industrial productivity. Such a strategy, more or less explicitly and coherently defined, exists in most of the Latin American countries. It may, however, be formulated in different ways, depending on the nature of the existing development programming.

In some cases, an intersectoral order of precedence is established directly; the priority sectors, and even the production and investment targets for each, are expressly indicated, the latter forming an integral part of an over-all development programme designed to maximize national income and often, in addition, to further other objectives of a distributional character or relating to the external sector of the economy. In this category are to be found countries where a development programming or planning process is actually under way; these are not yet in the majority in Latin America.

In other instances, industrial development priorities are assigned indirectly, through the promulgation of priority criteria for the approval of individual investment projects, based on the potential contribution of each undertaking to the saving of foreign exchange, the improvement of employment levels, the strengthening of a properly balanced industrial infrastructure, the more rapid development of specific areas in each country, the utilization of raw materials and natural resources in particularly plentiful supply, and so on. In this case, sectoral development objectives are not formulated, nor are investment resources allocated to the most important sectors of the economy, but the whole process of

* Paper prepared by the United Nations Economic Commission for Latin America.

industrial development rests on a series of investments and promotional activities on the part of the public and private sectors, which are not programmed but barely co-ordinated through the incentives and restrictions embodied in the priority criteria.

These criteria of course reflect the differences in existing conditions, aptitudes and basic resources available for industrial development, as well as each country's institutional structure, and its ideological leanings or the tenor of its over-all economic policy. During the last two decades, the industrial strategy prevailing in Latin America has consisted, in most cases, in an import substitution policy based on severe and not very selective restriction of imports both through the customs tariff and by means of quantitative and exchange controls. Recently there have been signs of a tendency to adapt this policy to the new conditions currently to be found not only in each individual country but in the international sphere. At the national level, an advanced stage of industrialization is being reached in respect of consumer goods, some of the simpler types of capital goods, and intermediate products. On the international level, both the formulation of regional integration schemes and the opening up of new prospects for the concession of preferential customs treatment by the developed countries on a basis of non-reciprocity are leading to a reshaping of industrial strategy, with greater emphasis on strict selection of the industries to be promoted and the degree of protection to be granted them. The promotion of exports and the redistribution of internal income are emerging as new development policy objectives which are not always easily harmonized.

A certain number of Latin American countries, however, are following a middle course between the two lines of industrial development strategy of which mention has been made. The countries in question, outstanding among which are Brazil and Mexico, have drawn up successive sectoral development programmes, that is to say, programmes comprising production and investment targets, allocation of resources, definition of the spheres of jurisdiction of the public and private sectors, and a set of incentives and other economic policy measures whose application is confined to the sector concerned, with due regard to the reciprocal compatibility of the various sectors' requirements, and to their consistency with the country's over-all growth prospects under a general programme of an indicative type. Sectoral programmes on these lines have been formulated and applied, generally with great success, for the installation or expansion of the iron and steel, motor-vehicle, heavy metal-transforming and ship-building and chemical industries, among others, in Brasil and of the iron and steel, petrochemical, textile and other industries in Mexico.[1]

It is worth-while to give a fairly detailed description of the kind of sectoral programming successfully applied in the more highly industrialized Latin American countries, since the relation between sectoral programmes and the evaluation of individual projects is a particularly important problem, to which reference will be made later.

The sectoral programmes which are being drawn up in Latin America relate simultaneously to the installation of new capacity and to the modernization of existing industries. They therefore include the formulation of investment objectives in connexion with the expansion of capacity, and the establishment of targets for the improvement of productivity and efficiency in existing industry, with a view to the better utilization of investment already effected, while at the same time they lay down measures to promote the fulfilment of both types of aims. These programmes are particularly complex in so far as they relate to the modernization of existing enterprises, since the close interdependence of the various factors which influence the level of efficiency that ought to characterize a modern industrial establishment means that they can be reached only through corrective measures designed to modify all of them simultaneously.[2]

The adoption of an integrated approach to the formulation of measures to promote productivity and efficiency in a given enterprise, so as to deal with both factors at the same time, is attended by two principal difficulties. In the first place, many of the necessary steps have to be taken outside the sphere of action of the enterprise itself. Generally speaking, this is true of the improvement of raw materials, or, in other instances, of the training of manpower or even advisory assistance in certain special aspects of internal organization. Secondly, some of the reforms required are particularly difficult to put into effect, since they call for a change of attitudes, procedures and methods which are obstructed by the sluggish addiction to routine characteristic of many Latin American enterprises, especially in the traditional branches of industry, which are precisely the sectors where the need for reorganization and modernization is most strongly felt.[3]

An efficacious way of dealing with these difficulties, and of encouraging the adoption of an integrated approach to the improvement of an enterprise, is to prepare reorganization and modernization programmes in which all the enterprises belonging to one and the same branch of industry participate, and which take into account all aspects of the necessary remedial action. Factors that individual enterprises by themselves can do nothing to modify, such as raw material characteristics, can be corrected

[1] The Seminar on industrial programming held by the United Nations at São Paulo, Brasil, in March 1963 (see *Report of the United Nations Seminar on Industrial Programming*, United Nations publication, Sales No. 64.II.B.8), analysed Latin America's experience in the field of industrial programming, as well as that of some countries in Asia and the Far East and, in addition, passed in detailed review the methods, problems and results of programming at the sectoral level in the metal transforming, chemical, pulp and paper, and textile industries, mainly in the light of what had been done in Latin America.

[2] The conditions that must be fulfilled in order to raise levels of productivity and operational efficiency in Latin American industrial establishments and procedures for promoting them through sectoral modernization programmes are set forth in "Conclusiones de la reunión técnica sobre problemas de productividad y perfeccionamiento de personal dirigente" (ST/ECLA/CONF.14/L.6).

[3] *Ibid.*

through joint action on the part of the industrial establishments concerned. The inertia and routine habits that resist the introduction of changes in internal organization can be eliminated or reduced by means of methodically applied incentives.

The objectives of capacity creation are often related, in two ways, to the reorganization and modernization of existing industry. On the one hand, additional production targets are laid down as a complement to the endeavour to expand output through the improved use of current investment; and on the other, the set of industrial policy measures is so designed as to be applicable, as far as possible, both to new undertakings and to the modernization of those already in operation.

The over-all approach to the programming of a whole industrial sector thus covers both existing industry and the installation of new production units.

B. EVALUATION AND SELECTION OF INDUSTRIAL PROJECTS AND SECTORAL DEVELOPMENT TARGETS

Both the preparation and the evaluation and selection of industrial projects are based on techniques and procedures which, although they are constantly being revised and perfected,[4] are too well known to need discussion here. In the present report, consideration will be given only to certain questions arising out of the interrelationships between industrial programming and project evaluation and selection.

The role of individual projects in industrial development programming consists in meeting, consistently with the volume of resources available, the production and investment targets established in the programme in question, as well as those relating to the improvement of operational efficiency in existing industries. There is nothing in the definition of this role that is open to controversy. The same is no longer true, however, once attention is turned from the contribution made by the evaluation and selection of projects, through the above-mentioned conventional procedures, to the determination of the programme targets. The question then to be answered is how far the sectoral production, investment and operational efficiency objectives that go to make up an industrial development programme can emerge from a mass of projects selected and arranged in order of priority on the basis of conventional procedures and private and social profitability criteria, applied outside the context of a clearly defined industrial strategy.

The formulation of an industrial programme implies the establishment of a group of sectoral priorities. The preparation and evaluation of projects will have to take place within the framework set up by this system of priorities, and should probably not be undertaken until it has been established. It may be asked, however, whether priorities can in fact be assigned before the projects have been prepared, that is, before their profitability has been ascertained. In other words, while it is true that a body of individual investment projects constitutes an integral part of any industrial development programme, a problem may arise as to which is the most appropriate order of proceedings as regards the preparation of the programme and of the projects which give it a specific content.

This problem, which appears to be a mere question of chronological sequence that could be pragmatically resolved by means of successive approximations, would seem nevertheless to entail a fundamental decision concerning the relative weight to be attached to considerations of profitability (necessarily of a preponderantly static character) on the one hand and, on the other, industrial strategy considerations (more strongly influenced by questions of dynamism), in the formulation of industrial development programmes.

There is, of course, no simple or general solution to this problem and it will have to be dealt with realistically. The usefulness of the application of profitability criteria with a view to determining sectoral priorities is most likely to vary according to the level at which the programming is undertaken. Where development programming is at its earliest stages, or in the absence of any programming at all implying an industrial strategy defined solely in terms of general criteria, the application of profitability criteria to individual projects might make a useful contribution to the formulation of sectoral targets.

The same may be said of the other extreme, namely, the case of a very elaborate development programming and of an industrial strategy defined as an integral part thereof. In such cases, the elements of uncertainty mentioned in detail in the paragraphs below are limited in scope, and thus the formulation of sectoral production and investment targets, based mainly on profitability criteria applied to individual projects, acquires greater viability. In the intermediate case, that of an industrial strategy consisting of sectoral programmes linked to one another either by a very vaguely-defined general programming framework or by simple over-all priority criteria, use might be made of more limited profitability criteria (applied to individual projects). In the following paragraphs a few arguments are adduced in support of this tentative conclusion.

C. THE PRIVATE SECTOR AND PRIORITY CRITERIA

Another important problem is that of the power of government authorities to exert a real influence on the channelling of private investment. How can the execution of the vast body of private sector projects that are not dependent upon the approval of any public institution, or even on long-term internal financing, be subjected to a system of priorities, whatever its nature? It should be mentioned, in this connexion, that of the annual investment contemplated in the development plans of some Latin American countries, among them Bolivia, Colombia and Venezuela, 80 per cent, on an average, is earmarked for the expansion of industrial sectors already existing in the country concerned. Only 20

[4] Some documentation on these techniques and procedures is presented at this Symposium. Mention may also be made of an ECLA study published in December 1958: *Manual on Economic Development Projects* (United Nations publication, Sales No.: 58.II.G.5).

per cent corresponds to the launching of new activities, and it is probably in this field that the greatest number of large-scale individual projects is concentrated, requiring government backing of one kind or another (internal credit, importation of equipment, endorsement of external loans etc.).

The application of the priority criteria involved in the industrial strategy to projects included in the first category, which are not expressly government backed, is therefore dependent either upon the establishment of a system of registration and prior authorization for the expansion of existing industrial enterprises or the launching of new ones, or upon the subordination of all direct or indirect government controls over the economy (which would have to be efficiently applied) to the industrial strategy defined.

Neither of the two conditions is easy to apply. The freedom of initiative allowed in most of the Latin American countries, a practice—whatever its merits or shortcomings—not likely to be easily modified in the near future, makes the fulfilment of the first condition difficult. The second condition would entail mainly the manipulation of the whole credit system and the fiscal and customs tariff régimes in terms of those targets and priorities, and could be achieved only through the establishment of a far more rigid planning system than the indicative form that is being instituted on an increasing scale throughout Latin America.

D. Profitability tests in the developing countries

The factors distorting the profitability tests in respect of individual projects in the developing countries are widely known and will be referred to very briefly here.

In the first place, in view of the precarious nature of the price mechanism, product and factor market prices do not always reflect the real cost to the economy of a specific undertaking. An effort has been made to deal with this obstacle through the system of shadow prices. In this respect, the following may be quoted from the report of the Seminar on industrial programming, held at São Paulo:

> "... it has been suggested that a plausible approximation of the 'accounting prices' could be provided by a trial and error method. This would involve selection of a certain set of factor prices on the basis of which the profitability of the candidate projects would be calculated. On the basis of these calculations the projects would be ranked in declining order of profitability and, by comparing the resource requirements of these projects against the resources available, a maximum set of projects would be determined corresponding to the limit of the available resources. It would be, of course, a sheer and unlikely coincidence if the first set of selected prices were to lead to simultaneous exhaustion of all resources by the set of projects determined under this procedure. It is more likely that the supply of only one resource would be exhausted, with an excess of others still being available, which implies that the price of the exhausted resource has been set too low. Through successive adjustment of prices and iteration of the described procedure, a set of projects would be found that satisfied the optimum solution, since it would absorb all the available resources."[15]

This over-all procedure for successive applications of shadow prices in project selection seems conceptually correct as a means of maximizing the product deriving from the resource in shortest supply, but would probably prove unfeasible owing to the practical difficulty of inducing the private sector to invest and operate on the basis of shadow prices. It would be necessary to "correct" the market prices by indirect measures (mainly taxation), in order to persuade a part of the private sector to follow the desired course. While it is recognized that vast possibilities are opened up by an economic policy deliberately aimed at correcting the deficiencies in the price system, it is nonetheless unrealistic to expect too much from such a course in the sphere of industry (as opposed to public [illegible]). As stated below, the inducement to [illegible] investment decisions from the standpoint of shadow prices is more practical within the [illegible] sectoral programme and as an integral part thereof.

Secondly, there arises the set of [illegible] relating to the difficulty of introducing [illegible] of a dynamic nature in profitability [illegible] since such criteria are based on current [illegible] prices, they cannot include certain future [illegible] economic policy aims in terms of political [illegible] choices relating to personal and [illegible] distribution, the structure of production, [illegible] ence of regional development [illegible] shadow prices [illegible] clearly [illegible] such choices.

Another factor which makes it difficult [illegible] a group of projects in order of priority [illegible] or mainly in terms of their [illegible] or social, without regard to a pr[illegible] a development strategy, is the [illegible] economic framework within which [illegible] calculated. Some causes of this [illegible] Latin America's experience, are given below.

Conditions of chronic inflation [illegible] distort the bases for calculation by [illegible] product and factor prices.

An unstable market reserve [illegible] against imports, in which [illegible] constantly changing both as regards the products concerned and the level of protection [illegible] of the foreign payments situation.

Fluctuating exchange rates [illegible] stable basis for the international [illegible] of prices and costs which is necessary for reaching a decision on whether or not to engage in local manufacture as a possible alternative to imports.

Other factors which tend [illegible] tests for particular projects [illegible] priority criteria [illegible] developing [illegible] be taken into account in establishing the projects.

[15] United Nations publication, Sales No.: 64.II.B.6, p. 45.

concerned. In this respect, the situation may be summed up as follows:

In the preparation of a given project—for the establishment of new manufacturing enterprises or the expansion and reorganization of existing activities—determination of the physical unit inputs entails selecting a specific level of efficiency in the combination of factors of production; this efficiency largely depends on the enterpreneurial factor and it is often very difficult to forecast with any degree of accuracy the entrepreneurial capacity that will be revealed in each particular case;

Because of the close interdependence linking the new enterprises in countries in the earlier stages of development, the unit prices of inputs, as well as, in certain cases, the physical inputs themselves, are often a matter of guesswork;

The lack of data especially designed for developing countries frequently leads to the use of input estimates based on the experience of the industrialized countries, whose performance levels are clearly far above those attainable by the developing countries.

E. Channelling of investment through sectoral programmes

Part of the solution for problems such as those mentioned above might lie in the systematic application of sectoral programming with a high technological content, based on diagnoses of existing industry and the evaluation of the capacity to develop new sectors through the system of approximately estimated potential costs for sectors of industry and not necessarily for industrial projects. The Economic Commission for Latin America (ECLA) has worked consistently along those lines for some years and it might be useful to present some examples based on the experience gained.

In the first place, there is the question of shadow prices. If it is accepted that they have been calculated correctly, the problem is how to induce the private sector to apply them, in the sense of using them to govern their investment decisions. The solution usually put forward is differential taxation which, however, raises insurmountable practical difficulties. While such a measure might prove of value for public sector decisions, it is hard to see how it could "operate" in the case of the huge investments which the private sector is constantly making. This problem could nevertheless be dealt with successfully through a series of constraints within the framework of sectoral programming. A programme for modernizing and re-equipping the textile industry, for example, makes it possible to obtain investment decisions (choice of techniques and equipment most compatible with the relative proportions of the factors present in each case) which are consistent with existing industrial strategy aims and which, of course, will certainly not coincide with those resulting from spontaneous entrepreneurial initiatives.[6]

F. The problem of future efficiency levels in project elaboration

Another problem mentioned above—that of uncertainty in regard to the performance of production factors—is no less serious an obstacle to the application of the conventional project evaluation and selection criteria and could also be resolved within the framework of sectoral programming, as part of a specific industrial strategy. Latin American industry—particularly in sectors applying discontinuous processes, such as in the metal-transforming and textile industries—are characterized by efficiency levels which are both very low and represent marked variations from the mean on the part of individual enterprises. These variations are not necessarily related to parallel variations in the level of capital formation or specialization of the enterprises considered. The basic element in the variations encountered—which exist to a greater or lesser extent, although always to a marked degree, in practically all sectors of industry—is internal organization, which reflects the unlimited variations of entrepreneurial capacity.

In this respect, some of the data relating to sectors of industry which have been studied recently by ECLA are illuminating.

To take Uruguay's metal-transforming industries,[7] for example, in a selected group of sixteen enterprises engaged in various types of metal-transforming, though fairly homogeneous as regards their products and the equipment used in their manufacture, it was found that the output per worker ranged from $2,300 to $9,400, or a variation of between 1 and 4, the mean being $5,500 per worker for the industry as a whole. A similar variation reflects the wide range of conditions obtaining in that industry from the standpoint of internal organization and operational efficiency.

In Brazil's textile industry, there is an even wider variation in manpower performance from one enterprise to another.[8] The average output of the cotton-spinning industry is 2,000 grammes per man-hour. The figures for individual enterprises, however, range from under 500 grammes to over 6,000 grammes per man-hour. This great difference in productivity figures from mill to mill is not, however, related to parallel variations in plant size, or

[6] The modernization and re-equipment programme prepared for Brazil's textile industry illustrates this possibility. In order to avoid the large-scale displacement of manpower as a result of re-equipment (nearly 80 per cent of the machinery in use is obsolete) at too high a level of automation, a study was made of the alternative techniques and equipment available and a scheme proposed for carrying out machinery replacement in such a way as to minimize unemployment, without unduly sacrificing operational efficiency and costs. This investment policy would be applied through a system of incentives, which would make the granting of tax and financing privileges conditional upon the adoption of techniques and equipment considered suitable within the context of a programme formulated for the whole textile sector. This would give rise to entrepreneurial decisions in accordance with a system of implicit shadow prices. See *The textile industry in Latin America: II Brazil* (United Nations publication, Sales No.: 64.II.G.2), chapters VIII and IX.

[7] *La industria mecánica del Uruguay* (E/CN.12/743).

[8] *The textile industry in Latin America: II Brazil* (United Nations publication, Sales No.: 64.II.G.2), chapters V and VI.

in the level of modernity or obsolescence of the equipment or product; or in this case, variations in the fineness of the count. According to a multiple correlation study based on the data deriving from extensive field research undertaken by ECLA,[9] those factors are not chiefly responsible for the variations in manpower productivity.[10] This means that the factors carrying most weight are those related to internal organization and production planning, that is, to entrepreneurial capacity (in the broadest sense of the term), as displayed in industry.

Accordingly, the following difficult question arises in connexion with industrial programming, particularly the evaluation and selection of projects: what levels of factor performance should be regarded as acceptable in the preparation of projects? Those that correspond to the average for the sector? Those attained by the most efficient enterprises in the sector? Or, simply, those resulting from engineering estimates prepared in direct relation to the project concerned? Generally speaking, such estimates represent the "best knowledge available", and indicate levels of operational efficiency similar or slightly inferior to those prevailing in more advanced countries.

None of these procedures is free from drawbacks. The average level of efficiency is generally very low, so that programme-makers are reluctant to adopt it. If optimum efficiency in the existing industry is not much above average, the same difficulties arise, while if the level reached is really high, its adoption creates some doubt as to whether the new enterprise will be able to attain it. Any new undertaking must have its roots in the industrial environment in which it is established, and these roots imply dependence on a corresponding number of factors that affect the prevailing levels of operational efficiency, such as availability of skilled labour, quality and cost of raw materials, spare parts or parts and services purchased or sub-contracted within the country or area concerned.

The way out of this dilemma might lie in the adoption of a given level of operational efficiency and the detailed specification of performance requisites. The viability of these postulates, however, will have to be ensured concurrently with the execution of the individual project under consideration, and this seems possible only if a transition is made from the individual project level to the programme level for a group of relatively self-supporting enterprises or for a whole industrial sector. Such a programme, covering the relatively expeditious establishment of basic conditions external to the enterprise that are compatible with the performance hypotheses adopted, thus becomes as important for the success of the project to be evaluated as its own internal characteristics, or more so.

G. Example of a sectoral programme for the metal-transforming industry

The programme recently prepared by ECLA for the light precision engineering industry in Uruguay (E/CN.12/743) shows how these difficulties can be by-passed. A few words will suffice to explain the nature of this programme.

Uruguay's existing metal-transforming industry shows a level of development which in quantitative terms is distinctly high in relation to the size of the country, since its output satisfies about 60 per cent of apparent domestic consumption of the products of metal-transforming activities (consumer goods and capital goods). But, for reasons which it would be out of place to dwell on here, levels of technology and operational efficiency in the existing enterprises are low, and compare unfavourably with those found in the adjacent countries (Argentina and Brazil). Nevertheless, in an analysis of the possibilities of promoting export industries, carried out within the framework of an over-all evaluation of development propects and in connexion with the formulation of a ten-year economic and social development programme, the conclusion was reached that it would be both desirable and feasible to promote the installation of a group of precision-engineering industries which could undertake the manufacture of measuring instruments (for electric energy, liquids etc.) and parts or components for machinery and equipment, with a view to exporting them to other Latin American countries. This programme was formulated in the report mentioned, and consists of the establishment of a group of ten industrial enterprises, employing rather more than 2,000 workers, of whom a high proportion would be skilled operatives, and requiring fixed investment in the neighbourhood of $12.5 million. Its viability, despite the inefficiency of the existing industry and the strong competitive position of Uruguay's two most highly industrialized neighbours, is grounded in the characteristics and features described below, which have been deliberately incorporated in it.

First, the products selected for incorporation in the programme, for technical reasons, must be manufactured in plants with a high degree of vertical integration, sub-contracting being practised on a very small scale. Consequently, this nucleus of new enterprises is virtually independent of the existing metal-transforming industry.

Secondly, most of the manufacturing lines to be installed in the country will be launched by foreign financial and industrial groups with international experience and standing in the corresponding activities. These groups will bring in at one and the same time the know-how, the equipment and a considerable proportion of the technical personnel required in the early stages of operation.

Thirdly, a special intensive programme of advanced training will be undertaken with a view to

[9] *Ibid.*

[10] The results obtained show that in all the establishments considered only 14.4 per cent of the variation in productivity is attributable to obsolescence or size. Some more detailed examples relating to establishments manufacturing the same yarn count help to confirm the vital importance of such factors as organization and administration in determining productivity levels. For instance, in spinning mills producing yarn count 10 it will be noted that plants of the same size (about 3,000 spindles) and with the same high level of obsolescence show a productivity range of from 1 to 3 (268 to 708 grammes per man-hour, respectively). The same is true of other counts. See *The textile industry in Latin America: II. Brazil*, pp. 78-79.

meeting the needs of the precision engineering sector and gradually replacing specialized workers from abroad. Special programmes would also be started on technical standards and technological research, in existing institutes, which would thus be able to improve their methods of work.

Finally, the precision products envisaged in the programme would require, in order to be produced economically, production runs of a magnitude exceeding the needs of the domestic market of either Argentina or Brazil alone. Geographical proximity and the consequent low transport and marketing costs would therefore be, instead of an obstacle, a factor favourable to the location of a large precision-engineering industry in Uruguay.

Hence the aim should be to plan the establishment in Uruguay at one and the same time of a group of industries with a technological level (in terms of the processes and equipment used, value added *per capita* or any other concept) appreciably higher than that existing in the equivalent industry.

How can the economic viability of such an undertaking be assured? Firstly, by the [illegible] different nature of the new activities planned and secondly by the simultaneous application of the group of measures referred to, which constitute a sectoral development programme. If, for instance, the standards institute or training body does not carry out the special programme assigned to it, the viability of the group of precision engineering plants will be endangered as it would be by the defective internal organization of the individual firms concerned.

In the context of such a sectoral programme, the analysis of the profitability of each individual enterprise loses its former importance as the criterion governing the decisions involved. That is because the productivity resulting from the projects is directly linked to the physical input unit adopted, which does not reflect previous experience in the industrial [illegible] which the new enterprise will have its roots, but rather the performance levels of more advanced countries, the transfer of which to Latin America will largely depend on the effective application of a group of measures extraneous to the individual enterprises (sectoral programme). These performance levels thus inevitably entail a relatively high degree of arbitrariness, and no final decision could be securely based on them.

Thus the decision to develop an export sector within the metal-transforming industry was taken as part of a general strategy of development, which for various reasons was based on a general policy of export encouragement. It in no way depended on any prior verification of the profitability of the projects concerned in comparison with that of other projects in other industrial sectors. Other export industries are being planned too, but as part of programmes for the expansion and modernization of the industrial sectors concerned (such as the woollen industry or the extraction and primary processing of mineral resources) within a general strategy of industrial development based on the concept of balanced development. Possibly a comparative analysis of profitability would show the proposed metal-transforming industries to be less profitable than the woollen textile industries. However, the development of a precision-engineering sector has advantages, in terms of introducing a dynamic growth facter and of obtaining foreign exchange, which greatly outweigh those to be derived over the short term from investments selected strictly, or mainly, in terms of maximum profitability. Moreover, in view of the element of guesswork involved in the estimates of the costs of any project, especially when such estimates are made on a dynamic basis, it is hard to see how these fundamental investment decisions can be based on them.

The establishment of individual projects and their evaluation from the profitability standpoint is nevertheless of basic importance, and will no doubt be effected in connexion with the precision-engineering programme for Uruguay (and other programmes of the same kind); but as a means of ensuring a full and rational planning of each undertaking rather than as the main criterion in taking decisions or as a guide to the ranking of various alternative undertakings in order of merit.[11]

II. Other applications of project evaluation and selection

The brief observations set out above are not intended to refute the necessity and importance of methodical procedures for project preparation, evaluation and selection. On the contrary, the importance of such procedures is widely recognized, and all that is desired is to sound a note of warning against their use unless it is adequately linked to an explicit and operative concept of an industrial strategy as part of a development plan or programme. Hence, caution is also advised against over-confidence in applying conventional evaluation and selection criteria, so as not to give a false appearance of accuracy through the application of refined evaluation procedures to data of doubtful value.

On the other hand, it would not be reasonable to consider the subject of project evaluation solely from the standpoint of the selection of investments within the framework of an industrial strategy.

First, the usefulness of a project is not confined to its serving as the basis for the decision to invest in the undertaking concerned. Even where this decision is imposed by other considerations and criteria, project evaluation is essential to ensure a rational, explicit and detailed assessment of an undertaking, thereby facilitating the many measures that have to be taken, both within and without the enterprise, to ensure its success. It should be noted further that the elements that are the basis of the economic calculation of a project of any kind cannot be determined with any degree of certainty; in other words, they are subject to some degree of risk (in relation to future prices and costs and

[11] Mention should also be made of the programme for the expansion of Venezuela's metal-transforming industry through import substitution, which is now being carried out (see ECLA, "La industria mecánica de Venezuela: un programa de sustitución de importaciones para su desarrollo" (E/CN.12/737), and Corporación Venezolana de Fomento, *Programa de expansión de la industria metal-mecánica* (Caracas, April 1965)).

short- and long-term performance levels etc.). If the success of any venture is to be assured, the elements that entered into the economic calculations must be kept within the original estimates, and this calls for a specific and detailed knowledge of what those projections are and what hypotheses they represent.

Second[illegible] project evaluation and selection can have the more limited but nonetheless useful aim of establishing an order of merit among a group of projects in terms of profitability, whatever the criterion or criteria according to which profitability is defined. This is the approach used in project evaluation, for example, in the sphere of national development institutions, for the purpose of distributing a fixed and limited sum among a series of possible uses, where the total financial requirements exceed this sum; or this approach may be used merely to determine the economic viability of each undertaking under consideration, rather than to establish an order of merit among them all.

Mention should also be made of the usefulness of project evaluation in a negative sense, that is, for the rejection of ill-conceived or improperly formulated proposals.

1. The problem of the shortage of projects

Lastly, a few words are in order on the problem of project preparation.

There is a tendency in certain developing countries, at least in Latin America, to explain the obstacles in the way of a more rapid industrial development as the result of the lack of projects, or the difficulties in preparing projects. There is an undeniable shortage of projects formulated in the industrial field, but the dearth of projects cannot be automatically explained by the lack of agencies devoted to their preparation, or unsatisfactory performance by these agencies. This does not appear to be a mechanical problem of preparation, nor is it likely to arise in the absence of certain more fundamental difficulties. What seems to happen in many, if not most, developing countries, is that conditions are lacking that favour the formulation of projects, such as the following:

The existence of a properly qualified entrepreneurial class prepared to take initiatives and assume risks;

A readiness on the part of this entrepreneurial class to assume debts and to share the ownership and control of their enterprises, thus far mainly characterized by what may be termed a family type of ownership and management; for an individual enterprise, rapid growth, in the sense of a growth more rapid than is permitted by its capacity for self-financing (reinvestment of profits), means sharing ownership and control, which is not easily achieved; hence there is often reluctance to expand too rapidly even among the most dynamic enterprises in countries where there is a great industrial upsurge;

An adequate economic policy (monetary, fiscal, and relating to the infrastructure);

A broad knowledge of resources, markets and technologies, essential for entrepreneurs' investment decisions, especially when embarking on new fields of activity; in most cases it is currently beyond the capacity of industrial *entrepreneurs* in developing countries to obtain such knowledge.

Absence of these factors, in different proportions in each case, would appear to lie behind the [illegible] excuse that projects are lacking. A change in this situation, by means of the group of measures that constitute an effective industrial policy, will make it possible to create the right conditions for taking investment decisions, and hence for the formulation of the corresponding projects.

The experience of SUDENE[12] in promoting a broad and well-organized programme for the modernization and re-equipment of the textile industry in north-eastern Brazil is a good illustration of the above arguments. This programme, begun in 1962, provides extensive tax privileges and long-term financing for enterprises that prepare projects for modernization and re-equipment and submit them for approval to the regional development authority.

The actual preparation of projects has been [illegible] encouraged and facilitated by SUDENE, which [illegible] worked out a model project to serve as a guide [illegible] enterprises.[13]

In July 1964,[14] after nearly two and one-half years of application, a balance sheet was drawn up for the re-equipment of the textile industry in north-eastern Brazil. This showed that, despite the high hopes formed, the results were disappointing as regards project elaboration.[15] The situation may be summed up in a few words. Of the sixty-one industrial establishments covered by the programme, only thirty-three submitted projects. Of the twenty-eight that failed to do so, about eight already had sufficiently up-to-date machinery and consequently were in no urgent need of replacing it, that being the central aim of the programme. As for the other twenty mills, some were simply not interested in

[12] Superintendência do Desenvolvimento do Nordeste [illegible] Brasil (the agency responsible for the development of the north-eastern region of Brazil).

[13] This interesting procedure deserves special mention. In view of the recognized technical and administrative weaknesses of the industrial establishments to which the re-equipment programme related, SUDENE considered that they could not be expected to work out a project on the basis of which they could apply for financing and tax privileges. Hence SUDENE itself worked out a model project with the idea of reducing the work of drawing up the project to the filling up of tables that provide, in an organized form, the data essential to the evaluation of the financial requirements and technical and economic needs of each enterprise. The model project, in addition to being of considerable help to the enterprises themselves, greatly simplifies the work of analysis by permitting uniform treatment of each aspect of the project. According to statements by SUDENE technicians, this method of dealing with the presentation and analysis of projects has [illegible] and has since been extended to other [illegible] sectors.

[14] This is the most recent date for which these data are available.

[15] These favourable expectations were based *inter alia* [illegible] the dynamic nature of the agency responsible for the programme (SUDENE), the [illegible] incentives offered and the existence of sufficient funds both in national currency and in foreign exchange already allocated to the programme.

making the investment required by re-equipment, while others did not even have the technical and administrative capacity to fill out the model project forms.

Moreover, not even all the mills that had presented projects maintained their interest to the point of obtaining the financing required. Of the thirty-three projects presented by July 1964, twenty had been approved and seven were being analysed by SUDENE or by the Banco do Nordeste do Brasil.[16] Six other projects had been returned for reformulation, either because they contained serious mistakes or because the administrative structure of the enterprise did not appear equipped to execute the project. No project had been rejected, even when, as happened in some cases, they had had to be continually reformulated, with the assistance of SUDENE experts, because of their defects as presented.

Lastly, in relation to the twenty projects for complete re-equipment that were approved, only two enterprises decided to obtain the necessary financing from the financial agency. For the remaining eighteen projects, the *entrepreneurs* concerned showed themselves reluctant to embark on their execution, either through misgivings about undertaking commitments in foreign currency or, in some cases, without offering any plausible excuse.

This is a striking illustration of the difference between preparing projects and initiating or continuing a process of industrial development. A concentrated, persistent and well thought out effort to promote projects by a regional development agency with abundant technical and financial resources proved incapable of overcoming obstacles to development that go deeper than any mere shortage of projects.[17]

[16] The financial agency which operates under the jurisdiction of SUDENE.

[17] This is not the place for an analysis of these obstacles. Suffice it to mention that they seem to relate mainly to the weakness of the industrial environment in the Nordeste region, and also to the lack of minimum technical and administrative capacities in most of the textile enterprises in that region.

III. PROJECT EVALUATION AND THE CONSISTENCY OF THE PLAN

by G. Cukor*

A. Interrelations between individual projects and over-all and sectoral development plans

Efficient use of available resources is the main prerequisite for the development of every economic unit, regardless of economic and social system, be it socialist, based on public ownership of the means of production, or a market economy, based on private ownership of those means, and more or less independently of the size and scope of the economic unit, be it a single enterprise or plant, an industrial branch, a region or the economy of a country as a whole. Obviously, efficient use of resources is the more important if the country's resources are scarce and rapid development is required for social, political or other reasons. This is a common situation in the developing countries of Africa, Asia and Latin America, where there is a marked scarcity of resources, together with an urgent need to accelerate economic development.

Different economic methods have been devised to advance the efficient use of scarce resources, the most important being the elaboration and evaluation of projects, permitting the selection of the most efficient ones and the planning of regional development on a regional, sectoral or over-all (country) scale.

As is well known, a project may be defined as a systematic set of numerical or other data and calculations, on the basis of which the consequences, costs and earnings and, more generally, the advantages and disadvantages of the production of specific goods and services can be reviewed and appraised. A project usually concentrates upon increasing the production of goods and services (although reconstruction, which is aimed at cutting costs, may also be the subject of a project) by putting new capital equipment into operation. Consequently, the role of capital as a scarce resource is emphasized, although other scarce resources, for instance labour and foreign exchange, also enter into the set of data. Project evaluation is the measuring of the efficiency of a project according to a scale formed by predetermined criteria. Such measuring can be carried out on the basis of a single criterion or of a complex of criteria, and from the point of view of a single private *entrepreneur* or from that of the society as a whole. The latter type of evaluation presents more methodological problems, with which we shall deal quite closely in this study.

As already mentioned, the evaluation of a project's efficiency is meaningful only in relation to a given predetermined criterion or to several criteria. The basic criterion from the point of view of the private *entrepreneur* who has invested capital is profitability, and from the point of view of society as a whole it is the increase in national income, but the methods of measuring these may differ. The concept of efficiency may sometimes be considered an absolute one, so that a project is said to be efficient *per se*; for example, from the point of view of the *entrepreneur* every object that results in a profit may be termed efficient. However, in practice efficiency is usually understood as a relative concept, one project being regarded as more efficient than another. This is the appropriate concept from the point of view of the economy as a whole, because there are always more possibilities of increasing national income by investment than available capital or other resources.

To achieve a high rate of economic development or sometimes even to initiate economic development it is necessary to achieve or at least to approximate the most efficient use of resources, i.e. their optimal allocation, given the available resources and opportunities and subject to the accepted efficiency criteria. This optimal allocation cannot be achieved exclusively on the basis of the evaluation of individual projects. The reason is easily understood. Let us suppose that, in a country, region or industrial sector, all eligible projects are evaluated and ranked in order of priority, according to the accepted criteria, and that even the amount of such scarce resources as capital, labour force and foreign currency is known. In that case it would seem sufficient, on a superficial view, to select the "best" projects according to their decreasing order of priority and to stop at the point where the sum of the resources, for example of capital, required by this set of projects, is exhausted.

Such a method, however, would not yield an optimal and perhaps not even a feasible result. In fact, there is compatibility among some projects and a special kind of competition among others. The former are vertically connected with one another, the one producing the factor, for example raw material, required by the other, while the latter, being horizontally connected in some respects, utilize the same factor or product to satisfy the same requirement, producing for the same market. If in the latter case the amount of the available factors or the size of the market is below that required by the projects, the simultaneous realization of those projects will be inconsistent. However, the evaluation of single projects according to efficiency criteria generally does not answer the question of consistency. Therefore the projects have to be evaluated not in isolation but taking into account their complex relationship to the rest of the economy.

* Institute of Economics, Budapest.

In addition, the [illegible] emerging and developing [illegible] having the operation of the [illegible] that prevailing during the [illegible] of the project [illegible] undertaking in question.

The economy is represented not only in its [illegible] the development [illegible] which is increasingly considered as the main instrument of government in furthering economic development, in framing and implementing economic policies and in allocating resources according to social priorities. It is well known that in centrally planned socialist economies development plans have crucial importance since they determine long term goals and the development of strategically important sectors. Economic development plans are also worked out in more or less detail in several countries where the economy is largely based on private ownership of the means of production, in market economies. The role of plans in the latter case is of course different from their role in the former. Here the plans represent partly a forecast, although based on serious studies and consultations with the economic agents including private ones, and partly a framework for government economic policies and actions. In these cases the plan is also used as a tool giving more cohesion to economic development even in the private sector of the economy and providing information [illegible] concerning the [illegible] path of development as well as a firm basis for their own decisions.

Developing countries also seem to rely more and more on economic development plans increasingly considered as an indispensable instrument even in economies based mainly on private enterprise. The reason is a complex one and cannot be discussed in this study. It is connected with the great importance government action has on economic development in such countries, and with the fact that political, economic and social goals can be expressed and given effect [illegible] directly through plans.

The development plan reflects a balance showing the requirements and availabilities of at least [illegible] products and services [illegible] capital [illegible] labour and foreign exchange. It can be [illegible] the mutual [illegible] consistency [illegible] probably prevail after the [illegible] In other words, the [illegible] can be appraised [illegible] its relationship to the rest of the economy. However, before dealing with [illegible] it seems useful to point out some characteristics of individual projects on the one hand and of development plans on the other.

A project deals as a rule with a single [illegible] a given plant. This [illegible] is then investigated in considerable detail, including the [illegible] of all eligible technological alternatives, and [illegible] performance [illegible] with the help of precise technological and [illegible]

with a somewhat restricted field: project evaluation typically does not include an appraisal of the relations of a project with the rest of the economy; it emphasizes the efficiency of the project concerned and does not deal with the problems of consistency. The plan on the other hand is concerned with the economy as a whole or some major part of the country, such as an industrial sector or region of the country. Such plans deal with much more complex economic units than the project, utilising average technological coefficients and containing only a few if any alternatives. There is emphasis on the interconnections of the economy, on the equilibrium of requirements and availabilities, in other words on the consistency of the plan.

We distinguish among short term, medium term and long term plans, with a duration of approximately one year in the case of the first, of between three and seven but most often of five years in the case of the second, and of ten years or more in the case of the third. Obviously medium and long term plans are principally concerned with project evaluation because the implementation of the projects generally takes some time and the results of their operation will be felt over periods of more than one year. Short term plans also play a certain role as some projects can be carried out more rapidly than others, and as the building and construction phase of a project has to be examined in a short term plan, for example in order to ascertain the availability of manpower, capital or foreign exchange for building and construction.

II. CONSISTENCY AND EFFICIENCY IN SECTORAL PLANS

Having this in mind, we may consider the stages listed below as the main stages of medium and long term planning; these stages are of course in close relationship with each other:

Preparation of planning by a comprehensive survey and analysis of the technical and economic interrelations and main development tendencies of the area covered;

Forecasting and prognosis of the expected development of the economic process or phenomenon in question;

Planning of the equilibrium of requirements and availabilities of commodities and funds;

Investigation to achieve the most rational allocation and use of resources; this can be considered as the concluding phase of planning and at the same time an important basis for practical economic decisions. The most essential part of this last stage obviously is the evaluation of projects and the selection of the projects to be carried out.

The content of these stages may be illustrated by an extremely simplified example taken from the production and utilisation of electric energy. The consumption of electricity is very closely related to almost every economic activity, from services and agriculture, changes in industrial production, to the increase in the level of living and changes in the consumption pattern of the population. At the same time the shortage of electric energy is [illegible]

[illegible] intensive [illegible] in the case of hydro-developments, a considerable amount of [illegible]. This sector has therefore both of the output and of the input side [illegible] with the [illegible] of the economy.

The essential content of the four stages may thus be briefly summarized as follows:

Preparatory surveys of the area covered, including review and analysis of past development and recent state of electricity consumption in the different sectors in the context of their economic activities and levels and changes in the technical coefficients of electricity consumption, and review and analysis of the technical and economic characteristics of the plants producing electric energy, and comparison of the main data of electricity consumption and production with those of other countries.

Forecast of demand for electric energy by extrapolation based on the development that has taken place in past periods, while the consumption of electricity is considered as a function of time. The mathematical and technical tool in this method is the extrapolation of trends with the basic assumption that the effects of the past will prevail in the future. This assumption of course is not justified, but the advantage of the method is that even without data on the expected development of other sectors, it can serve as an initial hypothesis.

The general form of such extrapolation is, for example, an exponential function

[illegible]

a parabola of higher degree

[illegible]

or even a linear function as a special case of the former

[illegible]

where E is the demand for electricity, [illegible] constants to be determined on the basis of past trends, and t is time.

Some forecasts have been worked out by such methods. For example, a forecast of electric energy consumption in Spain was given as follows:

[illegible]

E = demand for electricity [illegible] with 1950 as the base year.

The other method of forecasting the demand for electricity uses correlation calculations and is based on the causal connection between the use of electricity and its main factors. Here correlation is established between the demand for electricity and such economic parameters as are in close connexion with the demand, for example national income for total electricity consumption or the indices of industrial production for the industrial use of electricity. This is a suitable method for comparatively precise approximations compared to the main development ratios and proportions of the economy.

The general form of this type of function may be represented as follows:

[illegible]

[illegible]

Where again E is the demand for electricity and [illegible] the factor influencing [illegible]. This type of relationship has been utilized [illegible] other forms to forecast electricity consumption, for example the demand for electricity in [illegible]:

[illegible]

[illegible] index number of [illegible] 1950 and [illegible] of the industrial electricity consumption in the Netherlands.

[illegible]

[illegible] index number of industrial production [illegible] index number of [illegible]

In the first and second stages the problem of consistency [illegible] forecast of the foreseeable [illegible] energy correlated with the rest of the economy [illegible] related to only one variable [illegible]. In the [illegible] stage some such relationship to the remainder of the economy [illegible] established and the demand for electricity is made dependent on such [illegible] aggregate economic indicators as the national income and on the volume of industrial production. However, accepting this computation implies [illegible] assumption that the relationship between electricity consumption and national income [illegible] production which was observed in the past [illegible] in the future. As we know, this [illegible] the case and even most [illegible] precise method is required [illegible] consumption of electricity.

This method consists basically in [illegible] future electricity consumption [illegible] economic sectors [illegible] the demand for electricity [illegible] economic activity in the sector [illegible] electricity required to produce [illegible] of textile or machinery production [illegible] technological coefficient. The [illegible] of the single sectors are then added [illegible] total demand for electricity. [illegible] the forecast [illegible] electricity which [illegible] and consumption of electric energy [illegible] should be consistent [illegible] planned consumption [illegible] into account possible [illegible] in production [illegible] the existing producing [illegible] construction of new power stations.

The estimation of the balance of [illegible] exact calculation [illegible]

[illegible]

[illegible]

of planning in the socialist countries where, as we know, various balances play a very important role. However, balances for electric energy are worked out even in countries where otherwise there is no formal planning of the economy. As already mentioned, the planned balances of electricity are subject to the consistency criterion. In the case of comprehensive planning, the whole economy is reflected in more or less detailed balances. The activities of the different sectors, for example steel or cement production, underlying the planned consumption of electricity, are taken out of the respective balances, which have to be consistent too in the sense mentioned above.

Whether part of a comprehensive economic plan or not, even a consistent plan for electricity production and consumption does not fully resolve the efficiency problem, that is, the problem of the most rational utilization of resources. The solution of that problem is considered in the present paper as the fourth stage of the planning process. However, in connexion with consistency and efficiency, it should be pointed out that from the social point of view consistency or equilibrium between requirements and availabilities is a necessary although not sufficient condition of efficiency. The reason is clear. To take the same example as before, if a power plant were to remain idle for a considerable time for lack of demand, such "inconsistency" would certainly be a wasteful, inefficient utilization of resources. The opposite, namely lack of productive capacity to satisfy an existing demand, would also result in waste, for example in the idling of other plants that could not produce for lack of electricity. In principle, the necessary equilibrium between requirements and availabilities, between offer and demand, could be achieved either by the decisions of private enterprises through the market mechanism or through development plans, or even by some combination of both.

In the socialist countries the basic method for the strategically important sectors is that of planning, and the role of planning seems to be increasing also in the developed market economies. However, structural changes are generally rather slow in developed economies; the share of new undertakings in the input or output is not so great, and this facilitates the adaptation of production to changing situations through the market. In the developing countries, the structural changes might be very rapid, the input or output of some new plant proportionally very important and the adaptability of the market very imperfect. This probably is one of the reasons influencing the Governments of developing countries in favour of working out economic development plans.

As pointed out above, consistency is a necessary but not sufficient precondition for efficiency. Coming back to the example of the electric energy sector, let us suppose that the plan includes an increase in the production of electricity by a certain amount and that, the reserves of the existing power stations being exhausted, new sources of electricity are required. The balance in this case will answer only the questions "what" and "how much" to produce, but not the question how to produce it in the most efficient way. Generally many possibilities are open. To mention only a few: electricity can be produced in thermal and hydroelectric plants; in the first case the fuel can be natural gas, fuel oil or different types of coal. The size and technical characteristics of the plants can be very different. In some cases the importation of electricity might be considered as an alternative to domestic production. Obviously more than one of these different technical solutions can be achieved, or even some combination of them. In addition, there are important choices to be made concerning the location and construction period of plants. It is less expensive to build a large power station and thus to provide for the future increase in demand, than to build two power stations at different periods, but the first alternative requires an immobilization of resources which could be postponed to a later date. All these possibilities can be investigated and compared and the most efficient solution or combination of solutions selected by the elaboration and evaluation of projects. In this respect project evaluation is an indispensable part of the planning process.

To sum up the interrelationship between project evaluation centred on the efficiency criterion and the consistency of the plans, such interrelationship is particularly important if there is a need for evaluation from the point of view of the economy as a whole. From the point of view of private enterprise the profitability of a project can be established without taking into account its influence on the rest of the economy, provided that the data underlying the project, such as prices, technological coefficients, availability of raw materials and possibilities of selling the products, are correct.

From the social point of view, however, the whole situation created by the implementation of the project should be considered, and here consistency is a necessary precondition of efficiency. On the other hand, a consistent plan does not necessarily provide for an efficient solution or combination of solutions; efficiency can be ensured only by the preparation and evaluation of projects.

From the point of view of the single project or system of projects, the interrelationship in question can be considered as one in which the plans provide the necessary links for evaluating the projects in connexion with the remainder of the economy. The effects of the project on the rest of the economy can be classified as direct or indirect. The direct or primary effects of a project follow immediately from the production process: output, material consumption, labour force employed, capital required, value added. Measurement and evaluation of such primary effects and their inclusion in production and consumption plans, if such plans exist, is not particularly difficult. In our example, the production of electricity, fuel consumption and manpower used in one or more power plants have to be taken into account. There are, however, other effects on the economy much more difficult to measure and evaluate.

The putting into operation, for example, of a new power plant meeting demands [illegible] will have its effects in many sectors of the economy.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

rected prices and because the correction of prices includes only a few basic factors and not all inputs and outputs entering into a project the prices of which may differ from the true (or opportunity) costs, there is little hope of attaining consistency, and consequently efficiency, by that method alone.

One application of mathematical programming proposed by several authors has some similarity to the preceding approach. The solution of a linear programming model, optimizing (maximizing or minimizing) an objective function within the limits of given constraints of scarce resources will produce two sets of data. The first is the optimal programme of activities, which will be discussed later in greater detail. In the case of an investment programme this will be the selection of the projects to be carried out together with the size of the project or the corresponding activity. The second set of data comprises shadow prices for every limited resource and every product or activity appearing in the model. This [illegible] set of prices has a special relationship to the optimal programme. When evaluated on the basis of these prices there will be [illegible] equality in the value of costs and the value of products for those and only for those activities which also appear in the optimal programme. But the optimal programme is consistent by definition, [illegible] if necessary the upper [illegible] appearing among the constraints of the model. Were it possible to construct [illegible] mathematical model for the whole economy and discover the shadow prices for [illegible] and resource we should have [illegible] investment and production [illegible] indirect effects. [illegible] in the ECLA *Manual on Economic* [illegible] based on the economic [illegible] Chenery [illegible] follows: "If it were [illegible]

[illegible]

in the case of power stations, taking into account the effects of the proposed power station on the production and consumption of electricity and fuel, on employment and on the resources required for building the plant; the other direct effects probably being small enough to be disregarded. Of course, if the new plant or plants represent a considerable part of the total capacity in this sector, as may easily occur in a developing country, or if the industry is a completely new one, then direct inputs other than basic raw materials and labour have to be considered too.

As for the indirect effects, planning with balances is a multistage process, the changes resulting in one balance being taken into account successively in the other balances. In our example: the fuel requirement of the new power station will modify the balance of the given type of fuel, modifying, in the next step, inputs of this sector, which will in turn have indirect repercussions on the inputs and outputs of other sectors. If a high level of precision is required, a good number of steps may be needed to trace the effects of chain reactions, as well as considerable computational work to achieve a high order of consistency among sectors, particularly since the indirect effects operate in both directions and may even have circular effects. That would mean, in our example, that coal was needed to produce electricity while electricity and steel were needed to produce coal, and both coal and electricity were needed for steel production.

The computational difficulty can of course be dealt with in some cases by the input-output method: for example, if the technological coefficients are known, the total output of the individual economic branches can be computed with the help of the inverse matrix of the coefficients corresponding to any given final consumption. The vast amount of computation makes it impossible to recalculate the whole system of plans in order to ascertain the indirect effects on the evaluation of every single project, either through the conventional step-by-step method, or with the help of the input-output inverse matrix. To bypass this difficulty, a method was worked out in the Institute of Economics of the Hungarian Academy of Sciences[5] based on input-output tables and permitting the measurement and comparison of the most important indirect effects in a relatively rapid and easy manner.

The method in question was intended to analyse and compare the advantages and disadvantages, and in particular assess the efficiency of the development of the single economic branches of the industry, such as iron and steel, non-ferrous metals, non-electric machinery, electric machinery, cotton textiles, shoe manufacturing, etc. It was an attempt to evaluate and compare not projects (ultimately consumed) [illegible] to produce specific goods and services but the much more aggregated and complex economic branches. The method is based on a set of coefficients

[5] The method was worked out by the author in co-operation with Mr. [illegible] and [illegible] of the intermediate input-output balance for [illegible] and planning [illegible] industrial structure [illegible] of the Institute of Economics of the Hungarian Academy of Sciences No. 6

worked out with the help of the inverse matrix of the input-output table.

The first set of coefficients is designed to reflect the main effects of the increased production on the whole economy and/or the whole industry, that is, its effects on the value added[1], employment, capital and imports. These categories are characterised by several coefficients: for example, employment of the skilled and unskilled labour-force, and fixed and revolving capital per unit of production of a given branch. The second set of coefficients is derived from the first, expressing relationships which are relevant when evaluating and comparing economic branches. Such relationships are, for example: value added per one person employed, proceeds of foreign currency per one person employed, capital investment per unit of foreign currency proceeds and total costs of production per unit of final consumption of the products of the branch in question. (The final consumption is the sum of the consumption of the population, investment and export; the total costs comprise labour, imports and depreciation expressed in labour content.) This method makes it possible to answer some questions connected with structural changes in the economy and with the priority to be given to one industrial branch over another. Its advantage is, on the one hand, that direct and indirect effects are expressed concomitantly for the economy as a whole and, on the other, that the effects are expressed in terms which are relevant from the social point of view, such as employment, foreign trade and investment, and excluding ambiguous indicators or those subject to double count, such as total output. The method has, of course, its disadvantages. It can give only a rough approximation, because it tacitly assumes that the technological coefficients of the input-output table and the product mix of the single branches remain constant and that, in addition, the composition of the output originating in a given branch and being utilized as the input of other branches is always the same. This assumption, as explained in the theory of the input-output models, is by no means justified.

However, to evaluate the indirect backward linkage effects of single projects, it is the first set of coefficients that seems to be useful, namely, coefficients which express the total value added, and employment, import and capital required in the economy as a whole, or in some cases in total industry, when producing one unit of output of the branch in question. Such coefficients have been computed, on the basis of the 1957 input-output table of the Hungarian economy, for thirty-two branches of the industry. Some of these coefficients are reproduced as an example of selected industrial branches in table 1 below.[6]

[6] The method of computation is a simple application of the inverse matrix of the input-output table which is briefly described in annex I.

TABLE 1. COEFFICIENTS OF TOTAL (DIRECT AND BACKWARD LINKAGE) EFFECTS

Industrial sector	*Value added*[a]	*Volume of imports*[a]	*Industrial employment*[b]	*Effective fixed capital*[a]	*Investment requirements*[a]
Coal mining	58.4	25.0	50.1	434	99
Iron and steel	40.0	19.6	24.9	24	201
Non-ferrous metals	53.2	16.0	1[illegible].9	279	17[illegible]
Non-electrical machinery	76.9	8.7	23.2	171	71
Electrical machinery	71.7	7.1	18.7	132	64
Precision instruments	83.5	4.2	23.5	81	32
Electricity	58.8	23.4	18.8	[illegible]	321
Petroleum refining	79.6	6.6	3.4	44	56
Heavy chemicals	67.0	10.6	11.9	176	55
Wood products	66.6	3.1	14.9	72	35
Paper production	75.7	4.9	8.4	96	44
Cotton textiles	85.6	2.2	6.8	34	14
Leather production	64.1	2.8	8.3	61	32
Shoe manufacturing	84.4	1.5	12.1	32	1
Food [illegible]	84.7	3.6	1.2	101	[illegible]

[a] In forints, per 100 forints of output.
[b] Per 1 million forints of output.

The meaning of the coefficients of the capital requirements needs some further explanation. First, the output of the sector in question is compared to the amount of fixed capital effectively built in and measured by statistical observation, here called "effective fixed capital". However, if we are interested in the requirement, the utilisation of the built-in capacities has to be taken into account. Such utilisation is often less than 100 per cent and, in addition, it is usually different in the different industrial branches. If the fixed capital is compared to the volume of production corresponding to the built-in capacity instead of to the effective production, a second capital coefficient is obtained, known as capital requirement. The latter permits a more precise computation of the requirements for new investment than is possible through effective fixed capital coefficients. Production can be increased to the limit of the built-in capacities without new investment through better utilization of the existing equipment. As a result the third coefficient, called investment requirement, is a function of the supposed or planned increase in production of the different sectors. The coefficients of the example have been worked out on the basis of the assumption of a uniform production increase of 70 per cent in every sector. It may be useful to work out different variants, based on different increases, and to compare them with one another.

The importance of indirect backward linkage effects is demonstrated in table 2 below, containing the proportion of direct to total requirements (direct and indirect backward linkage effects) concerning imports, employment and capital.

It will be seen that the direct requirements are often only 50 per cent or even less of the total.

The utilization of coefficients presented in table 1 is self-explanatory. The direct effects of a project on employment, imports, capital and national income are determined by the conventional methods of project evaluation. The backward linkage effects of the major outputs can then be determined by the co-

TABLE 2. PROPORTION OF DIRECT REQUIREMENTS PER UNIT OF OUTPUT COMPARED TO TOTAL (DIRECT AND BACKWARD LINKAGE) REQUIREMENTS (PERCENTAGE)

Industrial sector	*Imports*	*Total employment*	*Effective fixed capital*	*Investment requirement*
Coal mining	56	74	61	63
Iron and steel	62	48	48	49
Non-ferrous metals	69	39	49	48
Non-electrical machinery	39	59	49	32
Electrical machinery	45	59	34	19
Precision instruments	58	76	51	36
Electricity	70	48	78	80
Petroleum refining	92	33	24	21
Heavy chemicals	78	54	57	55
Wood products	92	65	36	39
Paper production	79	57	54	48
Cotton textiles	82	79	71	64
Leather production	85	44	45	35
Shoe manufacturing	28	66	31	27
Food products	66	12	28	21

efficients of the corresponding branches. If more precision is necessary, the effects of the first backward link (for example, the investment necessary to produce the fuel of the power station) is determined by direct means, and only the rest of the linkage effects by the described method.

In Hungary, this method is utilized mainly to determine so-called indirect investments. A special method of project evaluation was issued and approved by the Hungarian Planning Office in 1957 and has since been further developed. One of these modifications is connected with indirect investment requirements. Originally the backward linkage effects on capital investment were taken into account by one uniform coefficient applied to the value of material inputs. However, as demonstrated in table 1, the indirect effects are very different for the different sectors. Consequently, in the method of the Planning Office valid since the end of 1964, different coefficients are utilized, computed for forty two different sectors on the basis of the 1959 input output table.

As we mentioned in connexion with the problem of shadow prices (opportunity costs), mathematical programming is utilized to determine the optimum programme of a system. Very frequently the problem of efficient allocation of investment resources cannot be resolved by calculating, comparing and selecting single investment projects, because of the very great number of closely interconnected technological and economic alternatives.

We may use as an example the problem of production and allocation of primary sources of energy, such as coal and petrol, and secondary sources, such as electricity and gas.[7] The object of efficiency calculations in this case may be summed up in broad outline as follows. We have to choose from among different primary sources of energy (producible or importable) whose production involves different inputs at the level of the economy as a whole (labour and other costs, investments, imports etc.). We may further choose from among various secondary sources of energy (e.g. between electric energy and municipal gas), these secondary sources also, perhaps, being produced with the aid of different primary sources of energy.

There are wide possibilities for substitution among different sources of energy. In the case of the sources of energy and other national resources needed to produce and transform them (including investments or imports), the choice is between certain natural or economic limits. The problem must of course be resolved with the least possible input at the level of the economy as a whole. Thus we are dealing here with a calculation of conditional extreme values, the solution of which, at our present stage of knowledge, is possible with mathematical programming and, considering the extent of the problem, with the use of electronic computers. Given the computation techniques available, linear programming is clearly indicated. A simplified example of such a model is briefly described below.

The computations start with the demand serving as a basis for the balance of energy, that is, with the production and services determining energy demand; for example, the production of steel or cement

[7] See G. Cukor and M. Sági, "Energy requirements and their long-term planning", Budapest, 1964.

or the production of any other industry, and the national demand for energy or for coal heating. We assume that the different types of production and services may be considered as homogeneous consumers of energy, so that the sector, production or service thus defined might be unambiguously characterized by one parameter each (e.g. production of steel in tons, or the demand for fuel for domestic use, with the number of flats or rooms), and that to these parameters belong similar unambiguously defined specific costs of energy and other costs connected with the use of energy (essentially investment and operating costs). Of course, the specific costs of energy and other products may also vary according to the technology applied, mainly according to the prime source of energy used. The maximum quantity of domestic sources of primary energy available may also be regarded as a specific constraint.

Let us call a production or service carried out by a given technology (source of energy) an activity, denoted by $x_1, x_2, \dots x_n$.

x_1 production of electric energy from coal /kWh/
x_2 production of electric energy from crude oil
x_3 production ot electric energy from natural gas
x_4 production of cement with coal /tons/
x_5 production of cement with crude oil
x_6 production of cement with natural gas
•
•
•
x_{n-2} heating of flats with coal /number of rooms/
x_{n-1} heating of flats with oil
x_n heating of flats with natural gas

Assuming that "b" represents the maximum of domestic sources of energy available, then the corresponding imports and savings as compared to the possible maximum utilization of domestic production are as follows:

	Maximum domestic primary source of energy	Imports	Savings
Coal	b_1	y_1	s_1
Oil	b_2	y_2	s_2
Natural gas	b_3	y_3	s_3

For specific use of energy, we have the following notations:

Production of / with	Electric energy	Cement	Heating of flats
1. Coal	a_{11}	a_{14}	a_{1n-2}
2. Oil	a_{22}	a_{25}	a_{2n-1}
3. Natural gas	a_{33}	a_{36}	a_{3n}

With the above notation, the following special balance of energy may be written in the form of equations:

$$a_{11}x_1 + a_{14}x_4 + \dots a_{1n-2}x_{n-2} + s_1 = b_1 + y_1 \text{ /coal/}$$
$$a_{22}x_2 + a_{25}x_5 + \dots a_{2n-1}x_{n-1} + s_2 = b_2 + y_2 \text{ /oil/}$$
$$a_{33}x_3 + a_{36}x_6 + \quad a_{3n}\,x_n + s_3 = b_3 + y_3 \text{ /natural gas/}$$

Here on the left-hand side of the equations we find the use of energy by "activities", as well as "savings" and, on the right-hand side, the domestic and import sources. Each of the equations is a balance-equation of a defined source of energy, for instance, coal, and the whole system of equations is the entire balance of energy where, however, the activities "x", the imports "y" and the savings "s" are still unknown.

The above system of equations has still to be completed. The basis for calculating the demand for energy is the volume of production (service) of each of the sectors, which is known, and which must be supplied with the aid of the various sources of energy (technologies, activities). Let us denote these "K". Then,

Electric energy $K_1 = x_1 + x_2 + x_3$
Cement $K_2 = x_4 + x_5 + x_6$
Heating for the population $K_k = x_{n-2} + x_{n-1} + x_n$

We may start, moreover, from the fact that the foreign exchange available for the imports of sources of energy is limited. If the maximum quantity of foreign exchange is "D", the unit price of individual imported sources of energy "d", and the foreign exchange possibly saved as against the maximum "z", we obtain another equation which expresses the balance between imports of energy and the foreign exchange available for cover:

$$d_1y_1 + d_2y_2 + d_3y_3 + \dots + z = D$$

The most rational, optimum utilization of resources is achieved if, keeping the balance ratios expressed by the above equations, the cost of all activities, considering imports also as an activity, is minimum. Thus, if the specific cost of activity "x" is "c"

$$c_1x_1 + \dots + c_nx_n + d'_1y_1 + \dots + d'_ny_n = \text{minimum}$$

where $d'_1 \dots d'_n$ denote the difference between the prices of domestic and imported source of energy.

The equations containing the balance of energy, the balance of foreign exchange and the connexions among the activities might also be written in the following manner:

$$\begin{array}{llllll}
a_{11}x_1 + & & & + s_1 & - y_1 & = b_1 \\
& a_{22}x_2 + \dots & & + s_2 & - y_2 & = b_2 \\
& & a_{33}x_3 \dots & + s_3 & - y_3 & = b_3 \\
x_1 + x_2 + x_3 & & & & & = K_1 \\
& x_4 + x_5 + x_6 & & & & = K_2 \\
& & d_1y_1 + od_2y_2 + d_3y_3 + z & & & = D
\end{array}$$

This system of equations might be written in the form of a matrix equation as

$$Ax = b$$

where x is the vector of activities, A is the matrix of coefficients belonging to the activities (the left-hand side of the equation system) and b is the so-called vector of capacities (the right-hand side of the equation system).

The so-called objective function expressing the minimization of costs may be written in the form of the vectorial function

$$cx = \text{minimum}$$

The minimization of the function cx with the constraint $Ax = b$ can be resolved by the method of linear programming not to be discussed here.[8] The solution yields the quantities of sources of energy to be produced at home (b [illegible] x), those to be imported (x) and their allocation to the different sectors using energy ([illegible]), that is, the activities $x_1 \ldots x_n$.

This type of computation will produce a result which is, within the limits of the system, both efficient through optimization of the objective function, and consistent, satisfying the special balances. Mathematical programming is necessary because of the very great number of interconnexions and possible activities, the proper selection of which is hardly possible with the conventional methods of project evaluation. Such sectoral programmes have been worked out in Hungary for several industrial branches, some of them taking into account not only production and investment, but also exports and imports.[9] As a rule, sectoral programmes do not include in their computations the linkage effects created outside the sector. The main interrelationships with the rest of the economy are embodied in the constraints of the model. In our example, these are the available domestic sources of energy and foreign exchange and the volume of production or services to be supplied by some source of energy. In another model, the volume of production, export or investment might be the constraints. Exceptionally, backward linkage effects outside the system are taken into account, for example in the model dealing with the investment programme of the Hungarian aluminium industry, in which the indirect investments have been determined by the input-output inverse matrix.

The limited consideration of linkage effects in sectoral programming models is obviously a weakness of the method, both from the theoretical and from the practical point of view. The method permits the efficient allocation of resources within the system represented by the model, but the allocations of resources (for example, investment and foreign currencies) or other constraints, such as production or exports, should be predetermined, and there is no guarantee concerning the efficiency of the latter allocation among sectors. It is of course assumed that efficiency is considered from the social point of view, and not from the point of view of single sectors or private enterprises. It is hardly possible to include the whole economy in one mathematical model; this would involve great computational and even some theoretical difficulties. To avoid them, a method was proposed in Hungary by Messrs. Kornai and Lipták, known as "programming on two levels". It consists basically in the optimization of several sectoral and one "central" model, the latter being intended to allocate the resources and other constraints, for example, production or exports, to the sectors. The optimum is achieved in iterative steps, the sectoral models receiving the central allocations and feeding back the results of optimization to the central model, which will in turn improve the central allocation. This method is now being experimentally tested and computations are being carried out.[10] If properly applied, this method should make possible the selection of efficient projects and at the same time ensure consistency for the economy as a whole.

[8] Several works deal with linear programming, as for example Dorfman, Samuelson and Solow, *Linear Programming and Economic Analysis*, New York, McGraw Hill 1958.

[9] See János Kornai, "Mathematical programming of investment", Budapest, 1962.

[10] See Janos Kornai, "Experimental programming in preparation for the third five-year plan", Budapest, Kozgazdasagi Szemle, 1965, No. 6.

IV. ESSENTIAL ELEMENTS IN THE PREPARATION OF INDUSTRIAL PROJECTS

by S. J. Langley*

INTRODUCTION

The purpose of this paper is to bring into perspective the essential elements that must be embodied in industrial projects destined for the scrutiny of both private and public bodies. It delineates the variety of their points of view and indicates the nature and extent of their extensive and frequently disparate informational needs. The nature of the criteria by which private investors and government officials evaluate the costs and benefits of industrial projects and their legitimate differences of approach are also examined.

What follows is not a guide to industrial project preparation or a chart of the obstructions to be avoided by those charged with the development of industrial projects; nor is it a catalogue of all the elements that must be included. The subjects considered are not necessarily treated in the depth or detail commensurate with their relative importance, since their choice reflects the experience of the author rather than a consensus of informed opinion. We understand, however, that many of the problems and procedures touched upon will be the subjects of detailed discussion in other papers presented to the seminar.

In the following discussion, we assume that the responsibility for project preparation lies with a government agency charged with encouraging and facilitating the growth of industry in a developing country, although this is only the most common of many possibilities. It is further assumed that the government agency responsible for industrial project preparation will have as an important objective the stimulation of domestic and foreign private investor interest and participation in the projects it prepares. The procedure for project preparation for industrial enterprises that will be implemented, owned and operated by a Government is not, however, different in any fundamental aspect.

Project preparation in the sense in which we use the term is more than a planning function; it includes follow-through to final operation of the project or a decision to abandon the effort. Too limited a concept of the project team's responsibility in this regard can lead to wasted effort, particularly if those, such as private investors, who implement the project are not permitted to take full advantage of the prior investigation and analysis which led the Government to include it in its programme. Waste is also predictable if the Government's project team is content to set out its work product without ensuring that the next steps towards implementation are taken by the competent parties.

The project itself may well be thought of as a constantly growing and changing set of concepts. In part these concepts are embodied in documents designed to enable the many different parties concerned to appraise the economic advantages and disadvantages of endorsing, promoting, contributing resources to and implementing the project. In another sense, the project consists of a collection in the minds of living persons of informed opinion and detailed understanding of the facts, the relationship of the facts to the interested parties, and the interrelationships among all the interests to the proposed activity. This view of an industrial project demonstrates the critical value of a high degree of continuity in the project team from the inception of preparation to successful operation. Individuals or organizations may be attached to or detached from the project at different times as different skills are required, but continuity in the growth of understanding and insight, both documented and undocumented, demands a substantial degree of continuity of personnel.

A. NATURE OF INDUSTRIAL PROJECTS AND STRATEGY OF THEIR PREPARATION

An industrial project may take many forms and its preparation may be approached in widely differing ways. There is, in fact, no established technique of project preparation and no attempt is made in this paper to develop one. What is attempted is a classification of industrial projects and problems frequently encountered in their preparation. We examine below the nature of an industrial project and the forms it may take in increasing order of complexity and then suggest a strategy for its preparation.

1. *Expansion of existing operations*

The expansion of an existing industrial operation, even though the investment involved may be very large, is comparatively straightforward if it can be financed from internally generated funds. The present management will normally be familiar with the equipment needed and will be able to supervise its installation and to integrate it into operations with relatively little assistance. This type of project can thus be prepared with [illegible] specialized [illegible] to any other [illegible] ment [illegible] business judgement. However, it is possible that the purchase of improved or an entirely new type of

* Paper prepared on behalf of Arthur D. Little Inc., Cambridge, Mass., United States of America, with the assistance of William A. W. Krebs, Phillips Perera, John H. Reedy and Robert H. Ward.

equipment must be considered, that new methods of marketing must be developed and new market outlets secured, that management skills must be increased or that careful consideration must be given to a wider range of problems. When these problems arise, the process of industrial project preparation is characterized by an increasing need for a wide range of specialized skills, experience and knowledge, and for formal documentation.

Other conditions may also lead to formality and complexity. For example, industrial plant expansion in developing countries usually requires external financial assistance. This may take one or more of a number of different forms, ranging from a short-term working capital loan from a commercial banking institution to a financing scheme that encompasses public issues of shares or bonds, participations by several financing institutions that may include foreign organizations, national foreign aid agencies, and one or more of the international financing authorities. In these circumstances, a higher degree of formality is requisite.

It is probable that some degree of documentation will be required for even the smallest working-capital loan, although some bankers make loans to well established customers with little or no investigation. Loans of significant size and medium- or long-term duration will, however, normally be made only after an examination of the application by a regional or head office loan authorizing officer or committee. It may be necessary to produce not only estimates of ability to repay the principal and service the debt from the profits of the proposed new activity, but also to provide evidence that market potential has been realistically assessed, that materials, labour, equipment and facilities are, in fact, available at the costs indicated and that the proposed extension of the plant is within the technical and managerial competence of the management. To provide the necessary information and present a convincing case to the banker, it may be necessary to employ the services of independent professional experts. In any event a high degree of formality and documentation will be needed.

There is another condition which normally leads to formal project preparation, even for the expansion of existing enterprise: the involvement of government. In the industrially advanced nations, enterprises are usually permitted to expand their operations without reference to government authority unless special considerations of size, regional balance or other aspects of national economic policy are involved. In the developing countries this is usually not the case. Shortage of capital for economic development, limitations of foreign exchange, scarcity of skilled labour and management and other important factors frequently lead Governments to impose controls on investment irrespective of its source of finance or geographical location and the object is the establishment of a new industry or the expansion of an existing one. Conformity with national investment policy or a national economic development plan is also frequently required.

Government association with the process of project preparation and with the attendant formalities and documentation may be sought by the investor himself. Assurances may be desired regarding the availability of foreign exchange for the purchase of equipment and the increased supply of materials that will be needed, and requests may be made for the imposition of tariff or quota protection, import duty or tax reduction or other concessions to encourage industrial development. Much of the information and documentation required to satisfy the financing institutions can be used for this purpose. In many cases, however, financial and government agencies will each make their approval dependent on approval by the other, creating a problem of simultaneous determination. For example, the banker will wish to see evidence that necessary tariff protection or other government assistance will be forthcoming before he agrees to commit funds to the project; government may at the same time wish to see evidence that the funds necessary to see the project through to completion are available before granting valuable concessions. In these circumstances, the process of industrial project preparation is likely to involve a continuous process of discussion with government and financing agencies, with feed-back to each cycle from the related one just before or after it.

2. *Establishment of new enterprises*

We now turn to the establishment of new industrial enterprises. It is with this type of industrial project, encompassing all the problems of plant expansion in addition to those of the initiation of new enterprises without the benefit of local experience and knowledge, that this paper is primarily concerned. Projects for the establishment of new industrial enterprises, as contrasted with the expansion of existing ones, require, in addition to the documentation and outside assistance that may be necessary to secure their approval by financing and government agencies, detailed technical and market information from many different sources. The absence of on-going industrial activity from which the new project may be extrapolated may complicate the process of project planning and in practice usually results in a need to seek advice from individuals or organizations experienced in the industrial activity under study. Lack of local experience also complicates the process of plant construction and equipment installation and frequently results in delays and economic loss in initiating production and bringing operations to a profitable level.

Two methods of reducing these hazards of new enterprises in developing countries are worthy of special attention. Existing industrial enterprises with well trained managerial and technical personnel at their disposal may be requested to undertake to launch the new plant; even if the industrial operation of the existing enterprise is unrelated to the proposed new one, its organizational skills and ability to attract additional well qualified personnel may greatly reduce the cost and time involved in project preparation and amply justify the fee that may have to be paid. Another approach to reducing hazards is the use of a "turnkey" contract under which the contractor undertakes not only to construct the plant to agreed specifications, but also to supervise initial operations until a predetermined level of efficiency has been attained and local staff trained. Unfortunately the latter, apparently logical, solution to the problem has been greatly abused by salesmen for machinery manufacturers, who hold themselves out as unbiased technical advisors and *bona fide* investors but who, in fact, offer only their own, often overpriced wares and accept little or no risk. Only careful, sound technical and economic analysis can expose such stratagems.

3. *Principles of project preparation*

Turning next to considerations of strategy, efficient industrial plants should be established in developing countries only if they are directed towards the attainment of clearly defined and widely understood objectives; further, a process of continuous evaluation must be employed to control and co-ordinate the orderly commitment of resources throughout the project preparation process. Adequate control includes the power to modify, postpone or abandon the project; and although these options become increasingly more difficult to take as project planning proceeds, they remain until the final objective is achieved.

Whether the project results in the addition of a few pieces of new equipment to a small manufacturing enterprise or the establishment of a major industrial venture, it must be thoughtfully and efficiently directed. Clear responsibility must be given to an individual or a group for the performance of this task. The quality of intelligence, judgement, initiative and executive ability required for the successful development of an industrial project is high and, in complex cases, men of outstanding ability will be required. They should have authority to make all the financial and other decisions necessary to attain their objectives. These objectives should be precisely and clearly delineated. However, decision-making authority in matters affecting the direction, form, content, duration, cost, termination and other substantive aspects of the project should, however, be reserved to others less involved in the day-to-day activities of the project and with a lower degree of emotional commitment than can be reasonably expected of the project staff.

When an industrial project is prepared and implemented by private businessmen in an enterprise economic system, the objective sought is either profit or a rationalization for it. In a developing country, the objectives to which an industrial project is directed may be quite different. National economic policy may dictate that preference in the allocation of resources should be given to industrial projects providing employment and labour training, conserving foreign exchange by currency earning or saving, or by contributing to the goal of structural change of the economy, even though the attainment of these objectives may not always contribute to an immediate increase in *per capita* income—a commonly accepted desideratum of national economic policy.

Those responsible for the preparation of industrial projects in either the private or public sector and the officials, bankers and others who may be called upon to evaluate their recommendations must be fully aware not only of the broad outlines but also of the details of national economic policy. Whether priority is to be given to economic growth, the balance of payments, employment, economic diversification or other considerations should be precisely stated in their instructions. Only in this way can projects be evaluated and development possibilities compared in a rational manner. A danger to be avoided is that, in the absence of proper guidance, project staff may develop its own egocentric objectives that may be at variance with national policy and the national interest.

Personnel responsible for the preparation of industrial projects should continuously re-evaluate the evidence they assemble and the conclusions they develop. Project staff are in a different situation from those who work under more routine conditions where the course of events may be predetermined and constant re-evaluation less important. In preparing industrial projects, continuous re-evaluation of the most searching kind is called for. The sole purpose of project development work is the ultimate establishment of an industrial enterprise justifiable in terms of clearly defined objectives; if at any point it becomes apparent that these purposes cannot be achieved, the justification for further effort and expenditure disappears. The process itself has no intrinsic value, except perhaps as a training exercise. Continuous re-evaluation in the light of the information generated by the process of preparation may also reveal that the project as originally conceived is inappropriate, but that in a modified form or manner the desired objectives or other comparable objectives can be attained.

Since the project staff can [illegible] the most intelligent and dedicated [illegible] relevant facts and their implications [illegible] that they should possess a high degree of [illegible] and emotional probity. In human [illegible] is to select project personnel [illegible] qualities of enthusiasm and drive [illegible] degree of scepticism and caution [illegible] recommend the termination of [illegible] own activities whenever it [illegible] that the objectives of their work [illegible] factorily attained.

The total cost of an industrial project in a developing country may greatly exceed the cost of a similar project elsewhere. It may be necessary to devote expensive effort to the assessment of resource availability and market potential and to develop information that would be readily available in other areas. Distance from sources of equipment, building materials, technical information, energy and public facilities will also add to cost. Although unit wages may appear to be low, high costs of supervision and low labour productivity may impose burdens. Not only are costs higher in developing countries, but they are also much more difficult to salvage than in economically developed countries. Equipment, materials, access roads, worker accommodations and many other costly items may have no alternative use if the project for which they are acquired is abandoned and, hence, no residual value.

Total project costs can be held to a minimum, and the danger of serious loss consequent upon major shifts in project direction or project cancellation at an advanced stage may be reduced by careful planning. Project preparation should be approached by a method of successive approximation that incurs costs for market information, surveys, plant and construction cost estimates and, at a later stage, for materials, equipment, roads and supplies only to the extent necessary to permit the next sequential decision to be made. For example, comprehensive resource surveys involving expensive scientific equipment and highly trained personnel should not be commissioned until a preliminary examination has been completed on the basis of existing reports and information, and the informed judgements of appropriately experienced specialists in technical areas obtained. If a comprehensive survey proves to be a necessary second step, the scope (and, hence, cost) of the survey should not be designed to provide more information than will be needed when the results are due. This is not to say that there are no cases in which it is reasonable to carry out resource surveys in more detail than is immediately required; there may be greatly increased cost in carrying out the work in two or more stages. Here, as in many other cases, only careful and dispassionate analysis and judgement can provide a sound basis for decision.

Industrial project design is an area in which the process of successive approximation is particularly important. Experienced industry specialists can estimate investment and ultimate operating costs within a [illegible] 20 per cent margin of error at very reasonable cost.

II. [illegible] ELEMENTS OF AN [illegible] PROJECT

Several of the elements that must be examined in the preparation of industrial projects have been [illegible] consideration of their nature and the strategy of their preparation. We pass now to a [illegible] treatment of the essential elements that must be considered and documented by an [illegible] in the preparation of an industrial project. Three types of principal parties will be [illegible] investors, financing institutions and government departments and agencies concerned with [illegible] aspects of social welfare and economic [illegible]. It is possible that in some countries government will [illegible] directly or indirectly the sole party [illegible] at all stages, but this will [illegible] change the situation; the points of view of government officials in their various capacities as industrialists, bankers and economic planners will in all probability differ as sharply as those of their counterparts in countries where industrial plants and [illegible] are in private hands.

We shall examine first the project elements that are of primary interest to the investor and incidentally to the project preparation staff. We shall then consider the information requirements of financing institutions and government agencies that may become involved in the project at a later stage. Finally, we shall briefly examine the role of the project preparation staff.

1. *Elements of primary interest to investors*

(a) *Present and potential markets*

The ability of an enterprise to earn revenues that exceed its costs depends upon the existence of a market for its products at prices that will cover the costs of production less any subsidies that may be receivable and plus any unit or sales taxes that may be payable by the enterprise. Methods of studying market demand for industrial output are described at length elsewhere and will not be discussed in detail here.[1] For our purposes it is sufficient to note that extensive market surveys outlining in great detail the market prospects for a projected industrial plant's output are usually not required in the early stages of project preparation. Potential investors will wish to see evidence that there is a reasonable prospect of marketing the project's output, but this can frequently be provided at modest cost. Greater detail may be sought by investors and their bankers at a later date, probably immediately prior to, or possibly even following, a decision to implement the project.

A danger to be avoided in market assessment, even greater than that of over-estimating market demand, is failure to allow for its natural growth during project preparation and construction as well as for the results of aggressive market development after the project comes into operation. Many industrial plants in developing countries have been designed on a scale that has proved too small to supply the market that their existence has stimulated. If it is particularly important to minimize capital investment, careful consideration should be given to the advisability of designing plant and equipment in such a way that productive capacity can be expanded at a later date so that at least some of the cost advantages of larger scale production may be secured.

A consideration of central importance in estimating the demand for an industrial product is that, however closely it resembles a previously imported product, it will not be regarded as the equal of the imported product by many consumers, at least for some time. It is therefore frequently necessary to ensure market protection in the form of import restrictions. If the project is likely to save scarce foreign exchange or result in an important net social benefit, the Government may be willing to do so, even though some measure of customer coercion will inevitably be involved. Indeed it cannot be denied that those concerned with stimulating and directing the economic development of a nation can have little regard for the wishes of the individual; they must constantly seek to make him work harder, save more and change his spending habits. An element frequently overlooked in individual project preparation is the need to mobilize the energies of many different people towards objectives that in certain respects may not be entirely congenial to them.

Problems of market acceptance are less likely to arise in the case of intermediate products such as industrial chemicals or building materials. Purchasers of intermediate products will seek assurances that

[1] See in particular *Manual on Economic Development Projects* (United Nations publication, Sales No. [illegible] II.G.5), chapter II.

cost, quality and reliability of supply will compare favourably with imports, and if these are forthcoming they may welcome the project. Indeed, substantial buyers of intermediate products are very good prospects who should never be overlooked as possible investors in a new industrial project. Importers whose business is, or can be, affected by foreign exchange licensing procedures are in a similar position and are frequently similarly responsive to persuasion.

(b) *Technical feasibility*

All parties concerned with an industrial project must be satisfied that it is in a broad sense technically feasible, but the investor, as the principal risk-taker, has the primary interest. To convince him, it will be necessary to assemble evidence that raw materials, utilities, labour and management can be obtained at reasonable cost and with reasonable reliability at the proposed location or locations of the plant. Assurances that the technology it is proposed to employ is well tried and not in serious danger of early obsolescence, that spare parts and maintenance services will remain readily available for many years and that numerous other technical aspects of the project have been carefully considered will also be sought by prudent investors.

To establish an industrial project's technical feasibility at the stage of its preparation which we are considering may not be a particularly costly or time-consuming task. It will require expert knowledge and judgement, but this can frequently be obtained at modest cost from men with extensive working experience in the industry under examination. Two dangers should be guarded against. Certain persons and organizations may offer to do the work at nominal cost or even without charge. Before accepting offers of this kind, the project staff should assure itself that the persons or organizations making the offer do not have an interest in promoting or frustrating the venture. Organizations overtly or covertly associated with the manufacture of industrial plant and equipment should be carefully avoided at this stage of a project since their interest in a positive conclusion is very strong. They may have an important and sometimes essential role to play after the decision has been made, at least in principle, to proceed with the implementation of the project. Offers to conduct major study projects at considerable cost should be equally suspect. Very costly resource surveys may in fact be needed before a project can move forward; these, however, should be the responsibility of a government department with responsibility for resource development and should not in normal circumstances be undertaken by or at the expense of an individual industrial project.

What are sometimes described as technical requirement studies are frequently undertaken to establish the technical feasibility of a proposed project. In evaluating such studies, it is important to appreciate that technical feasibility in terms of the availability of raw materials, developed technology, managerial and technical skills, and even potential markets, is not sufficient to justify the implementation of a project in meaningful economic terms in developing countries or elsewhere. Unless cost price relationships indicate the probability that an industrial enterprise will be financially viable or evidence can be adduced that reasonably attainable assistance from tariff protection, subsidies and tax remissions, transfers from the earnings of other enterprises and the consumers of the product would make it so, technical feasibility is irrelevant. It is technically possible to do many things that are excluded from serious consideration by the negative [illegible] costs[4] involved and the [illegible]

(c) *Financial viability*

The financial viability of an [illegible] will depend on the existence of [illegible] demand and the technical feasibility [illegible] several additional problems must [illegible] resolved. In addition to the inherent [illegible] projecting the future course of prices [illegible] we are faced with the need to estimate [illegible] of time required to [illegible] construction [illegible] down since this will determine the point [illegible] revenues begin, and the total [illegible] incurred for the [illegible] they become productive. [illegible] increases costs by increasing [illegible] resources from productive [illegible] it is extremely difficult [illegible] but some assistance can be obtained [illegible] similar project construction in [illegible] countries [illegible] by reviewing the [illegible] time-consuming problems.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] in the form of convertible debentures. [illegible] capital gains.

Debt equity relationship

[illegible]

[illegible]

[illegible] social costs and benefits

[illegible]

propriate to consider the social impact of an industrial project in one or more other countries.

The calculation of social costs and benefits, the method for which is set out in a companion paper, calls for inclusion in the project documents of the following informational elements: [illegible] average annual earnings in their present employment of each factor to be allocated to the enterprise and [illegible] government revenues and expenditures associated with the present employment of the factors as well as the government revenues and expenditures, with special attention to subsidies, expected in connexion with the projected enterprise.

With these data the economic benefits [illegible] of an industrial project [illegible]

[illegible]

Foreign exchange effects

[illegible]

change using saving and earning effects of a project will make possible a determination of its net foreign exchange impact and the ratio of the net foreign exchange effect to initial expenditures provides a useful measure for comparing the proposed project with other projects. This calculation will also be of interest to external financing institutions.

The existence of multiple exchange practices in some developing countries and the fairly common practice of pegging exchange rates at an artificially high level raise difficult problems for those concerned with estimating the foreign exchange effects of industrial development projects. It is most important that these should be approached and resolved in a consistent manner for purposes of project comparison and the determination of investment and foreign exchange [illegible].

4. Role of the project staff

The project staff of an industrial development agency that itself prepares the project to an advanced stage. Much of the work can also be done by a consulting firm, an international technical assistance group or perhaps an ad hoc team of experts under contract to the industrial development agency. The results should be very similar whichever procedure is employed provided that the staff concerned is entirely independent and objective in its approach to the project and that members of the development agency are associated with the project to a sufficient extent to acquire a full understanding of the facts and data assembled, the logic of the conclusions drawn and an appreciation of the intangible and incommensurable elements that inevitably contribute to the process of project preparation. Without this, the project report is likely to have limited impact even if its findings are positive and its recommendations convincing.

Positive findings may be accompanied by proposals to proceed further by (a) inviting private foreign or domestic investors to take up the project, possibly encouraged by concessions of various kinds [illegible] and obligations; (b) developing the project as a government or quasi-independent government agency enterprise or (c) exploring the possibility of further development by a partnership between private investors and government.

Heavy responsibility devolves on those charged with evaluating projects at this stage of their development. Insistence on conclusive evidence that an economically justified and profitable industrial project will result might rule out many promising projects. Unfortunately, enthusiasm may result in economically unsound proposals and seriously damage the investor confidence in the project sponsoring organization.

The expertise of the project [illegible] development may be outside [illegible] the practice [illegible] by a more prepared and able to assume the [illegible] and financing role [illegible] of a [illegible] and orderly programme may be [illegible]

[illegible]

process, the sequence of events is likely to be simpler if the Government also reserves the right of the [illegible] determination of the nature of its own participation, the [illegible] programme of [illegible] development that will result with this procedure.

When an investor, private or public, makes a tentative commitment to an industrial project, the role greatly increases in importance and many of the actions and decisions may henceforth be made without reference to, and frequently without the knowledge of, the project staff of the governmental industrial development agency that originally brought the project to his attention. Since the investor will eventually assume a major share of the risk of loss, the [illegible] of a new enterprise [illegible] independent action and decision making of this kind [illegible] to [illegible] Project staff should continue to be readily available to the potential investor to provide advice and information on local conditions and to facilitate the acquisition of the large number of permits, licences and concessions from government departments that are [illegible] may also have the important role of introducing local investors to the project and [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

APPLICATION OF PROFESSIONAL CRITERIA FOR INDUSTRIAL PROJECT EVALUATION, SELECTION AND FOLLOW-UP

by A. D. [illegible]

INTRODUCTION

The best intentions of development institutions to implement good project evaluation theory are often frustrated by organizational and procedural problems which superficially seem only distantly related. It is frequently assumed, for example, that once staff economists, accountants, engineers and lawyers have acquired appropriate techniques of evaluation, the battle of appraisal is won. This is not the case. Good project appraisal is not completed until their skills and [illegible] have been effectively merged in dealing with the project appraisal [illegible] the selection and follow-up of projects.

[illegible]

[illegible]

A. PHASES OF A PROJECT

From the development finance institution's position, the life of a project may be divided into a number of different stages.

1. Identification and evaluation

This phase may be divided into reception or development of a project, initial preliminary appraisal and full appraisal.

During the reception or development of a project, the development finance institution gathers sufficient data to provide a basis for an initial screening and usually meets the potential client for the first time. Applications which on their face do not fall within the institution's terms of reference may be summarily rejected. Project ideas initiated within the bank are put into shape. All projects are introduced into the processing flow.

The primary purpose of initial preliminary appraisal is to determine whether the project, on the basis of information initially submitted, merits the cost of a full appraisal investigation. Policy implications, rough estimates of feasibility (usually from an economic or financial aspect considered particularly critical in the economy concerned), background or character checks on the applicant are frequently considered or initiated at this time.

Project appraisal requires the fullest evaluation of all aspects of the proposed venture based on the most accurate data obtainable. A full appraisal should cover "all the circumstances surrounding a project ... the whole economic complex of which the project will form a part".[1] Appraisal has thus been described as encompassing a project's economic, technical, managerial, organizational, commercial and financial aspects.[2]

2. Selection

The selection or decision phase frequently has more than one element: a recommendation of the evaluators, a second recommendation at a high working level, most often by a loans committee, the decision by the Board of Directors or its Executive Committee and, finally, where foreign funds are involved, approval from international sources such as the World Bank for Reconstruction and Development (IBRD), or bilateral aid agencies from countries furnishing the funds and so extending the credit.[3]

[illegible]

[illegible]

3. *Administration*

As in the identification and evaluation stages, the three phases of the project administration stage overlap and are interrelated, namely, legal implementation, disbursement and repayment.

During legal implementation, the legal department or the secretariat draws up and completes execution of the loan agreement, containing terms upon which the finance will be made available as well as any conditions to be met both prior and subsequent to the disbursement of the finance. The department also draws up and executes, where called for, mortgage deeds and guarantees by banks or other third parties. Finally, it assures compliance with the above documents and other pertinent legal agreements.

The actual disbursement of funds may be carried out by the accounting section, with the secretary's office (or perhaps a special division) responsible for preparation of materials other than legal documents. For example, the post sanction and end use division of the Pakistan Industrial Credit and Investment Corporation (PICIC) ensures that clients obtain competitive quotations for machinery and sometimes helps directly in negotiations with machinery suppliers, ensures that machinery which is ordered has PICIC's approval, obtains import permits for the client, establishes letters of credit (in some banks these are prepared by the bank itself and in others by commercial banks), and receives shipping documents from suppliers and after checking them endorses them over to the client, who then receives the machinery.

Repayment, overlapping with follow up, consists of amortization and liquidation of the institution's interest in the project.

4. *Follow up*

This phase encompasses a development bank's continuing interest in a project and divides into two aspects: (a) short term follow up during disbursement, designed to ensure that funds are spent in accordance with the understanding between the borrower and the bank, and (b) long term follow up, or after care, by which the bank maintains a continuing relationship with the client for the life of its interest in the project through review of financial and other information, plant visits and provision of advice.

The administrative stage is only peripherally considered in the discussion of issues that follows.

B. PROJECT IDENTIFICATION AND EVALUATION STAGE

1. *Responsibility of the professional cadre of the development finance institution for project development, evaluation and follow up*

Frequently the initial problem is that of bringing a project to the stage where it may be adequately evaluated. Someone must often be prepared to assist potential clients of development finance institutions in developing their projects and in preparing their applications for assistance. When there is an insufficient flow of potential clients into the institution with ideas that can be worked out, someone must be ready to develop projects themselves.

This problem of elevating ideas to project status has been attacked at the international level by special institutional arrangements such as the United Nations Special Fund's work in preinvestment surveys. The support provided by the United States Agency for International Development (AID) to industrial development centres in twenty eight countries reflects another approach. The efforts of the Rockefeller Brothers Fund in West Africa in developing private sector project applications was still another experiment in this direction.[2]

The need for special institutional arrangements to ensure adequate evaluation and follow up is at least as great. It is frequently necessary to create alternatives for the accumulated body of data and experience which in more industrialized countries serve those who make decisions on the allocation of finance. Financial analysis ratios for different lines of business and credit reference services are two of the many supporting services most often absent in many developing countries. Also absent are reliable independent advisory or consultant services to advise the allocator of finance.[3]

Arthur Lewis's statement of a decade ago that "lending money to inexperienced small business people without supervision is often equivalent to pouring it down the drain" correctly extends the need for client assistance to the follow up stage.[4]

2. *Responsibility of the development finance institution*

Who is to have primary responsibility for providing such assistance to the borrower? The way a Government answers this question will affect the way it allocates its available professional manpower among various institutions. It will also affect the organization of the professional cadre within its development finance institutions and the vigour with which members of the cadre allocate their individual energy to their various tasks.

The shortage of projects and the dismal repayment record of many early development finance institutions which extended credit without adequate evaluation or follow up have led to experimentation with new institutions such as the industrial development centres mentioned above. These are charged with responsibility for developing projects, studying their feasibility and ... on their execution.

[2] One of the strongest current statements ... of the ... shortage of ... projects not capital ... is provided by Schatz in his study of the Federal Loans Board in Nigeria. He argues persuasively that "what really exists is not an immediate shortage of capital at all, but an immediate shortage of viable projects." ... Schatz and P. Sayre, *Development Bank Lending in Nigeria*, published for the Nigerian Institute of Social and Economic Research by Oxford University Press, Ibadan, 1964, p. ...

[3] In United States investment banking, when determining the feasibility and advisability of ... financing, such specialists as accountants, lawyers, engineers and industry and management consultants will be called in to assist in the investigation. R. I. Robinson, ed., *Financial Institutions*, Homewood, Ill., Irwin, 1960, p. 296.

[4] W. A. Lewis, *The Theory of Economic Growth*, London, George Allen & Unwin, 1955, p. 106.

This separatist tendency may blur the basic issue. The development finance institution should have, within broad terms of reference set by government, the final say on accepting or refusing a project. This authority should not be capable of being delegated to others. Therefore the institution's responsibility to the Governments, international sources and others who have lent or invested funds in it requires it to assure itself of the project's value both before it commits funds and thereafter until its interest is liquidated.[5] In effect, it should perform its own evaluation and follow up. If these functions are also carried out by other institutions, there may be overlapping of effort and thus wasting of scarce professional resources. Because of the close relationship among the three phases of the development and evaluation stage of a project, a development finance institution most often also finds itself thoroughly involved in the development of projects.

It follows that primary responsibility for the identification and evaluation stage as well as for the follow up and selection stage should normally be lodged in the source of finance. Exceptions should be made in cases where it is clearly hopeless to expect existing finance institutions to develop sound, independent assessment and supervision capability. Another exceptional situation exists when the level of professional manpower allows a service institution to be spun off from a development finance institution, leaving behind a viable professional cadre capable of satisfying the institution's own requirements.

Each phase is only one part in the life of a project, inextricably interwoven with the others. The reasons for establishing capability in one institution to deal with all phases seem strong. Since project selection is the fundamental responsibility of the development finance institution, it appears sensible under most circumstances to build up its capability to handle project development, evaluation or supervision rather than start a separate institution. As the source of finance the institution has the strongest leverage with which to obtain the needed co-operation from the borrower during the evaluation phase. Since it will look for repayment from the project over many years, it has the kind of continuing interest in the project's health that should motivate good follow up. The legal agreements frequently embodying covenants governing future activities of the borrower also normally run between him and the finance institution. These are some of the corollary reasons for placing the full range of functions in the hands of the development finance institution's professional staff. Admittedly, it is difficult to tell where self-interest arising from the financing function stops and a separable, identifiable development function begins.

For this reason among many others, the notion that primary responsibility should be lodged in the financing entity is not universally held.

Development bankers themselves voice many of the objections. The costs of maintaining the extra research and technical personnel necessary for project development and follow-up are not considered justifiable expenses to private investors. Government subsidies to cover the costs are not desired in many mixed or privately owned institutions because of fears that they will be accompanied by increased government influence. Other bankers may feel a traditional reluctance to probe as far into a borrower's affairs as is implicit in the kinds of relationships under consideration here.[6]

The policies of the international and bilateral external aid agencies have in some respects served to separate responsibility (most particularly in the development phase) from the sources of finance. Martin Rosen, executive vice-president of the International Finance Corporation, has cautioned Latin American development bankers about the dangers of excessive promotional responsibility. Citing expense out of proportion to immediate return, necessity for greater assurance of success, likelihood of a higher degree of involvement in management, particularly when no private management can be found, he concludes that a "financing institution cannot be entirely passive, nor can it be predominately promotional, it must set its sights somewhere in between."[7] The industrial development

5 Where development finance institutions have relied upon outside advisory councils for appraisal advice the experience has apparently not been too successful. The Industrial Development Bank of Pakistan (IDBP) and the Industrial Finance Corporation of India (IFCI) have in the past relied heavily upon advisory committees. Members are outstanding men in various technical fields. After the IDBP makes a preliminary screening and determines that, if technically feasible, the loan should be granted, the advice of the advisory committee is sought on the technical aspects. The advisory committees operate as the technical arm of the bank. Similar procedures have been followed in the past by IFCI. One difficulty experienced is that the advisors are only advisors and busy ones at that. Although they may attend meetings and take an active interest, the attention given to individual projects, even with their outstanding expertise, has in some cases been too scant.

6 This reluctance has also evidenced itself in the United States commercial banking community. Crosse states: "As late as 1956, the Board of Governors of the Federal Reserve System dropped a proposal to require a positive statement of purpose in connexion with loans secured by stocks and subject to regulation U because of the widespread objection on the part of member banks to 'invading the privacy of their borrowers'." See H. D. Crosse, *Management Policies for Commercial Banks*, Englewood Cliffs, N.J., Prentice-Hall, 1962, p. 199, footnote 5.

William Diamond of the International Finance Corporation (IFC) recently pointed out the difficulty in establishing relationships of "great and continuing intimacy" necessary for some types of promotional activity. See "The role of private institutions in development finance" in *International Development Review*, Washington, D.C., March 1965.

7 This statement was made in an address before the first international meeting of financial institutions for development, Caracas, Venezuela, on 18 February 1965. A distinction should be made between the initiation of projects by the finance institution itself and its development of client-initiated projects.

The *fomento* or development corporation type of institution normally has responsibility not only for initiating projects, but also for managing projects if private enterprise management cannot be found. Such governmental institutions include the Corporación Boliviana de Fomento, Corporación de Fomento de la Producción in Chile, similar institutions in Guatemala, Haiti, Jamaica, Panama, Honduras, Nicaragua, Peru and Venezuela, and institutions such as the Uganda Development Corporation, the National Industrial Development Corporation of India and the Pakistan Industrial Corporation. In addition, at least one private development finance company (MIDB) (Industrial Mining and Develop-centres supported by the United States Agency for International Development can be directly subsidized by government without interference in the running of the development finance institutions. Projects thus helped develop normally and then go to development finance institutions for support.[8]

Finally, it may be argued that by separating these responsibilities, one "service" institution may serve a large number of financial institutions.

The above arguments may not be as real as they first appear. Costs of developing, evaluating and supervising projects may be returned in the form of a better repayment record and repeat applications from old customers for new financing. The possibility of charging clients for evaluation and other services is being tried in some development banks. Most private and mixed development finance institutions are already subsidized in some form by government, and it is at least questionable that new arrangements acceptable to all could not be found. The attitudes of borrowers in the more industrialized countries towards advice from their bankers suggests that good advice will eventually be accepted by businessmen in the developing countries also.[9] Where the financial institutional structure is sufficiently developed to support a proliferation of small private development finance institutions, as may be the case in the Philippines or Mexico, or a smaller number of medium-sized finance institutions, as may be the case of the *corporaciones financieras* in Colombia, there may well be reason for centralizing project services to serve the larger number of existing institutions. However, the question would arise as to whether one service institution could cope if the institutions were geographically widely distributed or had different sectoral specialities such as agriculture or small business.

To sum up, the strongest arguments for separating responsibility for the identification and evaluation stage and the follow-up stage from that for the selection stage exist where it is necessary to bypass a weak institution. Where there is hope of building a strong one, the need for using the institution's existing or latent self-interest and the desire to conserve scarce cadre manpower argue for building the capability of the financial institution before spreading men into others to assume the same responsibilities.

The initiation of projects has several implications for the procedure and organization of the professional cadre. Should the same staff work on both the initiation of projects and their evaluation? There may be a danger of favourable bias towards self initiated projects. The development division of the Uganda Development Corporation (UDC), for example, was responsible both for evaluating clients' proposals and for initiating its own. The creation by the Industrial and Mining Development Bank of Iran (IMDBI) of a separate division for project development seems a better alternative. Another approach would permit anyone in the staff to work as time allows on new self initiated project. He would then have the responsibility of bringing it up for consideration by the loans committee at a preliminary screening place when the project was sufficiently developed. From that point on, such a project would be treated in the same manner as a client's project. In other words, it would be injected into the regular evaluation flow and would be subjected to evaluation by others.[10]

A second problem is the allocation of the professional cadre's time between self initiated and client initiated projects. To a large extent, this control of time may be beyond the capacity of the development finance institution. The ratio between self initiated and client initiated projects may to a large extent reflect the economic and political setting as it did in Iran. When conditions are favourable for private investment, the flow of client projects may leave little time for development bank staff to work on their own project ideas. When private investment is slack, however, the development bank can turn its resources to initiation.[11]

To some extent the relationship can be better controlled through the creation of a separate division for project initiation, rather than leaving it up to individual staff members to take the initiative or to choose between working on their own projects and outside projects. The creation of a separate organizational entity with initiation responsibility emphasizes management's commitment to the concept of project initiation. Even with such a separate division, there will probably be times when the institution management would like to shift cadre resources from client projects to initiation. The departmental structure should not be such as to hinder such a shift.

3. *Balance between cost consciousness and development determination*

Some development finance institutions indicate a tendency either to be too conscious of cost (and therefore scarcely earn the term "development" in their title) or, on the other hand, to throw all cost consciousness to the wind in an effort to fulfil their development function. Some development bankers take the view that literally all applications should

ment Bank of Iran), has begun initiating its own projects, although presumably not with the intent of managing them. Assistance in shaping a client's project may be distinguished from these efforts, although it is very closely related, since at times the institution may be contributing more than the potential client.

[8] It is of course possible that these institutions can work sufficiently closely with those providing the finance. In the Sudan, the industrial development centre and the development finance institution have offices in the same building. Ecuador is reportedly another country where the two work hand in glove.

[9] A recent survey of 1,000 businessmen in the United States ranked counselling on business problems third among the most useful services performed by United States commercial banks behind granting short-term loans and handling deposits and checking accounts. See *Dun's Review and Modern Industry*, New York, vol. 73, No. 6, June 1959, p. 175.

[10] The Industrial Development Corporation of South Africa (IDC-SA) meets the problem in this manner.

[11] Three related facets (cost considerations, use of professional cadres at the reception phase, and organizational means of permitting cadres to shift to different functions) are discussed at different places below.

be held and developed as a part of the finance institution's developmental responsibilities.[12]

Obviously a balance has to be struck somewhere between these two polar positions. Lending policies —including such consideration as collateral, interest rate, degree of risk involved—perhaps provide the greatest area of choice in determining this balance. These unfortunately are beyond the scope of the present paper.

The antithesis to project development is the early elimination of project applications unlikely to survive evaluation even when given development assistance at a level acceptable to the institution. To quote an Indian example, "one of the main factors making for higher expenses was the cost of examining projects which ultimately were not proceeded with or did not materialize".[13] A detailed preliminary appraisal phase is a critical element in maintaining cost consciousness.

The savings in costs of rejecting a project at the preliminary appraisal stage are considerable. Let us assume that a preliminary appraisal can be made by a three-man team in one day, based on the data provided by the applicant. Another day is required by the team to write up their report recommending whether a full investigation should follow. A maximum of six man-days has been expended so far. At this point, if the institution proceeds to a full investigation, a week's field investigation (twenty-one man-days), plus an equivalent amount for writing the investigation report, might normally be expected. Hence, a total of between forty and forty-five man-days may be involved. The cost at the end of the preliminary appraisal is therefore roughly 15 per cent of the anticipated manpower cost, if the development finance institution proceeds through the full evaluation stage.

Preliminary appraisal may be completed in several different ways. The three examples below illustrate a variety of methods.

In PICIC (Pakistan Industrial Credit and Investment Corporation), the preliminary appraisal spans the reception, initial appraisal and full appraisal phases. Its economic and general department receives applications and does some mechanical or formal screening. It also investigates the background of the applicant and the prospect of the project's producing a favourable impact on the economy. The department's report is a one-page summary. If it is negative, a letter from the general manager is sent to the applicant, stating a brief reason. In order to keep other departments informed of what is being turned away at this stage, a weekly list of applications rejected by the economic and general department, with a short statement as to why the negative action was taken, is circulated within PICIC.[14]

If the application is recommended for further study, it is sent for initial examination by the appraisal committee, which considers questions of policy. These include appropriateness of the corporation's entry into the particular industrial field and the effect of financing the project on PICIC's relationships with other financial institutions, the government and clients. If at this point the appraisal committee decides in favour of a full investigation, the first step is a preliminary analysis of the product's potential market. If no satisfactory market exists, further investigation is halted.

In Turkey's Industrial Development Bank (IDB/T), after the receiving office has determined that all data required in the application form are present, the financial department makes a rough appraisal of the financial aspects of the proposal to determine that estimates of cost and return are, on their face, within sensible bounds. The second component of the initial appraisal is a background check on the applicant, made through banking and business circles. The review, similar to one conducted in the Pakistan institution, ascertains the nature of the applicant's financial position and reputation.

In IDC/SA (Industrial Development Corporation of South Africa), an application is brought to the next meeting of the propositions committee, which convenes twice a week. Staff experts representing engineering, marketing and finance groups are assigned to complete a "basic assessment" of the proposal from the materials provided by the applicant. The three staff members work simultaneously making separate, brief reports. Assessments are completed within two or three days, with a report back at the next propositions committee meeting, which then decides whether a full investigation should be pursued. The financial, marketing or engineering department is assigned primary responsibility to see that the basic assessment is completed on schedule and to move the project forward if it receives a full investigation. Which department is assigned depends upon whether the project appears to involve mainly marketing, financial or engineering problems.

Sometimes it may be desirable to have a senior officer make the initial screening. On the basis of his single opinion, applications may be either sent back for further development or permitted to go on for fuller investigation. The loans department of the National Investment Bank of Ghana (NIB) was at its outset headed by a former commercial banker of considerable experience who received the initial inquiry and at the same time decided whether an investigation should be recommended. Thus preliminary appraisal was merged into the reception phase. In other development finance institutions, the general manager or other top officials do the screening to weed out applications that for political or other policy reasons are unacceptable. All these methods serve to save the time of the professional cadres and therefore cut costs.

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12 This viewpoint is not confined to development bankers. The author has seen it strongly expressed among young Nigerian commercial bankers in Lagos.

13 Industrial Credit and Investment Corporation of India (ICICI), "Report of proceedings, regional conference on development banks in Asia", Bombay, June 1962, p. 18.

14 Cf. [illegible], op. cit., p. 215, footnote 8). In a recommendation to United States commercial bankers he says: "A further sound policy not exercised enough is to require a review of loan applications of substantial amounts which have been denied by the lending officer." The purpose of this admonition is to ensure that lending officers do not turn down good requests in order to protect their records for safe lending.

A final area presenting opportunities for reducing costs is the elimination of full evaluation on all applications. Some banks are plagued with a large number of applications for small balancing loans or loans to very small *entrepreneurs*. Although beyond the scope of this paper, it should be noted that consideration should be given to developing special routines for such small loans. One development corporation has recently ceased making full team appraisals on smaller loans, and has turned them over to one man who makes an initial appraisal and then has the authority to co-opt another man from anywhere in the institution for the full investigation of the project.

The ideal initial appraisal, then, is a two-step process, combining some of each of the above patterns. First, a check is needed to ensure that the requisite material is present and that on its face the project falls within fairly clearly stated boundaries defining the institution's operations. Since it normally comprises a level of investigation not requiring the most highly skilled personnel, this examination might be conducted by staff other than the investigating and decision-making groups, thus saving costs and relieving them of some burden. In PICIC, for example, the economic and general department handles matters at this point, thereby lightening the load on the operations department. In IDB/T (Industrial Development Bank of Turkey), the application comes to the office of one of the deputy general managers, where a staff officer with the rank of *chef de bureau* goes over the information to determine that everything asked for has been received and that the data is ready for processing. In other development finance institutions, the secretary's office may receive applications, assemble the data and introduce the application into the evaluation stream.

The second step involves consideration of policy aspects and qualitative judgements as to whether a full investigation is justified. At this point, the wisest course would appear to be a brief evaluation, including all the major aspects of project evaluation, not merely one or two. To the extent that broad policy questions are at issue, senior management should take part.

4. *Teamwork by professional staff members in making evaluations*

The manner in which the skills of the economist, engineer, accountant and lawyer are harnessed in making an evaluation can be vital to effective appraisal.

Development finance institutions regularly meet the problem of combining these various skills. Two basic methods have evolved. The first is the separate departmental method in which the economist, the financial analyst and the engineer work separately. One of them or a fourth individual collates these reports at the end. In the second method—team appraisal—the three specialists work together and submit a single report. A third possible alternative—appraisal by one man acting alone or with the authority to build a team as necessary—is found only infrequently in the developing countries.

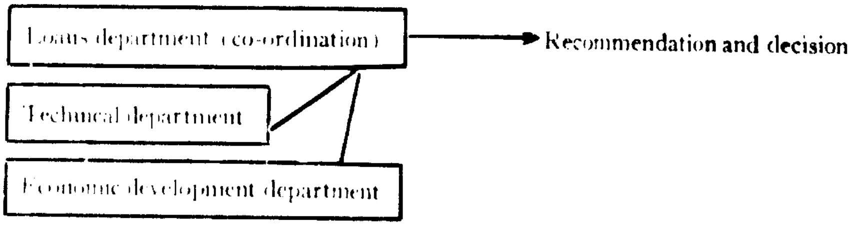
Team appraisal appears to be considerably more effective than separate departmental appraisal in evaluating projects. It forces each specialist to give more thorough consideration to the way closely related facts outside his own particular competence affect those within it. It apparently gets the job done more quickly. It stimulates a quicker transformation of the economist, the engineer and the financial analyst into professional development banker. It may be used under most administrative structures [illegible] by development finance institutions in establishing departmental organizations. Finally, team appraisal minimizes several negative attributes [illegible] inherent in separate departmental appraisal.

IDB/T (Industrial Development Bank of Turkey), IMDBI (Industrial Mining and Development Bank of Iran), PICIC (Pakistan Industrial Credit and Investment Corporation) and ICICI (Industrial Credit and Investment Corporation of India) [illegible] similar in many respects. All are privately owned with a relatively dominant commercial orientation, are strongly supported by the [illegible] Finance Corporation and [illegible] operate as a major source of [illegible] their countries and tend to concentrate [illegible] tively large loans. Within the [illegible] development finance institutions [illegible] countries, these four institutions [illegible] fairly comparable group known [illegible] opment finance companies.[15] [illegible] the very best development [illegible] experience is worth examining. [illegible] as of mid 1963 are described [illegible]

(*a*) In IDB/T, a full appraisal [illegible] by three departments: financial analysis, engineering and economic research. We have seen [illegible] check was made by another department to ensure the application material was in required form. A new project was then routed to the engineering department, which studied both technical feasibility and profit potential. A departmental report was prepared. The file then went to the economic department and the financial analysis department for separate investigations by each. The finance department chief merged parts of the other two reports into his final report, which was sent to the finance committee. Hence the flow of the loan appraisal under this consecutive separate departmental appraisal was as follows:

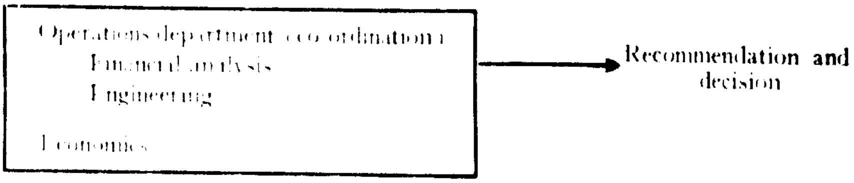
[15] [illegible]

(*b*) A loan application in IMDBI was co-ordinated by its loans department. After classification by a loans committee as to priority or likelihood of approval, the loans department, the economic development department and the technical department each worked on separate reports which were then co-ordinated by the loans department for presentation to the loans committee. (In late 1963, the technical department was merged with the loans department.) This pattern, which might be termed simultaneous separate department appraisal, may be represented as follows:



(*c*) At PICIC, after a loan application had cleared initial preliminary appraisal hurdles, the chief of operations assigned new projects to an engineer and a financial analyst, both of whom were in his own operations department. A marketing expert from the economics and general department formed the third member of the team,[16] although in fact he started his investigations slightly before the others on the theory that, if no prospective market were found, the investigation should stop. The three worked as a team although they had initially prepared separate, related reports. The chief of operations then worked with the three men, hammering out a single project appraisal which was presented to the project appraisal committee. The flow in this team appraisal was as follows:

[16] The marketing experts have since been placed in the operations department.



(*d*) ICICI used the same team approach as PICIC, but omitted the economics member, evidently due in part to its view that determination of long-range prospects for a particular industry was properly the responsibility of the planning wing of government and in part to the very pragmatic belief that, since India was currently and prospectively a seller's market, what could be produced locally could be sold.[17]

The separate departmental approach appears to have several defects. Time is lost when a file moves from one department to the next, where it waits until the staff member assigned to the case finishes the task he is currently working on. Frequently, by the time the appraisal file reaches the last department, changes in the applicant's business or economic conditions may require amendment to the earlier department reports. Finally, there is an inevitable overlap among the reports. The engineering department, for example, may make its own cost estimates, while the financial analysis department may sometimes alter the sales estimates of the economics department. Moreover, the possibility that one department might become a chronic bottleneck in the appraisal process and that there might be sustained rivalry among departments would appear greater than with team appraisal because of the emphasis on the separate assessment of the projects by different professions.

Both IDBT and IMDBI have moved away from strict separate departmental appraisal in the past two years. The former now passes files through the financial analysis and economic research departments on their way to the first full department report by the engineering department. This procedure makes possible early designation of case officers in each department and allows them to begin collecting data. In Iran, the loans department has been made responsible for appraisal of projects (presumably on a pattern similar to PICIC's). The technical department has been merged with it. A joint financial-technical team prepares a report covering these two aspects of an appraisal. The economics department will, as required, prepare a separate report on the marketing aspects of the project. Thus IMDBI is two thirds of the way towards a full team appraisal approach.

Team appraisal offers three advantages over separate departmental appraisal. First, it lets the appraisers collectively consider the many economic, financial and technical aspects of a project as parts of a whole. The intricately interrelated nature of the components of a project is brought out in the following passage from the United Nations *Manual on Economic Development Projects*:

"It is obvious that the volume of demand to be satisfied will have a very considerable influence . . . on the decision as to the capacity of the new productive unit. But the size of the market will depend, among other things, on the location of the enterprise, so that there is a definitive relationship between size, location and the market. On the other hand, selling prices will sometimes greatly influence the volume of demand. These are almost invariably dependent upon production costs, which in turn are a function of the scale of production and location."[17]

Secondly, there is evidence that team appraisal gets the job done more quickly. Engle in 1962 reported average processing times for the four institutions discussed above as follows: PICIC—three months, ICICI—three to four months, IMDBI—five to six months, and IDB/T—five to six months. Although Engle's data were based on rough estimates by the managements of the institutions and do not define "processing time", they do raise a strong inference that team appraisal results in faster appraisal.

Thirdly, team appraisal contributes in many ways to the growth of a truly professional development banker. Each team member is encouraged to consider aspects of appraisal which are foreign to his basic training. This experience gradually transforms an economist, accountant or engineer into a development finance expert. More immediately, team appraisal permits a development bank to undercut outside personal and political influence on its appraisal processes. First, it requires open group discussion of the case on its merits and, secondly, it provides collective strength to the professional estimates and recommendations of a bank's technical staff. As a result, political pressure is elevated to the decision-making level, where it more properly belongs. Finally, the team approach would seem to minimize rivalry and misunderstanding among the three disciplines, thereby further encouraging professionalism in development banking.

5. *Adequacy of methods for the acquisition of data used by professional cadres*

Some development finance institutions have experienced difficulty in seeking greatly detailed data from potential clients at the outset of the three evaluation phases. Interested businessmen are deterred from applying for finance because they balk at providing the data desired by the finance institution. They may be unwilling to divulge the information or go to the expense of gathering it unless they feel financial assistance is likely to be forthcoming. Yet it is most often not in the interest of the institution to give even a tentative commitment at the early phases. They may be unable to compile the data and hence require the help of the professional cadre. Requesting greatly detailed data may be regarded as a screening device since it eliminates the weak hearted, but normally its use should not be justified on such grounds, since it may foreclose applications from promising prospects who turn instead to traditional sources of funds. Professional cadre time ideally should not be committed to preparing data at a premature stage. Therefore a development finance institution should examine its procedures of data acquisition to ensure that sufficient, but not excessive, information is gathered at the various phases.

No one method of data acquisition is perfect for the needs of all development finance institutions. Methods will usually combine the use of an application form, field visits, interviews with the applicant and development work on the application by the professional cadre itself.

One method of meeting the problem is to let the client select initially the information he will forward. ICICI gives potential clients a list of subjects that should be covered in a proposal and then awaits the nature of the client's response as an indication of its general level of sophistication. If the client then provides the desired information with a fairly high degree of disclosure, ICICI feels it has a favourable basis for judging the status of internal accounting and information control systems within the client's company. Another method [illegible] different questionnaires for different sized projects. IBRD (International Bank for Reconstruction and Development) has a long questionnaire for industrial projects and also a shorter adaptation for "light" industrial projects. The Industrial Guarantee Fund of Iran (IGF) has three application forms, each applicable to a different category of loan. By contrast, the Banque Camerounaise de Développement (BCD) and the Economic Development Financing Organization of Greece (EDFO) have different application forms for different loan purposes.

A different approach would be to finance the cost of feasibility studies by the client. This is a better alternative to either rushing into a [illegible] based on inadequate data or losing [illegible].

It would seem wise, however, to design the requests for data in a series of stages [illegible] the actual needs of the finance institution. In the first stage there should be enough data to [illegible] the development finance institution to determine whether a full investigation is necessary. More data [illegible] required at the full appraisal phase [illegible]. There seems to be a third level of data that becomes important really only after the basic decision has been taken in principle to provide finance. These are the data necessary to ensure proper legal implementation and also data for the creation of a permanent record of the client project. Legal data and as past corporate records might be included in the latter category.

The ultimate solution lies in building up the confidence of the business public in [illegible] the development finance institution. If the public is convinced that the presentation of data supporting a sound application will be rewarded by forthcoming finance, it is more willing to go through the arduous task of compiling the information requested.

[17] United Nations publication, Sales No.: 58.II.G.5, p. 10

We know really very little about the decision-making processes of development finance institutions. We must assume, for example, that the knowledge and experience that goes into a professional evaluation of a project is really brought to bear on its acceptance or rejection by the decision-makers. Our empirical knowledge as to why projects are accepted or turned down is scant. The political structure and current political pressures, the existence of government screening through licensing or planning bodies, the prevalence or shortage of projects within the country, the presence of one dominant figure in the development finance institution, all effect the decision pattern of a given development bank or corporation.

The selection of a project for financing is normally a flow of steps rather than a single distinct process. We have seen that, in most cases, staff charged with evaluating a project will have collected the data, analysed it and made a recommendation. Just as they usually go beyond the mere collection of data, so they seldom make the decision to commit funds, although they sometimes have primary authority to reject an application.

There appears to be a common pattern for decision-making: a recommendation by those making the evaluation to a body on a level below that of a board of directors; the decision by the board of directors or members to whom it has delegated authority; and, finally, where the funds used are from an external aid agency, approval from that agency prior to final commitment to the borrower. This pattern of course varies with the size of the institution and the depth of its organization. In the case of several development corporations established by the Commonwealth Development Corporation (CDC), for example, the pattern is to keep a very small staff and back them up by technical specialists from the CDC as required. Here such an elaborate decision process may not exist.

6. [illegible] of increasing the selection process by strengthening its collective nature

The most notable characteristic of this pattern is that it appears, at least on the surface, to be as much a collective process as the evaluation process. The recommendation of the evaluating cadre normally goes to a committee. The committee consists of senior management, typically the general manager, his deputies and department heads. It considers the project before it is submitted to the board of directors. PIDC's project appraisal committee consists of the general manager, deputy general manager, chief of economic general department, officer in charge of economic research, chief engineer, chief of operations, chief of accounting and finance and the law officer. [illegible] finance committee is made up of the general manager, two deputy general managers and the heads of the technical, economic research and finance departments.

In IDC-SA, the promotions committee is composed of officers immediately below the top managerial level as represented by the general manager, his deputies and managers. As the IDC-SA is among the oldest development finance institutions, this pattern suggests that, as a development finance institution matures, this particular committee function may step down one or more levels of management. In contrast, Ghana's young NIB (National Investment Bank) has an executive committee of the board, apparently performing the same function.

There are notable exceptions to this collective nature of decision-making. Two of the development corporation type institutions, the Pakistan Industrial Development Corporation (PIDC) and the Uganda Development Corporation (UDC), had in their formative years very strong, dynamic leaders who really were the decision-making forces in their institutions. Such leadership may be a characteristic of the successful development finance institutions with strong entrepreneurial responsibilities.

In general, there are advantages for many development finance institutions in continuing the collective aspect observed in the evaluation stage forward into the selection stage. Such practice probably reduces the likelihood of arbitrary, personally biased or improperly influenced decisions. The resulting interchange provides a continuing forum for broadening the capability of participants. Thus although they undoubtedly slow the process and tend to obscure the location of responsibility, committee decisions appear to be a worthwhile price to pay for better evaluation. As the institution and the whole institutional structure of society becomes more sophisticated, increasing weight will probably be given to individual decisions.

7. Merits of assigning responsibility for the selection process to a single officer

The concept of a loan officer who combines both the evaluation and the selection function is infrequently seen in development banking practice.[18] The evolution of a class of professional development bankers is likely to take place eventually in two phases.

The first will see a widening of the individual officer's scope in the project identification and evaluation stage. Some development finance institutions have gone part way by having individual officers primarily responsible for the evaluation stage of a project with authority to call on other staff members for assistance as necessary. But selection remains a committee matter. Basically, institutions still tend to regard members of the professional cadre as engineers, accountants, lawyers or economists rather than as development bankers. In reality, many of these men may be undergoing a subtle transition similar to that noted among IBRD staff members: "All these three types of men—economists, engineers, and financial men—work in very close contact together. And in the end, after they have been working together for a certain number of years, a new type is produced—a kind of hybrid investigator in the World Bank and in the International Development Association."[19]

[18] This situation contrasts with that in many United States commercial banks which make a point of the decision-making authority vested in their loan officers.

[19] H. B. Ripman, op. cit., p. 2, footnote 2.

The second step would involve placing more responsibility at the selection stage in the hands of individuals, as experience in development finance grows and as more accurate data and technical advice from external supporting services become available.

There are already signs at the managerial level that some professionals have responsibility for supervising more than one professional specialist field. A number of years ago, IDC SA (International Development Corporation of South Africa) dropped designations indicating the specialist background of their department heads. The titles of technical manager, financial manager and marketing manager were all changed simply to manager. The rationale was that such men should be recognized both by the IDC and its clients, as capable of dealing with the full range of problems of any project. The effect was to deepen general management capability. In Turkey, India and Pakistan, the creation of deputies to the general managers in IDBI, ICICI, PICIC are similar moves to widen the management levels which span the specialist fields. IDBI has two deputy general managers. ICICI has a deputy general manager as well as a general manager and a fully active chairman (the deputy general manager post may currently be vacant since its incumbent assumed the post of general manager of the Nigerian Industrial Development Bank early in 1964). PICIC has one deputy general manager. This experience suggests that the evolution of the development finance institution manager would be towards a gradual overlapping of the three specialities in one person who will either have technical competency or supervisory responsibility bridging more than the one field in which he was trained.

At lower levels of the professional cadre a few similar experiments are taking place. IDBI had in 1963 a staff engineer, who also had a business administration degree, working in both its financial analysis and engineering departments. The deputy general manager of PICIC was thinking in the same vein when he expressed the hope that PICIC engineers would some day be trained as financial analysts. Engineers are most likely prospects for such multiple discipline competency. Waterston has noted that it is probably "easier to train people possessing a technical background with some knowledge of economics to be good sectoral programmers than it is to provide economists with the minimum technical education necessary."[29] Although the quote pertains to programming, the point applies also to project evaluation.

Timely progression towards these goals would facilitate the establishment of professional standards in what is, after all, a new institutional system. The result would inevitably be a tighter, more capable cadre. Such a transformation would also bring about changes in the procedures and organization of development finance institutions. The present problem is neither to lag behind the readiness of the staff to assume wider and deeper responsibilities nor to push the concept too fast.

[29] Albert Waterston, Planning the planning under the Alliance for Progress, in Development Administration: Concepts and Problems, Syracuse, 1965, p. 147.

Oddly enough, the [illegible] different stages [illegible] for developing offices [illegible] responsibility [illegible] in consideration [illegible]

Pushing [illegible] basis is another [illegible] States [illegible] of their [illegible] the development of [illegible] post [illegible] training loan officers than to permit them use their own judgement and [illegible] takes to let them work [illegible] ing difficulties.[30]

Still another [illegible] munication between upper and [illegible]

[illegible]

As the project [illegible] the appraisal [illegible] professional cadre which [illegible] comes important [illegible] should be such that those who [illegible] should be present [illegible] present when the [illegible] projects [illegible] reports should be [illegible] mittee deliberations.

At PICIC the men who [illegible] active part in the [illegible] discussed even though [illegible] their joint opinion [illegible] In IDBI and MIDC [illegible] and the [illegible] is the links between [illegible] vestigating staff.

There are [illegible] effect upon the [illegible] good men [illegible] operating staff [illegible] the fundamental [illegible] Senior [illegible] private development finance [illegible] accelerated the strong [illegible] less than experienced in [illegible] tions to the fact that staff [illegible] management [illegible]

[illegible]

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[illegible] which is the first step to avoiding haphazard capital investments.

It is not our task here to go into the design of a long range capital plan. [illegible] companies and nations need different kinds of plans. However we can briefly suggest some elements that such a plan might take into account. Certainly it should incorporate a forecast of the level of general economic activity which should include such basic information as population trends, gross national product and price and wage levels. Another important element of such a plan would be an estimate of the stock of human and capital resources required to carry out projected activities five years hence. Still another would be [illegible] the necessary replacement capital [illegible]. Of course it is extremely difficult to predict the rate and effects of technological change or other important factors such as shifts in [illegible] sources and markets. But it is possible to estimate the probable level of replacement capital [illegible] that will be required over a given period if no radical changes take place in other areas. Finally, a long range plan should include consideration of [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

B. ALTERNATIVE TECHNIQUES OF INDUSTRIAL PROJECT EVALUATION USED BY PRIVATE ENTERPRISE

With long- and short-range capital management plans and an adequate supply of industrial project proposals that seem promising, the problem is to choose the proposal that will be most worthwhile. To do this a yardstick is needed. Here we discuss and evaluate some yardsticks used by private enterprise to determine the profitability of investment in industrial or other kinds of projects. Of course, profitability is not the only criterion of a project's worth. But it is a most relevant measure to use in ranking proposals, even if it is overshadowed by one of the other criteria we discuss later. The three most commonly used yardsticks of profitability are the pay-back or recoupment period, the average return on investment method, and the discounted cash flow method.

1. *The pay-back period*

The pay-back period represents the number of years it takes for the gross earnings from a project to recoup to the treasury the total expenditures on that project. It answers the question: "How long before the cash income from this project returns the original costs?" For example, a new machine is installed at a cost of $6,000. If the net cash inflow from this machine (generally defined as income after taxes, plus depreciation) is $2,000 a year, then the pay-back period for this machine is three years.

Pay-back is popular as a yardstick for determining investment worth because it is measurable, many people know how to compute it, and it can be explained easily to others who do not know what it is. In addition, pay-back has some other advantages: it concentrates on earnings in the near future, which are more valuable and certain than earnings in the distant future; also, it guards the company's liquidity by preventing investments that tie up funds for long periods.

However, this method has some important disadvantages. A major one is that it often ranks projects incorrectly because it ignores the years after the pay-back period. If the goal is simply to get cash back in the treasury quickly, making no investments at all would be the best course. If, however, the goal is to make profits, what matters is how much the investment will yield after the pay-back period. One project may pay back in two years but produce no earnings after that, while another project with a four-year pay-back may have a ten-year earnings life. The pay-back yardstick would rank the first ahead of the second, whereas the second is actually more profitable in the long run.

A second shortcoming of the pay-back method is that it sets no objective cut-off criterion to separate projects that improve the company's profits from projects that do not. Should the maximum acceptable pay-back be one, two, three years, or ten years? This question must be answered arbitrarily; the pay-back method gives no way of comparing a project's earnings with the cost of the capital invested.

Finally, pay-back penalizes investments in new products or processes where [illegible]

anticipated, although the long-term earnings from such investments may be very high. Yet such innovations often turn out to be the most profitable investments.

2. *The average return on investment method*

Another yardstick of investment worth is average lifetime return on investment. This is the average income from a project expressed as a percentage of the capital outlay.

Average return on investment does not take into account the time pattern of income: whether the income is evenly distributed over time or is bigger in the early or later years. Using both the pay-back and average return on investment methods together alleviates this deficiency. However, the question still remains as to which is to carry the more weight, pay-back or profit: how is one investment to be compared with another investment with a quicker pay-back but a lower profit?

Furthermore, the average return on investment method has many variants, each usually giving a different rate of return for the same project. The range results from several ambiguities inherent in the method. First, the earning figure that should be used in computing the rate of return is not always clear. Should it be earnings before or after depreciation? (The answer to this question alone can halve or double the result.) Should it be before or after income taxes? Should the [illegible] on a straight line or a curved line [illegible]

Users of the average rate of return method must decide what investment base to employ. Should it be the total investment, or should it be [illegible] total investment, because this [illegible] closely the average amount of capital that [illegible] (The average amount of capital invested is the [illegible] of each year's investment after depreciation [illegible] by the number of years.) Should [illegible] only the amount capitalized on the books [illegible] it include associated outlays [illegible] expenses.

If the various departments [illegible] free to choose among these and other [illegible] lifetime average rate of return method [illegible] comparison of various projects would [illegible] less. Of course, top management [illegible] specify the method, for example [illegible] depreciation and taxes, with an investment [illegible] the amount capitalized [illegible] the [illegible] possible [illegible] sometimes rank projects incorrectly [illegible] at all in determining [illegible] between desirable and undesirable [illegible]

3. *The discounted cash flow method*

The most precise yardstick of investment [illegible] provided by the discounted cash flow [illegible] [illegible] the whole [illegible] ment outflow [illegible] into account the time pattern of both investment and [illegible] and [illegible] discount and

The discounted cash flow method considers each year's earnings separately. It takes into account the fact that early earnings are worth more than late earnings because near future earnings can be reinvested and continue to earn. It also makes automatic provision for the return of the money invested as well as earnings above the pay back amount. A major advantage of the discounted cash flow method, therefore, is that it correctly takes account of differences among projects in the "time shape" of future earnings. It avoids considering distant earnings as just as valuable as earlier ones.

Similarly, this method also makes provision for differences in the timing of outflow of capital. Few investments are made in an instant of time; rather, they are made over a period of time. This has an effect on the true rate of return. A commitment to spend in the future is less burdensome than a commitment to spend the same amount now (for the same reason that current earnings are worth more than future earnings). The discounting formula takes the time span of capital outlays into account correctly.

One variant of the discounted cash flow method uses the cost of funds to the firm explicitly in the screening of investment proposals. We can view this "cost", which will be described in more detail below, as the interest rate charged to investment projects by the controlling agency, or as the minimum acceptable rate of return on invested funds. It is a "challenge" rate, and proposals not meeting the challenge would be rejected under this criterion. The computation involves converting cash inflows and outflows associated with the adoption of the project to their "present value" at the specified "cost" of funds. If the present value exceeds zero, the project meets the test; that is, it generates returns in excess of the minimum required by the firm's financial commitments.

[illegible] of the discounted cash flow method [illegible]:

1. [illegible] "earnings" [illegible] solely on the [illegible] concept of cash flow.

2. [illegible] strictly with the [illegible] time [illegible] only the first few years.

3. [illegible] the only method that takes proper account of [illegible] timing of earnings and investments [illegible] requirements [illegible] consequences.

C. [illegible] THE YARDSTICK TO ESTIMATE INVESTMENT WORTH OF SPECIFIC PROJECTS

Now that we have described alternative yardsticks of investment worth, we can turn to the problem of applying the selected yardstick to estimate the investment worth of individual capital proposals. In this process at least four economic dimensions of the project must be measured and appraised. These are: the amount and timing of investment outlay; the amount and timing of the added stream of earnings (net cash receipts); the economic life, that is, the duration of the earnings stream; and the risks, uncertainties and imponderable benefits associated with the project.

The first three can usually be estimated quantitatively with fair margins that are tolerable for decision purposes. The last, on the other hand, requires a high order of judgement. Let us see how these dimensions are measured.

1. *Measuring investment*

The appropriate investment base for evaluation purposes is incremental outlay, which may be less than total outlay. For example, the alternative to a new bridge costing $1.5 million could be modernizing a ferry system, which would cost $0.5 million. The proper investment base for the bridge is not its total cost, $1.5 million, but its incremental cost, $1 million. However, if the ferry system were to be modernized regardless of whether or not the bridge was built, the ferry system modernization project would not be a true alternative to the bridge, and the incremental outlay for the bridge would be $1.5 million. On the other hand, the investment amount should include the entire amount of the lifetime added outlays, no matter how portions of it are treated in the books. Expensing certain items rather than capitalizing them may produce tax savings that should be reflected in estimating the investment. Any additional investment in working capital or other auxiliary facilities occasioned by the project should be included in the investment amount, as should any future research and promotional expenditures involved. If the proposal calls for transferring any existing facilities, this cost should also be included in the investment amount.

For the purpose of calculating prospective return, the items included in the investment amount should be valued at their economic, rather than their accounting values. For capitalized outlays at the time of the investment decision, these values are identical. For existing facilities, however, there can be a pronounced disparity between them. What is pertinent is the present value of the earnings opportunities of such transferred facilities; this value is likely to differ from the book value. If the value of the foregone opportunity of continuing to use the facilities in the next best alternative way is lower than their disposal value, then their disposal value should be used.

The timing of these added investments has an important effect upon the rate of return and it should therefore be reflected in the discounted cash flow computation. After tax cash flows alone matter.

2. *Measuring added earnings*

The productivity of the capital tied up in an investment project is determined by the increase in earnings or savings, that is net cash receipts, caused by making the investment as opposed to not making it. Only costs and revenues that result directly from adoption of the proposal should be included. However, earnings should be conceived broadly enough to encompass intangible—and often unquantifiable—benefits. When these have to be omitted from the formal earnings estimates, they should be noted for inclusion in any subsequent appraisal of the project. As with investments, the timing of added earnings is significant and should be reflected in the computation.

3. *Estimating economic life*

The economic life of a project is that period during which economic benefits continue to result from it. It may be brought to an end by physical deterioration, obsolescence, or the drying up of the source of earnings. Economic life is often the most difficult dimension of project value to quantify, but the problem cannot be avoided. While some estimate is better than none, the depreciable life forecast for bookkeeping or tax purposes is not always the best available forecast of economic life.

4. *Appraising risks, uncertainties and imponderable benefits*

Appraising the risks, uncertainties and imponderable benefits associated with a project requires a high order of judgement. These appraisals should result from the collective wisdom of those best qualified to make them. Usually, only the differences in amount of risk among projects need be considered, since the company's cost of capital reflects over-all risks of investment. Only when an investment alters the general character of the company's operations significantly will the risk reflected in the company's cost of capital be revalued in the market.

In the process of measuring the probable return on each project, the company may be successful in adjusting the probable range and timing of earnings. If so, only the dispersion of possible outcomes constitutes differential risk. For example, a labour-saving device would probably have a lower dispersion of outcomes than a new product, and the chances of big gains or losses would be smaller than for a new product. Though determining the dispersion of probable results is difficult, some headway occasionally can be made by a necessarily arbitrary risk ranking of candidate projects or categories of projects.

Most projects have some added benefits over and above those that are measurable. However, care must be taken not to give excessive weight to these imponderables. When a low rate of return project is preferred to a high one on the grounds of unmeasurable benefits, the burden of proof clearly rests on the imponderables.

Some important principles of measurement emerge from this discussion of measurement:

(*a*) Only added investment and added earnings connected with the project are relevant. No revenues that will be the same whether the proposal is accepted or rejected should be included in estimated earnings, and a like rule should be applied to investment calculations.

(*b*) After-tax cash flows or their equivalents alone are significant for measuring capital productivity. Book costs (e.g. depreciation on existing facilities) are confusing and immaterial.

(*c*) Timing of investments and earnings is significant and should affect the rate of return calculations.

(*d*) Usually only differences in amount of risk between proposals need be considered. The dispersion of possible outcomes is a good indicator of these differences.

A final note: it should always be remembered that there is at least one alternative to every proposed capital expenditure. It may, of course, be so catastrophic that refined measurement is unnecessary to reject it. Often, however, one or more alternatives appear of almost equal worth. In this case it is important to evaluate each carefully before a decision is made.

D. Criteria of industrial project evaluation

Ranking a group of project proposals according to the best available determinations of the return on investment that can be expected from each, or according to any other measure, does not completely solve the problem of making investment decisions. The proposal that ranks highest may still be unacceptable. To determine which, if any, proposals are acceptable, the potential investor needs a comprehensive list of criteria for investment projects. Each proposal must then be measured against these criteria.

Clearly, criteria can be of many different types depending on the investor's needs, desires and situation. For example, profitability can give way to a wish to enhance private or national prestige or a need to provide people with work in an under-developed area. Investors with large amounts of funds readily available can take greater risks than can those with limited resources. The goals governing public agencies' use of funds are different from those pursued by private enterprise.

The important general rule is that any investor considering industrial investment projects, whether large or small, public or private, needs to state clearly and apply consistently and rigorously the investment criteria that fit the particular situation. Investment criteria of course are inseparable from the long range plan discussed above. The elements that go into this plan and the policies that emerge from it determine these criteria, which should be designed to ensure attainment of the plan's objectives.

A convenient way to attack this phase of investment proposal evaluation is to set objective standards of minimum acceptability. With such standards, unacceptable proposals can be screened out automatically and, if all proposed investment projects should prove unacceptable, a search can be begun immediately for new proposals.

A company's cost of capital is the amount the company has to pay for money. It reflects the financial market's appraisal of the company's risk and profit outlook as compared to other alternative opportunities open to investors. If the company invests in projects with rates of return that are lower than its cost of capital, its financial position is weakened, the market loses confidence in the company, and ultimately it becomes more difficult and expensive for the company to obtain capital. The company's cost of capital is thus a good minimum standard to use in evaluating projects.

Since cost of capital must be used as a standard for future investment decisions, what is relevant is not what money costs now but what it will cost in the future. Thus costs of capital estimates are made on the basis of past experience and present actualities but must be projected into the long-run future. In measuring the company's total cost of capital, it is necessary to examine the cost of each source of capital available to the company—for example, through borrowing money, issuing stock, ploughing back cash earnings, selling assets. The total cost of capital is a combination of the costs of capital from all sources open to the company.

This suggestion of what cost of capital means to the individual firm and how it is measured can, in principle, be broadened to a consideration of the cost of capital to the national economy and to society.

There are three alternative concepts of the cost of capital to the nation. Unfortunately, they produce distressingly different estimates of this figure.

The first concept is that, to government, capital is a free good. Those holding this belief cite three reasons for it. One is that government can create unlimited quantities of money. However, creating money does not increase the nation's real resources: it merely reallocates them and, as spending power grows, causes inflation. Thus capital obtained in this way is paid for by the instability and slow growth associated with inflation.

Another reason is that government's power to tax is unlimited. Excess taxation, however, destroys the taxable base of real wealth and income. Capital obtained through increased taxation has a hidden cost in the form of a decaying growth rate, impaired incentives and misallocation of resources.

A third reason for claiming that capital costs government nothing is that some Governments can get capital from more affluent nations in the form of gifts and loans that will never be repaid. To the extent that these gifts and loans require no use of national resources that would be otherwise productively employed, this capital is free. Often, however, a condition for these gifts and loans is the costly diversion of the nation's resources from more profitable uses. In this case capital is obtained at the cost of crucial, scarce national resources, for example, skilled labour and supervision.

A second concept of the cost of capital to a nation is the government borrowing rate, which is the visible market cost of borrowed capital. Unlike the market cost of corporate debt capital, which is determined by the market forces of supply and demand, these rates are manipulatable and arbitrary. Often, the government rates conceal a subsidy by not reflecting the degree of risk associated with the borrowing.

A third concept is that the cost of capital to government is the sum of the cost of capital to all the corporations constituting the private enterprise sector of society in the nation concerned. The reasoning behind this view is that funds must ultimately come from the private enterprise sector, and the alternative is to have them employed there rather than by government capital formation.

Like all criteria, that of the cost of capital can be bypassed under certain conditions. Whenever that happens, however, there should be ample proof that the investment project in question is justified by other important contributions. Such proof should be required of public as well as of private investments, since both government and private industry can only stand to gain by planning and appraising investment projects with as much care and sophistication as present methods permit.

VII. GENERAL CRITERIA OF INDUSTRIAL PROJECT EVALUATION

by A. K. Sen*

Introduction

The different approaches to the evaluation of alternative industrial projects can be broadly classified into two groups: those that try to relate the exercise to some explicit attempts at optimization, and those that suggest some rules of thumb without any explicit use of optimizing methods or concepts. The adherents of the first type of approach tend to regard the adherents of the second as unduly crude, and the latter in their turn tend to regard the former as somewhat unpractical. The unfortunate fact is that each group is essentially right about the other, and there does not seem to exist at the moment any definite approach to the problem of project evaluation that is both intellectually satisfactory and practically usable. This is a dilemma that is difficult to escape, and we do not intend to try to do so in this paper. Instead, our object will be to outline some methods of evaluating industrial projects that are essentially practical, but which include some of the more important elements of the problem of optimization involved in the exercise. It can be regarded as a cross between the two types of approaches outlined above and, while it probably has some of the merits of both approaches, it also shares some of the defects of each.

There has been a great deal of discussion in recent years on the efficiency of market-induced allocation of resources. The question is not necessarily related to that of socialism *versus* capitalism, as is sometimes thought; indeed, socialist economies seem to make very wide use of the market, while some capitalist economies have very restricted markets. It is perhaps also worth mentioning that some of the earliest and the best works on the efficiency of the market mechanism came from economists advocating socialism.[1] The position will be taken in this paper that, while the market mechanism has some extremely serious drawbacks, it provides a useful starting point for resource allocation in general and for project evaluation in particular. As such, we start with an examination of the notion of commercial profitability, and move from there to the general question of national economic profitability.

A. Commercial profitability

Each project proposed can be described in a specific blueprint indicating the amount of the different types of productive resources to be used and when they will be used, as well as the expected time stream of output or outputs. We thus have two time streams, one representing input flows and the other output flows. While these two streams completely describe the physical features of the project, they do not, of themselves, tell us much about the profitability of the project. For this we need more information, namely, a set of prices of the inputs and outputs at different dates. Given these prices, we can convert the two time series into one of net profits in each period, representing the gap between the aggregate value of the outputs and that of the inputs of that period. To convert this into one profitability figure, we need still further information, some means of making inter-temporal comparisons. Much of the controversy of recent years on investment allocation has been connected with precisely this question. We might therefore first devote some attention to this problem of time series evaluation.

To formalize what was said in the last paragraph, let a time series $(R_1^i, R_2^i, \ldots, R_m^i)$ represent the flow of planned input of type i in period 1, 2, ..., m, respectively. We have one such time series for each type of input i, with $i = 1, 2, \ldots, r$, where there are r types of inputs. Similarly, when there are k outputs, there are k number of time series of the type $(O_1^j, O_2^j, \ldots, O_n^j)$, representing the flow of output of type j in period 1, 2, ..., n, with $j = 1, 2, \ldots, k$. In this model of r inputs, k outputs, m periods of input application and n periods of output production, we have a complete description of the "physical features" of a project. For convenience, we shall take $m = n$ and make up for the gap by putting zero values to the relevant inputs or outputs, when m as originally defined is less or more than n. Indeed, in a typical model, there are some inputs and no outputs for a while, and later on there might be some outputs and no inputs in a number of periods. We simply attach a zero value to stretch the time series of each over the entire period.

If the prices of input i in periods 1, 2, ..., m be given by the respective [illegible]

$$(p_1^i, p_2^i, \ldots, p_m^i)$$

the physical time series of inputs of all types can be converted into one series of aggregate [illegible] for each period, of which the m^{th} element looks as follows:

$$C_m = \sum_{i=1}^{r} p_m^i \cdot R_m^i$$

We have such a time series $(C_1, C_2, \ldots, C_m)$

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[1] See in particular Lange and Taylor [20], Lerner [21].

Similarly, given the prices of the outputs for each period, $(\pi_1, \pi_2, \ldots, \pi_m)$, representing the series for the typical output i, we have a time series of aggregate value of returns derived in an identical manner $(U_1, U_2, \ldots, U_m)$. By subtracting from the value of returns of each period the value of costs of that period, we can easily obtain the time series of net profits $(N_1, N_2, \ldots, N_m)$.

We have spelled this out only for the sake of clarity. Once, however, we get the series of net profit, which we shall refer to by the vector (N), we have a difficult problem in constructing a scalar index of profitability. Two methods in particular have been suggested, namely, estimation of the "internal rate of return" and evaluation of the "present value of the series" at a given rate of interest, or at a given sequence of rates of interest. Let us start with the simpler version of the second, that is, the evaluation of the present value at a given rate of interest q. The present value in period 0 of the series (N) at the rate of interest q, is given by:

$$PV[q,(N)] = \sum_{t=1}^{m} \frac{N_t}{(1+q)^t} \qquad (2)$$

This is the standard formula for obtaining the discounted value, and need not be elaborated here. Given a rate of interest q, therefore, all the time series of the type (N) can be converted into a present value of the type $PV[q,(N)]$, and after that the projects can be simply ranked in terms of present value. Any project that has a positive present value will justify itself at that rate of interest.

An alternative approach, mentioned earlier, is that of the internal rate of return. This consists not in comparing the different projects at the same rate of interest, but in finding out for each project the rate of interest that makes its present value nil. To illustrate, take any project (N), and use any interest rate q, and calculate $PV[q,(N)]$, as given by (2). If this present value is positive, consider a lower interest rate, and if the present value is negative take a higher interest rate.[2] Through these iterations we can find out the rate of interest which makes the present value of the series (N) to be exactly zero. The rate of interest $q(N)$ at which this happens is defined as the "internal rate of return of (N)":

$$PV[q(N),(N)] = 0 \qquad (3)$$

Alternative projects can be classified according to their internal rates of return, providing an alternative measure of their respective profitability.

In what has been said above the implicit assumption is that for each project there exists only one internal rate of return. This is not necessarily the case. We shall not here go into the question of the existence of the internal rate of return, which might be threatened in the case of discontinuity, but which is, in general, not a serious objection to the internal return rule.[3] However, the question of uniqueness is a very important one, and the fact remains that a project may have more than one internal rate of return. For example, the three-element stream of net profit $(-1, +5, -6)$ has two internal rates of return, namely, 1 and 2, since the present value of the stream is zero if we discount it at 100 per cent, or at 200 per cent.[4]

There is, however, one case where the problem of uniqueness of the internal rate of return does not cause any difficulty. That is the case when the project in question is of the "investment" type,[5] that is, has negative returns (costs) up to a point and positive returns beyond that. More formally, there exists a time period such that for $t \leq \theta$, $N_t < 0$, and for $t > \theta$, $N_t > 0$. It is perhaps of some comfort to note that the typical investment projects that are to be considered very often fit this description, and are thus free from the possibility of having more than one internal rate of return. However, when we compare two projects and try to look at the differences between their net returns each period, this one-switch pattern may not hold.[6]

In my judgement, the problem of non-uniqueness of the internal rate of return is not perhaps the most significant objection to it, for even if all internal rates are unique, maximizing the internal rate of return may not be the best thing to do. What we are concerned with is not only the rate of return per unit of investment, but also the size of the undertaking. For example, given the choice between two incompatible projects, it does not follow that the one with the higher internal rate of return should be chosen, for it might be a much smaller project. We might prefer to have 10 per cent on \$100 rather than 100 per cent on \$1, when the market rate of interest is, say, 5 per cent.

The main advantage with the alternative "present value" approach is that it gives a clear expression of the total net benefit expected from the project as evaluated today with the proper rate of interest. By the proper rate of interest is meant the market rate, assuming the market to be perfect, which makes it the relevant rate for the commercial profitability calculation. The individual taking the decision has the option of borrowing or lending at the market rate of interest, and so the proper basis for the evaluation of the time series, from the point of view of his personal profits, is to discount it throughout at the market rate of interest.

Thus the conclusion we arrive at is that the proper basis for a commercial evaluation is not the

[2] It is assumed here that the present value is a decreasing function of the rate of interest. While this is true of projects typical of the investment type with which we are mainly concerned, it is not universally true. The question is related to the problem of uniqueness of the internal rate of return which is discussed later in the text.

[3] Apart from the problem of existence as such there is the problem of whether the internal rate might not be "imaginary" (see Hirschleifer [16] p. 349), a problem into which we do not go here.

[4] On this question of uniqueness, see Lorie and Savage [25], Hirschleifer [16], McKean [26], Pitchford and Hagger [32], Wright [48], Feldstein and Flemming [11] and Sondrum [44].

[5] See Wright [48].

[6] This is related to Irving Fisher's "rate of return over cost rule".

internal rate of return but the present value. This point has of course been much discussed in the literature,[7] and is repeated here only because the appeal of the alternative criterion of maximizing the "rate of profit" or the "internal rate of return" still seems to be very great. It should perhaps be noted that the conclusion quoted is based on a number of simplifying assumptions that may be rather restrictive. In particular, the assumption of a perfect market for borrowing and lending is a serious one for the efficiency of the present value rule. If, for example, the indivisible project was so big that the assumption of atomistic calculation was no longer appropriate, we should then have to consider not only the market rate of interest, but also the possible changes in the market rate itself as a result of the project evaluation in question.

Only with atomistic competition can one assume that the market price of everything, including the rate of interest, is fixed irrespective of the decision at hand. The present value rule is based on this assumption, but it may not be a very good one in the case of a big project, and when we come to the giant sized projects that government might consider, for example, canals across the country, the question of the variation of the market rate of interest in response to the project must be brought in.

It should also be noted that an underlying assumption of the present value technique is that the market rate of interest is not only fixed irrespective of individual actions, but that all individuals who have to take decisions can in fact have access to such a market for as much borrowing and lending as they want. Any restriction in the market is ruled out, and it is of course quite relevant to ask whether government can be treated like an individual vis-à-vis the market. Even from the point of view of private *entrepreneurs*, one limitation of the present value rule clearly lies in the non-perfect nature of the capital market. Indeed, the importance of the "availability" of funds as a determinant of investment that has been discussed in the context of private investment decisions in a capitalist economy[8] is clearly an indicator of an imperfect capital market.

We need not go further into the question of commercial profitability. Our interest in it is only incidental, being confined to the light it throws on industrial project evaluation from the point of view of the society. For such a background, it is sufficient to note at this stage that the greatest private profit is obtained by evaluating projects at the market rates of interest, converting them into present values. The rule of internal rate of return does not give a proper indication of what to do in this case. We have also noted that the soundness of this present value rule from the point of view of commercial profitability is crucially dependent on the assumption of a perfect market for borrowing and lending to which each decision-maker has unlimited access.

B. National economic profitability

The calculation of commercial profitability is analytically similar to that of evaluating national economic gain from a project, but the variables to be dealt with are often quite different. Since the term "efficiency" and "optimality" are used in economics in some widely different senses, it is perhaps worth making analytical distinctions before going further into the analysis of national economic profitability.

The most widely used notion of optimality in economics is a surprisingly limited one, that is, the so-called "Pareto optimality". A Paretian improvement indicates a situational change where some people (at least one person) gain and nobody loses. Each individual is assumed to be the relevant judge of his own welfare, so that the Paretian improvement means that at least one person regards himself as better off and no person regards himself as worse off. This is indeed an improvement in a very fundamental sense. "Pareto optimality" defines an economic situation as optimal if no Paretian improvements are possible, starting from such a situation, but it is obvious that this optimum is a very weak one. It can, for example, be achieved even when some people are suffering acutely from hunger while others are excessively rich, so long as the misery of the poor cannot be alleviated save by disturbing the well-being of the rich. In short, Pareto optimality says nothing about distribution and is consistent with any degree of inequality.

The main appeal of the criterion of Pareto optimality is that it is something which most of us will find to be necessary for welfare maximization, though we may not find it sufficient. Treated as a necessary condition the criterion is indeed a remarkably good one. The only difficulty with it has been a tendency to confuse this necessary condition with a sufficiency condition. We shall go further into this presently.

The optimality of the perfectly competitive market mechanism has been proved within the range of certain specific assumptions by using the notion of Pareto optimality. Briefly, it is shown that given certain economic assumptions (such as absence of external effects or of saturation of wants), every competitive equilibrium is a Pareto optimal situation.[9] So that if projects are evaluated at the

[7] See in particular Hirshleifer [16], Bailey [2], Feldstein and Flemming [11]. For a defence of the internal rate of return criterion in a modified form, see Sundrum [44]. Incidentally, one further advantage of the present value criterion is that it can take into account variations in the market rate of interest over time if the time path of such interest is known at the point of decision making. Equation (2) has to be correspondingly modified when $q_1, q_2, \ldots q_m$ are the relevant rates of interest in the time periods 1, 2, ... m, respectively.

$$P[(q_i), (V_t)] = \sum_{t=1}^{m} \frac{V_t}{(1+q_1)(1+q_2)\cdots(1+q_t)} \qquad (2A)$$

[8] See Kalecki [18], Meyer and Kuh [31].

[9] The reverse statement that every Pareto optimal situation is a competitive equilibrium with respect to some set of prices requires the further assumption [illegible] ruling out possibilities such as increasing returns [illegible] Both propositions are based on ruling out external effects, which can of course be important [illegible] [17] and Samuelson [illegible].

market [illegible] people [illegible] the competitive deci[illegible] [illegible] undoubtedly [illegible] given the assump[illegible] [illegible] position where no one's eco[illegible] situation can be made improved without [illegible] deteriorating. Indeed this result lies at the root of the practice followed by many in [illegible] identifying market profitability with eco[illegible] [illegible]

[illegible] reasons for differing from this [illegible] the assumption [illegible] markets are perfect is crucial, and is [illegible] any economy that one [illegible] particular the imperfection of the [illegible] drawn much attention and, in [illegible] planning for labour surplus econo[illegible] the fact that the wage rate often differs from the [illegible] product of labour which [illegible] has been noted. Further [illegible] for the optimality result that [illegible] even [illegible] very large [illegible] the competitive rules but [illegible] hold. If one market is imperfect [illegible] follow that the best that the other [illegible] themselves to follow the [illegible] Indeed the optimality of the competitive rule in one field is critically [illegible] the same rule followed in every other field. If there is imperfection elsewhere, then we need a different set of calculations to achieve what is some[illegible] called the "second best." There is indeed [illegible] any situation in the world where the com[illegible] rule can be put forward without any hesi[illegible] because the condition of all other units fol[illegible] the competitive rule is such a restrictive one.

[illegible] assumed that all markets [illegible] of no external effects [illegible] This implies that [illegible] different individuals work [illegible] and that each has a price at[illegible] purchase a telephone I am [illegible] benefits from it and people [illegible] of being able to ring me [illegible] on our intentions dis[illegible] price attached to it which [illegible] keeping him [illegible] example might be thought [illegible] context of industrial project [illegible] problems of external [illegible] significant effect [illegible] labour force that [illegible] does not fully reflect [illegible] the project to [illegible]

[illegible] project [illegible] effects [illegible] welfare [illegible] people today but also of those of [illegible] context the assumption of no [illegible] effects has to take a curious form. If we [illegible] the assumption literally, then all that the [illegible] mechanism will achieve is that no one [illegible] present generation can be made better off with[illegible] making someone else in the present generation [illegible] off. This guarantees nothing whatever about [illegible] welfare of the future generations. Faced with [illegible] the contention of those advocating purely market-based decisions has been to assume that the members of the present generation identify their own interests with those of their heirs, so that the future generations are also represented indirectly in the market operations of today. To some extent this is undoubtedly true. The question, however, is whether these future welfare interests are adequately represented by the market prices. This will be an important consideration for us to take up in the context of correcting market prices.

Finally, so far we have not raised any objection to the goal of achieving only Pareto optimality and nothing more. Clearly this is a very limited goal. We are interested in the distributional questions also, even if we cannot always formulate this consideration very precisely.[10] The market attaches no price to the reduction of income inequality whereas we might wish to do precisely that. Thus in this respect we need to distinguish the question of national economic profitability from that of commercial profitability. With these problems in mind we can now go on to discuss the important question of how to move from an evaluation of commercial profitability to that of national profitability.

[illegible] FROM COMMERCIAL TO NATIONAL PROFITABILITY

Essentially the problem of finding a set of general criteria for industrial project evaluation is one that is only a part of the optimization exercise for the economy as a whole. The problem cannot be resolved without resolving the more general problem for the entire economy. The trouble is, however, that such a giant "general equilibrium" analysis of optimum allocation is well outside the capabilities of practical planning of any country at the moment. An alternative is to give up the exercise [illegible] and follow some clear-cut rules of [illegible] irrespective of their consequence. Neither [illegible] as mentioned before, is particularly appealing. Before we go on to a compromise solution it [illegible] that we briefly evaluate two approaches that are often put forward in dealing with these questions and which I would like to claim are grossly misleading.

One approach is to claim that the problem of social optimum invariably involves value judgements and that since economists are not permitted to indulge in this luxury, the best they can do is to take up some "objective" criterion, such as the financial "feasibility" of the project. The notion [illegible] an economist should not make value judgement has predominated in economics since the celebrated book by Professor (now Lord) Robbins[11] and it is usually argued that economists should make only analytical points rather than policy recommendations. The fact is, however, that economists really have no choice in the matter once they are actually involved in project evaluation, and the "objectivity" of the "feasibility" criterion is essentially an illusion. For anyone can put forward innumerable criteria for project selection that are all equally "objective," varying from commercial feasi[illegible]

[illegible] see Little (1957) and Graaff (1957).
[11] R[illegible]

bility to maximizing the specific gravity of the output, or minimizing the number of bald headed men on the project site, and if we want to defend any one of them we have to do so on grounds other than objectivity. After all, what we are concerned with is trying to find some criteria that correspond to our own, or to society's, notion of goodness, and to expect that we can do this without making some serious value judgements is naivete. There is no reason, of course, why the economist's own value judgement should be given a special place, and this is indeed a valid objection up to a point. The economist's job, however, is to represent as faithfully as he can the values that are generally held in the community in question, and while this may be difficult to do precisely, the imprecision involved here is probably no greater than that involved in a variety of other exercises that the economist is continually forced to do. Once the problem is viewed in this light, it is clear that it cannot be resolved by using certain criteria simply on grounds of their objectivity.

A second approach, closely connected with this one, is to point out that the hope of achieving a social welfare function based on the values of the members of the community is very weak, for these values cannot really be combined into a consistent set of social orderings. In so far as this objection is intended to point out that the problem of social decision making is exceedingly complex, the point is well taken, although it is difficult to see what exact policy implication this recognition has. Sometimes, however, the point is made in an analytically stronger form, claiming that there is something inherently wrong in expecting social values to be consistent. Much of this criticism arises from Arrow's well known impossibility theorem,[17] though he himself was anxious to point out that in certain circumstances the problem of combining individual values into social orderings might not arise. In particular, Arrow showed, following a suggestion of Duncan Black,[18] that when individual preferences are "single peaked", majority decisions provide a consistent method of combining these values. In these circumstances, the overriding of market decisions by certain political measures would be justifiable in purely democratic terms. This result can be further extended and it can be demonstrated that when there is little similarity in the community's preference pattern, of which Arrow's single peakedness is a special case, social decisions based on the values of the individual members of the community can be altogether consistent.[19] We do not propose here to go further into this question and only wish to point out that the overriding of market decisions by political decisions need not necessarily violate the usual canons of democracy.

We have claimed so far that market criteria may grossly violate our notions of social welfare and also that our preferences on social questions can in certain circumstances be perfectly consistently combined in a democratic manner. We have

not, however, as yet, said anything ... [illegible] we shall proceed with [illegible] the general approach of deriving [illegible] formal optimisation exercises and [illegible] though, we can consider the following [illegible]. We can start with the market [illegible] and benefits and compute [illegible] each project at the market [illegible] then systematically correct [illegible] by bringing in those factors [illegible] neglect, for example, external [illegible] tions of inequality, the weight to be [illegible] welfare of future generations. [illegible] include the market interest rate [illegible] the basis of the present value [illegible] modified the profitability figures [illegible] indication of our notions of social [illegible] will provide the basis for project [illegible]

What is suggested above [illegible] the framework of shadow [illegible] flows, or for a variety of [illegible] accounting prices has been [illegible] pletely with that of the [illegible] have used were the market [illegible] shadow prices [illegible] in a variety of [illegible] based on marketed [illegible] ties. Nevertheless, the basic conceptual [illegible] recently expressed [illegible] the general [illegible] [illegible]

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For practical planning it might be convenient to express the intertemporal political judgements in the form of a [illegible] horizon and a fixed rate of interest up to the end of the horizon. Indeed this is how the problem is usually posed. An even simpler procedure is [illegible] discounting at all until the end of the horizon and to have a sudden drop of the discount rate from [illegible] per cent to [illegible] per cent. In either version we have a sudden [illegible] which may be analytically [illegible]. The planner will have to choose between having such simple formulae and making use of more sophisticated formulations [illegible] for example infinite horizon with [illegible] continuously increasing social rate of discount [illegible] question of striking a balance between [illegible] and sophistication.

[illegible]

Therefore [illegible]

[illegible]

rate of interest the appropriate [illegible] for public project evaluation. What it does [illegible] is that both public and private sector costs and benefits must be evaluated at the appropriately determined social rates of discount. Therefore [illegible] the opportunity cost of capital in public projects we must take into account the returns that [illegible] in the private sector but the method of evaluation will be to compare the two time series aggregated at the appropriate social rates of discount. The problem of the corrections needed [illegible] public investments has been studied [illegible] Marglin [illegible]

[illegible]

[illegible]

purchasing power and leads to more consumption. [illegible] of more consumer expenditure is not to lead to inflation we have to increase the production of consumer goods and shift resources from making investment goods to making consumer goods. This [illegible] from the point of view of long-run growth [illegible] employment of otherwise unemployed labour [illegible] cost since extra employment reduces investment and possibilities of future growth.

[illegible] is the problem. It depends on a number of things. In a developing economy the wage earners tend to consume practically everything [illegible] will therefore roughly [illegible] to the extra consumption generated. But [illegible] possibilities of taxation and also of absorbing [illegible] part of the extra purchasing power [illegible] inflation. Given the practical limitations of [illegible] however and the political limitations [illegible] such inflation the link between employment and consumption cannot be entirely severed. [illegible] in terms of future growth there remains [illegible]. What weight we want to attach to [illegible] valuation of future [illegible] with present consumption. [illegible]

[illegible]

$$\frac{dR}{dL} = [illegible]$$

i.e. when $\frac{dY}{dL} = [illegible]$ [illegible] λ [illegible]

Since the left hand side represents the marginal product of labour equation (8) can be interpreted as equating the marginal return to marginal cost, so that the right hand side can be taken to be the appropriate marginal social cost of labour. Here we get a precise expression of exactly the measure that we have been looking for.

Those[20] who believe that labour is really costless in an economy with surplus labour must argue that the right hand side of equation (8) is zero. In principle there are two ways of arguing this. First it can be argued that there is no point in attaching any extra weight to savings, that is we should take $\lambda = 0$. This implies that the rate of savings is just right and the value of a marginal unit of saving is the same as that of a marginal unit of consumption. For the reasons discussed in the last section, this seems to be an inappropriate assumption for most developing economies. Secondly it can be argued that wage earners do not have a markedly higher propensity to consume than the recipients of capital income, that is [illegible]. In either case we have the right hand side of equation (8) equal to zero, i.e. labour being really costless. The second assumption [illegible] also does not seem to be particularly appropriate for an underdeveloped economy, even when the possibilities of taxing wages are taken into account. Particularly when the project in question is a public project this is a very bad assumption since the marginal propensity of the Government to consume out of its income can be taken to be approximately zero and that clearly cannot be an appropriate assumption for the wage earners.

On the other hand those[21] who take the appropriate cost of labour as given by the market wage rate can do so only by another set of extreme assumptions. For example if the wage earners consume everything [illegible] capital [illegible] and the weight attached to saving is so high that the relative importance of consumption is negligible [illegible] then the right hand side approximates [illegible]. When we have a very long time horizon and no discounting of future benefits this last assumption is appropriate but that is an extreme one.

The [illegible] of the proper social cost of labour when there is surplus labour is given by the right hand side of equation (8) and the extreme values of it are given by zero [illegible]

[illegible]

the market wage rate. Equation (8) expresses the relevant concept of cost in a manner that can be directly related to observed magnitudes (m, and c) and an explicit value judgement (A). Incidentally, it is through the choice of A that the link between the last problem, namely, the choice of the social rate of discount, and the present one, namely, the choice of the social cost of labour, is established: both depend on whether the present rate of saving is taken to be too low or not.

6. STRATEGY OF INDUSTRIAL DEVELOPMENT: CONCLUDING REMARKS

The approach used in this paper has been one of detailed calculation of costs and benefits from a social point of view. We have outlined the different types of corrections needed to move from an estimate of commercial profitability to one of national gains. To resolve the problems satisfactorily there are no alternatives [illegible] to detailed calculations making use of observations as well as of explicit judgements.

A general reference should however be made to the approaches that lay down some general principles, for example choosing "balanced" growth, or selecting quick yielding projects, or going in for "basic" industries. In avoiding discussion of these general principles we do not intend to question their wisdom. Some are indeed very helpful guides to general planning and spotlight certain strategic considerations. For example, since "basic" industries produce mostly investment goods, the emphasis on "basic" industries is not different from an evaluation of the social desirability of raising the rate of saving from the figure given by the market rate (section [illegible]). Similarly, the emphasis on balanced growth outlines the factors of interdependence between different projects, and that, with [illegible], is part of the cost benefit evaluation outlined in the paper.

However, while these principles are often quite helpful, they can never really be taken as substitutes for the detailed cost benefit evaluation on which project selection must be based to avoid unnecessary mistakes. The principles in question can [illegible] no more than preliminary [illegible] of what type of projects need be considered. The actual selection needs more specific estimation.

An illustration may be helpful [illegible] the [illegible] project in India [illegible] [illegible] [illegible] a gigantic amount of [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] alternative explanations from Streeten and [illegible] [illegible] [illegible] [illegible] arguments.

[illegible] Streeten [illegible]

[illegible] [illegible] in the [illegible] [illegible] [illegible] great [illegible] [illegible] [illegible] the north of India, the largest dam in the country and the highest [illegible] the world. There was an [illegible] [illegible] in the site [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible]

else. The skyline was filled with cranes and hoisting equipment, while a great length of machine belting, electrically driven, climbed like an endless vibrating snake over the hills, across a bridge over the river, and then up the steep side of the bank up to the dam itself, bringing its continuous load of stone from a quarry several miles away. Why, I asked the engineers in charge, did they not draw on the huge reserve of unemployed Indian labour to replace some of the machinery? They could also have saved some electricity which was so short it was holding up the production of factories in the area. The official answer was that the dam site was too narrow for masses of people to work on it; also a high dam by its nature requires a lot of mechanical handling. No one could deny, however, that there was plenty of room for many more people than were actually there. The essential point which emerged in the course of further conversation was that these technicians did not want thousands of primitive and probably half starved Indians crawling all over their site. They would be out of control, they would get in the way, and everything would be slowed [illegible]

To quote Ray:

Taking the last two alternatives [illegible] broadly are that the capital [illegible] a specified amount [illegible] about half of the capital cost [illegible] moving machinery required [illegible] but the amount needed in the [illegible] excavation, loading and unloading [illegible] watering and for [illegible] trucks will be [illegible] although undoubtedly [illegible] need be only unskilled [illegible] [illegible] [illegible] the [illegible] technique [illegible]

[illegible]

[illegible]

the comparative economic advantage which has been claimed for it."[38]

This brings us back to the question of shadow prices as opposed to market prices, influencing a major decision.

General principles can give us some guidance but cannot take us all the way. To take them as preliminary hints on what questions to ask and what to expect can lighten the burden of project selection, but to take them as sufficient ground for straightforward choice of projects seems to be a course full of pitfalls. In the last analysis, there is no substitute for the evaluation of social costs and benefits in making a proper selection of projects. That is why this paper has been devoted to the issues involved in this detailed evaluation.

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VIII. PROBLEMS OF COMMERCIAL AND NATIONAL PROFITABILITY

by C. D. Foster*

INTRODUCTION

There is a story which could be apocryphal of a country which shall be nameless. It was on the edge of war. The cabinet met to discuss strategy, feeling that it ought to decide in a rational way what its objectives were and, when those were decided, by what routes and with what force and penetration it should counter-attack. But after forty-eight hours of debate in which it touched on matters as separate as the army's cooking arrangements and the reactions of the Press to what it might decide to do, it said in despair to the generals who were lurking in the shadows: "You know the enemy: now fight the war." Which the generals did.

Now it is not difficult to see why discussions of project evaluation and investment criteria slide off the conference table and are lost in the shadows or why it is virtually impossible to achieve agreement on the topic of investment criteria in the public sector. [illegible] I believe it is almost if not quite [illegible] country [illegible] there is [illegible] which [illegible] central [illegible] and lower [illegible] public invest[illegible] where the investment criter[illegible] implicit [illegible] the [illegible] economic plans are carried down [illegible] investment dec[illegible] all levels [illegible]

[illegible] the [illegible] not be [illegible] real entities [illegible] not a battle [illegible] politics. [illegible] difficult [illegible] comment to maximise [illegible] that [illegible] of economic choice each become con[illegible] stirring the [illegible] ship planning [illegible] and recently [illegible] these [illegible] with [illegible] Secondly [illegible] advance [illegible] of course [illegible] an investment criteria [illegible] political [illegible] to be as [illegible] statement [illegible]

clarity provokes dissent. Thirdly, the notion that investment criteria should be co-ordinated and consistent presupposes that the decision-making process in a nation is consistent in the sense that all political decisions—among which must be included economic decisions—are harmonised to achieve compatible aims. But everyone knows that the process of governing is not like that, whatever the overt form of government. Many decisions are not taken rationally but emerge as a vector of pressures, pressure groups, conflicting interests and personal ambitions, and it is inevitable that it should be so. The political process cannot be smoothed away into some over-all maximizing process. It is unthinkable and probably undesirable that this should happen since it would mean the obliteration of most of the individuality and independence of mind of lower level decision makers. The cost in terms of loss of energy and incentive could outweigh the gain in rationality.

So far apart are the actual worlds of political and economic decision making on the one hand and of investment criteria and the social welfare function on the other that one wonders whether there is any point in trying to bridge the firmament between them. Such a bridging must be a limited adventure to have a chance of success. All that one can say is that the attempt to formalize the seamless web of an actual piece of decision making as if those responsible were trying to maximize something may throw light on motives or the adequacy of means. Alternatively, a normative discussion of what alternatives would be chosen if certain principles (criteria) were adopted may be useful in illuminating the possible and so affect policy.

But it is not political reality alone which makes it impossible to think of economic decision making in practice as the maximization of some given social welfare function. The economic literature on investment criteria in underdeveloped countries has been large, but it has been admitted not once but several times that it has not been satisfactory. The ideas that relate to project evaluation converge from two directions: the theory of the firm and its investment policy on the one hand, and Business investment procedures have in practice been developed with several ends in view, profit maximization, incentive to management, the [illegible] of board, the [illegible] of shareholders and [illegible] limited extent some [illegible] in past decisions. The other [illegible] of influence is the theory of economic growth and as an integral part of it the macroeconomic theory of investment. It does not take much imagination to see the difficulty in asking for the right investment criteria for the individual enterprise, particularly in a developing country, or [illegible] asking [illegible]

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the efficient secret of economic growth, a secret which it is too easy to keep, and we are asking for it in general in a form that will enable individual decision makers in the economy, heads of firms and public enterprises, directors of agricultural programmes and so forth, to optimise their behaviour in relation to the over all national economic criterion. The theories of economic growth and planning are not far enough advanced to make this as yet a theoretically feasible programme.

Therefore, however the problem is approached, nothing one says on investment criteria can be satisfactory, whether one starts by considering what is implied for individual project evaluation by national economic planning, or whether one starts from the other end and asks how considerations of national, as against commercial, profitability diverge from the society's standpoint.

In section A this stage of the argument is examined in more detail. It is only recently that a long debate on the definition of an optimum growth path has ended by the demonstration that a large number of supposedly independent criteria were special cases of the recommendation that a country should maximise its growth rate subject to some rate of time preference. The question of the choice of a rate of social time preference is considered briefly. Even when there is agreement on the exact criterion there are informational and computational problems which make it impossible at present to maximise that criterion consistently for an economy. But no country will maximise a single well defined criterion. It is not even an approximation to the truth. Even if we suppose they are consistent, the existence of different criteria for different purposes stretches the informational and computational problems further. These are the questions considered further in the next section, and they reinforce the same conclusion we have already come to, that the choice of investment criteria must be broken down into a number of sub-optimisation problems.

Section B accepts this conclusion and discusses alternative investment criteria from the standpoint of some imaginary administrator whose duty it is to define investment criteria for public enterprise, bearing in mind questions of consistency and [illegible]. Section C [illegible] considers the problem of [illegible] criteria other than ordinary commercial profitability from the point of view of someone evaluating a project. [illegible] might he be expected to [illegible]? Where might he reasonably expect help?

A [illegible]

[illegible]

[illegible]

Conversely if $K/\Delta Y$ is given the policy [illegible] S/Y maximizes ΔY [illegible]. All investment [illegible] their roots in the theory of economic growth [illegible] their roots in one or other of these [illegible]. The first has a rough correspondence [illegible] static notion of efficiency (maximization of [illegible] output with given inputs, the difference [illegible] the only input specifically mentioned [illegible]) second reflects the dynamic notion that [illegible] growth is a function of the rate of saving. [illegible] is no reason why an investment policy [illegible] the one should achieve the other [illegible] period. But unfortunately it is not the case that a policy which sets out to minimize $K/\Delta Y$ [illegible] finite time period will maximize S/Y [illegible] for that matter ΔY.

As it happens, confusion over the objective [illegible] maximizing output and growth [illegible] of the theoretical debate in economic [illegible] investment criteria. Professor Sen [illegible] that the dispute is essentially political [illegible] over the social rate of time [illegible] proved by von Neumann (1938) [illegible] possible rate of growth [illegible] the highest rate of return on capital [illegible] certain assumptions [illegible]

[illegible]

But we can get a yet higher [illegible] make an assumption that [illegible] developing countries there is disguised unemployment [illegible] agricultural labour [illegible] without any increase in aggregate wages [illegible] other words the shadow price of labour is zero [illegible] Lewis (1954) [illegible]

[illegible]

getting [illegible] if [illegible] the factories, then the rate of growth will be correspondingly lower. [illegible] (1961) has made a useful double distinction: first between [illegible] and "functional" consumption. An increase in "functional" consumption [illegible] necessary to increase the labour force, [illegible] between sectors, or to raise [illegible] of the work force. "Extraneous" [illegible] unnecessary in the same sense [illegible] consumption increases achieved by [illegible] of the [illegible] of government [illegible]. The other distinction is between in- [illegible] wage bill which government [illegible] by increased agricultural taxation [illegible] consumption per head constant, and [illegible] of such in offsetting [illegible] depends on institutional factors and [illegible]. The conclusion is that economic growth [illegible] imply rising real wages [illegible] real cost of increasing output [illegible] is unable to prevent it through [illegible] higher the growth of real wages [illegible] lower the rates of profit, savings [illegible] has demonstrated [illegible] the point is obvious intuitively [illegible] that the [illegible] growing economy [illegible] consumption, the less its investible [illegible] intuition remains even [illegible] some of the assumptions of the von [illegible] model.[2]

[illegible] economy, a higher rate [illegible] feasible. It becomes easier [illegible] the Keynesian conditions of sufficient [illegible] the rate of profit up in such circum- [illegible] imagine growth [illegible] towards exports, the proceeds from [illegible] saved and reinvested. If we allow that some [illegible] is consumed [illegible] the growth rate will be lower. By exact analogy [illegible] argument above [illegible] some propor- [illegible] wages will not be a leakage [illegible] imperfect competition and [illegible] diverge from the [illegible] of investment [illegible] different, but the general proposition that the greater the in- [illegible] the higher the growth rate will [illegible] economies and [illegible] these are [illegible] there should be no difficulty. If there is technical progress the effect depends on its causation. If technical progress is a function of the rate of investment or of the growth rate (Kaldor, 1957; Arrow, 1962) then a fortiori the higher the rate of savings and investment the higher the growth path. [illegible] the form of the relation [illegible] investment, the optimal investment [illegible] to be different.

We will consider below investment criteria which relate to the maximum growth path. But what would such a growth path imply? It would mean that all increases in consumption would be accounted a cost of development. In other words, production's aim would be to produce more production, and if one were to imagine it proceeding ad infinitum the result would plainly be absurd, since there would never be an increase in non-functional consumption per head. And the purpose of economic growth is, in the end at least, to raise consumption per head. But several economists, among them Little (1961) and Balogh (1962), have recommended a movement in this direction for a finite period: a "big push" of investment is needed in some countries if the bogey of increasing population outstripping the growth rate is to be avoided, or to establish certain growth-oriented propensities. Afterwards, the "millenium" is allowed to break and the capital accumulation is used to raise the standard of living. The proposition can also be put as the maximization of terminal capital, given the time period, and since consumption is given a weight of zero, the concept of social time preference rate does not apply.

But although such a policy (given the real wage function) would facilitate the highest possible growth rate, it is obvious that countries cannot be so ruthless towards consumption. And it is equally plain that a Government is not being in any sense irrational if it opts for a lower growth rate to allow consumption to rise faster than is necessary or functional in the Little sense. If, then, society is to give weight to consumption before the "millenium" is allowed to break, the question is what weight, and if we divide a finite period into slices of time, what weight in each slice? The converse assumption to the maximal growth path is of course to give present (year 1) consumption infinite weight and future consumption no weight at all, so implying zero saving: "eat and drink, for tomorrow we die". One possibility is to try to give equal weight to consumption in different time periods in the sense of trying to achieve the maximum constant level of consumption per head over time. This notion has received great attention recently as the "neo-neo-classical" theorem or the "golden rule" of growth (e.g. Phelps, 1961; Robinson, 1962, 4th essay; Swan, 1964; Hahn and Matthews, 1964, pp. 816 et seq.). Under certain very restrictive assumptions (constant proportionality growth, constant returns, no technical progress, infinitely durable capital, all profits and no wages saved, inter alia) it can be shown that this growth path is realised when [illegible] and by implication the capital/labour ratio is such that the rate of growth equals the rate of profit.[8] But if one tries to be more realistic here by relaxing assumptions, the model loses its intuitive appeal. There is no likelihood in the real world that a policy of growing at a rate so defined would achieve anything like a constant level of consumption per head or the maximum constant growth rate of aggregate consumption. This further strengthens one's feeling that there is nothing par-

[7] There are excellent discussions of the issue [illegible]

[8] [illegible]

[illegible]ularly optimal (Pearce 1962) about this growth path. Why a constant level [illegible] abstracting from population growth, why a constant growth rate of consumption?

Most [illegible] of the optimal growth path takes place in terms of the social rate of time preference: the more future consumption is discounted, the less the savings and the lower the growth rate and [illegible]. Thus the notion of a variable rate of time preference provides a continuum from a rate so high that it virtually implies zero savings or the 'eat and drink, tomorrow we die' policy, to a rate so low that it approximates to an infinite postponement of consumption or the maximal growth path. The idea that a socially desirable time path of consumption is one that can be approximated by a discount [illegible] has been challenged by a number of writers [illegible] 1964 [illegible] Solow 1963 [illegible] society might want the weight to be given [illegible] to rise gradually over a limited time period, perhaps while society tightens its belt, and then increase more rapidly. Of course there [illegible] infinite number of time paths which could be held to reflect various value judgements about the desirable balance between consumption and saving [illegible]. This generalisation of the problem has been [illegible] the choice of social time preference function [illegible] by [illegible] time stream described by [illegible] sequence of variable short [illegible]. The [illegible] underlying the various versions of the [illegible] model, the 'eat and drink tomorrow we die' and the constant level of consumption [illegible] are all such that although [illegible] by [illegible] cannot be represented [illegible]. All the same [illegible] support the [illegible] next sub-section [illegible] preference rate.

[illegible] of social time preference rate

The optimal growth path and therefore [illegible] investment [illegible] of a social time preference [illegible] the lower the rate of time preference [illegible] less future consumption will be discounted in relation to present, the higher [illegible] savings [illegible] principle the nearer [illegible] growth [illegible] maximal [illegible] economists [illegible] of the considerations which ought to [illegible] a Government [illegible] of rate [illegible] alternative [illegible] one might expect [illegible] concerned [illegible] distributive point [illegible] of income [illegible] the [illegible] point [illegible] Government has [illegible] on the social rate of time preference [illegible] simply [illegible] level of [illegible] in the habit of [illegible] leave [illegible] of an optimal growth path and [illegible] investment [illegible]. Neither is it possible to pretend [illegible] decision [illegible] on the [illegible] up to a social time preference function [illegible] of [illegible]

the point of view of [illegible] rate rises.

The [illegible] from [illegible] argument [illegible] selves [illegible] and [illegible] consumption [illegible] of the population is [illegible] subsistence [illegible] a threatening population growth [illegible] increases [illegible] crease output per head [illegible] incentive [illegible] high [illegible] [illegible] accumulation [illegible] there is [illegible] between [illegible] of the [illegible] economic growth [illegible] compelling [illegible]

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[illegible] in a higher [illegible] sector [illegible]

[illegible]

over time [illegible] in principle [illegible] would expect [illegible] have [illegible] continuous shadow prices for every time period [illegible]

Secondly, it is similarly possible in principle to achieve any growth path by iterative planning [illegible] in principle [illegible] with normal planning techniques by iterative methods, [illegible] which more below, or by the use of [illegible] programming methods. Through the use of the appropriate programming methods the correct set of shadow prices, and by implication the correct divergences between social and private benefit and cost, would be produced.

Therefore we might say, using again the [illegible] phrase 'in principle', that any given growth path could be achieved by any of these methods and that [illegible] would be given to the [illegible] expressed notion that the correct investment [illegible] be achieved by choosing from the pool of projects that with the greatest return on capital, having accounted for all present and future inputs and outputs at prices which [illegible] will equal social costs and values. (Little [illegible], p. [illegible].)

But in practice none of this can be done. Nobody has tried to establish the divergence between social and private and therefore the shadow prices in relation to any growth path. Therefore no one has tried to work out an optimum set of taxes and subsidies to close these divergences. In recent years writers have in fact become much more critical of the possibilities of devising such taxes and subsidies even to correct market distortions in static allocation problems (Coase [illegible]; Davis and Whinston [illegible]; Buchanan and Stubblebine [illegible]; Turvey [illegible]).

Let us take the first of the so-called consistent methods, although in practice it is used in some form in almost every developing country whatever its politics. The standard pattern of such a plan is roughly as follows. There are equations linking [illegible] investment, savings and foreign aid, growth of income, demand for output in different sectors, [illegible] growth of savings, and so on. In more complicated plans these may be integrated with more or less disaggregated input-output matrices, whereas in simpler plans there may be only two sectors, agricultural and non-agricultural. [illegible] of the set of equations there are more unknowns than equations. This means that if one is assigned a value to the number of unknowns in excess of the number of equations the effects on all the other unknowns can be worked out. For example, 'plausible' values may be assigned to the amount of investible funds and of foreign exchange available and then the equations may be solved to find what values are

[illegible]

required for the other variables. [illegible]

Although linear programming [illegible]

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[illegible] following [illegible] programming [illegible] methods [illegible] [illegible] mathematical methods [illegible]

In mathematical modelling the given problem [illegible]

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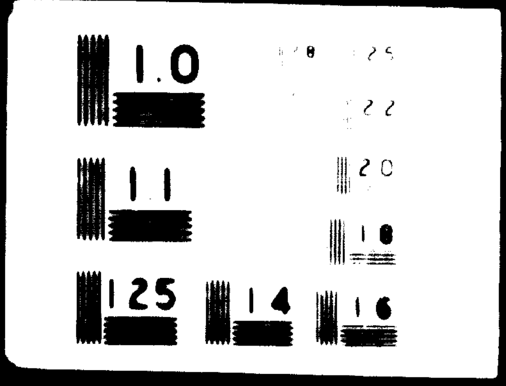

mum output at a given production capacity while retaining the given assortment, and the minimum that is an accurate realization of the programme of output of each article involving the least possible cost. These costs can be included both in fixing prices and in payment in kind (particularly if economies in certain scarce materials are needed). However, under production condition, factors such as meeting urgent orders necessitate consideration. For example, where an urgent order has to be carried out with the help of mathematical methods, it is possible to calculate the cost of a forced departure from the optimum.

In the USSR, economic mathematical modelling was successfully used in 1965 to determine the optimum distribution and specialization of plants for repairing lorries in Siberia and the Far East (transport production model of whole number programming), specialization of production of hardware in Novosibirsk (distribution of linear programming) and specialization of the production of a fibron half-finished product in the pulp and paper industry (general model of linear programming). Similar methods were used in many other cases.

Designing by industrial organization is largely used in the USSR. The laboratory of economic mathematical investigation of the Novosibirsk University alone carries out about twenty tasks of this kind in a year.

The problem of the optimum distribution of the production programme between several enterprises can be considered as an example. Let us assume that we have a certain number of enterprises of five types *A–E*, among which it is necessary to distribute orders of products Nos. 1 and 2. A definite ratio of product No. 1 to product No. 2 has to be maintained: twice as many products No. 1 are required as products No. 2. It is desirable that each enterprise produce only one kind of product. Data on the number of enterprises and their capacity are shown in table 1 below.

TABLE 1. PRODUCTION CAPACITY OF ENTERPRISES OF *A–E* TYPE

		Production capacity of an enterprise		*Relative labour-consuming character of production*	
Type of enterprise	*Number of enterprises*	*By 1,000 units, products No. 1*	*By 1,000 units, products No. 2*	*Products No. 2 compared with products No. 1*	*Products No. 1 compared with products No. 2*
A	5	100	15	6.7	0.15
B	3	400	200	2.0	0.50
C	40	20	2.5	8.0	0.125
D	9	200	50	4.0	0.25
E	2	600	250	2.4	0.41

Equal production costs for all enterprises are assumed. The question of transport is not considered; it is considered later in the present report. It is necessary now to determine the optimum order of distribution among enterprises and possible maximum volume of production (under other equal conditions).

If all the enterprises were to produce article No. 1, then their total output would be equal to:

$$5 \times 100 + 3 \times 400 + 40 \times 20 + 9 \times 200 + 2 \times 600 = 5{,}500 \text{ thousand units.}$$

However, a part of the production capacity must be used to produce article No. 2. By transferring enterprises *A* to the production of article No. 2 instead of the earlier production of 100,000 units of No. 1, we can obtain 15,000 articles of No. 2 (0.15 articles No. 2 to each article No. 1).

The data in the last column of table 1 indicate that it is more rational to transfer enterprises of *B* type to the production of articles No. 2. But this is not enough, because the carrying capacity of three enterprises of the *B* type is equal to 600,000 articles No. 2. As a result of further "ranging" approximations, we obtain the optimum plan shown in table 2.

TABLE 2. OPTIMUM PLAN OF ARTICLE OUTPUT IN ENTERPRISES OF THE *A–E* TYPE

	Article No. 1		*Article No. 2*	
Type of enterprise	*Number of enterprises*	*Total output per thousand units*	*Number of enterprises*	*Total output per thousand units*
A	5	500	—	—
B			3	600
C	40	800	—	—
D	6	1,200	3	150
E		—	2	500
TOTAL		2,500	–	1,250

In practice, the number of articles produced in each enterprise is often greater than anticipated on account of the conditions of the given task, and the computation requires complicated methods of linear programming. The establishment of a rational plan of supplying and transporting loads is one of the most common types of problems solved by mathematical methods, the main object being to transport loads from producers to consumers at minimum costs. The prime costs of transportation by railway, automobile and shipping comprise the given data. We must also take into account additional factors, such as restrictions resulting from limited capacity of some transportation units, interchangeability of some loads and necessity of supplying the most important consumers first. The optimum linkage of consumers to producers in many branches of the national economy of the USSR has proved economically effective. Therefore similar control calculations in the evaluation of the specified industrial projects are highly recommended.

The main computation centre of the Gosplan has determined the optimum plan for transporting saw timber and round timber on a countrywide scale. Three factors were involved: producers of round timber and saw timber (37 timber organizations); 87 intermediate sites of round-timber processing and, lastly, consumers (63 organizations). The restrictions on saw-mill capacities and the interchangeability of some timbers were taken into account. The optimum distribution of enterprises of each branch was determined, as well as the capacity of all enterprises required to meet consumer demands.

As a criterion of the optimum, the minimum combined costs of production, consumption and transportation of saw-timber and timber was determined. The optimum potential of the scheme was checked for the transport of coal, first to eastern Siberia and the Far East and then on a country-wide scale (coal transportation constitutes 20 per cent of the whole railway turnover in the USSR). As points of coal consumption, administrative centres of ninety-eight main economic regions of the country (Leningrad, Kharkov, Sverdlovsk and others) were taken, as well as the junctions of the coal basins (Debaltsevo for the Don basin, Usjat for the Kuznetz basin, Uztovaya for the regions near Moscow). The calculations were carried out in three forms: for the minimum run (in ton-kilometre), for the minimum prime cost and for the minimum price of transportation according to the actual tariff. Plans calculated on the computer have resulted in a reduction of the load-run of some 9 to 10 per cent and in a saving of 70 to 90 million roubles for operating expenses.

For the wider use of mathematical methods in planning and formulating projects, zone seminars are conducted; they are organized for persons dealing with mathematical methods and their use.

B. Linear programming

Most of the problems mentioned above were resolved by linear programming methods. That is the only method of resolving many production problems arising during the preparation and evaluation of industrial projects, in which the value considered depends on many factors, that is why these problems cannot be resolved by the usual methods of mathematical analysis (calculation of the first and second derivatives). With the use of programming, the main criteria according to which this or that version can be determined as the optimum can be, for instance, the highest productivity of the group of units or the lowest cost of production per unit, the best use of resources and, in particular, the reduction in the quantity of raw materials, energy and other elements used. Available production resources (quantity and capacity of given units, machine tools, machines) and the given production assortment can be referred to the principal given conditions.

The case illustrated above (see tables 1 and 2) is comparatively simple, with more complex given data (even without any great increase in the number of enterprises and products[8]), which are characteristic of all problems found in practice, the problem can be resolved only by the linear programming method.

Let us analyse some general methods of solution similar to the one considered. Let us consider the operation of n machine-tools (units) where m various articles (products) are produced. If on the i^{th} machine-tool (if $i = 3$, then machine tool N 3 is in question) the k^{th} article is produced, then the quantity of the articles produced during the time of the machine tool operation is expressed as $a_{i,k}$ units (if on the i^{th} machine tool k^{th} article cannot be produced, then the corresponding $a_{i,k} = 0$).

Now it is necessary to work out a programme of machine-tool operation (article distribution) providing the production of the maximum quantity of sets or to combine the conditions of the maximum volume of production with the realization of the given plan of nomenclature.

Let $h_{i,k}$ designate the needed portion of time for the production of k^{th} article on the i^{th} machine tool (a part of the total time of the machine tool).

It is known that the quantities $h_{i,k}$ are positive ($h_{i,k} \geqslant 0$ and the sum of all quantities $h_{i,k}$ under the change of k from 1 up to m is equal to 1, which follows from the very determination of the quantity $h_{i,k}$). Using the sign Σ (sigma — sum designation), we can write this dependence in the following form:

$$\sum_{k=1}^{m} h_{i,k} = 1$$

From the determination given above for the values $a_{i,k}$ and $h_{i,k}$ it follows that the products $a_{i,k}\,h_{i,k}$ corresponds to the k^{th} production on the i^{th} machine-tool.

The total production of all k^{th} articles Z_k will then be equal to

[8] To determine the optimum distribution of five types of operations among eight machine-tools, it is necessary to solve about 100 algebraic systems of linear equations, which is impossible even with the use of rapid, up-to-date EC methods.

$$Z_k = \sum_{i=1}^{n} a_{i,k} \cdot h_{i,k}$$

The conditions of article sets under the above-mentioned designations will be as follows

$$Z_1 = Z_2 = \ldots = Z_k = \ldots = Z_m$$

Thus the conditions of the problem under consideration will be the following:

To find quantities $h_{i,k}$ ($i = 1,2, \ldots n$; $k = 1,2, \ldots m$) from the following conditions:

1. $h_{i,k} \geq 0$

2. $\sum_{k=1}^{m} h_{i,k} = 1$ $(i = 1,2, \ldots n)$

3. Value $h_{i,k}$ should be chosen so that the quantity $Z = Z_1 = Z_2 = \ldots = Z_k = \ldots = Z_m = \sum_{i=1}^{n} a_{i,k} \cdot h_{i,k}$ be maximum.

Use the ratio indicated for the following example. Productivity conditions of three types of machine-tools at the production output of two types are given (see table 3).

TABLE 3. MACHINE-TOOL PRODUCTIVITY DEPENDING ON THE TYPE OF PRODUCTION

*Machine tool type**	*Quantity of machine tools*	*Productivity (in conditional units)*			
		Of one machine-tool		*Of all machine-tools*	
		Production N 1	*Production N 2*	*Production N 1*	*Production N 2*
A	3	10	20	30	60
B	3	20	30	60	90
C	1	30	80	30	80

* Lathe, turret lathe, automats and others.

It is necessary to establish the optimum programme of machine-tool operation (production distribution) under the condition of production in sets; in this case the set consists of production N 1 and production N 2, each per single unit. Let the given data of this problem be in the form of table 4.

TABLE 4. PRODUCTIVITY OF GROUPS OF MACHINE-TOOLS BY ARTICLES OF TWO TYPES

Articles	*Groups of machine-tools*		
	A	*B*	*C*
N 1	30	60	30
N 2	60	90	80

The formulas for the case considered (with two types of articles) will be as follows:

1. $h_{i,1} \geq 0$; $h_{i,2} \geq 0$.

2. $h_{i,1} + h_{i,2} = 1$;

3. $\sum_{i=1}^{n} a_{i,1} \cdot h_{i,1} = \sum_{i=1}^{n} a_{i,2} \cdot h_{i,2} = Z$

One must determine $h_{i,1}$ and $h_{i,2}$, at which the value Z will be maximum.

Let us designate the ratio $a_{i,2} : a_{i,1} = l_i$. The value l_i characterizes the labour-consuming nature of the production on the i^{th} machine-tool of article N 2 in relation to article N 1.

Let ratios l_1, l_2 and so on always increase, i.e. $l_1 \leq l_2 \leq l_3$ (if this condition is not fulfilled, then we can change the order of machine-tools).

This system of inequalities means that it is more profitable to produce the first article on first machine-tools (i.e. on first machine-tools $h_{i,1} = 1$; $h_{i,2} = 0$, and on the last $h_{i,1} = 0$; $h_{i,2} = 1$).

Let the transition from article N 1 to article N 2 be performed on S^{th} machine-tool.

This condition can be expressed in the following way:

$$\sum_{i=1}^{s-1} a_{i,1} < \sum_{i=1}^{n} a_{i,2},$$

$$\sum_{i=1}^{s} a_{i,1} \geq \sum_{i=s+1}^{n} a_{i,2}$$

so that to make one article on $S - 1$ machine-tools is little, and on S machine-tools is sufficient or much.

Thus, one can accept $h_{i,1} = 1$; $h_{i,2} = 0$ for all i from I up to $S - 1$ and $h_{i,1} = 0$; $h_{i,2} = 1$ for i from $S + 1$ up to n; values $h_{s,1}$ and $h_{s,2}$ are found from the conditions:

$$h_{s,1} + h_{s,2} = 1$$

$$\sum_{i=1}^{s-1} a_{i,1} + h_{s,1} \cdot a_{s,1} = \sum_{i=s+1}^{n} \cdot a_{i,2} + h_{s,2} \cdot a_{s,2}$$

Use these ratios to solve an example from table 4. Ratios l (coefficients of a labour-consuming nature) will be equal to: $\frac{60}{30} = 2$; $\frac{90}{60} = 1\frac{1}{2}$; $\frac{80}{30} = 2\frac{2}{3}$

Arrange values l in increasing order:

$$1\tfrac{1}{2} < 2 < 2\tfrac{2}{3}$$

Designating their productivity in accordance with the new order of machine-tool arrangement, we obtain:

$$a_{1,1} = 60; \quad a_{2,1} = 30; \quad a_{3,1} = 30;$$
$$a_{1,2} = 90; \quad a_{2,2} = 60; \quad a_{3,2} = 80.$$

Taking $S = 2$ $(1 < S < 3)$, we have:

$$\sum_{i=1}^{s-1} a_{i,1} = a_{1,1} = 60 < \sum_{i=s}^{n} a_{i,2} = a_{2,2} + a_{3,2} = 140;$$

$$\sum_{i=1}^{s} a_{i,1} = a_{1,1} + a_{2,1} = 90 < \sum_{i=s+1}^{n} a_{i,2} = a_{3,2} = 80.$$

Consequently:

$$h_{1,1} = 1;\quad h_{1,2} = 0;\quad h_{3,1} = 0;\quad h_{3,2} = 1.$$

To find $h_{2,1}$ and $h_{2,2}$, use the equations:

$$\left.\begin{aligned} h_{2,1} + h_{2,2} &= 1 \\ 60 + 30h_{2,1} &= 80 + 60h_{2,2} \end{aligned}\right\}$$

whence:

$$60 + 30h_{2,1} = 80 + 60\,(1 - h_{2,1});$$

$$90h_{2,1} = 80;\quad h_{2,1} = \frac{8}{9};\quad h_{2,2} = \frac{1}{9}.$$

The results of this solution are shown in table 5.

Table 5. Optimum distribution of production output in machine-tools

Machine-tool type	*Production N 1*	*Production N 2*
A	26	6
B	60	—
C	—	80
Total number of sets	86	86

The optimum solution of the problem provides an increase in productivity by 10 per cent in comparison with the simplest method of distribution: conservation of set production character in each machine-tool group.

This index corresponds to the figures obtained under actual production conditions; thus, at one of the plants the use of linear programming in planning the loading of the stock of machine-tools in operation and the time of the execution of orders contributed to an increase of 10 per cent in shop productivity. At another plant, using 200 machine-tools to produce several thousand articles (the volume of orders varies from several units up to 1 million) the optimum distribution of orders in machine-tools made it possible to save between 15 and 20 per cent of the production time, and only one planner was added to the staff of the shop.

To handle these problems by linear programming, it is necessary to have detailed data on the nomenclature of the articles produced, the productivity of the equipment of various kinds in respect of all articles, the time of the equipment operation or units (excluding normal and abnormal off-time) and also the prices for different kinds of articles and the prime cost of their production.

C. Method of decisive factors

This method, worked out in 1939 by the Soviet mathematician L. V. Kantorovich,[3] together with the simplex method and the transport (distribution) method described below, becomes more and more applicable.

[3] L. V. Kantorovich, "Mathematical methods of the organization and planning of production" Publication of the Leningrad State University, 1939

Let us introduce additional designations and conditions, which allow us to use this method for the solution of problems with machine-tools from the simple case $m = 2$ (two articles) to the case of any m.

The given problem will be resolved if the relation I_s corresponding to the value of the needed S is determined.

In fact, if this ratio equal to

$$I_s \quad \frac{a_{s,2}}{a_{s,1}} = \frac{\lambda_1}{\lambda_2}$$

is known (the new ratio of values λ is introduced to make the following considerations more convenient; further, the values λ_1, λ_2, ... will be called decisive factors), the solution will be found for all values i, for which

$$\frac{a_{i,2}}{a_{i,1}} < \frac{\lambda_1}{\lambda_2};\quad h_{i,1} = 1;\ h_{i,2} = 0$$

For the values i, where $\lambda_2 a_{i,2} > \lambda_1 a_{i,1}$: $h_{i,1} = 0$; $h_{i,2} = 1$. Finally, for the values i at which $\lambda_1 a_{i,1} = \lambda_2 a_{i,2}$, the corresponding h must be found from the equation

$$\sum a_{i,1} h_{i,1} = \sum a_{i,2} h_{i,2}$$

In the above example, this relation was established for machine tools A (see table 4)

$$\frac{\lambda_1}{\lambda_2} = \frac{2}{1}$$

Before making clear the principle of the determination of decisive factors, let us introduce the following change in the condition of the typical problem under discussion:

It is necessary to find numbers $h_{i,k}$ ($i = 1, 2, \ldots n$, $k = 1, 2, \ldots m$) from the following requirements:

1. $h_{i,k} \geq 0$

2. $\sum_{k=1}^{m} h_{i,k} = 1 \quad (i = 1, 2, \ldots n)$

The value $h_{i,k}$ should be chosen in such a way that

3. value

$$Z = Z_1 + Z_2 + \ldots Z_k + \ldots Z_m = \sum_{i=1}^{n} a_{i,k} h_{i,k}$$

is maximum.

Let us change condition 3 for the following

$$3'.\ Z' = \min (Z_1, Z_2, \ldots Z_m)$$

and the value Z' must have the maximum possible quantity. In reality, this change of condition 3 is equal to the following: it is clear that the number of whole sets is found by the number of articles which are fewer than others, that is the least from the values Z_k; let this least value $Z' = \min (Z_1, Z_2, \ldots Z_m)$; our task is to make value Z' the highest possible.

As a result of the transformation the solution of the problem is greatly simplified owing to the fact that, instead of finding mn quantities of $h_{i,k}$, it is enough to find only m quantities of the decisive factors $\lambda_1, \lambda_2, \ldots \lambda_m$.

This simplification is still greater, because usually $n \geq m$ (in reverse case they can be changed, but then we have to find the minimum of the function, not its maximum).

The next system can be called that of decisive factors for the problems of the type considered: $\lambda_1, \lambda_2, \dots \lambda_m$ ($\lambda_k \geq 0$), and not all values λ are equal to zero, possessing the following property.

If for each given i one considers products $\lambda_1 a_{i,1}, \lambda_2 a_{i,2}, \dots \lambda_m a_{i,m}$ and denotes through t_i the values of the largest of these products, then taking $h_{i,k}$ equal to zero, for which the corresponding product is not maximum, $\lambda_k a_{i,k} < t_i$. Again, $h_{i,k}$ can be obtained from the equations:

1. $h_{i,k} \geq 0$

2. $\sum_{k=1}^{m} h_{i,k} = 1$

3. $Z_1 = Z_2 = \dots = Z_m$

Thus the problem consists of determining the decisive factors.

This solution can be accelerated through "ranging" (successive approximation). Thus, if instead of real values of decisive factors one takes random numbers

$$\lambda_1^0, \lambda_2^0; \dots \lambda_k^0, \dots \lambda_m^0,$$

then it is possible to solve the problem as though the decisive factors were unknown, namely: compare products $\lambda_k \cdot a_{i,k}$ and make those $h_{i,k}$ for which the corresponding product is not maximum equal zero. Then, because the condition of the value Z equation will not be fulfilled, it is necessary to "pull" the least quantities of this value up to the condition mentioned.

Such is the main principle of the method of decisive factors; changing λ_k "pull" Z_k gradually approaching the unknown maximum (or minimum) of the value

$$Z_k = \sum_{i=1}^{n} a_{i,k} h_{i,k}$$

Let us consider the use of the method of decisive factors to resolve one industrial problem.

Excavators A, B and C must be placed on three levels (sections), 1, 2 and 3, which differ in regard to mining conditions but are situated not far from each other, so that they can be replaced within a definite period of time. A more rational place for the excavators has to be found, enabling them to dispatch 200,000 tons in a shorter period of time. The dispatch of ore in an hour (productivity) for each kind of operation and excavators is listed in table 6.

TABLE 6. EXCAVATOR'S PRODUCTIVITY IN VARIOUS SECTIONS, TON/HOUR

Sections	Excavator A	Excavator B	Excavator C
I	105	107	64
II	56	66	38
III	56	83	53

To find the minimum duration of operation at which the given level of production is ensured, it is enough to find the distribution of excavators giving the maximum productivity, if one and the same quantity of ore is dispatched from each section. The conditions of this problem (taking into account the designations accepted above) can be represented in the form of table 7.

TABLE 7. PRODUCTIVITY ($a_{i,k}$) OF EXCAVATORS IN DIFFERENT SECTIONS (k), T/HOUR

K	i			$\sum a_{i,k}$
	1	2	3	
I	105	107	64	276
II	56	66	38	160
III	56	83	53	192

It has been found in practice that, as original meanings of λ_k^0 it is rational to take values inversely proportional to the values of sums $\sum a_{i,k}$.

Let $\lambda_k^0 = \dfrac{1000}{a_k}$

i.e. $\lambda_1^0 = \dfrac{1000}{276} = 3.62$; $\lambda_2^0 = \dfrac{1000}{160}$

$$= 6.25; \lambda_3^0 = \frac{1000}{192} = 5.22$$

Then $a_{1,1} \cdot \lambda_1^0 = 105 \times 3.62 = 381$ and so on. Let us write out all the corresponding values $\lambda_k^0 \cdot a_{i,k}$ (multiplying the lines of table 7 by 3.62; 6.25 and 5.22 respectively) in the upper part of the left-hand columns of table 8.

TABLE 8. CORRESPONDING VALUES

$\lambda_k^0 \cdot a_{i,k}$			$a_{i,k} \cdot h_{i,k}$			Z_k
			Zero approximation			
381*	388	231	105 × 1	107 × 0	64 × 0	105
349	412	237	56 × 0	66 × 0	38 × 0	0
292	432*	276*	56 × 0	83 × 1	53 × 1	136
			First approximation			
381*	388	231	105 × 1	107 × 0	64 × 0	105
365	432*	249	56 × 0	66 × 0.915	38 × 0	60.2
292	432*	276*	56 × 0	83 × 0.085	53 × 1	60.2
			Second approximation			
365*	372	222	105 × 0.67	107 × 0	64 × 0	70.5
365*	432*	249	56 × 0.33	56 × 0.786	39 × 0	70.4
292	432*	276*	56 × 0	83 × 0.214	51 × 1	70.7

Let us choose the maximum value which is marked by an asterisk in each column of the left hand part of table 8. The value 381 is marked out of the values 381, 349 and 292.

For these maximum values, take the value $h_{i,k} = 1$, for the rest $h_{i,k} = 0$.

In central columns of the upper part of table 8, write out the values $a_{i,k} \cdot h_{i,k}$ (taking into account values $a_{i,k}$ shown in table 7 and values $h_{i,k}$ equal to zero or to a unit).

The sums of these values give values Z_k for the zero approximation $Z_1^0 = 105$, $Z_2^0 = 0$, $Z_3^0 = 136$.

By comparing these data we see that the value Z_2 is low, and for its increase it is necessary to increase the value λ_2 arbitrarily chosen. Let us consider, then, the second column of table 8 (numbers 388, 412, 432).

To "pull" the value closest to the maximum (the closest to 432 is 412), it is necessary to multiply it by a correction factor $\lambda_2^1 : \lambda_2^0 = 432 : 412 = 1.05$ (values λ^0 refer to the zero approximation, λ^1 to the first one, and so on).

A way of reducing the value λ_1 is the following: $\lambda_1^{\prime\prime} : \lambda_1^{\prime} = 365 : 381 = 0.958$, i.e. set a task to reduce the value of the maximum quantity of the first column of the first approximation in table 8 (381) to the next nearest quantity from the same column (365).

Since the value of the second line (365, 432 and 249) and of the third line (292, 432 and 276) remain unchanged, assume correction factors for λ_1 and λ_3 to equal 1. Thus, multiplying the values of the first line by 0.958, insert the corresponding values in the section "second approximation" of table 8.

For the maximum value 276 (see table 8, $h = 1$, for all other values $h = 0$, for equal maximum values (365 and 432) one must again solve corresponding systems of linear equations:

$$h_{1,1} + h_{1,2} = 1$$
$$h_{2,2} + h_{2,3} = 1$$
$$Z_1 = Z_2 = Z_3$$

where $Z_1 = 105h_{1,1}$; $Z_2 = 56h_{1,2} + 66h_{2,2}$; $Z_3 = 83h_{2,3} + 53$.

$$h_{1,1} = \frac{56.83 + 66.136}{161.83 + 66.105} = \frac{13624}{20293} = 0.67$$

$Z_1 = 105h_{1,1} = 105.0.67 = 70.5$; to obtain the remaining values h, place them in table 8.

The values Z differ slightly from each other (within the limits of the accuracy of calculations) and thus the problem can be considered completed.

The resulting value $Z = 70.5$ corresponds to the maximum average hour productivity of excavators, provided the same quantity of ore is delivered from each of the sections. Thus for an output of 200,000 tons of ore it is necessary to spend 200,000 : 70.5 = 2,840 hours or 118 days and nights.

To obtain the unknown optimum duration of operation for excavators A, B and C in each of the sections, let us multiply the corresponding values $h_{i,k}$ by 118 (days) and thus obtain:

$h_{1,1} \cdot 118 = 0.67 \cdot 118 = 79$ and so on, the results are shown in table 9.

TABLE 9. OPTIMUM DURATION OF EXCAVATOR'S WORK IN EACH SECTION (DAY AND NIGHT)

	Excavators		
Sections	A	B	C
I	79		
II	39	93	
III		25	118
Total	118	118	118

The Kantorovich method of decisive factors is recommended in connexion with economic problems of production, in order to ensure the optimum distribution of tasks and orders among industrial enterprises (machine tools, teams, shops) and to determine the most rational alternative uses for resources.

D. THE SIMPLEX METHOD[4]

A general scheme of equation, to which the data considered above in connexion with linear programming can be applied, may be presented in the following form:[5]

$$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = b_1$$
$$a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n = b_2$$
$$a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n = b_m$$

In this case it is necessary to find positive values for the variables $x_1, x_2, x_3 \ldots x_n$, which are the solution of these equations.

Probably, one part or all of the above equations were obtained by replacing linear inequalities. And the inequality

$$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \leq b_1 \text{ (or } \geq b_1\text{)}$$

can be replaced by the equivalent equation

$$a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n + x_{n+1} = b_1$$

under the condition $x_i \geq 0$ ($i = 1, 2, 3 \ldots n, n+1$).

In this case, a new variable x_{n+1} is called an additional one. Let us consider the problem of making this function minimum. Let the whole set of variables "m" ($m < n$, where n = general quantity of variables) be characterized by the fact that a matrix from the coefficients of corresponding equations is non-specific (that is, the determinator of the matrix is not equal to zero). These variables, in distinction to the others, will be called main ones; the main solution will be obtained by equating non-main variables to zero and by solving equations for main variables. In the simplex method, the consecutive order of solving the problem will be the following. First we find the principal solution of the equation. Then we determine if it is optimum. If it is determined that it is not optimum, then we omit one of the main variables and introduce instead another variable.

[4] The foundations of this method were formulated by J. D. Danzig in 1949 and published in 1951.

[5] "a_{11}" should be read "a one, one", not "a eleven".

We do the same with a new main variable, repeating the same operations. We may prove that this process must be completed by obtaining the optimum solution or by concluding as to the non-correspondence of terms. Thus, in solving problems by the simplex method as in applying methods of linear programming in general to determine the optimum, the method of successive approximation is used.

Let us consider the application of this method in a specific case. The system of equations is given as follows:

$$\left.\begin{array}{r} -2x_1 + x_2 + x_3 = 2 \\ x_1 - 2x_2 + x_4 = 2 \\ x_1 + x_2 + x_5 = 5 \end{array}\right\} \qquad (1)$$

and $x_i \geq 0$ (all magnitudes of x are positive); and it is necessary to determine magnitude x_i, for which magnitude $Z = x_2 - x_1$ is minimum.

In the given case, the variables x_3, x_4, x_5 enter one equation only. Let us make variables x_1 and x_2 equal to zero, which we shall conditionally take as additional ones, and solve equations in respect to each of the main variables x_3, x_4, x_5.

We then obtain:

$$x_1 = 0;\ x_2 = 0;\ x_3 = 2;\ x_4 = 2;\ x_5 = 5.$$

Let us express the main variables and the value of Z by non-main variables:

$$\left.\begin{array}{l} x_3 = 2 + 2x_1 - x_2 \\ x_4 = 2 - x_1 + 2x_2 \\ X_5 = 5 - x_1 - x_2 \\ Z = x_2 - x_1 \end{array}\right\} \qquad (2)$$

Let us find out whether the minimum of Z is reached at these values of x_i. Evidently it is not the case, as Z can be reduced by increasing x_1. However, the increase of x_1 is limited by the condition $x_4 \geq 0$.

Thus the first of the equations (2) does not impose any restrictions on x_1 (as coefficient in x_1 is positive), the equation for x_5 makes it possible to increase x_1 up to 5, and the equation for x_4 — to magnitude $x_1 = 2$ only.

Taking $x_1 = 2$ (and for $x_2 = 0$), we obtain:

$$x_3 = 6;\quad x_4 = 0,\quad x_5 = 3.$$

Thus the new basis from variables which are not equal to zero consists of x_1, x_3 and x_5.

Let us express again the new main variables and the meaning Z by non-main variables:

$$\left.\begin{array}{l} x_1 = 2 + 2x_2 - x_4 \\ x_3 = 6 + 3x_2 - 2x_4 \\ x_5 = 3 - 3x_2 + x_4 \\ Z = -2 - x_2 + x_4 \end{array}\right\} \qquad (3)$$

From the equality for Z, from the same considerations as were mentioned above, it follows that its further reduction can be achieved by increasing the magnitude x_2.

And as it follows from the system of equations (3), limiting the increase for x_2 is the equation for x_5 only, making it possible to increase x_2 up to 1 only ($x_4 = 0$; for $x_2 = 1$ we have $x_5 = 0$).

Thus we obtain:

$$x_4 = 0;\ x_2 = 1;\ x_1 = 4;\ x_3 = 9,\ x_5 = 0.$$

We obtain a new system of equations, repeating again the procedure of replacing main variables (now x_1, x_2 and x_3) and the value Z by non-main variables:

$$\left.\begin{array}{l} x_1 = 4 - \frac{1}{3}x_4 - \frac{2}{3}x_5 \\ x_2 = 1 + \frac{1}{3}x_4 - \frac{1}{3}x_5 \\ x_3 = 9 - x_4 - x_5 \\ Z = -3 + \frac{2}{3}x_4 + \frac{1}{3}x_5 \end{array}\right\} \qquad (4)$$

The solution obtained is final because any further increase of x_4 and x_5 does not lead to a decrease of Z.

Thus, for the final values obtained of unknown quantities $x_1 = 4$; $x_2 = 1$; $x_3 = 9$; $x_4 = 0$; $x_5 = 0$, we obtain the minimum value of linear function Z:

$$Z = -3.$$

To solve more difficult problems, the main rules of so-called linear algebra are applied.[6]

At one of the plants, the simplex method was successfully used to obtain the optimum quantity of rolled metal of three types, the monthly gross output of which in money terms was maximum (taking into account the given power of the rolling mills, annealing furnaces and an etching unit).

The simplex method is of a labour-consuming character; however, it can be used for the solution of any problem of linear programming and high accuracy of results is ensured.

E. Graphical method

This method is suitable only in cases when one of two variables ("*m*" or "*n*") is not greater than both; for three variables the solution of the problem becomes difficult, and for four it is practically insoluble. The advantage of the method lies in its visual character. Moreover, it makes it possible to understand through geometrical interpretation the relation between the solution of inequalities and the equations corresponding to them and also the principle of the gradual improvement of the original basis (programme) typical of the problems of linear programming considered above.

F. Transport method (distributive)

The method of solving problems by the transport method is described in detail in a number of text books on the subject.[7]

This method, which is one of variants of the simplex method, is characterized by comparative simplicity, but it has proved successful only in the solution of certain programming problems, in particular, of problems relating to the best organization of transport.

[6] See M. I. Romakin, "Elements of linear algebra—and linear programming", Moscow, Visshaya Shkola Publishing House, 1963.

[7] See, for example, the above-mentioned handbook by M. I. Romakin; also O. A. Mihailov, "Mathematical statistics and linear programming in the steel and iron industry", Moscow, Metallurgizdat, 1961.

The condition of its use is that all given factors of the problem and also all final results should be expressed by one and the same unit of measurement. If these factors are expressed in different units of measurement, then the transport method can be used only where we have the possibility of reducing them to a common unit.

Most of the problems mentioned in the first part of the present report were solved by this method. As we have seen from the methods of linear programming described above, their common idea is consecutive transition from one variant (beginning with the given, evidently non-optimum) to another, every new variant approaching the optimum.

In some cases of linear programming, a strict mathematical procedure can be replaced by a scheme of approximate solution.

G. Plural correlation

If by experiment the influence of accidental causes on a phenomenon under study can be excluded, then we obtain a strictly functional relation: the strictly known magnitude of one of them corresponds to the magnitude of another. However, it is not attainable very often, and then one and the same magnitude of mutually connected phenomena resulting from the influence of accidental causes will correspond to a number of magnitudes of another which appear with a known probability.[8]

Despite this uncertainty, the relation studied is realized first of all in a regular change of the average value of the given distribution. These dependencies are called correlational and a section of mathematical statistics devoted to their investigation is known as the theory of correlation.

The correlational analysis is widely used for the investigation of the factors influencing the production process.

Let us cite an example of making up a correlation table on the following data:

$$X \quad 12 \; 13 \; 15 \; 19 \; 22 \; 27 \; 33 \; 42 \; 46 \; 54 \; 58$$
$$Y \quad 51 \; 64 \; 65 \; 73 \; 78 \; 79 \; 82 \; 98 \; 102 \; 108 \; 112$$

Let us group these data as in table 10.

[8] See O. A. Mihailov, "Mathematical statistics and linear programming in the steel and iron industry". Moscow, Metallurgizdat, 1961.

TABLE 10. CORRELATIONS BETWEEN VARIABLES X AND Y

X	Y: 50-60 (55)	60-70 (65)	70-80 (75)	80-90 (85)	90-100 (95)	100-110 (105)	110-120 (115)	m_x
10-20								
(15)	1	2	1	–				4
20-30								
(25)	—	—	2	—	—			2
30-40								
(35)	—	—	—	1	—			1
40-50								
(45)	—	—	—	—	1	1		2
50-60								
(55)	—	—	—	—	—	1	1	2
m_y	1	2	3	1	1	2	1	n 11

The values of x_1, in the first column, give the limits and average values of intervals of this indication. The values of y are placed horizontally in the upper line. Inside the correlational table frequencies are given which correspond to different combinations of the values of x and y. For example, 1, in the upper left corner, means that combination $x = 15$ and $y = 55$ was observed in one case only.

It is clear that $\Sigma m_x = \Sigma m_y = n = 11$. From the data in table 10, the straight relation of indications is clear: the greater x, the greater y; correlational and functional dependence may be straight as well as reverse.

If the increase of one indication corresponds to the increase of another, then the correlation is called positive, but in the opposite case negative. In the example in table 10, definite average values of y, which we shall denote as y_x, correspond to different values of x (average value of y for x or particular average values of y corresponding to the given values of x). Let us calculate the conditional (particular) average values of y_x (for the example given in table 10):

$$y_{15} = \frac{55 \cdot 1 + 65 \cdot 2 + 75 \cdot 1}{1 + 2 + 1} = 65$$

Likewise we find:

$$y_{25} = 75, \; y_{35} = 85, \; y_{45} = 100, \; y_{55} = 110$$

We can represent the results obtained in the following form:

$$X \quad 15 \; 25 \; 35 \; 45 \; 55$$
$$y_x \quad 65 \; 75 \; 85 \; 100 \; 110$$

This row of figures expresses the empirical dependence of "y" on "x", and depending on whether this equation is a straight line or not one speaks about straight or non-straight correlation. Similarly the empirical line of relation of x against y may be drawn.

Because many correlation dependencies which may be met in practice more or less approximate to the straight line, the correlation equation of the following kind is of great importance:

$$y_x = a + bx$$

Using this designation we may mention some concepts which may often be found in a correlation analysis.

Magnitude of c_{xy} is called co-variation of x and y, if

$$c_{xy} = \frac{\sum n_{xy}(x - \bar{x})(y - \bar{y})}{n}$$

Otherwise, the co-variation is a mean product of any combination of deviation x and y from their average values.

Magnitude

$$r = \frac{c_{xy}}{\sigma_x \sigma_y}$$

$$\text{(where } \sigma_x = \sqrt{\frac{\sum (x - \bar{x})^2 m}{\sum m}}$$

is the quadratic mean deviation of variable x) is called the coefficient of the correlation of x and y and characterizes the degree of relation between these variables.[9]

This coefficient has the following main properties:

1. Coefficient of correlation r is always in the interval $-1 \leq r \leq +1$.

2. For $r = +1$ or $r = -1$ y and x are connected by the following direct functional relation: $y = a + bx$, the sign of r determines the sign of the coefficient b. The nearer r is to ± 1, the closer is the relation between y and x to a precise line relation.

3. For $r = 0$ the straight relation does not exist, but the curvilinear correlation can exist (for example, the following relation $y = a + bx + cx^2 + \ldots + kx^m$).

For the linear relation in an equation of regression

$$y_x = a + bx$$

The coefficient of regression "b" (angular coefficient of a straight line) means the increase y indication when indication x increases by 1. When the considered magnitude does not depend on two, but on many variables, the analysis is made by the methods of plural correlation. This allows us to study the relation between many magnitudes, using methods almost similar to those used for the investigation of the relation between two factors.

[9] For examples of calculation of coefficient of correlation see O. A. Mihailov, op. cit. (see footnote 8 above).

If there is the linear relation between three variables: $Z = ax + by + c$, then instead of the magnitude x, y and Z it is better to consider their deviation from the average magnitudes $\bar{x}$, $\bar{y}$ and $\bar{Z}$. The linear correlation between the three variables will be the following:

$$Z - \bar{Z} = A(x - \bar{x}) + B(y - \bar{y}) + c$$

In this equation, coefficients A and B represent the coefficients of regression. One can calculate them, for example, from the bi-pair coefficients of correlation r_{xy}, r_{xz} and r_{yz} between corresponding x and y, x and z, y and z.

Measurement of the degree (strength) of the linear correlation between z and the magnitudes x and y is total (plural) coefficient R, which is always positive and is in the interval from 0 to 1.

The value of the coefficient of correlation $R = 0$ indicates the absence of the linear relation between Z and magnitudes of X and Y (however, there can be a non-linear relation between them as well). The value of the coefficient of correlation $R = 1$ indicates that the straight linear relation exists between Z and magnitudes of X and Y, which are similar to $Z = ax + by + c$.

To establish the strength of the relation between any two variables correctly, it is necessary to eliminate the influence of all other variables which are connected with the one under consideration (that is, we should conditionally assume that the influence of all factors on the magnitude in question, except one, does not vary). In this case, the coefficient characterizing the relation between two variables is called a special coefficient of the correlation. The special coefficient of the correlation between X and Z is denoted by $R_{xz(y)}$, which signifies a measure of the linear relation between X and Z for Y constant (the influence of X on Z only is considered).

Special coefficients, which correspond to two variables on the assumption that an additional variable remains constant, are called coefficients of the first (second, third etc.) order.

The properties of the special coefficient of correlation are similar to the properties of an ordinary coefficient of the correlation: the magnitude, which is equal to zero, corresponds to the case when the linear relation does not exist (between X and Z). The value, equal to 1, corresponds to the case where the linear relation exists.

The application of the method of plural correlation in industry has shown that the relation between the variables under consideration in many cases turns out to be linear or close to linear. Thus, as the result of one of the investigations concerning the dependence of coke costs in the blast-furnace production for 300 various production factors it was established that 15 factors possessed decisive influence, of which only two factors (the sulphur content in raw iron and the durability of lining) were coupled with independent variables (cost of coke or carbon) as curvilinear. In all other cases the relation was still near to the linear relation. These studies resulted in the improvement of the main technological and economic indications of blast-furnace operation.

At one of the mills, the method of plural correlation was used for the evaluation of an industrial project which established the designed capacity of a new rolling-mill as 800 tons of rolled metal per single shift. This evaluation was necessitated by the fact that the designed power had not been reached in a period of a few months of operation after the starting point. As a result of the correlation analysis, which continued for three weeks on the basis of an investigation of the time of rolling of 2,100 ingots, the conclusion was drawn that a productivity of 1,000-1,200 tons per shift could be reached at the mill and that at rolling profiles of an average labour-consuming character the mill's normal productivity could reach 1,150 per shift. As a result of the improvements in the organisation of production, the mill's productivity greatly surpassed its designed capacity and reached the values predicted on the basis of the correlational analysis.

Several years ago, the designing of units for tube production was based on the erroneous assumption of the coincidence of the largest sag of tube with the cross-section where the tube has the largest diameter. Investigators P. T. Emelianenko and N. V. Paniushkina found by mathematical methods that there was practically no interrelation between the above-mentioned parameters. For example, the coefficient of correlation between the largest outer diameter and the thickness of the wall of the tube was found to be equal to 0.00039.

The investigators recommended a reduction in the dimensions of the original tubes and offered a new method of calculating them which made possible a saving of up to 30 to 40 per cent of metal, a reduction in the volume of rough mechanical treatment of up to 30 per cent and an increase in the productivity of rolling mills of 30 to 60 per cent.

This is but one of numerous examples of the successful use of mathematical methods for the evaluation of industrial projects.

X. INTERINDUSTRIAL ASPECTS OF PROJECT EVALUATION

by Zoltán Román*

A. THE PROBLEM OF PROJECT EVALUATION

Economic growth is determined by social and political factors on the one hand, and by economic factors on the other. The role of both kinds of factors is equally important and a generally valid priority cannot be determined even in the case of economic factors such as land, labour, capital and institutions. The stimulation and acceleration of economic growth requires social, political and institutional changes and investments both in capital goods and in "man". Priority cannot be given either to capital or to "human" investments. In some stages of development, "human" investments may enjoy priority (for example, in developing countries improvements in health conditions and elementary education, and in developed countries the training of scientific personnel); in other periods, priority may be assigned to capital investments. Moreover, the two kinds of investments may be interconnected (for example, capital investments in health and educational institutions and human investments in vocational training for new establishments). The present paper deals only with capital investments, more precisely with investments in fixed assets from the interindustrial point of view.

Capital investments in fixed assets may be classified roughly in three groups: investments aimed at replacement or substitution in order to reduce costs and to increase productivity and competitiveness, and at the establishment of new capacities. In most cases these [illegible] cannot be distinguished precisely: replacement usually brings modernization and often widening of capacities, and establishment of new capacities more often than not yields an increase in productivity [illegible]. Nevertheless in most cases one of these interrelated aims may be considered as primary. In order to facilitate the exposition of the ideas that follow, this study will focus on investments in fixed assets aimed at the establishment of new capacities. In developed economies replacement or modernization and substitution of existing fixed assets may have the same or similar significance as the establishment of new capacities, but in developing economies the latter is of greater importance, having generally a greater impact on the rate of growth and the structure and balance of the economy, and being therefore better able to illustrate the complicated problems of interdependences of investment activity. A distinction may also be made between productive and non-productive investments: in the present study the more complex type—productive investments—will form the basis of the discussion.

By interindustrial aspects of investment activity is meant the analysis and consideration of interindustrial relationships influencing the balance and efficiency of investments and of the economy, as well as criteria and problems of distribution of investments by sectors or branches of the economy. Although interindustrial relations in developed economies are as a rule more numerous and complex than in developing countries, the analysis of such relations in developing countries is of no less importance owing to the special sensibility of those economies to structural changes and unbalance. In developing economies more rapid structural changes occur, even though increases may be small absolutely speaking, owing to the low level of development in general.

The investment process includes various activities. It starts with a preliminary design of development serving as a general framework of resource allocation. It includes preparation and evaluation of individual projects as well as implementation and subsequent supervision and evaluation of the chosen projects. Interindustrial relations must be taken into account at all these stages, but they appear in condensed form at the project evaluation stage. That is the stage at which the present paper deals with the consideration of interindustrial aspects. We begin with the case of developed economies, particularly since the methods recommended for and used by developing countries have grown out of the practice of the developed countries.

B. PROJECT EVALUATION IN DEVELOPED MARKET ECONOMIES

In developed market economies, balanced growth must be regulated and stimulated by the price mechanism. According to the opinion of the majority of economists of those countries, such mechanism leads not only to an equilibrium but also to an efficient allocation of resources and a quasioptimal path of growth. That means that decisions of individual *entrepreneurs* based in the first place on prices and then on other information are generally correct, concerning both current production and investment activity. We may add, however, that the price mechanism can fulfil its function of optimization only in case of perfect competition, a condition practically never met, and even in that case only approximately. The recognition of such imperfections in the functioning of the price mechanism is reflected in the increasing scope and role of state planning and intervention in most developed market economies. State planning and measures of economic policy are intended to correct both current

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production and—perhaps even on a larger scale—investment and development activities.

Private profit may be considered as the main criterion of project evaluation in developed market economies. It may be measured by various formulas dealt with in detail in production, engineering and accounting handbooks and manuals. It is usual in such formulas to measure both costs and benefits from the *entrepreneur's* point of view at actual market prices (with anticipations), and to evaluate only the stage of the production process performed by the given project, disregarding its impact on the efficiency of other production units and activities. Two most commonly used types of calculation and evaluation are comparison of the pay-off periods and comparison of total costs and benefits of the project by discounting methods. The first criterion disregards the working time of the projects and the time after the pay-off period respectively, as well as time preference aspects. It concentrates on the quickest possible return on the invested capital, on liquidity and on reducing duration of the risk. The other type of evaluation is based on a comparison of total (investment and operating) costs and benefits of projects, calculated at market prices and for the full life of the projects, present and future values made equivalent by discounting methods (present worth or annuity). Consideration of other (even not measurable) factors is, of course, also recommended in both cases and is in fact widely practised.

Recent research has also investigated the actual motives of investment decisions of private *entrepreneurs* and the calculations and evaluations actually performed.[1] The results point to a modest role for calculation; routine decisions are widespread and, among calculations, pay-off indicators and simplified cost-benefit comparisons are preferred.

Project evaluation in developed market economies takes into account interindustrial aspects only indirectly by prices and market studies. It is supposed that by taking prices into consideration and by the use of market studies and analyses of actual and expected (estimated on basis of time series) demand and supply curves and conditions, investments may be correctly allocated to the structure of the economy. Both logical considerations and practical experience, such as data on underutilization of capacities, seem, however, to hint at deficiencies in this process. It is quite generally acknowledged that mutual information among investors, as well as a more or less extensive and intensive co-ordination of investment plans and projects, may be recommended in developed market economies too. Such steps may reduce the risks and imbalances of growth. Prices serve as criteria of efficiency, and they are also relevant from an interindustrial point of view. The wide use of taxes, subsidies, direct investment allowances, analyses of external economies and social costs indicates, however, that this mechanism needs corrections in this respect as well. To quote Robert Stone of the National Economic Development Council, London: "positive action is necessary . . . to make the economic system work better and the mechanism by which these are put into effect. One of the most important ways in which this can be done is to bring private costs as nearly as possible into line with economic cost to the community as a whole. . . Another important area where action is needed to make the 'market' work better is the need for a more rational and informed basis of reaching investment decisions."[2]

C. Project evaluation in centrally planned economies

Within the group of countries known in United Nations terminology as countries with centrally planned economies (and among themselves as countries with socialist economies) it is also possible to make a distinction between developed and developing countries. Nevertheless, from the point of view of the problems discussed in the present study, this distinction does not seem to be especially fruitful. Despite their common features, such as public ownership of the means of production, and central planning with similar targets and policies, there are of course important differences among these countries and in some of them significant changes and improvements are going to take place in the methods of central planning and administration of the economy.

From the point of view of investment activity and project evaluation problems, the centrally planned economies may perhaps be studied better if they are classified not according to level of development but according to size of country and share in foreign trade. These two interconnected factors [illegible] to account for more of the actual differences [illegible] problems and for more experimental [illegible] than the distinction between developed and developing economies. As for size of country and share in foreign trade, there is on the one hand the Soviet Union, a self-sufficient economy with a population of over 200 million, and on the other the small and medium-sized countries of eastern Europe (among them Hungary) with a high share and an outstanding role in foreign trade.

To begin with the common features in centrally planned economies the overwhelming proportion of investments (and the new established ones exclusively) are financed from central state funds. In the framework of a fairly detailed nation-wide planning the central institutions determine the total investment expenditure of the country and distribute it between directly productive and other (social overhead) goals. The funds available for productive investments are distributed among the sectors and branches of the economy. Individual [illegible] and selection will be performed for major projects centrally and for other [illegible] delegation to lower authorities.

[1] See the works of John F. Meyer and Edwin Kuh on the United States; B. R. Williams, *International Report on Factors in Investment and Behaviour*, Paris, 1962, on the co-ordinated research programme of six OECD (Organisation for Economic Co-operation and Development) countries; a survey by Erich Gutenberg of the Federal Republic of Germany, etc.

[2] *The Economic Journal*, Cambridge, England, March 1965, p. [illegible]

The distribution of investments by sectors and branches is based in the first place on the co-ordinated production programmes of sectors and branches. The harmonization of such sectoral programmes is effected through successive iterative methods analysing results, impact on material and product balances (mostly expressed in physical units), as well as on resources available for investment and operation. The first experiments started recently with the utilization of input-output and other mathematical methods. In this framework, the distribution of investments by sectors and branches will be evaluated from the point of view of the requirements of the leading sectors and balanced growth.

Special efficiency calculations and project evaluations facilitate decision making in the case of alternative solutions of identical project targets, that is, substitutive and technological variants, and variants for size and location. In addition to partial measures, synthetic formulas are used to compare costs and benefits *per annum*, benefits measured by total value of output or value added, by operating costs and by the normative charge on capital. This charge on capital may be interpreted also as the opportunity cost of capital, or social marginal rate of substitution between labour and capital, or prescription of a standard period of recoupment. In order to equate time differences in the implementation of projects, discounting methods are also applied. The relationships of the new establishments with input-providing sectors will be taken into account in the case of major specialized suppliers (such as thermoelectric stations and coal mines) by evaluating these total complexes or multi-purpose projects. In other cases only additive (indirect) investment requirements of the supplier's sectors will be considered. Costs of major social overhead capital investments needed by the new establishments are also calculated and included. Corrections of actual prices to measure social values are not as a rule considered necessary.

In recent years, much refinement and differentiation in these formulas has taken place in most centrally planned countries, with which we cannot deal here in detail.[8] We shall mention only some characteristic problems and modifications taken from Hungarian practice in connexion with interindustrial aspects of project evaluation. These may to some extent be regarded as typical for most countries of eastern Europe. The modifications probably originate in the full realization of the great importance of the international division of labour and foreign trade for a country the size of Hungary, so lacking in raw materials. Consideration of the importance of foreign trade has lead to a close analysis of balance-of-payments effects and to an assessment of the benefits of projects by value of gross or net output in foreign currency equivalents. Doubts about the adequacy of actual prices has led to experimental uses of accounting prices to measure domestic inputs (costs) as well. The realization that foreign trade increases possibilities of substitution among projects on an extraordinarily large scale is also very important.

According to this frame of reference, projects serving the same goal may be and are in fact compared. Efficiency can be measured only by equalizing benefits and comparing costs or by equalizing costs and comparing benefits. Considering any export or import-substitution as ways of earning foreign currency, these are identical goals with commensurable benefits and their costs are to be minimized and may be compared. This means that new projects should be chosen in order to make up for lack of capacities; moreover, since such lack may be eliminated by reducing exports or increasing imports, these projects can and must be evaluated also by the criterion of their efficiency as to earning (or saving) foreign exchange.

In Hungary, systematic investigations of the actual role of efficiency calculations in investment decisions are not yet performed. Many indications suggest that the role of such calculations is fairly limited. Interindustrial relations and linkages of single projects have recently been investigated with more attention. Research is proceeding with a view to ensuring improved methods within the framework of input-output analysis and mathematical programming. Some aspects of this research and some proposals based thereon will be outlined in sections F to H below.

D. Project evaluation in developing market economies

From the point of view of investment and project evaluation activity, only three characteristics of developing as against developed market economies need be pointed out. In developing market economies, the overwhelming proportion of investment expenditure and the vast majority of projects are subject to government decisions and to direct or indirect government influence respectively; secondly, it is recognized that the functioning of the market and price mechanism is especially imperfect and needs correction; thirdly, central nationwide planning may be recommended and is widely used to promote economic development and the achievement of social objectives. As for project evaluation, private investors judge investment possibilities in developing economies essentially by the same criterion as in developed economies, namely, private profit. Of course, they also take into account the special conditions of those countries (risk and other elements) and measures of government development policy. Further analysis is required, first of all, of the problems, criteria and methods of the project evaluation to be carried out by central authorities and government agencies in developing economies (either in regard to self-financed projects or assistance to private enterprise).

The specific problems of investments in "under-developed" areas were raised in the literature on the subject some twenty years ago, and many criteria of project evaluation, theoretical considerations

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[8] In addition to national publications, see "Evaluation of projects in centrally planned economies", in *Industrialization and Productivity Bulletin* No. 8 (United Nations publication, Sales No.: 64.II.B.6). On the Soviet Union, recent works by T. S. Hachaturov may be recommended and, on Poland, M. Rakovski's study.

and formulas for practical calculations have been suggested and discussed since. From the multitude of the proposed criteria only some characteristic ones will be quoted here. The first proposals (such as those of J. J. Polak and N. S. Buchanan) recommended—as we may call them now—"scarce-factor" criteria: rate of capital turnover (incremental capital-output ratio) and balance-of-payments effect. The critics of these proposals recognized the usefulness of such partial criteria but denied their general application, since they implicitly neglected other important factors, in the first place, labour. The more comprehensive criterion of "social marginal productivity" was suggested by A. E. Kahn and others. This SMP criterion measures national income instead of private profit. Here, "social values" as well as economic factors are to be taken into account.

The quantifaction of this SMP criterion, however, raises serious problems[4] and it may be and has in fact been criticized for neglecting time aspects of efficiency. The "marginal *per capita* reinvestment quotient" theory put forward by Galenson and Leibenstein aims at maximizing the *per capita* output potential "at some future point in time" and gives—according to some critics—an exaggerated preference to future growth against present benefits. This criterion favours capital intensity, the argument being that in this case the share of profit and the rate of capital formation will be higher than in the case of labour-intensive techniques, where a large part of the incremental output will be absorbed by wages paid to workers with a relatively high propensity to consume. Other proposals, such as the marginal growth contribution criterion (by Otto Eckstein) or the time series criterion (by A. K. Sen) also ascribe an important role to the time aspects, but in a more balanced form. The use of discounted figures for both costs and benefits, as suggested by J. Tinbergen,[5] is also intended to measure time effects.

The discussion concerning adequate criteria for project evaluation indicates clearly that in each case (and especially in the case of projects aimed at different purposes) many targets and constraints must be considered simultaneously. Some of these, however, cannot be quantified and it is difficult to combine even only the most important considerations in a single criterion or synthetic formula of measurement. To avoid these difficulties, combinations of partial criteria are also recommended through qualitative or quantitative weighting of the usually divergent ratings according to single criteria. A survey of the practice of six developing countries prepared by the United Nations Division of Industrial Development[6] reported that three countries used multiple criteria with a weighting of the partial criteria, while the other three countries applied synthetic formulas. Discounting methods are used in only a few cases. The *Manual on Economic Development Projects*,[7] prepared by the Economic Commission for Latin America, recommends both the use of partial criteria and their combination by weighting and synthetic formulas.

Two crucial points of project evaluation are stressed in the above paragraphs: the problem of multiple criteria and the time aspect of investments. We turn now to the third crucial problem and the main subject of this paper: the interindustrial aspects as they appear in the course of project evaluation in developing market economies. The need for an analysis of interindustrial relations and effects in evaluating single projects is widely recognized. The following methods are recommended:

Explicit analysis of interindustrial effects and appropriate corrections on both the costs and benefits sides of the efficiency calculations; the effects to be examined include both backward and forward linkages; recently, the use of input-output techniques has also been recommended;

Use of accounting or shadow prices in the calculations of single projects which should result, through a correction in the price and market mechanism, in an evaluation leading to a consistent and efficient allocation of resources;

Simultaneous evaluation of projects already selected by calculating their impact on scarce factors and utilization of redundant resources and, further, in case of the availability of development programmes, by checking their consistency with the over-all programme; this analysis may be connected with the process of assigning accounting prices and with simultaneous improvement in project selection;

Choice of projects simultaneously by mathematical programming, probably in consecutive steps, alternating and connecting procedures of over-all and sectoral programming.[8]

The limited scope of this paper does not allow detailed comment on the methods suggested above and used in different countries. On the practical application of all the methods dealt with above, R. N. Tripathy contends: "In the actual formulation and implementation of the policy of allocation of investment, planners in the developing countries may be predominantly influenced by political and social considerations rather than by strictly economic considerations."[9] We have not surveyed the specific motives of investment decisions in those countries, but it is often pointed out by experts with practical

[4] For an attempt to resolve these problems see *inter alia* H. B. Chenery, "The application of investment criteria", *Quarterly Journal of Economics*, Harvard University Press, February 1953.

[5] See "The relevance of theoretical criteria in the selection of investment plans", 1964, in the volume, *Investment Criteria and Economic Growth* (Massachusetts Institute of Technology, Centre for International Studies), London, Asia Publishing House, 1961.

[6] See "Evaluation of projects in predominantly private enterprise economics" in *Industrialization and Productivity Bulletin* No. 5, United Nations publication, Sales No. 62.II.B.1.

[7] United Nations publication, Sales No.: 58.II.G.5.

[8] See H. B. Chenery, "Development policies and programmes", in United Nations, *Economic Bulletin for Latin America*, vol. III, No. 1, March 1958.

[9] "Criteria for the choice of investment projects in development planning", *Indian Journal of Economics*, Bombay, July 1964, p. 76.

experience that simple rule-of-thumb, scarce-factor approaches or selection of "key sectors" predominate. This does not mean that the potential role of efficiency calculations and project evaluation should be underestimated, but it may serve as a warning against extremely complicated methods and procedures. It further underlines the importance of adapting project evaluation methods to real decision processes and to the various stages and motives in those processes.

E. Interindustrial aspects of project evaluation

Interindustrial aspects will be reconsidered here from the point of view of central authorities which have to evaluate projects in the light of social and national criteria. It is assumed, moreover, that those authorities have economic means of influencing investment activity and that the required investment in the backward or forward linked industries[10] may not take place if it is solely dependent on the entrepreneurial initiative resulting from the stimulation of a given investment activity. The interdependence of the projects to be chosen may be analysed from the two points of view of consistency and efficiency.

Consistency means that the implementation of the projects selected and the operation of the new establishments contribute to the balanced growth or the planned (provisional) imbalance of the economy, that the inputs needed are available and the outputs offered are in demand (permitting a provisional planned imbalance). The criterion of efficiency involves consistency but also implies a further restriction: the degree of utilization of available resources (including existing capacities) should not decline but rather increase, and the selection from among feasible projects must ensure the best possible fulfilment of national objectives and development policy targets.

The establishment of new capacities means not only an addition to existing capacities at that stage of the production process but also affects backward and forward linked industries. The importance of these linkage effects depends on the one hand on the relative value of the new capacities, and on the other hand on their place in the production process. The best linkage effects will be produced by capacities manufacturing domestic intermediary products for other intermediary products for domestic use; primary production has fewer backward, production of final goods fewer forward linkages.

Theoretically, consistency and efficiency should be analysed within a given time horizon for the whole duration cumulating and discounting total costs and benefits. This is possible in practice, and should be required for single projects (through the use of discounting methods). For the total set of projects, and for the economy as a whole, it presents serious difficulties. Usually one typical or certain selected years are analysed in this connexion.

[10] For a detailed analysis of these effects, see A. O. Hirschmann, *The Strategy of Economic Development*, Yale University Press, 1958.

Consistency must be ensured not only during the periods of the operation of the enterprises but also while they are under construction (in the latter case in terms of availability of equipment, raw materials and skills for the scheduled construction of the projects). To ensure the consistency of selected projects during the years of their implementation, total resources available for investment must be confronted with the requirements of the proposed projects. The scarcity of some resources, such as imported machinery, must be reflected in prices; factors of this kind will influence the choice of projects in their turn. In some cases, actual (market) prices of these resources must be replaced by estimated accounting prices.

From a macroeconomic point of view, the total economy may be considered as a single production unit with three primary inputs—labour, capital and imports, and an output serving final demand—consumption, gross investment and export. Strictly speaking, capital and imports, if not received as foreign aid, are not primary but produced inputs, since both capital goods used for replacement and export goods paid for by imports must be produced by labour (and capital and imports). In this sense, the only primary input is labour, and its output the net national product (national income). Capital and imports may, however, be treated as primary inputs. Capital goods represent a special materialized form of labour, their availability is limited, their production requires time, and they serve production for more than one consecutive cycle. Imports are limited too, since as a rule they must be paid for by equivalent export goods (excluding the case of foreign aid and other sources of income), and the possibilities of an increase in export activity are limited and are usually accompanied by decreasing returns.

Consistency in a broad sense may be defined as agreement between output of goods serving final demand and availability of primary inputs required for their production. The flexibility of primary inputs, first of all of capital, however, is strongly limited by the fact that the production process is divided and organized in single production units with given capacities, staff and management. Since the mobility of these units and the factors of production is very limited, agreement between total final output and total final requirements of primary inputs does not mean consistency in reality; excess and lack of capacities and labour may exist simultaneously. Therefore consistency must be analysed and satisfied not only by final goods and primary inputs but also by intermediary stages of production, that is, by sectors and branches of the economy. The construction of new establishments adds new capacities, new production units to a given sector or branch, but at the same time may require intermediary goods from, or offer them to other sectors or branches. Whether the projects meet the needs of consistency or not can be evaluated only in the context of the whole system.

If actual (market) prices reflect the true "social" value of the goods produced and inputs used by the new capacities, the efficiency of the project (in the given stage of the production process) may also be correctly evaluated by the usual cost-benefit comparisons from a macroeconomic point of view. What are called external economies and diseconomies may be analysed in each case separately. In most cases, however, we cannot rely upon the supposition that prices are adequate measures of social values at a given point of time and even less that they are adequate in a dynamic sense, taking into account all the effects of the new investments and other changes over time. In order to overcome these problems, use of accounting (shadow) prices is widely recommended. A consistent use of accounting prices requires, however, a completely new system of prices. Since such a system of prices should reflect the impacts of new investments, it should be built upon an over-all programming of the economy.

From a macroeconomic point of view, each project may be considered and evaluated as a "bundle of activities" in different stages of the total production process. In this case, in order to take into account efficiency in the preceding stages of the production process (in the backward linked industries), instead of measuring costs of intermediary products consumed, total primary inputs should be measured (total in the sense of input-output analysis). Where the output is an intermediary and not a final product, forward linkages may be considered too, and the efficiency of the final product (taking into account further processing) should be analysed. This analysis may be performed by means of accounting prices for the intermediary products as well. The total primary input approach encounters, however, similar difficulties as the former one. Since primary inputs are substitutive, they must be evaluated, and this needs availability of accounting prices for primary inputs, as well as some kind of over-all programming. Further, investments may be and as a rule are allocated in the "linked" industries, and their impact on input coefficients must be considered too.

Both approaches mentioned above—the project analysis by use of accounting prices and the analysis of "bundles of activities" of total primary inputs—assume an anticipation of the project selection and of its effects on the given projects to be evaluated and on the over-all development of the economy respectively. A third approach of efficiency evaluation may be called the simultaneous choice of projects. This may be carried out simultaneously with the assigning of the accounting prices or may be based on a more comprehensive programming of the economy. Both procedures presuppose the availability of the whole series of "candidate" projects with the detailed data needed for evaluation as well as the setting of national objectives and economic policy targets. For programmings, further data are required, too, but this selection of the best combination of the feasible projects takes into account theoretically all the interindustrial relationships and effects. Practically, however, this solution cannot be applied without many concessions, among them linearity and divisibility. Evaluation of linkage effects on efficiency may be performed in a more simple way through direct analysis of the major backward and forward linkages. This procedure may be combined with some elements of the former methods. The problems and practical possibilities of these different approaches will be dealt with later.

It seems appropriate here to note the costs of projecting and of the losses caused by rejection of thoroughly elaborated projects. Of course a minimum degree of maturity of projects is required for the first rough evaluations, but this first selection should be performed as soon as possible in order to avoid unnecessary further expenses. Feasibility analysis of interindustrial aspects forms the most important part of this first selection. One of the best methods of a preselection of projects seems to be a preliminary evaluation and distribution of the investments by sectors or branches of the economy. Some major methods of project evaluation even require such an analysis first by sectors.

F. Methods of evaluating the consistency of projects

Two methods of evaluating the consistency of single projects will be outlined here briefly: the material balance method and the input-output method. Programming methods may evaluate consistency as well but they also analyse efficiency simultaneously. They will be dealt with, therefore, in that context. Consistency may be evaluated also by direct analysis of the major backward and forward linkages, but this simple method does not require further treatment. All these methods and their combinations can be applied more or less extensively and comprehensively, depending on the basic data available, on accurate checking of consistency and on the level of development planning.

The designation "material balance method" refers to the centrally planned economies where co-ordination of material balances is the main instrument of consistent planning. These balances include of course not only materials but the important intermediary and final goods, mostly in physical units. The supply side of these balances comprises anticipated production of existing capacities, expected production of the new establishments, and, as a mobile item, imports. On the demand side anticipated final demand (including exports and changes in stocks) and intermediate demand are indicated. Design of these balances requires an over-all programming of the growth and structure of final demand, foreign trade, major intermediate demands and so on. Further, the balances are interconnected *via* output and consumption of the intermediary goods. The co-ordination of the balances is carried out in centrally planned economies by successive steps, that is, on a trial and error basis. If material balances form a part of the actual planning system they may serve (and as a rule they do serve) also as means for evaluating the consistency of single projects. In the absence of such a system of balances, they may be drawn up for the major materials and products, but this needs basic statistical data and also some kind of over-all planning, since balance items touch consumption, foreign trade and other basic variables of development planning.

The material balance method may be used not only for the evaluation of single projects but also for groups of projects aggregated by sectors or branches, that is, for the checking of investments by sectors. This is valid for input-output methods, too, which are especially appropriate for sectoral analysis.

Input-output methods may be used to evaluate the consistency of projects in two ways: either by checking over-all consistency or by analysing the total impact of the projects. The first approach is well known. It may indicate the consistency or lack of consistency between final demand and total output by sectors or branches. We have to range each project in the corresponding sector and then check whether their outputs are absorbed and their inputs produced within the given system. A surplus of calculated total output *versus* final demand indicates danger of underutilization of capacities in the given sector; if total output lags behind demand, this refers to problems of supply from the products of these sectors. Inconsistency may be eliminated on the one hand by changes in the structure of the final demand, of foreign trade, etc. which belongs to the competence of over-all planning, and on the other hand by changing the projects to be selected.

A similar use of input-output method may help to analyse investment requirements from the point of view of consistency or to distribute investment sources. For this purpose, we have to know the planned or anticipated final demand, the imports and the further excess capacities unutilized in the base period, all by volume and sectoral hreakdown. On the basis of anticipated final demand data, we may calculate the total output by sectors consistently with final demand. A part of this total output may be supplied by the production of existing capacities equal to the production of the base period, hy the production of the excess capacities and by imports. The other part is needed from the new capacities. Investment expenditure required for the establishment of these new capacities may be calculated by means of capital/output ratios.

A second approach based on input-output methods may measure the total input requirements of single projects (or groups of projects). For this, data are needed on the operating inputs of the given projects in the breakdown of the input-output tahle available (a vector). Subsequently, the inverse matrix of this input-output table will be required. The vector-matrix product gives the total input requirements of the project which may be compared to the resources available. An example of such calculation is presented in annex I. This flexible method may be applied also to groups of projects with the same output or to "sector-investments", or to evaluate the impact of choice of different technologies, etc. In the latter case, we have to calculate the total input requirements only for input items which are not identical in the two or more variants of the project.

The first approach mentioned above presumes the availability of a complete input-output table; the second may be applied if only the technological (and inverse) matrices are available. The first approach involves some kind of over-all planning; the second may be applied for isolated evaluations too. Both methods are burdened with the well-known assumptions of the input-output analysis. In both cases an up-to-date technological (and inverse) matrix is needed; that is, corrections of the basic input-output table (matrix) corresponding to the actual and anticipated changes in technology and import-substitution have to be carried out.

The usual aggregation of the input-output tables is disadvantageous as compared with the material balance method, but sectoral interdependence is dealt with more correctly by input-output methods. Some experiments are proceeding with input-output tables in physical units which may help to resolve the problems of aggregation and may facilitate the correct use of this second approach. Some elements of this method may be combined with the direct analysis of the major backward and forward linkages and this may offer a sufficient solution too. For this purpose also a "typical" technological matrix in some standardized form may give valuable information on the major linkages and may be fruitfully used. The possibilities of the use of some such standardized matrix will be dealt with later.

G. Methods of evaluating interindustrial efficiency effects of the projects: use of accounting prices

Use of accounting (shadow) prices is one of the most highly recommended methods of considering interindustrial efficiency effects in project evaluation. All manuals prepared on this topic for developing countries include such suggestions. Elements of accounting prices (although perhaps not always in the same sense) are largely used in centrally planned economies, and recently their wider application has been proposed, for instance in the Soviet Union and Hungary. Several methods of the use of accounting prices are suggested which have some common features but which in some respects differ significantly.

A common feature of these methods is the assumption that the use of accounting prices, instead of actual (market) prices, gives a correct efficiency evaluation from a macroeconomic (social) point of view, since accounting prices are supposed to reflect intrinsic social value. There are differences, however, concerning the following points: what should be meant by intrinsic social value; whether accounting prices may be determined by some corrections of the actual (market) prices or whether this needs a special procedure; whether accounting prices should be determined only for inputs or for outputs too and, in the former case, whether accounting prices should be assigned only for primary inputs or for intermediary goods as well; how accounting prices should be used, since they may be substituted in the well-known formulas of efficiency calculations of single projects or as an auxiliary instrument (guide) in the process of the selection from the total set of projects. From the descriptions of the various methods used or suggested we do not always receive clear answers to these questions. The raising of these questions may help, however, to clarify the matter.

As far as the meaning of intrinsic social value is concerned, there are two opinions, and consequently two ideas of what accounting prices should be: measures of actual social (macroeconomic) costs or equilibrium prices on an opportunity cost basis. We also find combinations of these views.

In order that accounting prices may measure actual social costs, the elimination of taxes and subsidies from actual (market) prices is often recommended as a first approach.[11] Although this correction may help to eliminate distortions, some objections must be raised here. First, taxes and subsidies paid (or received) in the last stage of the production process by the output-sector, form only a part of total taxes and subsidies included in the prices. Secondly, in some cases taxes and subsidies reflect social costs (or benefits) and their elimination does not lead to a better approximation of social values. Thirdly, the distribution of profits in the prices cannot be assumed to be proportional to the costs they have to express (especially not in developing countries, in case of a very imperfect competition) and the differences in profit ratio may cause even more significant distortions.

The practical importance of these objections may vary widely between countries according to the weight of these items. In annex II, some figures are quoted on the economy of Israel. As for the first objection, the differences in direct and total taxes and subsidies are striking only in some cases but in a number of sectors they may be considered significant. As for the third objection, the share of profits is in most cases much higher than the share of the taxes and subsidies and the rate of return to capital varies in a large scale: if measured by direct coefficients, it varies between −3 and 68, and by total coefficients, between 1 and 48 per cent. The data on the Hungarian economy (see annex III) give a similar picture of the indirect effects of the sales (turnover) taxes and subsidies. The rates of return to capital vary similarly, too; they are according to the direct coefficients between 0 and 71, and according to the total coefficients between 2 and 33 per cent. The second remark in the previous paragraph cannot be tested by the available data.

Some methods are used in Hungary which seem to avoid the first and a part of the third objection but not the second. By use of input-output tables, all (direct and indirect) elements of taxes, subsidies and profits have been eliminated from actual prices and the primary inputs of capital and import have been converted to labour input (in wage terms). The indicators gained by this calculation (total macroeconomic labour inputs) are intended and used as measures of actual social costs.[12] These indicators serve as a rule only for measuring costs of domestic inputs. Output in case of exported or exportable goods and costs of imported materials are valued at world market prices, i.e. at foreign currency equivalents The data on total macroeconomic labour inputs proves very useful for different analyses but their application to efficiency calculations as accounting prices is open to criticism.

Disregarding the deficiencies connected with the use of typical input-ouput tables (some of them can be eliminated by disaggregation, by combinations with product calculations or with input-output tables by products, etc.), only four principal issues will be raised here. First, these "accounting prices" are based on data of some previous period, while investments refer to a future period; consequently they must be built up on planned, anticipated data (input-output table). Secondly, they exclude all income elements except wages. A part of these income elements reflect (or should reflect) social costs, or benefits. Thirdly, they do not take into account the scarcity of capital which ought to be reflected by an adequate price system (this issue is under discussion in centrally planned economies, but in Hungary it is already accepted). Fourthly, they do not reflect such intentional departures from prices as are considered necessary to balance supply and demand.

The first of these criticisms is acknowledged in Hungary and claims involved are met by some recent calculations, by means of extrapolations. The second and fourth remarks were pointed out only recently by the author and await discussion. The third objection is acknowledged and in some recent evaluations it is also avoided by calculating with an "accounting" charge on capital (added to the total macroeconomic inputs in labour terms). Some numerical examples of these calculations are given in annex IV.

As an example of a similar approach, an appraisal of social profitability, of the real cost of foreign exchange earned in exports, the work of M. Bruno concerning the economy of Israel may be mentioned.[13] He applies a correction of market prices by taxes/subsidies and excess remuneration on capital over an imputed limit of 8 per cent

The above remarks on the Hungarian experience may lead to the conclusion that a comprehensive system of accounting prices aiming at the measurement of actual social costs is to be built up on the elimination and redistribution of taxes, subsidies and profits by means of input output analysis, or on a consequent macroeconomic cost calculation. The third and fourth remarks refer to a seemingly unavoidable use of some elements of opportunity cost accounting in this case too. The rate of the charge on capital should perhaps be based on opportunity cost rather than on data of past periods, and this applies in some sense (although it is debated in Hungary) to the foreign currency exchange rates.[14] Accounting prices based on actual social costs do not seem to be appropriate to measure the social value of output (with the exception of intermediary

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[11] See for example *Manual on Economic Development Projects* (United Nations publication, Sates No.: 58.II.G.5), part II, chap. II

[12] The calculation was performed by means of an input-output table in sector aggregation; the ratios of actual and "calculated" prices by sectors were applied to the corrections of the individual prices. Experiments are proceeding with input-output tables calculated by products mostly expressed in physical units.

[13] See annex II

[14] The actual cost basis for foreign currency exchange rate is the average costs (total macroeconomic labour inputs) of foreign exchange earned in exports

goods). For this purpose, another set of accounting prices should be defined. For goods circulating in foreign trade, estimated "world market prices" may furnish an adequate starting point.

On the general possibilities of the use of accounting prices on an actual social cost basis and in order to answer the questions raised above, several points may be made.

First, accounting prices on an actual social cost basis may be applied in the usual formulas of efficiency calculations. Their assignment is not connected with a selection from the feasible projects as in the case of accounting prices on an opportunity cost basis. These accounting prices may be used both to evaluate single projects and for the analysis of groups of projects (sector investments).

Secondly, as a first very rough approximation, taxes, subsidies and transfer payments may be eliminated from actual (market) prices. Price changes must be anticipated in each case. Use of input-output methods to eliminate even indirect effects of these items may result in some improvement. These accounting prices may be used in the usual formulas both for output and input figures.

Thirdly, after the above corrections, accounting prices are to be defined separately for primary inputs, since these corrections do not apply to the valuation of primary capital and labour inputs. Accounting prices must be determined for capital in each case, and preferably for categories of skilled and unskilled labour too. For this purpose, an opportunity cost basis seems to be appropriate even if based on rough estimations. The corrections according to the second point yield some kind of accounting prices for imported goods, but the use of foreign currency prices and accounting exchange rates may be recommended too.

Fourthly, if actual (market) prices do not deviate from social values on a large scale at a given point of time, only modifications resulting from changes over time are needed to establish proper accounting prices. Since such modifications require knowledge of future developments which may be influenced by decisions based on the same accounting prices, they have in each case an approximative character. In case of rapid growth or structural changes of the economy which may occur in developing countries this seems to be a valid argument for a simultaneous determination of accounting prices and development plans.

Fifthly, where an input output table is sufficiently detailed, the attempt may be made to design a total system of accounting prices reflecting actual macro-economic costs with complete redistribution of taxes, subsidies and profits, by means of a macro-economic cost calculation. For this purpose, the accounting price of capital is needed first, which may be defined on an opportunity cost basis, connected with the design of the over-all development of the economy.

Dealing with the problems of accounting prices on an opportunity cost basis, we shall start from the moderate and realistic proposal made in the report of the first group of experts on programming techniques of the United Nations Economic Commission for Asia and the Far East.[15] This seems all the more appropriate since among the authors of this excellent report we may find Jan Tinbergen, one of the first and most respected advocates of the use of accounting prices. According to the report (p. 40): "Accounting prices are fictitious prices which may be assigned to some cost elements, or products, with a view to giving a better approximation of the relative importance of these elements or products to the economy". Unfortunately, further questions about the scope and assignment of these accounting prices remain unanswered in this report. From examples described, however, it may be concluded that the accounting prices of cost elements and intermediary products are to be defined on an opportunity cost basis; that accounting prices are to be used for final products too and that they must be fixed according to development policy targets; that accounting prices are not needed for each cost element or product but only for the major ones, and that the best way to determine and to utilize accounting prices may be considered a trial-and-error method of the selection of feasible projects.

It is characteristic of this type of use of accounting prices that it assumes the availability of the whole set of feasible projects, and data on the total investment resources and possibilities, including not only establishment of new capacities but also knowledge of the main development policy targets. Consequently this method may be used only in advanced stages of project evaluation but not for preliminary selections. Further, this procedure, with a mixed use of actual (market) and accounting prices, renounces the consistency of the valuation. As a rule, primary inputs such as capital, labour and import will all have accounting prices, but only some of the intermediary goods. In order to evaluate not only the direct, but also the indirect use of primary inputs at accounting prices, we have to change the prices of the intermediary goods too. Without such corrections, the bias of the project evaluation will depend on the share of intermediary goods in the total operating costs of the project.

The logical way to determine accounting prices on an opportunity cost basis is either through the project selection method treated above or through methods of programming. Programming may be performed either by trial-and-error methods or by mathematical techniques such as linear programming. It is useful to make a distinction between what is called a project selection method and a programming method, in the sense that the former includes only the projects to be selected and the latter all the activities, i.e. existing capacities as well. The former method generally assumes a preliminary choice of projects, the latter may start without such preliminaries.

The programming approach seems to be superior but requires much more basic data. In case of a limited number of feasible projects, all these alter

[15] Development Programming Techniques Series, *Programming Techniques for Economic Development, with Special Reference to Asia and the Far East*, United Nations publication, Sales No.: 60.II.F.3

natives may be included in the model and the programming method may give the proper project selection and the accounting (shadow) prices simultaneously. A further use of these accounting prices does not seem to be required. The number of the feasible projects, however, usually exceeds the framework of the workable model. The projects are to be aggregated, e.g. by sectors and branches, and the shadow prices thus obtained may be used for further selection of the projects, either in the usual efficiency calculation formulas or by further sectoral programmings. A similar procedure may be followed by the project selection method too, and in this case the accounting prices will have not only a direct distributing but also an evaluating role.

On the use of accounting prices on an opportunity cost basis, a number of points may be mentioned.

First, as a first approximation, accounting prices may be defined only for primary inputs. The opportunity cost basis for them may be estimated or investigated by a trial-and-error method. These accounting prices may be applied in the usual efficiency calculation formulas. In order to reduce biases caused by neglecting the use of accounting prices for indirect primary inputs (*via* intermediary goods), major linkages are to be analysed in this respect.

Secondly, accounting prices are to be assigned also for the valuation of outputs. They may be based in case of intermediary goods on opportunity costs or on "world market prices" (first of all for exportable and importable goods); and, in case of final goods, on "world market prices"; on priority ratings according to the national objectives and development policy targets; on the elimination of taxes and subsidies from actual (market) prices, or a combination of the above methods.

Thirdly, the trial-and-error method of finding proper accounting prices may be improved in different ways. If it is connected with an iterative selection of projects, criteria of choice in harmony with development policy targets must be stated clearly. Accounting prices may be calculated for major (scarce) intermediary goods as well (such as electric energy). If all candidate projects are included in the trial process, the accounting prices will not have an independent role. The result of the last step of iterations gives both the project selected and the final, correct accounting prices. These prices may be used, however, by evaluating even further variants of the chosen projects. The selection of the projects may be performed in two stages. The first stage gives a choice of groups of projects and proper accounting prices as above. In the second stage, the usual efficiency calculation formulas may be applied for further selection, with these accounting prices.

Fourthly, programming methods may yield accounting prices with a better approximation than the project selection method. They do not need a preliminary selection or suggestion of projects and they make possible a freer choice; they take fully into account activities of the economy even if not touched directly by investments. On the other hand, for programming (either to be performed by trial and error or by new mathematical methods) a great deal of numerical data are needed on development policy targets, on resources available and other constraints, on existing capacities and on technologies actually and potentially used which are not available in most developing countries. Programming methods may also be used in different ways, for instance, for a final choice of the projects when accounting prices are not needed more; in two stages as by the project selection method, when the final choice will be made at the second stage by means of the accounting prices obtained in the first stage; or in two stages, when for the final choice, besides the accounting prices of the first stage, programming methods will be used again.[16]

Where accounting prices are assigned by means of input-output or programming methods, they will be defined as a rule for groups of products aggregated by sectors or branches of the economy. Accounting prices for products must be determined by separate calculations at a second stage. The accounting prices for sectors or branches may be fruitfully utilized for sectoral analysis of investments and projects. Subsequently, project selection through the use of accounting prices or especially by programming may apply not to single projects but to groups of projects by sectors or branches. This immediately provides an analysis or selection of projects by sectors. The same applies to the total primary input approach based on input-output analysis. The possibilities and problems of sectoral analysis of investments and projects will be dealt with later.

II. Other methods of evaluating interindustrial efficiency effects of projects

Theoretically, programming methods may yield the best project evaluation but for developing countries, owing to the usual lack of data needed, they are seldom practicable. Therefore only a few remarks will be added here on these methods. We have numerous examples of the successful use of mathematical programmings or process analyses for sectors of the economy, for project evaluation within sectors. Thus, for instance, in Hungary, linear programming methods have been applied for development planning of the cotton weaving industry, paper industry, aluminium industry and synthetic fibre industry (here concave programming has been used too). We are interested here, however, in the interindustrial aspects of project evaluation which are taken into account in sectoral programming in only a very limited way.

Some experiments on intersectoral, that is, economy-wide, programmings are known, too, but they do not seem to give direct project evaluation and selection. The experiment now going on in the Hungarian Planning Office, known as two-level planning, is an iterative combination of overall and sectoral programming [illegible] quote H. B. Chenery, [illegible] for the past several years has been doing [illegible] theoretical and [illegible] work [illegible]

[16] The results of these sectoral programmings may also be used [illegible] of the accounting prices

of programming can be applied in a very detailed model of the whole economy. At best they can be used to determine the proper accounting prices for some of the principal inputs—labour, capital, foreign exchange and a few industrial materials—and to revise sector programmes. For the latter purpose, accounting prices are very important, since they make it possible to decentralize the analysis while maintaining the consistency of the result.[17] The methods suggested along the same lines in the Soviet Union, in the first place by L. V. Kantorovich and V. V. Novozhilov, are intended to achieve appropriate prices and not direct allocation of investments (the same applies to the investigations now conducted in the Economic Institute of the Academy of Sciences in Hungary).

An important result of the over-all programming of the economy may be a preliminary allocation (distribution) of investments among sectors. Sectoral programmings and single-project evaluations may correct this distribution. Nevertheless, this distribution provides an important starting point for further analysis. Theoretical, computational machinery capacity, data availability problems of the programming methods are not treated here, but they cause serious difficulties even in developed economies. Their solution seems to be attempted first in developed countries.

As a rule, accounting prices may yield a proper valuation for primary inputs, but they can hardly be determined even for major intermediary goods. Since the indirect use of primary inputs *via* intermediary goods may often exceed their direct use, this may reduce the possibility of measuring interindustrial efficiency effects on a larger scale. These difficulties may be overcome not only by assigning accounting prices for intermediary goods, but, even more easily, by calculating total primary inputs based on input-output analysis. In this case, accounting prices are needed only for primary inputs (as a rule for major categories of labour, capital and foreign exchange) or even—failing proper accounting prices—alternative valuations can be simply applied as in the case of parametric programming. These total primary input figures may be used in the accepted efficiency calculation formulas on the one hand, and for other analyses on the other.

Some further types of analyses based on total primary input data will be mentioned here which may facilitate the evaluation of the interindustrial efficiency effects.

By means of an ordinary input-output table, total primary input coefficients may be simply calculated for sectors and branches of the economy. They may help to analyse the characteristics of the sectors from a macroeconomic point of view, the average impacts of investments in these sectors on requirements of primary inputs. They may help the formulation of a rational structure of the economy by sectors. In order to eliminate the influence of the actual (market) prices on these indicators, they may be related to each other (as for instance total labour/capital, import/capital, etc.) or to the value of production at "world market prices" (foreign currency equivalents).

The total input coefficients of the input-output analysis measure interindustrial effects within the limits of the chosen model. The usual open static model deals with replacement of fixed assets and exports as items of final demand. That means, for instance, that the usual total labour input coefficients do not include the labour input needed for the replacement of fixed assets and for exports to be paid for imported materials consumed. Interindustrial effects may be measured in a wider sense, too, by analysing further multiplier effects. The usual total labour input coefficients may be augmented, for instance, by the total labour input needed for the replacement of fixed assets and for exports to be paid for imported materials consumed. These indicators may be called total macroeconomic labour input coefficients. Later, to the usual total import coefficients may be added the import needed for the replacement of fixed assets, and to the usual capital coefficients the capital needed for the exports to be paid for imported materials used. Some numerical examples based on Hungarian experience are given in annex V. Total requirements of skilled and unskilled labour, stocks (circulating funds), several kinds of energy and other scare resources or goods may be analysed in a similar way.

Total primary input requirements for single projects may be analysed similarly. In this case, however, the cost data of the project are needed in the sectoral breakdown of the input-output matrix utilized and problems of aggregation and disaggregation are to be solved as shown in section G above. Various criteria may be tested on this total primary input basis, synthetic formulas may be calculated, etc.

The simple methods of direct analysis of major backward and forward linkages do not need detailed description. I should like to emphasize the great importance of these analyses in cases where more sophisticated methods are used. First it is difficult to treat forward linkages and efficiency effects by most of the methods mentioned above, as for instance input-output methods. and they are often neglected. Secondly, backward linkages (effects which can well be analysed, for instance, by input-output methods) are examined as a rule with aggregate calculations. Many assumptions vitiating these calculations may be dropped only in case of a detailed direct analysis. The direct analysis usually involves only some major linkages, one or two connected stages of the production process, but then this is done in a realistic way, without aggregation, and taking into account such specific factors as capacity utilization, marginal costs, returns to scale etc. The direct analysis of the major linkages and less precise methods of analysis of the further interindustrial effects should be combined and for single projects this may provide the best solution for an adequate evaluation of interindustrial effects.

[17] "Development policies and programmes", in *United Nations, Economic Bulletin for Latin America*, vol. III, No 1, March 1958, p. 71.

I. Criteria and distribution of investments by sectors or branches of the economy

In section F, five methods of evaluating the consistency of projects were analysed which may now be listed in order of their complexity:

(c.1) Direct analysis of interindustrial linkages;

(c.2) Material balance method;

(c.3) Input-output method of evaluating single projects;

(c.4) Input-output method of evaluating general consistency;

(c.5) Mathematical programming methods.

These methods, as mentioned above, may and are to be combined. Method (c.4), always, and method (c.5), mostly, are to be carried out rather for sectors or branches of the economy than for single projects; methods (c.2) and (c.3) may be used both for sectors and single projects, while method (c.1) seems to be appropriate primarily for single projects.

In sections G and H, different methods of evaluating interindustrial efficiency effects of projects have been analysed. The following groups of these methods may be listed here:

(e.1) Direct analysis of interindustrial effects;

(e.2) Use of accounting prices (both for inputs and outputs) to evaluate efficiency at a given stage of the production process;

(e.3) Project selection method: simultaneous selection of projects and assigning of accounting prices;

(e.4) Total primary input approach (evaluation of the "bundle of activities" touched by the project);

(e.5) Programming methods (with one or more stages).

These methods may and are to be combined as well. All these methods may be carried out both for sectors and single projects. Methods (e.4) and (e.5) seem to be especially suited for sector analysis, (e.1) for single project analysis.

From a macroeconomic point of view, each project touches not only the given stage of the production process but a bundle of activities linked with it and it must therefore be evaluated, both for consistency and efficiency, by taking into account interindustrial impacts as well. As this notion indicates, interindustrial impacts, effects between industries (sectors or branches) are to be analysed. The methods available for these analyses are suited in many cases only for evaluating linkages between industries (sectors or branches) and not between single projects. In other cases these methods require a two-stage evaluation, first at the sectoral level and then by single projects. (For the first case, see the input-output methods; for the second, mathematical programmings.) That is one of the reasons why sectoral evaluation, or preselection or predistribution of investments by sectors, may be recommended. A second argument may be raised from the time aspect of these evaluations. Projects may and are to be evaluated on the basis of their full working time. A total set of projects, however, can be checked for consistency, analysed for interdependent efficiency and co-ordinated with the development plan—by relatively simple methods—only for a given point of time. This issue demands a two-stage evaluation, first at the sectoral level for a given point of time; and then by single projects for the full working time. Finally, institutional and organizational requirements may argue for an intermediate project evaluation at that sectoral level, especially in the case of development planning. P. Rosenstein-Rodan has emphasized that "estimates of priority can be more easily formulated for sectors than for projects within sectors.... Delegation of decisions as to sectors and dispersal of decisions as to single projects composing a sector seem to be the appropriate rules of programming."[18]

Sectoral evaluation of investments does not render superfluous the evaluation of single projects or the analysis of their interindustrial impacts. First, single projects and not sectors are to be chosen. Secondly, the constraints of the aggregated sector-analyses are well known and their results, therefore, are to be checked by single project analyses. Some selected "best" projects of a given sector may be after all less efficient from a macroeconomic point of view than some "wrong" projects of another sector which have been eliminated. Owing to the often very rough aggregation, even a coincidence of the summarized input and output figures of the single projects and aggregate figures calculated for the same sector do not prove a real consistency. Sectoral evaluation of investments, consequently, is not a substitute for, but supplements and facilitates single-project evaluations. The main fields of application of the sectoral evaluation of investments are the preliminary distribution of investment funds and the preselection of projects by sectors.

The preliminary distribution of investment funds by sectors is an important part of development planning in centrally planned economies and it seems to be necessary or at least desirable in each case of central planning. Central planning requires a certain delegation of decisions, among other those concerning investments. For this purpose, a preliminary distribution of investment funds is needed. In centrally planned economies, this preliminary distribution is based as a rule for consistency on the material balance method (c.2) and on direct analyses of interindustrial linkages (c.1), as for efficiency on direct analyses (e.1) and on a more or less wide use of elements of accounting prices (e.2). Recently, in some countries (as in Hungary), the application of the other methods listed above has been attempted too. A wider use of methods based on input-output analysis (c.3), (c.4), (e.4) may be recommended. These methods may be applied, perhaps by means of a standardized input-output matrix, by developing countries. For these calculations, accounting prices assigned at a sectoral level may prove useful. The preliminary distribution of investment funds may be based on a ranking of single projects proposed, too, without any use of aggregate data.

[18] "Programming in theory and in Italian practice", *Investment Criteria and Economic Growth* (see footnote 5 above), p. 25.

A preselection of projects by sectors may be recommended first of all in case of a great number of "candidate" projects and even more in case of a development planning with central and subordinate institutions. As for evaluating consistency, the whole set of methods listed above may be used, but perhaps the input-output and programming methods (e.3-5) are to be preferred. To evaluate efficiency, the project selection method (e.3), the simultaneous choice of projects and assigning of accounting prices, and the total primary input approach (e.4) seem to be appropriate in the first place. Subsequently, economy-wide mathematical programmings may be carried out as a rule at the sectoral level and consequently they may yield a preselection by sectors too.

The main criteria of project evaluation from a macroeconomic (social) point of view both for sectoral and single project analysis are consistency and efficiency. The criteria of efficiency need further explanation. These criteria are to be formulated in accordance with national objectives and economic policy targets, and should take into account, first, if possible total costs and benefits at social values (accounting prices); secondly, the interindustrial impacts and, thirdly, the time aspects. This paper has concentrated on the problems of the interindustrial aspects of the project evaluation. The time aspects are taken into account at the evaluation of single projects as a rule by the use of discounting methods with an accounting rate of interest. This accounting rate of interest may be differentiated in the calculations by periods and it largely depends on the over-all design of development which forms an important background to all these calculations and evaluations. Discounting methods may be applied from among the methods listed above: for direct analysis and accounting price evaluation of projects (e.1-2) with ease, at the project selection method and the total primary input approach (e.3-4) with some difficulty and at programmings (e.5) with serious difficulties. For sectoral evaluations, when using aggregated data by sectors, discounting methods can hardly be applied. Time aspects of investments may be evaluated only with the help of the accounting prices of capital. Therefore, as a rule, simplified formulas of calculation may be recommended for sectoral evaluations, without discounting procedures.

For project evaluation, partial criteria, their combination with or without weighting, or one (or more) synthetic formula are generally used. Partial criteria, as a rule, give a correct evaluation only in cases of projects which, from the point of view of the disregarded criteria, do not differ significantly. For this reason, and particularly in case of sectoral evaluation, the combination of such partial criteria and/or synthetic formulas may be recommended. On the cost side, among the partial criteria, the three primary inputs, i.e. labour, capital, and foreign exchange must be represented in each case by their major categories, as e.g. skilled and unskilled labour, foreign currencies, etc. From a macroeconomic point of view, the primary input requirements are to be analysed with the help of total input coefficients, i.e. by the use of the total primary input approach (e.3). Further, besides their partial analysis, the primary inputs may be valued and also added by means of accounting prices. For example, the following formula may be suggested:

$$\frac{\text{Domestic value added at accounting prices}}{\text{Domestic costs at accounting prices}}$$

This indicator has been used in Hungarian practice for statistical analysis but may be calculated for future periods, too. According to the Hungarian calculations, the nominator is the total value of output minus total primary inputs at world market prices (in foreign currency equivalents), while the denominator is domestic costs at accounting prices based on total macroeconomic labour input coefficients (on total capital and labour inputs added at accounting prices). An example of these calculations is presented in annex V.

In case of programming or project selection methods (e.4-5), we can take several criteria for maximum/minimum, and other criteria may be treated as constraints. By using direct analysis of interindustrial efficiency effects (e.1), various criteria may be evaluated but primary input requirements (and possibly total requirements) must not be omitted, either by this or by the other methods mentioned above. Benefits may be measured as a rule by total value of output or by domestic value added and, of course, in accordance with the measurement of the costs. The correct evaluation must be ensured by the use of accounting prices and special benefits may be analysed separately.

We may conclude from our analysis that a project evaluation from the macroeconomic point of view should be based on a measurement of total costs and benefits at intrinsic social values. This requires first of all adequate consideration of interindustrial and time aspects of the projects. As a rule, however, both requirements may be met only approximately. Any methods of project evaluation, therefore, are burdened with assumptions and hypothetical elements. As J. Tinbergen points out, "in order to calculate the full consequence of a certain investment on the national economy one has to have a dynamic model of development of the economy (and even of the world economy)".[19] Nevertheless, project evaluation may help significantly to make adequate investment decisions in order to use national resources better and to promote development. Moreover, project evaluation from a macroeconomic (social) point of view may not only be facilitated by formulating national objectives and economic policy targets, but it also calls for more or less detailed development plans. Development planning may facilitate entrepreneurial investment decisions.

J. Possibilities of use of a standardized input-output matrix

The coefficients of an input-output matrix are determined by a great number of different factors. The major factors are: technology, returns to scale, import, price-relations, infrastructure. In spite of these factors, some empirical investigations (by W. Leontief, H. B. Chenery, T. Watanabe and others)

[19] Op. cit. (see footnote 5 above), p. 12.

indicate a great similarity of input-output matrices in different countries. Further research has to show whether these similarities make possible the compilation and use of a standardized input-output matrix with special reference to developing countries. In this section, some basic problems and ideas related to the use of such a matrix in project evaluation will be considered.

A standardized input-output matrix may be used to obtain an over-all picture of interindustrial relations, linkages and impacts and to make some numerical calculations concerning the given economy. For both kinds of uses, the inverse matrix (that of the total input coefficients) is needed and the matrix of the technological (direct input) coefficients has only an intermediate but important role. The standardized matrix yields information about the nature of the interindustrial relations, about the major interdependencies to be analysed, and this may be useful in itself. For more precise analyses, however, the standardized matrix has to be adapted to the given economy. The task to be resolved is, therefore, a twofold one: to design a standardized matrix and to facilitate its transformation in a national matrix. In case of developing countries, the second task seems to be especially important since the characteristics of these economies may deviate considerably from a "standard economy" (use of backward technologies, special price relations, different infrastructure etc.). On the other hand, the lack of basic industries which have the most interindustrial linkages may simplify the task. Of course, in each case only the major coefficients are to be calculated and analysed. In the Hungarian input-output matrix for the year 1959, for instance, of the possible 9,000 coefficients of the 95 × 95 sector table, only 770 coefficients had values of over 1 per cent.

Five major factors are listed in the opening paragraph of this section which have the most significant impact on the input-output matrix. From the standardized matrix, one of these factors, imports, seems to be eliminated in each case. The standardized matrix is to be calculated in such a way that its coefficients comprise the total use of domestic and imported materials; in other words, it has to be drawn up for a closed economy. Subsequently, each country has to separate the use of domestic materials and imports according to its special conditions, that is, determine the distribution of domestic production and import by sectors. That is one of the reasons why the inverse of a standardized input-output matrix cannot be used without further improvement, that is, without the corrections of the technological matrix based on imports. Since the inverse operation may encounter difficulties in some countries the possibilities of the use of a triangularized matrix should be investigated as well.

Corrections resulting from the use of other than "standardized" technologies may be carried out in a similar way, that is, before the inverse operation. Effects of returns to scale and of differences in the infrastructure cannot be isolated by simple methods and may thus be neglected. As for elimination of the impact of price relations, it is possible to attempt the compilation and use of an input-output matrix in physical units, but this would require a very detailed matrix. Some supplementary figures on the major coefficients in physical units, however, may be very useful and such a supplement is to be recommended.

The possible ways of solving the price problems in the transformation (adaptation) and use of the standardized input-output matrix need further investigation. If the standardized matrix is expressed in a common currency (such as the dollar), the corrections due to import and differences in technologies may be carried out in this currency, by means of exchange rates. Subsequently the matrix may be inverted, evaluated and utilized in many ways without its conversion into national currency. For instance, the ratio of direct and total input coefficients measured in the common currency may yield a great deal of valuable information. More sophisticated uses of this corrected standardized matrix require some further calculations; either a conversion into national currency must be attempted, or the related national data (on final demand, on single projects, and perhaps on the final results of calculations) are to be converted into the common currency. Both solutions need the calculation of special exchange rates, a complicated task but without which the adapted matrix can hardly be used for exact numerical calculations and analyses.

As for the use of a standardized input-output matrix for project evaluation, only some preliminary issues may be mentioned. A standardized matrix without a national adaptation may give only a general picture about interindustrial linkages and only some guidance about the major interdependencies to be analysed. More help may be obtained from a corrected version of this standardized matrix. Corrections are to be made because of imports and some significant differences in technology. The corrected matrix and its inversion (also in the common currency)—may give a better insight into the interindustrial relations of the given economy and make possible also some further numerical calculations. For these calculations, however, there is needed a conversion of the basic national data of the given projects in the common currency. In this way the direct analysis of the consistency effects of the projects (c 1) may be supplemented by an input-output evaluation of the consistency impacts (c 3). For analysis of the impacts on primary input requirements, the calculation of the row vectors of labour and capital is needed as well. These vectors may be calculated in a standardized form too, but as a rule, in this case, there appear to be the most striking differences among countries and consequently national data may be required. Through the help of the direct coefficients of the primary inputs and the inverse matrix, total primary input coefficients may be calculated and analysed. Some methods of project evaluation based on input-output analyses dealt with earlier (e 4) may be used, too. For further analyses, however, a whole set of exchange rates is necessary and either the corrected standardized matrix must be converted into the national currency or a great number of national basic data are to be converted into the common currency of the standardized matrix.

ANNEX I

EXAMPLE OF CALCULATING TOTAL REQUIREMENTS OF INTERMEDIARY AND IMPORTED GOODS OF A PROJECT AIMING AT FURNITURE PRODUCTION

Supplier sectors	Projected direct (Requirements in million national currency units) 1	Calculated* total (Requirements in million national currency units) 2	1 : 2 (in percentage) 3
Mining	0.5	5.2	10
Metallurgy	1.5	6.9	22
Machinery and instruments	0.9	3.5	26
Other metal products	4.1	5.3	77
Electric power	3.1	5.7	54
Building materials	2.8	4.2	67
Chemicals, rubber and plastic products	5.8	10.7	54
Wood	35.7	40.9	87
Paper and printing	0.6	1.5	40
Textile	17.2	21.3	81
Leather, apparel	0.5	1.1	46
Food	1.0	1.9	53
Agriculture	0.1	2.2	5
Domestic intermediary goods	73.7	110.4	67
Imported goods	29.0	43.2	67
TOTAL	102.7	153.6	67

* On the basis of the Hungarian input-output table for 1961.

ANNEX II

SHARE OF DIRECT AND TOTAL TAXES AND SUBSIDIES AND RETURNS TO CAPITAL (PROFITS) IN THE ECONOMY OF ISRAEL IN THE YEAR 1958*

Sectors	Taxes and subsidies: Direct	Taxes and subsidies: Total	Returns to capital/profits: Direct	Returns to capital/profits: Total
201 Field crops	−3.9	−1.5	17.5	23.2
202 Livestock	4.4	5.5	22.9	31.8
203 Citrus	2.3	3.8	34.6	37.3
204 Other agriculture	0.1	1.0	14.3	19.3
205 Mining	1.0	3.8	10.7	19.0
206 Food	0.9	4.0	5.9	21.8
207 Textiles and apparel	5.2	9.3	13.1	26.9
208 Wood and carpentry	12.4	16.8	7.9	18.1
209 Paper, printing and publishing	3.7	7.3	5.3	15.2
210 Leather and leather products	1.4	3.3	23.9	36.3
211 Rubber and plastic products	6.3	8.4	15.4	22.5
212 Chemicals, oil and soap	6.0	8.4	0.2	7.5
213 Oil refineries	0.1	1.1	−0.7	3.3
214 Glass, ceramics and cement	8.9	12.6	6.2	12.4
215 Diamond polishing	0.0	0.2	12.1	13.2
216 Basic metals	1.8	3.6	2.0	7.1
217 Metal products	4.9	7.3	6.9	13.4
218 Machinery and vehicles	6.9	9.9	5.9	12.9
219 Construction and housing	6.6	11.8	7.8	16.7
220 Electric power	3.1	5.0	3.4	8.7
221 Water	−13.2	−9.4	5.9	3.3
222 Inland transportation	6.2	10.4	13.2	10.6
223 Shipping and aviation	1.1	2.4	−4.0	−0.5
224 Other communications	4.8	6.7	13.0	18.0
225 Services and trade	5.1	8.5	20.0	30.0

* In percentages of the value of output. Total coefficients calculated from input-output table. Source: M. Bruno, *Interdependence, Resource Use and Structural Change in Israel*, Jerusalem, 1962, pp. [illegible].

ANNEX III

Share of direct and total sales taxes and subsidies in the Hungarian economy in the year 1959*

Sectors	Sales taxes and subsidies: Direct	Sales taxes and subsidies: Total
Mining	0.5	2.3
Metallurgy	0.4	2.6
Machinery	0.1	3.2
Electrical machinery	—0.3	2.4
Instruments	5.4	7.4
Other metal products	5.0	7.4
Electric power	0.0	1.6
Building materials	[illegible] 3	8.7
Chemicals	19.4	23.0
Rubber and plastic products	37.0	43.1
Wood	9.8	13.2
Paper	13.1	15.9
Printing	7.2	14.9
Textile	30.7	38.8
Leather	13.2	18.9
Apparel	26.3	41.4
Food	10.6	14.4
Construction	0.3	1.7
Agriculture	0.0	1.9
Transport and communication	16.8	– 13.6

* In percentage of the value of output. Total coefficients calculated from input output table.

ANNEX IV

Example of calculating accounting prices on actual macroeconomic (social) cost basis by means of input-output analysis

Accounting prices for (i) brick and tile products and (ii) cement and concrete products, based on data of the Hungarian input-ouput table for the year 1961

A. *Basic data*

	Brick and tile products		Cement and concrete products	
	Percentage share of value of output			
	Direct input 1	Total input 2	Direct input 3	Total input 4
a. Domestic intermediary goods	33.0		49.3	
b. Imported goods	8.1	12.7	6.6	15.6
c. Depreciation	10.9	16.5	6.8	14.6
d. Wages and salaries	27.7	39.7	12.2	28.0
e. Profits	15.7	23.0	13.3	24.4
f. Taxes and subsidies	4.6	8.1	11.8	17.4
g. Total value of output	100.0	100.0	100.0	100.0
h. Capital requirement	148.4	244.1	118.0	256.5

B. *Variants of accounting prices (per 100 units of value of output at actual prices)*

	Brick and tile products	Cement and concrete products
(i) By eliminating taxes and subsidies paid at the given stage of the production process	95.4	88.2
(ii) By eliminating total taxes and subsidies	91.9	82.6
(iii) By eliminating total profits, taxes and subsidies	68.9	58.2
(iv) Based on total macroeconomic labour input in wage terms	56.0	43.7
(v) Based on total macroeconomic labour input + charge on wages 75 per cent	90.0	76.5
(vi) Based on total macroeconomic labour input + charge on capital 15 per cent	107.8	96.2
(vii) Based on total macroeconomic labour input + charge on wages 25 per cent + charge on capital 10 per cent	104.5	89.8

(Annex IV continues on page 114)

ANNEX IV (*continued*)

C. *Methods of calculation, illustrated by the example of the brick and tile products*

(i) $= (g) - (f1) = 100 - 4.6$

(ii) $= (g) - (f2) = 100 - 8.1$

(iii) $= (g) - (f2) - (e2) = 100 - 8.1 - 23.0$

(iv) = total labour + total import converted in labour (based on average cost of foreign currency earned by exports + total depreciation converted in labour (based on average costs of the replacement of the fixed assets) $= 39.7 - 7.6 + 8.7$

(v) $= (iv) \times 1.75 = 56.0 \times 1.75$

(vi) $= (iv) + C_{tm} \times 0.15 = 56.0 + 345 \times 0.15$
where C_{tm} = total macroeconomic capital requirement including requirements of imports (*via* exports) and depreciation (*via* replacement)

(vii) $= (iv) \times 1.25 + C_{tm} \times 0.10 = 56.0 \times 1.25 + 345 \times 0.10$

ANNEX V

EXAMPLE OF USE OF TOTAL INPUT COEFFICIENTS FOR EVALUATING SECTORAL CHARACTERISTICS AND INTERINDUSTRIAL EFFICIENCY IMPACTS

Two sectors will be analysed based on data of the Hungarian input-output table for the year 1961.

A. *Basic data*

	Data per 100 units of value of output at actual prices	
	Sector A	*Sector B*
Accounting prices for output at foreign currency equivalents (FCE)	30	26.5
Imported goods used at FCE		
Direct	2.8	1.9
Total	4.0	4.5
Labour input (in 10^{-4} man years)		
Direct	12.3	6.0
Total	17.2	12.6
Capital requirement		
Direct	184	118
Total	204	257
Total macroeconomic labour*		
Labour (in 10^{-4} man years)	25.4	20.5
Import (at FCE)	6.9	7.1
Capital requirement	345	352

* Total macroeconomic labour input includes total import and total depreciation converted in labour (see annex IV (C)). Total macroeconomic import includes import needed by depreciation for replacement of fixed assets. Total macroeconomic capital requirement includes capital needed by import for equivalent export production.

ANNEX V (*continued*)

B. *Sectoral characteristics*

	Sector A	*Sector B*
Per 100 units of output at FCE		
Total labour (10^{-4})	57	48
Total macroeconomic labour (10^{-4})	85	77
Total capital requirement	813	980
Total macroeconomic capital requirement	1,150	1,329
Total import at FCE	13	17
Total macroeconomic import at FCE	23	27
Total capital requirement per total labour (10^{-4})	14.2	20.4
Total import at FCE per total labour (10^{-4})	0.24	0.35

C. *A synthetic formula of efficiency calculation*

	Sector A	*Sector B*
Domestic value added per 100 units of output at actual prices	26	22
Domestic costs at accounting prices per 100 unit of output at actual prices		
Variant (v)	84.7	62.5
Variant (vi)	86.0	74.3
Variant (vii)	84.9	70.3
Domestic value added per domestic costs		
Variant (v)	0.307	0.352
Variant (vi)	0.307	0.299
Variant (vii)	0.307	0.313

Variants refer to annex IV (B). Domestic costs were calculated by the formulas indicated in annex IV, but from the total macroeconomic labour input coefficients, excluding costs of import, and from the total macroeconomic capital requirement excluding the part needed by import.

XI. CRITERIA FOR THE EVALUATION OF INDUSTRIAL PROJECTS IN AN OPEN ECONOMY

by L. Csapó and M. Mandel*

Introduction: Development Strategy and Conditions

During the last twenty years, Hungary has changed from a relatively underdeveloped agricultural country into a relatively developed industrial country. In this process the high rate of industrial growth has played an important role: between 1950 and 1960 industrial production increased by 10 per cent on an annual average. The economic structure of the country changed radically. While in 1938 industry produced 35.7 per cent of the national income and agriculture contributed 36.5 per cent, in 1961, 70.3 per cent of the national income was produced by industry and construction and only 20.4 per cent by agriculture. According to census data in 1941, 48.1 per cent of the working population was agricultural and 22.4 per cent industrial, while in 1961 the agricultural portion of the population had decreased to 35.2 per cent and the industrial population had increased to 31.7 per cent of the total.

These results were achieved to a large extent through extensive investment activity. Before the Second World War, the share of accumulation in national income was no more than 8.5 per cent annually. During 1949-1962, this proportion increased to 25 per cent on an annual average. It should be mentioned that, in some years, the increased accumulation was as high as 35 per cent. This fact cannot be seen from the statistics because of the two-level, distorted price system (low prices of capital goods and high prices of consumer goods). The price system changed in 1959. Before the war some 15 to 20 per cent of total investments was spent on industry annually, while between 1950 and 1962, with the exception of two years, the share of industry in total investment outlays increased to about 40 per cent annually and in 1953 had reached a peak, with 47 per cent of the total. We mention these facts here to indicate that, during the last twenty years, special attention has been paid in Hungary to investment problems and also to research and experimentation, in order to find the proper criteria for evaluation of industrial projects. There are some results, but we cannot, of course, state positively that we have found the solution and have now the correct system, principles and methods of industrial project evaluation.

The first lesson we may draw from our twenty years' experimentation is that formulation of the correct criteria for industrial project evaluation is an extremely difficult matter. In this paper we will first show the most important lessons we have drawn from our past experiences, and next explain the new ways and means we intend to use in the near future. The first question is: what facts and principles have to be considered in order to formulate the proper criteria for project evaluation? And the second question is: what are the right criteria and the methods of applying them?

The second lesson we should draw from the Hungarian experience—and this is probably the most important—is that it is impossible to formulate such general criteria as to be applicable in any country, at any time, irrespective of the given circumstances. Such general criteria do not exist. Criteria of project evaluation in general depend on two factors: development strategy, and the economic situation and possibilities of a given country at a given period of time.

The first factor, however, is not independent of the second, and both of them change from time to time. By "development strategy", we mean long-term development targets and the means required to fulfil them; on "economic situation and possibilities", we take into consideration the existing amount of capital, labour and natural endowment and the institutional framework of the economic activity. Since both of the above mentioned factors change over time, the criteria of project evaluation have to change too. As a consequence, criteria are always relative by nature. This, of course, does not mean that we are unable to formulate relatively stable criteria. In a centrally planned system it would be impossible to elaborate investment programmes for the economy as a whole without some kind of criteria elaborated on the basis of the two above mentioned determining factors. In a market economy, of course, where investment decisions are taken by private enterprises, the conditions and criteria of the investment decisions are different, but there are many features common to both systems. In recent years, economic research has devoted attention—both in the west and in the east—to experiments which provide proper methods of choosing the optimum variant within given limiting factors (mathematical programming).

The limiting factors are usually official plans and development programmes prepared by ruling circles or Governments. On this basis, economic models are built. The models usually start with the limiting factors established in the official programmes. These limiting factors are built into the models and the optimum size of the activity is calculated at those limiting factors. In other words the criteria of the optimum variant are determined outside the model and the model itself is dominated by them. The opti

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mum is always relative and depends on the evaluation criteria, while the evaluation criteria are determined mainly by the development strategy.

At the same time, research efforts are seldom directed to finding out the proper ways, means and methods of elaborating a long-term development strategy and further to formulating a sound investment programme on national and sectoral levels, applying the criteria determined by the long-term development strategy. This is one of the main reasons why it is so difficult to formulate the criteria for project evaluation. In the real planning activity, the criteria for industrial project evaluation have been decided with the elaboration of the long-term development programme. In the optimum calculations, the criteria of evaluation are built into the model as limiting factors and the optimum variant is a relative optimum, in relation to the limiting factors decided upon by the targets and objects of the long-term development strategy. We base this statement on the real experiences gained in the development of the Hungarian economy.

The post-war reconstruction in Hungary ended in 1947-1948 and a radical change of the socio-economic structure began. The development strategy elaborated by leading circles comprised such goals as speeding up the long-term rate of growth, rapid industrialization, full employment, complete reconstruction of agriculture and infrastructure, and an increase in consumption, thus ensuring the complete economic and political independence of the country and the attainment of the economic level of the highly developed industrial countries within ten or fifteen years. It was obvious from the beginning that the achievement of these ambitious goals required huge investment. Three variants of an investment programme were considered:

Rapid increase of investment in such a way that consumption would also increase, however slowly, as investment and national income rose;

Rapid growth of investment at a stagnant level of consumption;

Rapid growth of investment at an absolute decreasing level of consumption.

At the same time, the economic conditions and possibilities were as follows: external resources were not available; development targets had to be achieved by domestic accumulation and resources; natural resources of energy and basic raw materials were very limited; a large part of the main raw materials and machinery also had to be imported; free labour resources were at hand but they were mainly derived from an unskilled agricultural labour force; agriculture and infrastructure were socially and technically backward; the economy had an "open" character: export-import sensitiveness was high; finally, the institutional framework had been transformed from a market economy into a centrally planned model based on state ownership of the means of production.

The official development strategy accepted the first investment variant. Rapid growth of investment and a moderate increase of consumption were the targets in the first five-year plan (1949-1954). National income was expected to rise by 63 per cent and consumption by 35 per cent.

At the implementing of the plan, however, the Government was forced to achieve all the above-mentioned targets at the same time and as rapidly as possible. In consequence of this development strategy, the third variant of the investment programme was realized. Investment increased rapidly while consumption declined considerably. In this paper we cannot explain all the consequences of the development strategy. We shall therefore focus our attention on the consequences connected with the criteria for industrial project evaluation.

The above-mentioned ambitious targets decided by the development strategy and the forced implementation of these targets within a relatively short period of time shifted the whole development programme towards an autarchic type of development, neglecting the open character of the economy. Every capital-intensive raw material producing branch had to be developed at a very high speed, as had every branch of manufacturing. This situation necessarily led to the dispersion of the limited investment resources: the volume of unfinished investments continuously increased; the average time of project completion did not increase; and the technical level of new projects lagged behind the required level.

In consequence of the development strategy, every project providing the planned increment of production in quantity was considered useful and necessary irrespective of the cost and commercial profitability of the project; moreover, the basic criterion of a project was the maximum level of production and employment the new capacity could produce.

The Hungarian experiences indicate without any doubt that the criteria for project evaluation are determined basically by the development strategy. We would like to call attention to some of the consequences of the applied criteria in an extensive phase of industrial development since this might be useful for some developing countries with an open economy where the extensive period of industrialization has just begun. In Hungary between 1949 and 1953, the share of new construction in national income was about 15 per cent. The ratio of construction to machinery and appliances was 5.3:1. (It is worth mentioning that the same ratio in the United States at the end of the nineteenth century, when the industrialization drive started, was about 3:1, and after the Second World War it had declined to 1:1. Moreover, the share of machinery had become a little higher than that of construction.) At the same time, in case of new projects the capital coefficient

$$\frac{\text{increment of national income}}{\text{increment of investment}}$$

was no more than 0.28, while in old factories every one unit invested in expansion and reconstruction produced 3-7 unit increment.

Between 1957 and 1962, the construction-machinery ratio changed to 1.3:1 while the capital coefficient increased from 0.28 to 0.39. In the first five-year plan, about 35 per cent of the national income was invested and the national income increased by 50.3

per cent, about 8 or 9 per cent on an annual average; between 1958-1962, 23.7 per cent of the national income was invested while the increment reached 38.8 per cent or about 7 per cent, on an annual average. In addition to this, personal consumption increased considerably.

In the 1960s, investment decisions have been increasingly dominated by the criteria of efficiency and profitability.

The basic shortcoming in our opinion of the development policy of the 1950s was that the open character of the economy was neglected. Therefore, in an autarchic type of development, the basic criteria of project evaluation were necessarily reduced to the maximization of output and employment. In spite of these difficulties, one of the most important targets, that is, full employment, has been achieved. Industrial employment increased from the 547,409 in 1949 to 1,193,800 in 1962. Indeed during the 1960s something of a lack of labour power is characteristic, indicating that the period of an extensive-type industrialization has ended.

We are approaching a new stage of development usually referred to in Hungarian literature as intensive industrialization. The most important question of this stage could be formulated as follows: what should be the criteria for project evaluation in an industrial country where natural resources, industrial raw material and energy are very limited and therefore a large part of the national income (more than one third of the gross national product) flows through the channel of foreign trade? In the following sections we shall try to summarize the new efforts and research, attempting to discover the answers to the above-mentioned questions.

A. Basic assumptions and theses

1. *Definition of the "open economy"*

An economy is considered to have an open character when the actual and potential scarcity of natural resources and conditions makes it impossible to utilize fully the existing and expected capacities on the basis of domestic resources. From this definition follows the basic characteristic of the open economy: the amount of foreign trade activity is very high measured by its share in national income, both in exports and in imports. The open character of the economy of course influences the criteria of project evaluation, both in the extensive and in the intensive stage of industrial development. However, in the intensive stage, this influence is much stronger. While in the extensive stage the rate of growth can be increased by building a large number of projects of relatively low technical level and using the maximum amount of labour and domestic natural resources in the short run, in the intensive stage these resources are already exhausted. The more rapid the development in the earlier stage, the more pressing is the scarcity of natural resources in the intensive stage, since capacities have greatly increased. The import needs of the economy suddenly rise to a qualitatively new level. Therefore, in an open economy (such as the Hungarian economy) where a certain high level of industrial development has been achieved, the implementation of any long-term development programme, even at a reduced, moderate rate of growth, is a function of the increasing export ability of the economy.

This is the most important premise in an open economy, which has to be taken into account in any sound development strategy. Taking into account the cumulative effects, one unit decrease or increase in export produces much more than one unit fluctuation in national income, in employment and in the living standard. This indicates a very high foreign trade sensitivity. According to our present estimate, one unit decline in export, through the decrease of import, produces 4-5 unit decline in national income. These conditions of course determine the criteria of project evaluation. Since the increase of national income, employment and consumption are the function of the economy's export ability, the most important criterion for project evaluation (and at the same time the most important criterion of efficiency of the national economic activity) is the expected maximum net foreign exchange earnings (yields) of a project, or of the national economy as a whole, in the long run.

If in the open economy the maximum of the net foreign exchange earnings is the basic criterion, the character of the efficiency computations is determined by this very fact. On the other hand, the criteria of sectoral allocation and project planning are determined too.

2. *An experimental method for the calculation of net foreign exchange earnings*

The objects of the experiments are as follows:

(*a*) To determine the net yields of a single project (that is, the difference between the inputs and yields in foreign exchange for the expected lifetime of the project);

(*b*) To determine the expected increment of national income (expressed in foreign exchange) produced by investment expenditure;

(*c*) To determine the expected net foreign exchange yields in every sector and on this basis allocate investment funds among sectors (choosing the "leading sectors").

The first bottleneck encountered by planners in these computations is the price system. In centrally planned economies, domestic and foreign trade prices are rigidly separated. Domestic producer prices are calculated in domestic currency on the basis of domestic inputs. In addition, producer prices and consumer prices are separated both for industrial and agricultural products. The changes occurring in producer costs are not reflected in consumer prices. Taxes are differentiated by sectors. Therefore the calculation of real costs is very difficult. Since domestic prices are separated from world market prices (while more than one third of the national income is realized on international markets) national income, calculated by domestic prices and in domestic currency, is different from the national income measured in world market prices.

In an open economy, however, where the real rate of growth is a function of export ability (and ex port ability is a function mainly of costs related to international standards), the efficiency of a project or of the economic activity as a whole can be measured only by the net foreign exchange earnings realized or realizable on the world market. In order to get the net foreign exchange earnings of the economy (or a sector, or a project), we should be able to express inputs and outputs in foreign exchange on the level of world market prices.

The first experiment in this direction started in 1964, and it is in progress. The experiment is called in our literature "world market price model". We had to provide two preconditions for the computations: an input-output table containing the quantitative relationships of sectors; and foreign exchange rates for comparison of domestic and foreign trade prices, substituting for the rate of exchange.

In Hungary, since the use of input-output analysis is well known, the proper tables are available. However, the formulation of foreign exchange rates is most difficult: we need the kind of rates that take into consideration the differences of the price levels of market and centrally planned economies. The root of the matter is that total domestic production will be calculated in dollar prices on the basis of the input-output table. As a result, first we shall be able to get a real domestic price structure and, as a second step, we might have a static comparison of sectoral efficiency measured by the realized net foreign exchange earnings of the sectors. The main steps of the calculations are as follows:

First, the output of various producing sectors is calculated and expressed in dollar values, taking into account the average world market prices possible at a certain time. The total output of a sector is divided in two parts:

SECTOR'S TOTAL OUTPUT

(a) *Main products*

Relatively few products of a sector which determine the sector's profile. These products are subdivided into the following two groups:

- Products for export
- Products which are not exported but could be exported

(b) *Secondary products*

A smaller part of output

- Products not characteristic of the sector's profile
- Products characteristic of the sector's profile but having little weight

The world market prices of the main products are immediately given. In the case of secondary products, we use foreign exchange rates. For products not characteristic of the sector's production we use average rates of foreign exchange calculated on the national level, while for products characteristic but not important for the sector's main activity we use average rates calculated on the sector level. In the formulation of product groups there is a basic rule: in general to represent the domestic composition of production in every sector as accurately as possible. Applying this method, the total outputs of the commodity producing sectors are expressed in dollar terms calculated in average world market prices, that is, line vectors of the input-output table are expressed in dollar terms or average world market price levels. There are, of course, several difficulties to overcome during the calculations. We mention here a few of them: in some sectors output is not homogeneous, price calculations of a single product are usually misleading and in such cases we have to use price indices related to product groups.

We have mentioned the calculations connected with the commodity producing sectors. This is, of course, not enough. We have to calculate the outputs of service-producing sectors, such as communications, transport and trade and also output of construction. We shall deal with these sectors later.

As a second step, the input of commodity producing sectors has to be calculated, taking into account average world market prices in dollar terms, that is, column vectors of the input-output table have to be expressed in dollar terms. Since in the first step we calculated outputs of commodity producing sectors in dollar terms and intersector relations are given by the technical coefficients of the table, on this basis those domestic material inputs originating from various commodity producing sectors are also given in the column vectors, expressed in dollar terms in average world market prices.

The next input item of the column vectors is: import material. Dollar prices of import materials, however, are immediately given. The most complicated items of the column vector to calculate are wages and amortization, which have to be calculated in dollar terms too. Calculation of wage input starts from the so-called "food basket". We take the average world market prices of the products represented in the "food basket" in dollar terms. In this way one part of the wage bill is expressed in a proper scale. It is more complicated to compute those services which are used by consumers. We do not have the proper methods yet and many possibilities are under discussion at the present time.

The next input item of the column vector is amortization. The calculation of amortization starts with the computations of the dollar values of investment expenses. Before that, however, we have to be able to express the value of construction activity in dollar terms. The output of construction cannot be determined from the commodity side. Therefore wages have to be determined first and later, using various calculation methods based on wage costs expressed in dollar values, output of construction (and in the same manner outputs of service-producing sectors) will be computed in dollar terms too. At the pricing of amortization a special index will be used which is a quotient of the total domestic price of investment-replacement and foreign exchange price of the same aggregate. The sum of investment and replacement is given in the investment column of the table.

The calculations are accomplished on three price levels:

(*a*) On the level of average export-import prices accepted in 1961 among centrally planned economies in foreign trade treaties;

(*b*) On the level of average Hungarian foreign trade prices with the western market economies (in the case of products which are not exported to western markets we use the method of "price identification" based on comparison of technical-economic parameters of the given product);

(*c*) On the level of average prices of one of the "main markets".

When the above-mentioned computations have been completed, we have the following results: the balance of sector activity, gains or losses in every sector expressed in foreign exchange terms (in dollars) and the net aggregated foreign exchange earnings (direct and indirect) for the national economy as a whole. These calculations, however, are static in character. Therefore, as a third step, the model has to be dynamized. Since we do not have an input-output table for every year, the foreign exchange gains or losses calculated for one base year have to be estimated for other years, or for a period of time, on the basis of changes in production, in technical coefficients and in world market price levels. The estimated foreign exchange gains or losses should be related to the foreign exchange value of investment expenses in every sector. The calculations reflecting foreign exchange gains or losses by sectors for 1961 will be completed at the end of 1965 and dynamization of the model follows in the next two to three years.

We indicated above that the first picture is a static one: gains or losses by sectors in a certain year. Therefore the next step is to dynamize the model by interpolation and get a picture of trends of gains or losses.

Let us suppose, as a first approach, that we wish to know how the foreign exchange balances of various sectors have changed between 1951 and 1961. Let us suppose further that sector A had:

Output	$200 million
Input	$140 million
Balance of foreign exchange	$60 million

Volume of production in sector *A* doubled. Foreign exchange gains of sector *A* interpolated only on the basis of the production index equal $30 million in 1951.

We suppose that the developments in sector *A* in the last eleven years were as follows (in $ million):

Year	*Chain index*	*Balance of foreign exchange*	*Changes in balance of foreign exchange in relation to the previous year*
1951	100	30	
1952	110	33	3
1953	109	36	6
1954	108	39	9
1955	108	42	12
1956	107	45	15
1957	107	48	18
1958	106	51	21
1959	106	54	24
1960	105	57	27
1961	105	60	30
TOTAL			$125

Taking into account production increases only and extrapolating changes of foreign exchange yields during eleven years, foreign exchange earnings originating from sector *A* are $125 million total (discount effects are disregarded). We have neglected, for the moment, the effects produced by changes of the technical coefficients' labour power, as well as by world price level movements; however, these effects should be taken into consideration too. The proper methods of considering them are not yet elaborated and various ideas are widely discussed.

At the end, calculated foreign exchange increases by sectors have to be related to the foreign exchange values of invested capital by sectors. Applying the method described above, we expect to get the following results:

(*a*) When the "world price model" is completed, all basic data we need to calculate net foreign earnings of a project, sector, or the national economy as a whole are given;

(*b*) We will have a sound basis (difference among sectors in net foreign exchange earnings) for sectoral allocation of investment funds based on the principle of maximization of net foreign exchange earnings (as the most important indicator of efficiency in an open economy);

(*c*) With the help of a dynamized "world price model" we expect to have a good method for elaborating long-term investment programmes;

(*d*) Since we expect to be able to have all basic data in foreign exchange value, it will be possible to calculate the increment of national income also in foreign exchange and have a clear picture about the efficiency of aggregated investment activity at the sectoral and national levels.

In other words, with the help of this method, we expect to apply in practice our principle that, in an open economy, the most important criterion of project evaluation is the net foreign exchange earnings gained in the long run. The method described above in general terms, of course, is only a starting point for industrial project evaluation in so far as it indicates at a certain moment the net yields of various sectors on the one hand and the world price trends calculated *ex post* which might be used as starting points for estimations of world market price trends *ex ante* on the other hand. There are some other aspects of project evaluation in an open economy which have to be considered in the preparation stage of the investment programme. Because of the economy's foreign trade sensitivity the number of "uncertainty factors" is considerable. The longer the duration of the investment programme (and in many cases we have to deal with fifteen to twenty five years), the higher the number of uncertainty factors. In connexion with a high degree of uncertainty, the importance of the risk element and the calculation of possible risk increases.

The first question which planners must answer is how to minimize uncertainty and risk. The first step (because of limited domestic resources and the high degree of uncertainty) is to concentrate investment funds in those branches where expected foreign exchange earnings are highest. In this way we choose "leading sectors". The allocation of investment expenses mainly into these "leading sectors" and the additional and auxiliary investments induced by the "leading sectors" main investment expenses determine the investment programme as a whole. As a consequence of applying the principle of the "leading sectors" approach, the foreign trade sensitivity of the economy will increase in the long run. In spite of this effect in an open economy, we do not see any other way to achieve a considerable growth of national income, employment and consumption, in the long run. The concentration of scarce resources in a few leading sectors is the key to increasing efficiency. If the above-mentioned principle is accepted, some of the criteria for project evaluation are determined almost automatically. The open character of the economy makes necessary and the concentration of limited resources into "leading sectors" makes possible in general the use of the most modern, up-to-date machinery and technology for the construction of new industrial projects. Probably this is one of the most important criteria for project evaluation in an open economy.

Applying the principle of the "leading sectors" approach, and as a consequence using up-to-date technology, is the only real guarantee against uncertainties and risks in the long run; otherwise, decreasing costs and increasing net foreign exchange earnings cannot in the long run be ensured.

In our experience, applying the above-mentioned means is still not enough where the foreign trade sensitivity is as high as it is in Hungary. An economy producing for the world market and depending on it to a large extent has to be ensured against uncertainties by "strategic reserves", which are able to counterbalance the effects of the uncertain movements in all circumstances. The quantity and composition of "strategic reserves" are determined by many factors, both economic and political, but a considerable part of national income has to be reserved for this purpose in general. The material forms of these reserves are: capacity, labour, raw material and foreign exchange reserves. As far as industrial project evaluation is concerned, determination of capacity reserves has a high importance. At the present moment we do not have the proper method of determining the necessary capacity reserves. One part of research efforts should be devoted to this object in the near future. It is obvious, however, from our present discussions that "capacity reserve" is a special form of risk-taking; therefore the costs of "capacity reserves" should be calculated as a rate of risk and should be incorporated in the inputs of new projects as a necessary cost element. The other forms of necessary reserves have to be calculated in the same manner. A basic rule of development strategy in an open economy—which determines some of the criteria for industrial project evaluation—is that balanced growth of the economy cannot be achieved without "strategic reserves", or in other words: a balanced and optimum rate of growth cannot be sustained at full employment of all resources (capacity, labour, raw material and foreign exchange).

In this section we have tried to explain the basic ideas of "strategy" formulation in an open economy and in connexion with it those main criteria of project evaluation that are determined automatically by the development strategy. In the next section we intend to explain those conditions and methods by which the above-mentioned criteria might be used in practical project planning.

B. Process of industrial project evaluation

1. *Preliminary steps in setting up industrial projects*

We indicated in the previous section that the "world market price model" is only a first step in calculating expected net foreign exchange yields in the long run. The static model should be transformed into a dynamic one in order to formulate sound investment decisions. The first step in dynamization is the elaboration of special studies about expected foreign market and price trend movements, that is, a long-term estimation of future market and price trends, by main products or main groups of products. We do not have wide experience in this field yet and the first studies were prepared in recent years. Foreign and domestic market estimates and price trend movements should be calculated for at least ten to fifteen years in order to calculate expected net foreign exchange earnings. Market studies have to be prepared through a series of steps described below.

(a) *Selection of main markets*. The proper selection of main markets means that we are choosing those markets where we are already in successful competition or we have a chance for successful competition in the near future. In general we have to analyse the "accessible markets". In this respect, current foreign trade practice provides much information to start with. This information of course is not enough. The selection of the proper market as a first action requires extended research and analysis.

(b) *Estimation of capacity increases and market possibilities of prospective competitors*. This study and analysis is the most complicated to prepare. Limited information is the most important bottleneck. In case of centrally planned economies we are in a better position since their development targets and economic situation are well known, so we are able to estimate their prospective capacities and export ability too. To estimate trends in market economies is the most difficult task (business interests and government interference are distorting factors). In spite of these difficulties, we have to prepare some estimates, otherwise we cannot forecast the expected supply position and price movements in the market.

(c) *Estimation of prospective changes in technology and research*. This must include the possibility of a new technology, creating new methods for mass substitution of the given product. This estimate is very important from the point of view of expected costs and prices.

The importance of these preliminary studies came to light in connexion with the development planning of such rapidly growing industries as chemicals, artificial fibres, instruments, precision machinery and telecommunications. In these industries, calculations based on current price movements may cause a complete misunderstanding. We mention here just one example: and it is a classical one. Production of B_{12} vitamin was decided on the basis of current world market prices. When the capacity expansion started the prices were very high. At the completion of the new project, prices came down to a fraction of the earlier prices.

World market prices of B_{12} vitamin 1958–1964
(In $US gramme)

1958	1959	1960	1961	1962	1963	1964
100	85	42	16.5	9.5	8	6.6

In spite of the importance of market and price forecasting at the evaluation of industrial projects, only very few studies have been completed so far. This is due to various difficulties. The remnants of the earlier development ideas and criteria and bottlenecks in information gathering have hampered the elaboration of the above-mentioned studies. Notwithstanding these facts, preparation of market and price forecasting studies have been carried on since the 1960s. The first experimental studies were connected with the development of mathematical programming in two sectors: in artificial fibres and in the aluminium industries. On the following pages we shall explain the main steps of these experiments.

2. *Elaboration of price-forecasting studies*

The research work started in 1963, and its aim was to predict the expected world market price level in dollar terms for 1975 for some artificial fibres and for aluminium.

Planners gathered all information about the production conditions and technology of the product. On this basis, and taking into account the application of technological discoveries, they calculated the expected cost level in 1975 of direct material labour inputs etc. The cost level gained for 1975 was expressed in dollar values, and it was considered a minimum level of the expected price. They also presumed that, in case of the introduction of a new technology between research and mass implementation, some six to twelve years would be required. Therefore this process would not change the main price trends for the calculated period of time. They came to the conclusion that in 1975 the expected minimum level of price would be equal to the cost of the product.

Export prices have been analysed for the last ten to twenty years by products and main producers. At first, domestic prices were calculated and expressed in dollar terms by countries. Spreading was very high and prices were very far from the price level of the Hungarian import. Planners then presumed that Hungarian import prices from market economies in the base year were objective and real prices, and transposed the price lines of various countries to the level of effective Hungarian import prices. In this way price changes were related to the average Hungarian import price in the base year. After that, they constructed regression functions and fitted curves to the various prices, and in this manner prices were expressed in the function of time. The trend lines and zones covered by the curves clearly indicated world price movements *ex post*. These export analyses have been used as starting points towards *ex ante* price analysis.

As a third step, expected export market changes were estimated, taking into account prospective capacity increases of the main producers and changes in demand. The lack of information in this field was greatest.

In the case of new products, current prices were taken as dynamized median values. The uncertainty of price level in this case was indicated by a higher degree of oscillation around the current level.

Further research has tried to take into account as many factors as possible. In the case of artificial fibres production, various raw materials are used, such as bensol, fenol, toluol and paraxilol, the so-called aromatic compounds. Since these products are produced from the same basic material (coal bitumen or by petro-chemistry), market analysis had to deal with all of them at once. After the Second World War, the raw material basis of artificial fibres production shifted from the coal base to the petrochemical base and this change influenced prices more than many other changes in technology or skill. Therefore special attention had to be devoted to oil price estimates. These examples indicate the difficulties confronting market and price forecasting. Interrelationships of world price movements also have to be considered. For the period of 1953–1960, price correlation computation has been applied between various product prices.

On the basis of *ex post* correlation coefficients planners estimated an expected correlation for 1975. After *ex post* analysis had been completed, they calculated export prices. Since these products had not been produced and exported before, export prices were calculated from import prices, presuming that Hungarian export could not realize better prices than western competitors. In addition, some price losses had to be taken into consideration due to expected discriminatory policies. (This factor was neglected with regard to raw and semi-finished products.)

With these methodological aspects, the price of aluminium was calculated as follows.

Prospective costs of 1 ton of aluminium based on expected conditions of [illegible]
(In $US)

		Per unit	
Electric energy	14 [illegible] kWh	0.45	6[illegible]
Aluminous earth	1.91 tons	60	11[illegible]
Kriolite and aluminium fluoride	50 kg	33	17
Electrodes	600 kg	[illegible]	33
Labour costs	17[illegible]	[illegible]	3[illegible]
Total			[illegible]
Estimated amortization and general expenses			1[illegible]
Total			1[illegible]

The expected cost level, \$430, is equal to the expected minimum price level. Aluminium price data were collected and transposed to the level of Hungarian export prices (western) and later deflated.

ALUMINIUM PRICES*

	Canada (C \$/ton)	*Norway (N.K./ton.)*	*Hungary (\$/ton)*	*USA (\$/ton)*	*UK (£/ton)*	*France (fr./ton.)*	*Italy (lira/ton)*	*W. Germany (Dm/ton)*
1938				926	314	38.100	574.000	2.900
1948					122			
1949					136			
1950	413			391	120	21.600	323.000	2.100
1951				428	93	18.100	366.000	2.114
1952		2.940		451	139	21.900	388.580	2.250
1953	437	3.140		434	157	21.520	388.580	2.267
1954	444	3.070	525	489	152	22.000	379.000	2.280
1955	485	3.210	638	487	156	22.000	390.000	2.210
1956	525	3.590	497	508	177	21.300	422.000	2.180
1957	531	3.800	504	522	184	21.600	421.000	2.220
1958	507	3.680	520	506	182	21.900	403.130	2.130
1959	504	3.500	470	505	177	22.600	410.000	2.050
1960	516	3.560	474	531	180	22.500	413.000	2.040
Changes in the above prices deflated by wholesale price index and transported to Hungarian exported prices in 1960 (to western markets)								
1938				825	825	802	658	673
1948					322			
1949					360			
1950	379			350	317	455	370	489
1951				336	246	384	421	493
1952		394		384	365	460	445	526
1953	403	417		403	412	455	445	526
1954	408	408	525	388	403	464	436	530
1955	436	426	638	436	412	464	450	513
1956	484	479	497	436	455	450	484	504
1957	489	508	504	464	484	455	484	519
1958	464	489	520	450	479	459	459	497
1959	464	489	470	450	469	479	469	474
1960	474	474	474	474	474	474	474	474

A number of conclusions may be drawn from these figures.

(*a*) We cannot formulate a regression function because there are three different periods:

- (i) Between 1938 and 1950 prices declined considerably;
- (ii) Between 1950 and 1958 prices increased considerably;
- (iii) After 1958 prices declined slightly.

(*b*) Taking into account market factors, the rising trend of aluminium prices has stopped. A relatively stable or slightly decreasing price level can be expected because prices had not followed decreasing costs (an effect of monopolistic producers).

(*c*) Capacities have increased and are rising slightly, while a decreasing rate of use of aluminium products is highly probable.

(*d*) Presumably the price level will oscillate around production costs.

(*e*) The minimum expected cost level is \$430/ton. If the expected price is equal to \$430, the American producers cannot hold this level, since American labour costs are higher than \$2/h. Therefore the difference between United States domestic and international price levels will increase.

(*f*) The international commercial price of aluminium in 1970-1975 will fluctuate presumably around \$430-\$450/ton. While foreign market and world price-forecasting can be conducted, we are still in a preparatory stage, and a number of further investigations remain. Special studies must be prepared on the topics listed below.

Evaluation of import possibilities, including capital imports; at this stage we may use the information gathered earlier in connexion with market and price forecasting;

Calculation of the expected reserves: on the basis of market analysis, we have to estimate future changes and calculate optimum size capacity, labour, raw material reserves and the foreign exchange stocks necessary to offset any eventuality;

Estimation of integration and co-operation possibilities, taking into account existing trade connexions and treaties;

Estimation of domestic market developments: in this study the open character of the economy also plays a very important role. Not only raw material and machinery but consumers' tastes and habits are also often "imported". Therefore we have to use the method of extrapolation based on domestic norms and the so-called "comparative analysis" which follows the development of more advanced countries and analyses of the development of consumption in those countries, in the expectation that similar consumption patterns will dominate domestic markets.

3. *Analysis of domestic resources*

This study should contain the following items:

(*a*) Natural resources: energy resources, geological resources, mining products etc.;

(*b*) Existing capacity: volume, age, technical level, possibility of reconstruction or expansion, capacity of construction by sectors and in the economy as a whole;

(*c*) Labour force: actual labour force, reserves, long-run demographic estimates etc.;

(*d*) Material resources: stock and composition of raw material, semi-finished and finished products (import material separately);

(*e*) Foreign exchange situation: analysis of the balance of payments position, debts and foreign exchange reserves etc.

4. *Preparation of a preliminary investment programme*

When all the above-mentioned information is collected and the main targets and political-economic aspects of a long-term development strategy are formulated, a preliminary investment programme should be prepared containing a hypothetical allocation of investment funds and indicating the "leading sectors" and the most important large single projects by sectors. This is what we may call a prime investment decision.

5. *Optimum computations at the sectoral and national levels with mathematical programming, taking the maximization of net foreign exchange earnings and/or minimization of import expenses as basic criteria*

At this stage, three problems should be solved:

The sector model computations should produce an optimum variant for the sector as a whole and optimum variants for the most important single projects within the sector;

The model of the national economy should produce an optimum allocation among sectors;

The model of the national economy should control the preliminary investment programme.

Finally, planners should have a quantitative form of criteria for project evaluation.

In this respect we are glad to introduce a new Hungarian experiment, initiated by the Hungarian Planning Board in connexion with the third five-year plan, and now in progress. The experiment started in 1963 and its object is to prepare a long-term plan by means of mathematical programming. As far as we are informed, this is the first experiment of this kind in a planned economy.

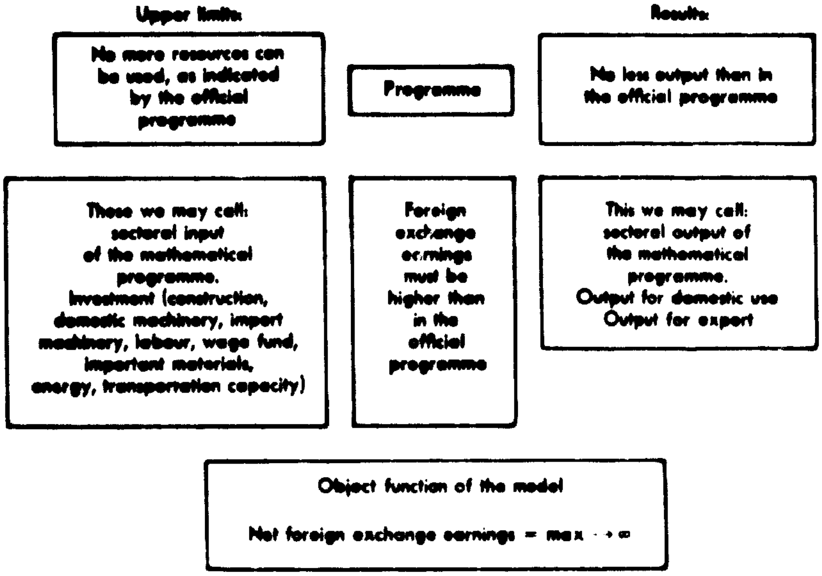
Programming on the national level means a series of calculations by computers. The computations will be arranged in four stages: basic computations on a sectoral level; sensitivity computations on a sectoral level; basic computations on the level of the national economy as a whole; and sensitivity computations on a national level.

(a) *Basic computations at the sectoral level*

There are thirty-nine sectors in the national model. (The number of sectors might change somewhat during the research.) These sectors are as follows:

(1) Bauxite-aluminium
(2) Leather, shoe, peltry
(3) Food industry: vegetable oil
(4) Food industry: milling, beer, wine
(5) Food industry: meat, poultry, milk
(6) Food industry: sugar, alcohol
(7) Food industry: canned food
(8) Building material: brick, cement
(9) Building material: panel
(10) Construction
(11) Machinery: vehicles
(12) Machinery: agricultural machines
(13) Machinery: engine, freight car, coach
(14) Machinery: ship building, crane
(15) Machinery: instruments
(16) Machinery: casting
(17) Telecommunication goods I
(18) Telecommunication goods II
(19) Transportation: railroad
(20) Transportation: automobile
(21) Oil production
(22) Oil processing
(23) Agriculture: cereals
(24) Agriculture: animal products
(25) Agriculture: potatoes, vegetables
(26) Agriculture: fodder
(27) Agriculture: fruits
(28) Artificial fibre
(29) Chemical fertilizer
(30) Paper
(31) Coal-mining
(32) Organic basic chemical I
(33) Organic basic chemical II
(34) Textile-clothing: silk, cotton
(35) Textile-clothing: wool, linen, hemp
(36) Chemical: except 28, 29, 32, 33
(37) Iron metallurgy: iron, steel
(38) Iron metallurgy: plates
(39) Electric energy

Sectoral activities include production and foreign trade, for example textile export import are included in textile sectors. Each of the sectoral models deals with 6-10 groups of products. In exceptional cases we have one homogeneous product (electrical energy), in the majority of sectors we are dealing with groups of products (product aggregates). In some sectors "product" means a service (for instance, in the railroad sector, the volume of transported goods). The model in general deals with about 350 products. Each product is connected with various alternative "activities".



is that sectoral models are aggregated into a large unified national model. The function of the national model is the maximization of the net foreign exchange earnings of the national economic activity, expressed in dollar terms. As a starting point, limiting factors are taken from the official development programme. These limiting factors, such as realization possibilities, capacity limits, investment funds and labour are aggregated on the national level by traditional methods for the time being. At the national level, the variables (the x's) of the model are the optimum allocation proportions (among sectors) —including investment fund allocation—applying the function: net foreign exchange earnings of the economy as a whole should be $= \max \rightarrow \infty$. The national model contains about 2,500 variables (x) and, as in the case of sector models, it is presumed that no more resources will be used and no less output will be produced than by the official plan, but more foreign exchange earnings should be gained during the same period of time, as in the case of sector models.

(d) *Sensitivity computations on national level*

The object of national level sensitivity computations is to measure the cumulative effects of any factors on the others. We would like to know, for example, the effect of a decrease of investment funds on consumption, export or on sectoral allocation of investments, labour etc. and sensitivity computations will provide it easily if the model and the optimum size of various activities are already determined.

At the present moment we cannot give a detailed list of mathematical apparatus, and other methods used in model or programme construction since the research work is just in progress. Some of the advantages of this planning method, however, can be described at this stage.

In the case of traditional planning (balance method) "complex co-ordination", that is, measuring the effects of partial changes through all the balances and plan targets is extremely difficult (usually impossible within a short period of time). In the model, however, plan co-ordination is mechanized, since every important plan target is modelled in one simultaneous system of linear equations.

Changes in various parameters could be controlled almost automatically in every segment of the model.

In traditional planning, planning of economic activities and prices are separated. By the programming model these two kinds of activities are connected and we get a "calculative price system", called "shadow price system". In this way, we may calculate the following items quite exactly: rate of interest for existing production capacities (fixed capital), rate of interest (Δ) for investment, wage taxes, rent, mine rent, rates of exchange (dollars, roubles), export-import duties, dotation. Therefore a real price system can be built up which reflects both scarcities and possible development goals. These questions of shadow prices of the efficiency computations of single projects will be considered below.

With the help of programming, we are producing variants for various activities which are impossible to calculate with traditional (balance) methods.

It is obvious from the requirements of model building and programme-determining that a number of parameters and factors built into the model should be considered before model construction. We mentioned some of them when we described the need in the preliminary stage of project evaluation, for such special studies as market analysis, price trend estimates and analysis of existing resources.

In order to obtain the numerical forms of criteria for project evaluation by programming some other aspects—in addition to the studies mentioned earlier—should be considered.

6 *Technical and economic parameters of products*

Technical and economic parameters of a product will influence the production costs, technical quality and technology, as well as investment expenses, expected prices, marketing and competitiveness of a given product. These parameters of course differ for each product and therefore the methods of measuring them differ too.

The simplest methods are in cases where natural qualities determine the basic parameters of a product, for instance prime energy bearers, coal, oil, raw materials in general, or products from extracting industries. Many agricultural products belong to the same group since natural endowment and weather conditions influence their special quality and expected markets and prices depend to a large extent on the special, natural qualities of the product. In the case of homogeneous products (artificial fibres) product analysis by technical-economic parameters is not so complicated. In other branches, however, in machinery and other rapidly developing branches where product quality analysis is indispensable for efficiency computations, there is no other way of comparison by technical-economic parameters or, as we may call the process, product identification by parameters. Product analysis is not very developed in our country; we have only a few years of experience, but we quote here an example of product identification in order to indicate the importance of product analysis for project evaluation.

A comparison has been made between two television sets. One is a product of a West German company, the other is a Hungarian product. The steps of product identification are described below.

(a) Determination of technical-economic parameters

(i) Selectivity measured by: field amplification (μV)
(ii) Linearity measured by: per cent
(iii) Tube size measured by: cm
(iv) Line frequency measured by: lines
(v) Channels measured by: No.
(vi) Automatic functions measured by: No., such as brightness, remote control
(vii) Adaptability measured by: W
(viii) Weight measured by: kg
(ix) Size measured by: m³

(b) Comparison of parameters

Parameters	German TV set		Hungarian TV set	
	Absolute	Relative points	Absolute	Relative points
Selectivity	100 μV	0.5	50 μV	1
Linearity	max. 3 per cent	0.66	max. 2 per cent	1
Tube size	53 cm	0.9	59 cm	1
Line frequency	500 lines	0.9	550 lines	1
Channels	11	0.9	12	1
Automatic functions	4	1.0	4	1
Adaptability	100 W	1.0	200 W	0.9
Weight	30 kg	0.93	35 kg	1
Size	0.122 m³	0.8	0.100 m³	1
Total points collected		7.59		8.9

The parameters of the better product are taken as 1 unit and the parameters of the other product are related to the former in proportions of natural measurement weights. This is expressed by adding the relative point. The more points a product collects the higher is its quality. With the point system described above, technical parameters have been compared on the basis of a common denominator. In this case the Hungarian product proved to be a better one since its parameters were better in seven cases, the same in one, and worse in one case.

7. *Choice of technological variants*

In the preparatory stage all available technological variants should be collected and considered. At this stage we do not have to choose and evaluate them. The programming model of course will limit the number of possible technological variants (the number of variables will be limited by computer capacity and time) but we have to have an idea about all the possible variants before we start model building. In case we came to the conclusion that domestic technology was not available or obsolete, we should have to analyse the possibility of developing a new domestic technology or of importing the technology from abroad by purchasing the licence. In case of the possible development of a domestic technology the time of research and experimentation as well as the material-technical-personnel preconditions would be taken into consideration and calculated as project programming in order to discover how the technology would influence the installation, capacity, and other factors of the new project. (In connexion with artificial fibre programming, for example, planners considered nineteen technological variants.) In our recent practice technological variants have been limited considerably, since the official plan targets (calculated by the balance method) limit or determine investment funds in each sector and investment of imported machinery is also limited; these conditions are therefore reflected in the sector model as limiting factors. Only a few variants can be taken into consideration in present practice and this reduces the possibility of finding the real optimum later by means of efficiency computations.

8. *Machinery (domestic or imported)*

Machinery requirements should be determined on the basis of an analysis of possible technological variants. In connexion with planned machinery the following aspects should be taken into account:

Purchasing possibilities of main machines and appliances of the project (domestic or imported);

Time of deliveries (domestic or imported);

Expected prices of machinery at the time of purchase (in the case of imported machinery, foreign exchange prices should be considered) and other conditions of delivery (spare and reserve parts, costs of delivery, insurance, and guarantees);

Required space for machinery and a plan of the building site are extremely important.

In this plan we have to consider: what technological processes are connected and in which building they are located; also, which technological processes will be located outside the buildings and under what conditions.

9. *Construction capacity*

After technology and machinery have been considered, a construction capacity analysis has to be elaborated covering the following aspects:

Plan of required buildings;

Information about available construction capacities (local or not local) and technology (mechanized, prefabricated locally etc.);

Expected costs of construction (taking into account all special construction requirements);

Expected technology of heating, electricity, water supply, canals, climatic appliances and special construction needs in connexion with them;

System of transportation and construction needs of the planned transportation system;

Time of completion of all buildings, roads etc.

There are many other construction activities, which have to be taken into account later at the preparation of detailed blueprint work.

10. *Estimation of optimum capacity*

When all the above-mentioned information is at hand, a preliminary estimate of optimum size should be prepared, taking into account local labour power, needs of local infrastructural and related investments, transportation costs, geographical location, reserve capacities and several other points.

11. *Expected time of technical planning (blueprints) and realization*

Time of completion should be estimated in two parts:

Time requirements of technical planning;

Time requirements of realization.

The aggregated time of a project construction is the total amount of required time mentioned at the earlier steps of the preparation stage plus the time of blueprint work and realization. The aggregated time requirements consist of: time of preliminary studies, time of technical planning, time of realization. The time requirements of preliminary studies should be taken into consideration in the same manner as the other elements. This aspect is usually neglected in spite of the fact that costs are involved.

12. *Required infrastructure (social, not local)*

These aspects of project planning cannot be considered at the project level. Central planning bodies should provide norms and information for every project. This factor can be calculated by input-output analysis only.

13. *Methodology of choice*

One of the most widely discussed problems of project evaluation in Hungary is the evaluation of project variants, the comparison of the efficiency of various projects. Despite the officially prescribed efficiency computations, since 1957 many Hungarian economists have not agreed with the computations accomplished by official methodology. The authors are among them. Later we intend to discuss the applied formulas used in official efficiency calculations.

The first problem of efficiency calculations applied officially is connected with the price system. So far, prices have been centrally administered fixed prices, and their function is to help implement central development decisions. Therefore prices should be distinguished from the real costs. As a consequence, fictitious prices have been formulated as substitutes for prices reflecting real costs in order to provide an economic orientation for project evaluation, and these are called efficiency calculations.

Evaluation methods used in these calculations might be divided into two main groups:

(*a*) Methods based on the evaluation of labour costs;

(*b*) Methods of normative evaluation.

Methods of the first group are not suitable for efficiency calculations in our opinion. We shall try to prove our statement later in a critical analysis of official domestic efficiency computations. Within the second group we may distinguish two types of evaluation methods: evaluation based on the real world market prices which might be realized by foreign trade "world market price model" and shadow prices gained in mathematical programming.

We mentioned the first method earlier. Experiments with the second type started in Hungary under the influence of Novozsilov and Kantorovics, and the economists working with it are trying to use a system of shadow prices for efficiency calculations. The point of the matter is to create an optimum programme for the economy as a whole by measuring prime resources (existing capacities, labour, natural endowment) and secondary resources (created during the programme period by activities included in the programme: these may be semi-finished and final products) and by relating them to a target function of the national economy as a whole. The optimum programme is that which satisfies most the conditions formulated by the target function of the economy. According to the opinion of these economists it would not be proper to determine the target function as the maximization of national income or "net income" since these categories are calculated at distorted present prices and this would unfavourably influence the programme and distort it.

Therefore the target function should be determined as a maximum of net foreign exchange earnings for the economy as a whole. The optimum programme is developed on the basis of scarce resources (labour, wage fund, existing quantity of arable land, geological resources, accumulation), fixed and circulating capital (foreign exchange funds etc.). The results of programming are: elaboration of an optimum plan in accordance with the target function, and a system of calculated shadow prices indicating "yields" of factors of production (which will reflect scarcities); these shadow prices are considered as "normative criteria" of activity (project) evaluation. Since scarcities of production factors are reflected in shadow prices, the higher the scarcity of a factor the higher will be the shadow price or yield of the given factor. Through this method, the yields of invested resources (rate of return) or the "efficiency coefficient" are to be determined. In other words, it is intended to substitute for the real market a mathematical model of the economy, playing real market games with a fictitious market.

In connexion with the practical use of the method, several questions have still to be answered, such as the following: can all market relationships be included in the model (taking into account necessary abstractions and simplifications)? Is it possible to substitute real market games? How and what mathematical methods can be used to determine the optimum plan? Are shadow prices suitable for real price formation? How can we follow changes of productivity? For what period of time do shadow prices provide a realistic orientation? These questions have not yet been answered.

The other possibility we mentioned was to use world market prices (prices of a real market) as a base for evaluation. It is an accepted principle today (even officially) at every form of efficiency computation that we should calculate the results of economic activities by applying international market prices. Discussions are going on about only one aspect of the matter: whether we may use world market prices in the calculation of inputs or not? In our opinion, there is really no other way. Input-output technique is quite developed in our country and foreign trade plays a decisive role, while computer capacity is scarce, experience in model building is limited and the time required for model building is long; therefore in the interests of speed we have to use the method at hand and experiment with others in the meantime.

C. Practice of project evaluation: a critical approach

1. *Some institutional aspects*

Within the limited space of this short paper we cannot analyse the whole system of planning. Therefore we shall focus our attention on those features of the balance method which we consider important from the point of view of project evaluation.

The balances compare investment resources and needs. Needs are determined by the rate of growth of national income. Therefore every investment expenditure (or project) is deemed efficient which ensures the planned rate of growth of national income. The balance method therefore exactly reflects the requirements of an extensive type of development strategy, where the most important criteria of investment or project evaluation are the maximum level of production and employment produced by them. The producing units are directed by centrally elaborated obligatory and designated plan targets, and they are interested in collection of resources for the fulfilment of the plan. Since investment funds are provided centrally, every enterprise is interested in securing the maximum amount of investment resources in order to ensure its most rapid development irrespective of whether this is the most efficient use of resources for the national economy as a whole. In consequence of this system of direction and planning, inducement to invest is very high and a special "absorption effect" develops from enterprises for central investment funds.

The central planning of investments by balance methods cannot properly take into account the requirements of realization on world markets, that is, the open character of the economy. The target is to maximise national income, and aspects of market relations are necessarily pushed aside.

One of the main objects of central planning by the balance method is to ensure the consistency of the plan. In order to have a consistent plan, balances suppose the allocation of production factors (from the point of view of quantitative equilibrium) at a presumed rate of growth of national income irrespective of the aspects of efficiency (criteria of efficiency have been determined almost automatically by the desired rate of growth). There is no opportunity to formulate real variants or for choosing the "leading sectors" based on efficiency criteria determined by the open character of the economy. Therefore efficiency calculations are not organically connected with the planning system. These are the main reasons why for a long period of time before 1957 efficiency calculations for investment planning were not elaborated at all.

We have tried to use efficiency calculations for each project since 1957; however, the reliability of these computations is doubtful. In many cases enterprises use them to prove that establishment of this or that project is efficient and that the State has to provide funds for them. Distorted prices also are raising doubts as to the reliability of these calculations. These reasons among many others have led to revisions in the present system of direction and planning, which are at present under discussion, and a reform of direction and planning methods is expected in the near future. On the following pages we intend to analyse methods and formulas in use for project evaluation in present practice.

2. *Investment programmes, plan targets and documents in the project preparation stage and shortcomings*

Project evaluation in the present practice is connected with or rather is a part of investment planning. After the need for a new capacity arises during planning, the economic and technical preparation of the project is considered, and preparation starts. In the stage of preparation, the main object is to ensure consistency between the plan and single projects

Since projects should be authorised by central planning authorities, these authorities order investors to collect the information required for plan co-ordination and economic and technical control of the proposed project. This collection of centrally prescribed documents is called the investment code. The duration of preparation is the time required from the collection of documents to the decision making. The documents described below have to be prepared during the preparation stage.

(*a*) A study of the "object" of investment must be elaborated by the responsible authorities on various levels. It contains the data proving the economic necessity of the project as well as the initial data required for control, as follows:

Description of the project;

Geographical location;

Main data of investor;

Data of final realisation;

Expected value of production annually.

The first shortcomings are coming to light already. Planners usually do not have the targets of the long-term plan when they have to prepare the "object" of a project and a lack of co-ordination is inevitable.

(*b*) A study of the location of the project must be prepared, in two parts: one on the location of the project and the other on its establishment.

In connexion with location and establishment, the problem is that, while sectoral allocation is decided during national planning, geographical location remains for the preparation of projects. Therefore there is a lack of synchronisation between regional planning and project planning. Complete regional development plans are not ready when the investor wishes to locate the project.

(*c*) A study of the investment programme is the basic document in connexion with project evaluation. We shall therefore try to analyse it in some detail, especially the aspects concerning efficiency calculations.

The investment programme theoretically has four functions, namely, to prove the necessity of the project, to summarize the economic, financial and technical requirements of the project, to analyse the efficiency of the project, to locate the project.

The investment programme should be prepared for every project above certain limits. These limits are differentiated by sectors. The programme should be elaborated for the basic project but related investment needs should be included too. In order to ensure special aspects of trade, projects are classified in seven groups as general industrial, food industry, transportation and communications, agricultural, apartment, health, social, cultural and administrative projects, public works and storage projects. Special aspects of each of the trades, of course, cannot be solved within these narrow limits. Therefore central direction usually allows investors to prepare additional documents reflecting trade specialties.

The investment programme is divided into several chapters. It includes information on projects as shown below.

Chapter 1

(*a*) Motivation for production increase (domestic market, export increment etc.);

(*b*) Necessity of the project (a comparison or balancing of domestic demand and import with expected capacity increases produced by the new project);

(*c*) Motivation for accepted technology;

(*d*) Motivation for geographic location;

(*e*) List of related projects (statements of all investors, authorities and other interested parties should be attached);

(*f*) Declarations of raw material producers (in the case of imports, the Ministry of Foreign Trade and the foreign trade companies concerned should state their views).

As may be seen from the above-mentioned list, the motivation of a project is a complex affair. Yet, information in many cases is superficial, notwithstanding the huge quantity of documentation required. These information documents cannot substitute for a real economic analysis, including the market and price forecasting studies mentioned earlier.

Chapter 2

Here technical and material features and the soundness of a project should be described in very detailed form. This chapter covers the following items:

(*a*) A complete technical description of the project;

(*b*) Stages of installation of units of the new capacity;

(*c*) General plan of location (in a measurement of 1:1000), plan of building site indicating the integration of the project into the locality (in a measurement from 1:5000 to 1:10000);

(*d*) Sketch plan of the project, list of buildings, detailed description of the project, list of roads and of public works, related declarations of interested authorities such as fire and water control departments;

(*e*) List of machinery required (description of domestic and imported machinery, prices and sizes, weights etc.);

(*f*) Detailed description of planned technology;

(*g*) Timing of preliminary and final technical planning (blueprints) and realization;

(*h*) Data of the schedule of installation;

(*i*) Costs of the project (construction, machinery, imported machinery and others);

(*j*) Conditions of normal functioning:

(i) Labour (workers, skilled, unskilled, white collar, technical etc.);

(ii) Energy consumption (coal, steam, electricity etc. by quantities and supply sources, domestic or imported);

(iii) Material (domestic, imported, quantity, value, supply sources etc.);

(iv) Transportation requirements;

(*k*) Other information and instructions.

Chapter 3

This deals with motivation for the efficiency of the project. From the point of view of practical project planning and evaluation, this is the most important chapter of all, and we shall therefore focus our attention upon it.

Within this chapter, coefficients indicating the economic and technical level of the project are elaborated. These coefficients are the following:

(a) ***Investment costs per unit of product and per unit of domestic value of production***

$$\frac{B}{t}, \text{ and } \frac{B}{te},$$

where B = investment costs

t = number of products

te = value of production expressed in domestic prices.

(b) ***Capital per unit of product and per unit of value of production***

$$\frac{F}{t}, \text{ and } \frac{F}{te},$$

where F = costs of fixed and circulating capital.

(c) ***Quantity of products and value of production per worker***

$$\frac{t}{l} \text{ and } \frac{Te}{l}$$

where l = number of workers.

The above mentioned coefficients are supposed to indicate capital investment costs or labour investment costs of one unit of production. These coefficients however, are not very reliable or convincing since the technological character of products is very different and values expressed in domestic prices are distorted. Therefore although these coefficients are prepared at every project, in practice they are not analysed or used for evaluation.

(d) ***Efficiency coefficients in practice and their criticism***

The methodology of present efficiency calculations is based on the following principles:

(i) Efficiency = $\frac{\text{output}}{\text{input}}$ in other words, efficiency is measured by a quotient.

(ii) Productive investments are divided into two main groups by the methodology. First, capacity or production increasing projects and, secondly, labour saving projects. Efficiency coefficients are different for these two main groups.

Project evaluation with the first type of coefficient is solved in the following manner: output will be determined by the so-called "world market value" and transferred into domestic value by certain foreign exchange rates calculated by central authorities. Input is divided into two groups: original inputs of fixed and circulating capital.

(e) ***Annual inputs and costs of annually repeated inputs (ö)***

Since the dimensions of these two types of costs are different (dimension of E is forint—domestic currency—and dimension of ö is $\frac{\text{forint}}{\text{year}}$) a common denominator should be provided to aggregate total expenses of a project. For this purpose an efficiency coefficient had been formulated which is indicated in the methodolgy as Δ. (In the liteurature this coefficient has other names, such as: normative of profitability, interest etc.) The dimension of Δ is $\frac{1}{\text{year}}$. The reciprocal value of Δ is the recovering of the project expenses expressed in years. The Δ makes it possible to aggregate these two types of inputs in two forms:

$$\text{(i)} \quad ö + B \cdot \Delta$$

$$\text{(ii)} \quad ö \cdot \frac{l}{\Delta} + B$$

Usually the first form is accepted in the practical evaluation process. The Δ plays a very important role in efficiency computations. The methodology defines the Δ as follows: in order to expand, production tools and labour should be consumed; presuming full employment, for production of a unit of new product one unit of labour should be liberated; investment expenses necessary to liberate one unit of labour required are indicated by (b_g); this liberated labour unit should be supplied with tools of production, indicated by (b_k); therefore one unit of value of new production annually requires: $b_g + b_k$ investment expenses. The relationship expressed in an algebraic form is:

$$b_g + b_k \text{ (Ft)} = 1 \text{ Ft/year}$$

In order to reduce the different dimensions, the equation should be divided by $(b_g + b_k)$:

$$1 \text{ Ft} = \frac{1}{b_g + b_k} \frac{\text{(Ft)}}{\text{(year)}}$$

Consequently $\frac{1}{b_g + b_k}$ is the annual amount of new value produced by 1 forint of investment expenses.

This $\frac{1}{b_g + b_k}$ value is called efficiency coefficient or Δ.

The time element is also considered. According to the methodology, rules of simple interest are used. This method of calculation, however, is deemed unfit for considering the time element by the central authorities themselves. Therefore in the last year rules of partial compound interest rates have been suggested for efficiency computations, based on the principle that national income produced by the new project will be used in part for accumulation and in part for consumption. Therefore only one part of the value expressed by the efficiency coefficient will be capitalized, that is, that part of the increment of national income which will be used for accumulation. The new value ensured for year (n) by the total amount of invested resources (B) after instalment of the new project—

$$t_n = B \cdot \Delta \cdot q^{n-1}$$

where: t_n = new value of production at the end of year (n)

B = total amount of investment expenditures

Δ = efficiency coefficient

$q = 1 + \Delta i$

i = proportion of accumulation in national income

Value of time element $(b_n) = 1 + i_n$

Computations should be elaborated on national and factory levels. To measure the profitability of the project, methodology contains the following indicators.

(f) *In case of projects of capacity expanding type*

Indicator of profitability on national level:

$$g_n = \frac{T}{M + A_b + A_i + L + \Delta / B + F + B_k}$$

where: g_n = profitability on national level

T = value of production on world market prices expressed in domestic currency

M = wages

A_b = domestic material

A_i = import material on world market prices expressed in domestic currency

Δ = efficiency coefficient (0.20)

B = investment expenses (fixed capital)

F = expenditures on circulating capital

B_k = related investment expenditures.

The methodology regulates the price problem. World market prices should be used at the calculation of value of production and import, including transportation costs. Prices of Hungarian export products should be calculated on border parity. Prices are given in dollars or in roubles and central planning authorities are giving exchange rates for calculation. The reality of the world market price should be proved by a declaration of the Ministry of Foreign Trade.

In the profitability scheme, losses originating from capital absorption for more than a year are also considered. As we mentioned earlier, the time factor is taken into consideration by the simple interest formula. We will illustrate the method by a hypothetical example. We presume that realization of a project takes four years and 100 units of expenses are used annually. The following correction should be applied by the time factor:

	Invested inputs	*Time factor*	*Input corrected by time factor*
1 year	100	1.6	160
2 years	100	1.4	140
3 years	100	1.2	120
4 years	100	1	100
Total invested	400		520

The corrected input is much higher.

The function of related investments (B_k) in the above-mentioned formula is to ensure the aggregate character of the formula through the complexity of expenditures. In the development of manufacturing, for example, investment costs of raw material are taken into account by considering related investment expenditures. This method is applied because raw material needs are reflected in prices, but domestic prices do not react on capital intensity. The related investment factor is used to consider capital intensity.

Related investment expenditures are calculated by single projects with norms. Related investment expenditures caused by increasing raw material needs are also regulated by norms. This norm is unified for all the sectors. Calculation of this norm is done in the following manner:

$$B_k = 2.5 (A_b + L)$$

The methodology has changed and norms are now differentiated by sectors. So far we have described the profitability indicator formula on a national level. The same formula is different in two respects when calculated on a factory level: first, inputs of previous stages (material and amortization) are not included in the denominator, but are taken into account as decreasing items; secondly, related investment expenditures are neglected. Therefore the formula at the factory level is:

$$gf = \frac{T - (A_b + A_i + L)}{M + \Delta (B + F)}$$

This formula is used for the calculation of profitability only at the last technological stage.

(g) *Formula of labour saving projects*

On labour-saving projects, results (or yields) are calculated by the amount of labour saved by the project. Labour saving may be "living labour costs" or "fixed labour" embodied in the means of production. Both types of labour savings are measured by the saving of costs or by the evaluation of the cost level. "Fixed labour" and "living labour" costs are sharply differentiated. In case of fixed labour savings, investments saved are also calculated. With the installation of a new heating unit, for example, the producing units cost level declines because of savings in material costs. This saving is considered as a net gain. Not only immediate but related costs decline too. Saving in coal needs less investment expenses in coal mining. There is a saving in related projects. This saving should also be deducted from the calculated total (immediate and related) investment expenditures of a project. In cases when cost level declines because of savings in "living labour", while "fixed labour" expenses increase, the value of total input should be increased by the amount of related investment expense. The formula is as follows:

$$G_0 = \frac{[illegible]}{B + (B_k + F)}$$

where: G_0 = efficiency of labour saving projects

$\ddot{o}_2$ = costs before the investment
$\ddot{o}_1$ = costs after the investment
B = costs of the project
B_k = related investment expenditures
F = circulating capital needs

It may be seen from the above formula that this is an indicator of the turnover type. The reciprocal of ($G\ddot{o}$) indicates the years of turnover of a project.

D. Reliability of methods used

We mentioned earlier that we had some doubts concerning the reliability of these calculations. Our reasons are set out below.

1. *Difficulties originating from the institutional framework*

Efficiency computations are elaborated after planning activity, allocated resources and balances (including investment) are ready. Therefore computations are prepared after the most important investment decisions have been taken on a national level.

Because of the "absorption-effect" mentioned earlier, of the enterprises for investment funds, investors in many cases use computations as a tool for further "capital absorption", and manipulate them to prove that their development ideas are the most efficient and useful. This fact of course will influence the "tendency" of the computations.

2. *Difficulties originating from the price system*

In cases where products are exported to centrally planned and market economies, results calculated by different exchange rates will differ. Investors would apply the most favourable exchange rate; therefore the real efficiency might be different from the one calculated.

The calculated value of production may oscillate from 0-100 per cent above the real level.

Then there is the problem of calculation with very high world market prices. There are cases where four investors give four different "world market prices" for the same product, between \$200 and \$260 per ton. Sometimes prices are taken from less important, small volume foreign business contracts, and the production value calculated reflects this price as not representing real market opportunities.

There can also be miscalculation of the technical parameters of the product delivered by the new project. Parameters of the expected domestic product are taken, indicating a higher quality (and therefore a possibly higher price) than the potential competitors may achieve. The real situation is just the opposite.

There can also be miscalculation of the assortment produced by the new project. In many cases, investors use an assortment of products with which the calculation of value of production is much higher than with a "realistic assortment".

Finally, there can be miscalculation of the effect of natural features of the product, for example in coal mining, when prices (including transportation costs) are calculated as a function of caloric values. These miscalculations are very difficult to discover, and efficiency computations may therefore mislead rather than orient in the right direction, from the point of view of realistic world market prices.

3. *Difficulties originating from the structure of efficiency or profitability quotients*

The quotients have a particular character. Therefore the efficiency of projects on a national level cannot be measured by them. A project appearing efficient from the particular calculation may not be efficient for the economy as a whole, and *vice versa*. In a simple aggregated national economy, a particular efficiency is not identical with the macroeconomic efficiency.

Profitability formulas, by their particular character, cannot represent or provide alternative suggestions. The choice is reduced to one question: should a given project be built or not? There have been cases in practice, where the efficiency quotient indicated high profitability from the point of view of a single project, while during mathematical programming it came to light that reconstruction of old factories was more profitable. With particular calculations we do not have an opportunity for simultaneous comparison of variants.

Alternatives are prepared by various investors, and despite central regulations there are differences in collecting and evaluating basic data.

Data contain many uncertainties for particular projects. World market prices and various cost elements cannot be expressed by one single number. It is impossible to apply "price zones" or "cost zones" (as expressed by "from . . . to . . .") in these particular calculations.

The form of efficiency computations (quotient) can also be discussed. From the arithmetical point of view it does not matter whether 10,000 units of input will result in 12,000 units of production or 1,000,000 units of input in 1,200,000 units of production. From the economic point of view, however, it is quite important, since society is interested first of all in the volume of the realized net income, and only after that in the rate of it. These difficulties could be avoided by mathematical programming on a national level.

4. *Difficulties originating from the evaluation of various parts of the quotient*

Results and input are evaluated differently. While output and import material are evaluated in world market prices, input is calculated in domestic values, and almost every part of them are formulated by different principles. "Living labour" costs are calculated by wages plus wage taxes, while "fixed labour" costs, because of the price system, consist of various amounts of net income or accumulation. During the last year, however, in order to eliminate these contradictions, a new method has been tried. Various calculations are used. Besides calculations based on producer's prices, evaluation has been made on the basis of a so-called "net wage cost" or "real cost" level (net of net income or accumulation included in producer price). The point of the matter is that all inputs are reduced to wage costs, in other words, material and amortization costs of the last stage of production are calculated as wage costs of the previous stages. (This is possible by using input-output coefficients.) Particular fixed and circulating capital needs have been reduced to the level of "real costs" by the correction of the efficiency coefficient (Δ). In this way, a common denominator has been created. We do not mention here problems connected with aggregation.

Unified measurement in the form of real costs, however, cannot solve the problems of resource scarcities, for it is incorrect to say that various inputs may be evaluated by wage costs from the point of view of macroeconomic analysis. In construction, for example, labour absorbing less productive technology seems to be more efficient than mechanized technology. If labour costs reflected the real supply-demand position (equilibrium wages), it might be so. In practice, however, there is a scarcity of labour, of unskilled construction workers and, in spite of this fact, labour-consuming activities seem to be more efficiently met by labour-consuming technology than by mechanized technology. Therefore our requirements of efficiency seem to be in contradiction to economic possibilities. If scarcities were evaluated as in our example, it would be more efficient to use a mechanized technology because of the higher costs of unskilled labour.

5. *Difficulties originating from the evaluation of the efficiency coefficient or* Δ

Various views and ideas exist about the function of the efficiency coefficient. There are economists who state that the coefficient provides only a common denominator for particular and regular expenses; others attribute a normative role to it. There are again others who discuss whether a national average coefficient or a differentiated coefficient should be used in each sector. Some economists say that the coefficient should be differentiated on a territorial basis. There are discussions about the level and the volume of the coefficient. We have to mention here that an exact quantitative determination of norms of (b_g) labour saving investments and (b_k) labour outfitting investments is almost impossible.

As we mentioned earlier, another possibility is given by the shadow price calculation, by programming to determine the level of the coefficient. In this case, calculated returns of inputs of a project would reflect its efficiency where scarcities of various factors of production would be considered. The practical preconditions of a shadow price system are developing in these days but are not ready yet. Therefore we may say that at the present moment we do not have the proper methods for determining the level (volume) of the efficiency coefficient.

Since ideas differ about the nature of the efficiency coefficient there are also widely differing views about the quantitative magnitude of the coefficient, from a suggested 0.8 to an 0.20. In electric energy production, the coefficient similar to efficiency coefficient (known as the "intercaloric factor") has a magnitude of 0.12. This factor or coefficient is not only a common denominator for particular and regular expenses, but its function is also to discount various returns and inputs for a common base in time. In this connexion, another point arises: in electric energy production, simple or partial compound interest cannot be applied, but rules of compound interest are used. The partial compound interest used by the methodology is not correct since calculated rates for different points of time give various results. Let us explain it by an example.

One hundred units of 1960 investment expenditure according to the method used equals in 1956:

$$\left\{ \frac{I}{b_n} \cdot B \right\} \quad 0.526 \text{ or } 100 \cdot 52.6 \text{ units}$$

If we take the 52.6 units and recapitalize it for 1960 we will get 101 units. Namely, 100 units ≠ 101 units; in other words, the snake is longer from his head to his tail than from his tail to his head.

At the coefficient of production or capacity expanding investments on the factory level:

$$gf = \frac{T - (A_b + A_t + L)}{M + \Delta (B + F)}$$

value of production (T) should be calculated in world market prices while items calculated in domestic prices ($A_b + A_t + L$) should be deducted from that value of production calculated in world market prices. As a consequence, the nominator has no real economic meaning. If for example $T < (A_b + A_t + L)$ the value of the fraction will be ( ) or (∞). In order to measure the efficiency of the last stage of production, indicated fixed capital inputs should also be calculated in world market prices.

At the coefficient of labour saving investments, "fixed labour" is over-estimated in relation to actual or "living labour" since "fixed labour" prices contain a considerable net income or accumulation which increases the degree of the cost level decline. In addition to this, at fixed labour inputs, related investment requirements should be taken into account, while in case of "living labour" inputs additional charges and related investment needs (apartments, transportation, education and so on) are not calculated.

Summarizing all the remarks we have made above, in our opinion present methods of efficiency calculations should be considered as rough estimates containing several uncertainties rather than as exact computations of profitability or efficiency of industrial projects either on the national or on the factory level.

Despite all these shortcomings, efficiency calculations since 1957 have had a great importance. The very fact that some kind of computations had to be prepared in contrast to the period before 1957 indicates that economic policy has changed radically for the better, emphasizing more and more the importance of profitability and efficiency in project evaluation. The other very important fact, officially accepted by the methodology, that value of production should be calculated in world market prices, is a big step forward. We might say that this is an "unconscious" act, to accept somehow the basic principle of project evaluation in an "open economy", namely the maximization of net foreign exchange earnings in the long run. The efficiency computations indicated first that domestic prices were not proper prices in an open economy for the calculation of profitability neither on the macroeconomic or on the microeconomic level. These developments influenced many Hungarian economists in the proper direction. We would like to hope that the reader will conclude from this paper that the new experiments with various programming models have their origin somewhere in those rough estimates which we criticize so sharply.

6. *Stage of decision: criteria of decision*

After the preparation stage, we presume that all basic information is at hand and that we have reliable data for decision-making. In spite of the most precise preparation, however, decisions cannot be considered as absolutely safe. This is true in general, but it is more so in an open economy, where uncertainty is very high. The more ambitious the investment programme, the longer the time of implementation, and the higher the uncertainty will be. Therefore calculation of risk and risk-taking is one of the most important activities at the stage of decision-making. We intend to analyse the risk factor and levels of risk taking below.

(a) *Levels of risk taking*

Risk and risk-taking are influenced by the institutional framework. It is easy to see that the question of risk-taking is completely different in the case of a private firm or huge corporation or in the case of a socialized economy. A huge integrated corporation may take a greater risk than a small private enterprise and a socialized economy may balance losses of one producing unit with gains of the other. The advantages are obvious. These advantages, however, had been misinterpreted for a long time by many economists who presumed that, in a centrally planned socialist economy, calculation of risk and risk-taking had no economic function at all.

That is why risk calculations are so rarely discussed in our literature, except in one or two cases. Problems of risk calculations have come to light during the last few years in connexion with mathematical programming on the sectoral level. In sectoral programmes, planners use "zones of data" instead of single, fixed data. Zones of data (as expressed by "from ... to ...") provide an opportunity to indicate the degree of uncertainty on the one hand and to elaborate variants on the other. Uncertainty is indicated for decision-makers by the space of the zone: the bigger the certainty the narrower the space and *vice versa*. Planners usually have the following combinations of data to deal with: programming based on pessimistic data, programming based on average values, programming based on optimistic values of data.

In the first method, the most unfavourable values are calculated: upper limits of costs and minimum values of results are considered. This method is called "strategy of maximum certainty". In the second type, average values are used, presuming that changes in a negative and positive direction will balance each other. In this way, for example, variants in the zone from 100-to 300 are considered as variants in the zone of from 190-to-210, since in both cases 200 as average is used for the evaluation of the variant. The most hazardous case is the third, where uncertainties are not calculated practically. The second and third methods have proved to be extremes in which criteria of certainty are neglected. Therefore Hungarian literature and practice for determining uncertainty usually applies the method of "strategy of limited certainty". Values built in the programming model are determined by the following parameters:

K_{max} = maximum costs
K_{min} = minimum costs
K_a = average costs
= level of certainty value of costs, condition 0.5

$$K_b = K_a + (K_{max} - K_{min})\ (\quad - 0.50)$$

For example: (K max) = 100 units, (K min) = 70 units = 0.70 unit

$$K_b = 85 + (100 -- 70^{*}\ (0.70 - 0.50) = 85 + 6 = 91.$$

In the Hungarian literature, this is called programming with "certainty values". Despite cautious planning, unexpected changes may occur because of changes in technology prices, markets and other fluctuations. Therefore every development decision should be regarded as a risk-taking action.

The measurement of risk is that quantity of potential losses or lack of gains which occurs because decision-makers did not choose the variant proved to be most efficient *ex post*. Losses may also occur through circumstances beyond our control, or as a consequence of voluntary risk-taking in the hope of expected gains.

Hazardous decision-making, of course, imperils balanced growth, but from this we must not conclude that a decision-making policy of maximum certainty is the right policy. The policy of maximum certainty or safety would decrease rate of growth and hamper economic development because of a gradual backwardness from the point of view of technical level. In an open economy, however, technical backwardness is a hazardous policy, since the basic precondition of a sustained high rate of balanced growth, export ability, cannot be ensured without up-to-date technical and technological levels.

Another special problem of risk-taking in a centrally planned model is to determine the various degrees of risk-taking on various levels of decision-making. These degrees are determined to a large extent by the institutional framework and by various methods of planning and direction.

The degree of risk-taking by various enterprises in a centrally planned model is limited even in cases where development and project decisions are decentralized on the enterprise level. Sectoral allocation of resources, choosing of "leading sectors", decisions affecting international economic relations etc. cannot in our model be decentralized. This, of course, does not mean that every development decision should be centralized, and a central authority should regulate project evaluation and risk-taking in the form of mandatory targets. Producing units, that is, investors, may be directed through an "organized market" where the rules of the game are determined by central planning authorities with such regulators as monetary policy, central bank system, price control, wage control, credit control, duties and subsidies. But in such a case, responsibility for misinformation originating from centrally decided policies and losses caused by them cannot be laid upon enterprises.

Enterprises may take a "managerial risk". Since directors of enterprises are not owners they cannot take a risk in the form of material consequences. Therefore rules of risk-taking should be centrally regulated, leaving enough space for "managerial risk-taking" on the enterprise level.

(b) *Actual and potential scarcity of production factors as limits in risk taking*

There is a form of decision-making where planners are aware of potential losses even at the decision stage. These potential losses are in many cases connected with scarcities of resources. This is one reason for separating the stages of preparation and decision-making in the process of project evaluation. In the preparation stage, all possible variants of a project should be collected, while in the decision stage, those variants exceeding actual and potential limits of resources should be selected. Calculation of potential losses originating from limited resources are very important, for example, in decisions on international co-operation or integration.

In our present practice, it is rather a failure that limits of various resources are regarded as fixed, absolute limits. Substitution of resources and convertibility are not calculated properly. Substitution possibilities and the role of time in this process should be taken into account; however, in a strategy where full employment is a stable requirement, substitution of factors of production has a very limited possibility.

(c) *The role of time in the certainty of decision*

In stage of preparation, we have mentioned the time factor in connexion with cost of effects. Here, we investigate the time factor as a part of risk taking. The time required for carrying out a project is connected with the uncertainty factors in decision-making. If the required time of realization is longer, not only does the degree of uncertainty increase, but potential losses may also occur. Especially in the case of new products in rapidly developing industries, flexibility and speedy appearance on the market offer the advantage which we may call "a transitory monopoly of a sellers' market"; in other words, an opportunity exists for "skimming the cream". If decision is late, because decision-makers hesitate or are unable to calculate the potential risk involved, there is potential loss. Losing time in project realization may unfavourably influence efficiency. Therefore potential gains from flexibility and speed and additional costs for it should be considered and settled at the decision stage.

(d) *Risk-taking and "strategic reserves"*

One of the most difficult tasks in the stage of decision-making is to determine the quantity of "strategic reserves". The optimum size of reserves will influence the rate of growth of the economy as a whole. No general rule can be suggested for every project concerning the necessary quantity of reserves. All information gathered in the stage of preparation should be considered again and again in order to determine optimum sizes of capacity, labour, material and foreign exchange reserves. In many cases, political considerations also play a decisive role.

At the present moment, we do not have the proper methodology for calculating them except some basic rules which we are trying to apply in project evaluation. From the point of view of calculation, there is a basic rule: every cost of desired reserves should be taken as costs of risk-taking or as a price for insurance and safety.

(e) *Questions of follow-up*

Because of limited risk taking, follow-up does not play as important a role in a centrally planned model as in a market economy. Capacities can be transferred from one sector to another relatively easily by central orders. If all the above-mentioned steps are carefully executed in the stage of preparation, the necessity of follow-up will be limited. This, however, does not mean that we can neglect follow-up. The possibility of follow-up should be ensured. This possibility is connected with the question of calculated reserves. One part of the reserves should be in mobile form in order to introduce necessary changes that arise during realization of the project. In this respect, reserves of technical planning and research capacity play an important role too. The institutional possibilities for follow-up are generally speaking much better in a centrally planned model than in a market model.

(f) *Present practice and problems*

In our present practice, the preparation and decision stages are not clearly separated. The stage of decision, or a part of it, comes earlier than detailed preparation.

Main directions of development are decided during the preparation of the long term plan. New capacities (large single projects) are considered at that stage. Approval of construction of single projects is therefore limited decision-making. In general, one might say that the first question, whether a project should be established or not, will be decided during long term planning. The second and third questions, how and where, are answered after the stage of detailed preparation, during the process of approval of investment programmes for single projects. The separation of the stage of decision into various parts, in time and space, lies at the root of several difficulties and in many cases cannot be ensured. The second stage influences the first. It may happen that a planned project cannot be realized for various reasons, and the original plan targets must be changed, or that because of changes in plan other projects which have already been approved must be put aside.

Approval and preparation are generally accomplished in two steps: investment programme; plan target.

Plan target is much more detailed than the investment programme described earlier, and needs elaboration only in the case of large projects with complicated technical and economic relations affecting other sectors or the economy as a whole. There seems to be only one process of decision-making in other projects. In practice, however, there are two processes, because the plan of the investment programme and the investment programme itself are approved separately. In addition to this there are several difficulties originating from the process of approval. Decision-making takes a long time, which increases the time of realization too. These questions have been under frequent discussion recently in connexion with the revision of existing planning practices.

XII. THE RATE OF INTEREST AND THE VALUE OF CAPITAL WITH UNLIMITED SUPPLIES OF LABOUR

by Stephen A. Marglin*

Introduction

This essay investigates the choice of technique (labour : capital ratio) and the choice of the rate of saving as joint decisions, linked by the following mechanism: (*a*) the supply of labour is always infinitely elastic at an exogenously determined wage rate; (*b*) all wage income is consumed; and (*c*) the marginal disutility of labour as well as its productivity, unassisted by capital, are nil.[1] The principal conclusions of this investigation are, first, that for the optimal technique and saving rate, the marginal productivity of labour in the capitalistic sector lies between the wage rate and zero. Secondly, and more important, neither the private nor the social rate of return (or marginal productivity) of capital is equal to the subjective rate of interest defined by the marginal premium on present over future consumption implicit in the economy's social welfare function; optimally, the subjective rate of interest is equal rather to the physical marginal productivity of capital. The difference between the social and physical productivity of capital is the difference between a *mutatis mutandis* and a *ceteris paribus* change. The social return measures the extra output from an extra unit of output of capital if employment increases sufficiently to maintain the socially optimal labour : capital ratio, which is, of course, the correct employment strategy under the assumptions of this essay. The physical return to capital measures the extra output, under the assumption that employment does not change with the addition of a unit of capital.

The implication of this second conclusion for investment planning will be discussed later, but the extreme nature of our assumptions about the availability and behaviour of labour compel at least cursory attention at the outset to the relevance of these assumptions. Stated baldly they are far from realistic, especially the assumption of perpetually unlimited supplies of labour at a fixed wage. But the germ of truth that makes the assumption of unlimited supplies of labour worth exploring is that in many developing economies unemployment and underemployment is large, and the wage rate of unskilled labour is well in excess of its opportunity cost measured in terms of either marginal disutility or of alternative product foregone. And worse, in many countries the creation of employment opportunities hardly keeps pace with the growth of the labour force. In India, for example, the relative as well as absolute amount of unemployment has apparently increased since Independence, despite fifteen years of planned economic development.[2] This is not a state of affairs that will continue in perpetuity, one hopes, but certainly the wage rate will exceed the opportunity cost of labour for some time to come, and India is not unique in this respect.

The assumption that workers consume their entire wage-income may seem inappropriate in a model which attempts to simulate the choice of saving rate as well as technique. With unlimited supplies of labour, surely the labour : capital ratio should be increased until the marginal productivity of labour falls to zero, and the consumption of workers should be a separate issue. Even if workers cannot be induced to save voluntarily, it ought to be possible to force savings out of wages through a combination of taxation and reduction of real wages by means of inflation.[3] However, Governments are in general severely restricted in their ability to control the rate of consumption out of wage income. In decentralized, pluralistic societies, organized labour along with other interested groups can be expected to resist the taxation and inflation required to force savings from wage income. And this resistance is likely to be effective, for the political advantages of increasing employment are relatively few. The unemployed,

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[1] These assumptions represent a theoretical simplification of the framework of growth going back at least to Karl Marx. For a modern discussion, see W. A. Lewis, "Economic development with unlimited supplies of labour," Manchester School of Economic and Social Studies, No. 22, Manchester, England, 1954, and "Unlimited labour: further notes", Manchester School, op. cit., 1958. See also W. A. Lewis, *The Theory of Economic Growth*, London, Allen & Unwin, 1955.

[2] The following estimates are taken from V. R. K. Tilak, "Unemployment statistics in India", *Economic Weekly*, Bombay, 1965, p. 27.

Year	*At the beginning of*	*Number unemployed (millions)*
1951	First plan	Not available
1956	Second plan	5.3
1961	Third plan	9.0 (original) 8.0 (revised)
1966	Fourth plan	12.0 (anticipated)

The compound growth rate of unemployment is over 8 per cent, as compared with a growth rate of population of the order of 2 per cent. Underemployment is, of course, more difficult to estimate.

[3] Such an assumption is implicit in F. Bator's willingness to assume that the choice of a rate of saving can be made independently of the distribution of income. See "On capital productivity, input allocation and growth", *Quarterly Journal of Economics*, Harvard University Press, 1957, vol. 71, p. 98. Bator admits the logical possibility of a link between income distribution and savings (p. 103), but does not appear to take very seriously the problem such a link would pose.

after all, are a minority of the labour force even in the most labour-surplus economies, so that even if man for man the unemployed were as powerful politically as the employed, the sheer weight of numbers would make the interest of the employed in low taxes and price stability carry the day against the interest of the unemployed in expansion of the volume of investment and hence employment.[4]

Even in more highly planned and centralized economies, the latitude of the Government to increase savings and investment by decreasing the consumption per employed worker is limited. Joseph Pajestka indicates that the attempts of the Polish Government to do just that in the decade following the defeat of Nazi Germany "placed heavy burdens on certain social groups and brought in their wake the well-known social-political reactions and dispositions which resulted in checking further economic development".[5]

The Polish experience shows that it is consumption per worker rather than *per capita* that is at issue. More intensive use of existing capital goods makes it possible to increase total (and thus *per capita*) consumption and investment, at least to the point that the marginal productivity of labour falls to zero. But to increase the labour : capital ratio beyond the point where the marginal productivity of labour falls to the level of the wage necessitates either a fall in real consumption per worker or a fall in the rate of profit per unit of capital and hence in the rate of investment and growth. That consumption per worker rather than consumption *per capita* should be the politically sensitive magnitude is perhaps not so surprising after all. A society need not be Calvinistic for differences to exist in expectations and aspirations between employed and unemployed. Individuals may become inured to chronic underemployment or unemployment, but, like individuals in possession of jobs, may feel legitimately entitled to some minimum level of consumption in return for a day's work, and they exercise all the political power at their command to resist taxation or inflation which might deprive them of their accustomed standard.

The preceding discussion is not intended to suggest a belief on the author's part in the absolute realism of the assumptions that underlie the model analysed in this essay. The ingredients of theoretical models generally represent an extreme simplification of the actual environment of economic decisions, and the present case is no exception. Nevertheless, the model examined in subsequent sections of this essay captures sufficiently the distinctive features of a large number of countries in Asia and elsewhere to make it worth-while exploring its implications for development policy.

A. Technique and saving divorced

To provide a basis of comparison, it may be a good idea first to set out the relevant results under the assumption that the Government is able, by one means or another, to achieve any desired rate of savings regardless of the labour : capital ratio chosen. Thus the choice of technique can be divorced from the savings discussion. Given unlimited supplies of labour and our assumption that both the disutility of labour and labour-productivity unassisted by capital are zero, we may suppose that the labour intensity is chosen to maximize the output : capital ratio regardless of the level of the wage rate. In other words, labour intensity is increased until the marginal productivity of labour in the capitalistic sector is driven to zero. So much for the choice of technique.

Following Ramsey,[6] the optimal savings programme is defined as one which minimizes the integral over the interval $(0, \infty)$ of the difference between "bliss" (the least upper bound on instantaneous utility) and the utility actually achieved. If we denote consumption at time t by $C(t)$, instantaneous utility by $U(C)$, and bliss by B, the objective function can be written

$$\text{Min} = \int_0^\infty \{B - U[C(t)]\}\, dt \qquad (1)$$

Let ρ stand for the output : capital ratio,[7] K for capital, $\dot{K}$ for investment,[8] and Y for income. Then

$$Y = \rho K \qquad (2)$$

$$Y = C + \dot{K} \qquad (3)$$

$$C = \rho K - \dot{K} \qquad (4)$$

And expression (1) becomes

$$\text{Min} = \int_0^\infty \{B - U[\rho K(t) - \dot{K}(t)]\}\, dt \qquad (5)$$

If we apply the calculus of variations to expression (5), the first order Euler-Lagrange equation becomes[9]

$$-\rho U_c = \dot{U}_c \qquad (6)$$

or

$$\rho = -\frac{\dot{U}_c}{U_c} \qquad (7)$$

In view of the zero marginal productivity of labour associated with the optimal technique, the output :

[4] The irony of this conflict of interest is that the more successful a Government is in increasing the volume of savings and employment by taxation or inflation, the more difficulty it encounters. For the very people who are moved from the ranks of the unemployed to the employed, who might be expected to be the most vocal supporters of the taxation or inflation that created their jobs, now identify their interests with those who were already employed and hence lose from taxation and inflation.

[5] J. Pajestka, "Some problems of economic development planning", in O. Lange, ed., *Problems of Political Economy of Socialism*, People's Publishing House, New Delhi, 1962, p. 323.

[6] F. P. Ramsey, "A mathematical theory of saving", *Economic Journal*, Cambridge, England, 1928, vol. 38, p. 543.

[7] We shall assume throughout this essay that the production function is homogeneous of first degree which means that ρ is a function of the labour : capital ratio alone.

[8] Dots will in general indicate time rates of change.

[9] Subscripts will in general indicate differentiation with respect to the variable indicated.

capital ratio ρ becomes equal to both the social and the physical marginal productivity of capital. But both may differ from the private marginal productivity of capital since a private computation of profit properly deducts any wage costs from the total return, despite the assumed redundancy of labour. The right hand side of (7) is the percentage rate at which the marginal utility of consumption falls over time, or the subjective rate of interest implied by society's utility function. Thus (7) expresses the Fisherian balance of opportunity and impatience in the determination of the optimal programme of capital accumulation, although in the present instance the balance is one of social rather than private return, with a social rather than a private subjective rate of interest.

Since the integral of (5) is a function only of K and $\mathring{K}$, we can integrate (6) to obtain a solution in terms of $\mathring{K}$:

$$\mathring{K} = \frac{B - U}{U_c}. \tag{8}$$

Expression (8), the Ramsey-Keynes rule, says that the optimal rate of saving at any moment of time t is given by the ratio of difference between bliss and utility at t to the marginal utility of consumption at t.[10]

To give concreteness to (8), we shall adopt a specific form of the utility function, namely the constant elasticity function,

$$U(C) = -aC^{-v} \tag{9}$$

where a and v are positive constants.[11] This function naturally suggests zero as the bliss-level, that is, $B = 0$. The marginal utility of consumption is given by

$$U_c = vaC^{-(v+1)} \tag{10}$$

and (8) becomes

$$\mathring{K} = \frac{0 - (-aC^{-v})}{vaC^{-(v+1)}} = \frac{C}{v} \tag{11}$$

Consumption plus savings are equal to total output, that is,

$$Y = C + \mathring{K} \tag{3}$$

So, (11) is equivalent to

$$\frac{\mathring{K}}{Y} = \frac{1}{1+v} \tag{12}$$

In other words, the optimal saving rate $\mathring{K}/Y$ is constant over time and equal to the negative of the inverse elasticity of marginal utility with respect to consumption. Note that the optimal saving rate is independent of ρ.

For future reference we perhaps ought to specify society's subjective rate of interest (which henceforth we shall denote by r) implicit in the constant elasticity utility function. Division of the negative of the time rate of change of marginal utility

$$-\mathring{U}_c = (v+1)vaC^{-(v+2)}\mathring{C}$$

by the marginal utility of consumption (10) gives the subjective rate of interest

$$r = -\frac{\mathring{U}_c}{U_c} = (v+1)\frac{\mathring{C}}{C} \tag{13}$$

It can be shown that $(v+1)$ is the negative of the elasticity of marginal utility, and $\frac{\mathring{C}}{C}$ is the rate of growth of consumption. The subjective rate of interest is equal to their product. For any programme of capital accumulation which maintains a constant savings rate s over time the rate of growth of consumption is simply the product $s\rho$. Expression (13) becomes

$$r = (1+v)s\rho \tag{14}$$

Since v is fixed by tastes (those, that is to say, of the planning commission, acting on behalf of society), implementation of the Fisherian balance $r = \rho$ consists of choosing s equal to $1/(1+v)$.[13]

B. SAVING AND [illegible] RELATED

Now we can proceed to the heart of the present inquiry but not, unfortunately, without additional notation. Let w represent the exogenously fixed wage, and let λ denote the labour-capital ratio. Each value of λ is supposed to represent a different technique of production. The output capital ratio ρ is a function of λ alone by virtue of the assumption of a first degree homogeneous production function,[14] and we shall assume $\rho(\lambda)$ is a strictly concave function, that is, one reflecting strictly diminishing marginal returns of output to labour. Let α stand for the proportion of profits (surpluses) that are saved, which will be assumed to be a decision under the control of the planning commission. Assuming that all wages are consumed, we have (a) the following function of λ and α

$$S(\lambda, \alpha) = \frac{\alpha[\rho(\lambda) - w\lambda]}{\rho(\lambda)} \tag{15}$$

In order to avoid mathematical complications we shall limit our attention here to capital accumulation

[10] F. P. Ramsey, op. cit., p. 547.

[11] Cf. J. Tinbergen, "The optimum rate of saving", *Economic Journal*, Cambridge, England, 1956, vol. 66, p. 603; and "Optimum savings and utility maximization over time", *Econometrica*, Yale University Press, 1960, vol. 28, p. 481, and S. Chakravarty, "Optimal savings with finite planning horizon", *International Economic Review*, Osaka, Japan, 1962, vol. 3, p. 338. This utility function has simplicity to recommend it, but it also has the quality—compelling to some and distressing to others—of being the only utility function which implies that the subjective rate of interest depends only on the rate of growth of consumption and is independent of the level of consumption. A comprehensive discussion of the problems of defining a utility function in the context of infinite time can be found in S. Chakravarty, "The existence of an optimal savings programme", *Econometrica*, Yale University Press, 1962, vol. 30, p. 178.

[12] See footnote 8 above.

programmes in which λ and a, and hence ρ and s, are fixed once and for all at time zero.

One extreme solution to the present problem is to proceed as before: to choose λ to maximise immediate output, that is, to maximise ρ—but subject now to the constraint imposed by labour's insistence on consumption,

$$\rho - w\lambda \geq 0 \qquad (16)$$

Maximization of the productivity of capital represents a direct application to the labour-surplus economy of the social marginal productivity (SMP) criterion of Alfred Kahn[13] and Hollis Chenery.[14] But it should be observed that the context in which the SMP criterion was advanced was not one in which the rate of saving was linked to the choice of technique. Maximization of ρ, subject to the constraint embodied in expression (16), will—if the constraint is binding—lead to a zero rate of saving and hence a zero rate of growth of consumption. And precisely for this reason, the criterion of maximizing ρ is inapplicable under the present assumptions about the supply and behaviour of labour. A decrease in the labour-capital ratio and the output-capital ratio in order to step up the savings ratio and the rate of growth of output and consumption seems clearly called for.

This suggests another extreme solution: to choose λ and a to maximize the rate of growth of output and consumption. This is indeed the criterion suggested by Walter Galenson and Harvey Leibenstein,[15] on the grounds that the maximal growth policy will eventually provide more consumption than any alternative programme of capital accumulation. Maximization of the growth rate $s\rho$ clearly involves setting a equal to the boundary value of unity, and choosing λ to satisfy the first order condition

$$\frac{\partial(s\rho)}{\partial\lambda} = \frac{\partial[a(\rho - w\lambda)]}{\partial\lambda} = a\rho_\lambda - aw = 0$$

or

$$\rho_\lambda = w \qquad (17)$$

Maximization of the growth rate (which for $a = 1$ is equal to the investable surplus per unit of capital) implies choosing λ to equate the marginal productivity of labour with the wage.[16] This corresponds, by the way, to choice of λ to maximise the return on capital as a state capitalist or private *entrepreneur* would measure it: output less wage costs. This solution suffers from the defect of sacrificing the present to the future, regardless of how poor the present may become relative to the future in consequence, and regardless of how distant the future may be to which the present is sacrificed.

Maurice Dobb,[17] Otto Eckstein,[18] and Amartya Sen[19] have pointed out the extreme nature of these solutions, and each has sketched the outline of an alternative approach. Our own approach, choice of λ, a, s, and ρ in terms of utility maximization, is more in the spirit of Eckstein than of Dobb or Sen. As before, we suppose that instantaneous utility and consumption are related by the function

$$U(C) = -aC^{-v} \qquad a, v > 0 \qquad (9)$$

Total utility $\mathcal{U}$ is given by

$$\mathcal{U} = \int_0^\infty U(C(t))\,dt = \int_0^\infty -a[C(t)]^{-v}\,dt \qquad (18)$$

With bliss taken as zero, Ramsey's objective of minimizing the integral of the difference between B and U is equivalent to maximization of $\mathcal{U}$.

Since we are confining our attention to once-and-for-all choice of λ, a, s, and ρ, we can substitute for the equations

$$Y(t) = \rho K(t) \qquad (2)$$

$$Y(t) = C(t) + \dot{K}(t) \qquad (3)$$

the equations

$$C(t) = (1-s)\rho K(t) \qquad (19)$$

$$\dot{K}(t) = s\rho K(t) \qquad (20)$$

Integration of expression (20) gives

$$K(t) = K(0)e^{s\rho t} \qquad (21)$$

where $K(0)$ is the given initial capital stock. This also gives

$$C(t) = (1-s)\rho K(0)e^{s\rho t} \qquad (22)$$

in place of (19).

If we substitute the right hand side of (22) for the left in expression (19) we have

$$\mathcal{U} = \int_0^\infty -a[(1-s)\rho K(0)e^{s\rho t}]^{-v}\,dt \qquad (23)$$

After integrating and substituting an equivalent expression for s from (15), equation (23) becomes

$$\mathcal{U} = -\frac{a[\rho - a(\rho - w\lambda)]^{-v}K(0)^{-v}}{va(\rho - w\lambda)} \qquad (24)$$

Maximization of $\mathcal{U}$ is equivalent to minimization of $\log(-\mathcal{U})$ or to maximization of $-\log(-\mathcal{U})$, and this last is the easiest expression to work with. Now, $-\log(-\mathcal{U})$ is given by the equation

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[13] A. E. Kahn, "Investment criteria in development programmes", *Quarterly Journal of Economics*, Harvard University Press, 1951, vol. 65, p. 38.

[14] H. Chenery, "The application of investment criteria", *Quarterly Journal of Economics*, Harvard University Press, 1953, vol. 67, p. 76.

[15] W. Galenson and H. Leibenstein, "Investment criteria, productivity and economic development", *Quarterly Journal of Economics*, Harvard University Press, 1955, vol. 69, p. 343.

[16] The "marginal productivity of labour", unless qualified, means marginal productivity within the capitalistic sector; the marginal productivity of labour uncombined by capital is by assumption zero.

[17] M. Dobb, *An Essay on Economic Growth and Planning*, New York, Monthly Review Press, 1960, chapters 3 and 4.

[18] O. Eckstein, "Investment criteria for economic development and the theory of intertemporal welfare economics", *Quarterly Journal of Economics*, Harvard University Press, 1957, vol. 71, p. 56.

[19] A. K. Sen, "Some notes on the choice of capital-intensity in development planning", *Quarterly Journal of Economics*, Harvard University Press, 1957, vol. 71, p. 561, and *Choice of Techniques*, London, Basil Blackwell, 1960.

$$V = -\log(-\mathfrak{V}) - \log s + v\log[\rho - s(\rho - w\lambda)] + v\log K(0) + \log v + \log s + \log(\rho - w\lambda) \quad (25)$$

Necessary conditions for maximisation of (25) are given by

$$\frac{\partial V}{\partial s} \left\{\begin{matrix}\geq \\ =\end{matrix}\right\} 0 \text{ as } \left\{\begin{matrix}s = 1 \\ s < 1\end{matrix}\right\} \quad (26)$$

and

$$\frac{\partial V}{\partial \lambda} = 0 \quad (27)$$

[20]

From (25) we have

$$\frac{\partial V}{\partial s} = -\frac{v(\rho - w\lambda)}{\rho - s(\rho - w\lambda)} + \frac{1}{s}$$

Thus (26) becomes

$$\rho \left\{\begin{matrix}\geq \\ =\end{matrix}\right\} (1 + v)s(\rho - w\lambda) \text{ as } \left\{\begin{matrix}s = 1 \\ s < 1\end{matrix}\right\} \quad (28)$$

Now combining (14) and (15) gives

$$r = (1 + v)s(\rho - w\lambda) \quad (29)$$

so that (28) becomes

$$\rho \left\{\begin{matrix}\geq \\ =\end{matrix}\right\} r \text{ as } \left\{\begin{matrix}s = 1 \\ s < 1\end{matrix}\right\} \quad (30)$$

The derivative $\frac{\partial V}{\partial \lambda}$ is given by

$$\frac{\partial V}{\partial \lambda} = \frac{v[\rho_\lambda - s(\rho_\lambda - w)]}{\rho - s(\rho - w\lambda)} + \frac{\rho_\lambda - w}{\rho - w\lambda} \quad (31)$$

Thus equation (27) becomes

$$\rho - \rho_\lambda\lambda = (1 + v)s(\rho - w\lambda)\frac{s(w - \rho_\lambda) + \rho_\lambda}{sw}$$
$$= r\frac{s(w - \rho_\lambda) + \rho_\lambda}{sw} \quad (32)$$

Since the left-hand side of (32) is smaller than ρ unless $\rho_\lambda = 0$, and the right-hand side is greater than or equal to r, the equality in (28) can hold only in the event $\rho_\lambda = 0$, in which case (32) as well as (30) reduce to the Euler-Lagrange equation, (7), that characterises the optimal growth path under the assumption that savings and technique are divorced. This should not be surprising, for if zero marginal productivity of labour is consistent with the optimal solution in the present problem, the constraint on savings imposed by the consumption of wage income is in fact not binding, and the present problem reduces to the previous one, in which technique and savings can be independently optimised.

If the solution of (32) requires $\rho_\lambda > 0$, the constraint arising from the consumption of wage income limits the choice of savings rate and the choice of technique, and strict inequality must hold in (30). That is to say that s must equal unity, in other words, optimal growth requires reinvestment of all surpluses remaining after payment of the institutionally fixed wage bill, $w\lambda K$. In this case, the optimal technique is given by the value of λ, for which equation (33) holds

$$\rho - \rho_\lambda\lambda = r \quad (33)$$

This equation is (31) with s replaced by unity.

Equation (33) reflects a balance between "opportunity" and "impatience" when consumption of wage income is an effective constraint on choice of technique and savings rate. Marginal impatience is reflected in the value of the subjective rate of interest r. Opportunity is here represented by the physical marginal productivity of capital,

$$\left(\frac{\partial Y}{\partial K}\right)_{\text{employment} = \text{const}} = \rho - \rho_\lambda\lambda$$

the extra output from an extra unit of capital with employment unchanged. The physical productivity should be distinguished from the marginal social productivity of capital,

$$\left(\frac{\partial Y}{\partial K}\right)_{\lambda = \text{const}} = \rho$$

which measures the extra output from an extra unit of capital when employment is increased to maintain a constant labour capital ratio, which is the optimal employment strategy from the point of view of social utility maximisation. The physical productivity of capital is equal to the return on capital measured by subtracting from the social productivity a labour cost computed by replacing the wage w with a lower shadow wage equal to the marginal productivity of labour, ρ_λ.[21] For the optimal technique and savings rate the following inequality holds

$$\rho > \rho - \rho_\lambda\lambda = r > \rho - w\lambda \quad (34)$$

Note that as v approaches zero, the $\mathfrak{V}$ maximizing choice of λ approaches the Galenson Leibenstein growth-maximizing choice, and the physical productivity of capital and subjective rate of interest approach the private rate of return to capital. $v \to 0$ implies $r \to (\rho - w\lambda)$, hence from (33), $\rho_\lambda \to w$, which implies maximisation of the rate of growth. A similar argument establishes that as $v \to \infty$, the optimal choice of λ approaches the SMP choice of λ to equate ρ with $w\lambda$ (unless a smaller value of λ drives ρ_λ to zero).

[20] The boundary value $s = 0$ which would correspond to $\frac{\partial V}{\partial s} \leq 0$, and the SMP choice of λ (λ such that $\rho = w\lambda$), which would correspond to $\frac{\partial V}{\partial \lambda} \geq 0$, can be eliminated simply by virtue of the fact that either of these choices would lead to the dominated utility value $\mathfrak{V} = -\infty$. The possibility of $\frac{\partial V}{\partial \lambda} < 0$ for the Galenson-Leibenstein choice of λ (λ such that $\rho_\lambda = w$), can be ruled out by appealing to continuity: since $\frac{\partial V}{\partial \lambda}$ is positive for all values of λ less than the Galenson-Leibenstein value, it cannot be negative at the Galenson-Leibenstein value.

[21] The shadow wage can be expressed in terms of w by substituting in (33) an equivalent expression for λ from (15). This substitution gives

$$\rho_\lambda = \frac{(\rho - r)w}{(1 - v)\rho} < w$$

If we momentarily change the ground rules, and assume that a is a parameter fixed exogenously rather than a choice variable, equality between the subjective rate of interest and the physical productivity of capital no longer characterises the socially optimal choice of technique. In this case, which corresponds to a mixed economy in which the Government controls employment but not savings (the value of a being determined, for example, by the behaviour of private capitalists, just as the consumption of wage income is determined by the behaviour of workers), equation (32) alone characterises the optimum, and the optimal physical productivity of capital exceeds the subjective rate of interest. The ratio of the physical productivity of capital to the subjective rate of interest,

$$\frac{aw + (1-a)\rho_\lambda}{aw}$$

varies inversely with the capitalist propensity to save.

A numerical example might be useful in assessing the difference between optimisation in terms of utility maximisation and optimisation in terms of the alternative criteria of choice, to which reference has been made. Suppose production is governed by the Cobb-Douglas function (with L representing employment and the other variables defined as before)

$$Y = L^{1/2} K^{1/2} = \lambda^{1/2} K$$

so that

$$\rho = \lambda^{1/2}$$

Further, let $v = 2$, and let $w = 2$. Then, the table below gives the values of the several variables associated with utility maximisation and, for contrast, with maximisation of immediate output and with maximisation of the rate of growth.

PARAMETER VALUES RESULTING FROM APPLICATION OF ALTERNATIVE CRITERIA WITH $\rho = \lambda^{1/2}$, $v = 2$, $w = 2$

	Criterion		
	Max ρ	*Max* $\mathfrak{V}$	*Max* φ
a = proportion of profits saved	*	1.0	1.0
λ = labour/capital ratio	0.25	0.173	0.0625
ρ = output/capital ratio = social productivity of capital	0.5	0.416	0.25
s = rate of saving	0.0	0.166	0.5
$\varphi = \rho - w\lambda$ = rate of growth = private rate of return on capital**	0.0	0.0695	0.125
ρ_λ = marginal productivity of labour = shadow wage	1.0	1.2	2.0
$\rho - \rho_\lambda \lambda$ = physical productivity of capital	0.25	0.208	0.125
r = subjective rate of interest	0.0	0.308	0.375

* The value of a is irrelevant since $\rho - w\lambda = 0$.
** Since either $a = 1$ or $\rho - w\lambda = 0$, it follows that $\varphi = \rho - w\lambda$.

It should be observed in the table that the physical productivity of capital and the subjective rate of interest are equal only for the optimal growth path "max $\mathfrak{V}$." For growth rates less than optimal, of which the "max ρ" path is an extreme example, the physical productivity of capital exceeds the rate of interest; for growth rates greater than optimal, of which the "max φ" path is the limiting case, the opposite is true.

Figure 1 illustrates some of the magnitudes of the table. The next three figures indicate the time profiles of output, consumption, and employment resulting from the three criteria. Initial capital stock $K(0)$ is assumed in all cases to be equal to 100.

C. THE VALUE OF CAPITAL

In the economy of our model output and consumption are governed by the simple relationships

$$Y(t) = \rho K(t) = \rho K(0)e^{\varphi t}$$

$$C(t) = (1-s)\rho K(t) = (1-s)\rho K(0)e^{\varphi t}$$

But suppose we relax this assumption slightly to allow the planning commission to be presented with the possibility of an alternative use of one unit of capital at time t. The time pattern of consumption provided by the new opportunity, let us suppose, is given by the function $\Delta(t)$, $t_0 \leq t < \infty$. (This function is assumed to reflect reinvestment of surpluses over wage costs.) The choice facing the planners is whether or not to divert one unit of investment to the new option when the opportunity arises.

How might planners make this decision? The first step is to compute the marginal utility afforded by the new opportunity. Denoting this marginal utility by $\mathfrak{V}_\Delta$, we can write

$$\mathfrak{V}_\Delta = \int_{t_0}^{\infty} U_t\,\Delta(t)\,dt = \int_{t_0}^{\infty} U_{c(0)}\,\Delta(t)\,e^{-rt}\,dt$$

$$= U_{c(0)}e^{-rt_0}\int_{t_0}^{\infty}\Delta(t)\,e^{-r(t-t_0)}\,dt$$

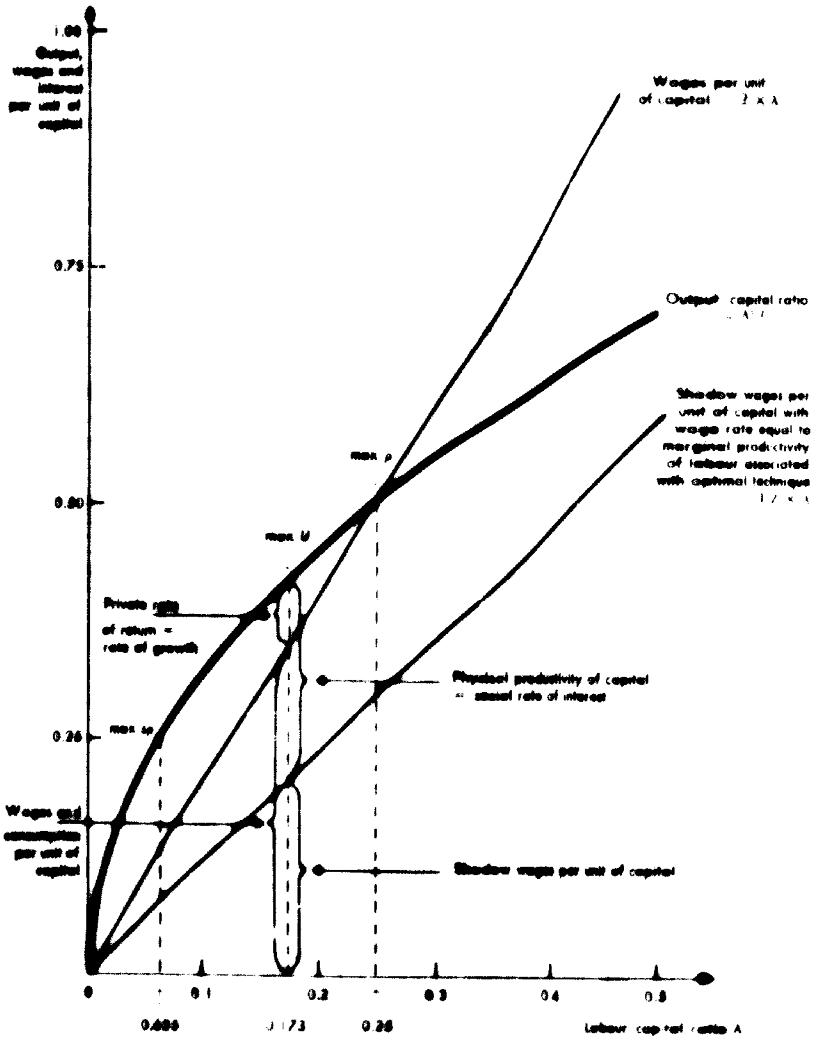
where $U_{c(0)}$ equals the marginal utility of consumption at time $t = 0$ and (by virtue of the constancy of the elasticity of utility)

$$U_t = U_{c(0)}e^{-rt}$$

The second step is to compare $\mathfrak{V}_\Delta$ with the marginal utility of investment at time t in the optimal technique as determined by v, w, $\rho(\lambda)$ and $s(\lambda, a)$. This marginal utility we denote $\mathfrak{V}_{K(t_0)}$. We have

Figure 1

OUTPUT, WAGES AND INTEREST AS A FUNCTION OF PRODUCTION TECHNIQUE



$$K(t_0) = \int_{t_0}^{\infty} U'_C \left(\frac{\partial C}{\partial K}\right)_{K=K(t_0)} dt = U'_{C(0)} e^{-wt_0} (1-s)\rho \int_{t_0}^{\infty} e^{(s\rho - w)(t-t_0)} dt = U'_{C(0)} e^{-wt_0} \frac{(1-s)\rho}{w-s\rho}$$

For the $\mathfrak{V}$ maximising choices of s and λ, substitution from (15) and (33) gives the equality

$$\mathfrak{V}_{K(t_0)} = U'_{C(0)} e^{-wt_0} \frac{w}{w-\rho_\lambda} \qquad (36)$$

Now the new opportunity should be exploited only if $\mathfrak{V}_\Delta > \mathfrak{V}_{K(t_0)}$, or in other words, only if

$$U'_{C(0)} e^{-wt_0} \int_{t_0}^{\infty} \Delta(t) e^{-w(t-t_0)} dt > U'_{C(0)} e^{-wt_0} \frac{w}{w-\rho_\lambda} \qquad (37)$$

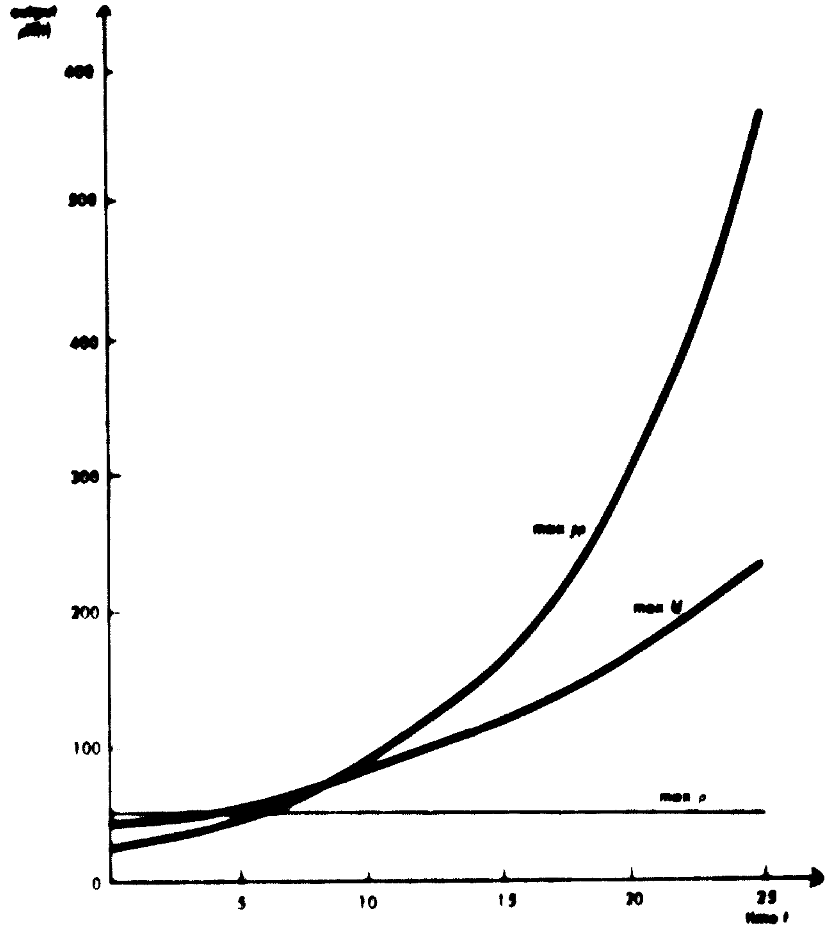
This criterion can be made a little more familiar by normalising by means of division of (37) by $U'_{C(t_0)} = U'_{C(0)} e^{-wt_0}$, that is, by dividing both sides of (37) by the marginal utility of consumption at time t_0. Then

$$\frac{\mathfrak{V}_\Delta}{U'_{C(t_0)}} = \int_{t_0}^{\infty} \Delta(t) e^{-w(t-t_0)} dt \qquad (38)$$

$$\frac{\mathfrak{V}_{K(t_0)}}{U'_{C(t_0)}} = \frac{w}{w-\rho_\lambda} \qquad (39)$$

Figure 2

TIME PROFILE OF OUTPUT RESULTING FROM UTILITY MAXIMIZATION AND FROM ALTERNATIVE CRITERIA



And the criterion of superiority of the new use of capital over the "optimal" technique, expression (3[illegible]) becomes

$$\int_{t}^{x} \Delta c(t) [illegible] \, dt [illegible] \qquad (40)$$

The integral $\int_{t}^{x} \Delta c(t) [illegible] \, dt$ is customarily called the present value at time t_0 of the consumption stream $\Delta c(t)$ evaluated at the discount rate r. Similarly

$$[illegible] \qquad (41)$$

is the marginal present value of investment in the "optimal" technique. Thus (40) says that the present value of the new opportunity must exceed the marginal present value of investment in the "optimal" technique. This may be somewhat surprising, for the physical trade-off rate between consumption and investment determined by the equation

$$Y(t) = C(t) + \dot{K}(t) \qquad (3)$$

is unity, and we might therefore have expected that the new investment option would be attractive provided its present value,

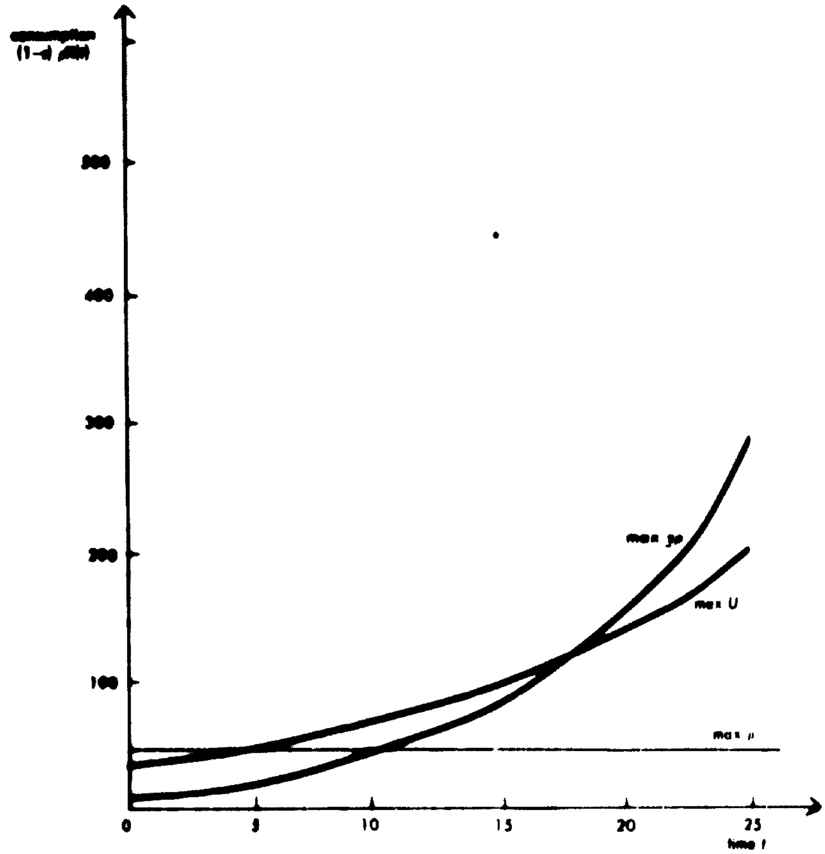
$$\int_{t_0}^{x} \Delta c(t) e^{-r(t-t_0)} \, dt$$

exceeded unity.

But in the present model, limitations on the choice of s mean that the marginal rate of substitution, as reflected in the marginal present value of investment, is in excess of the technological transformation rate, and it is with the first rather than the second that the present value of alternative

Figure 3

Time profile of consumption resulting from utility maximization and from alternative criteria



$$\int_{t_0}^{\infty} \Delta(t)\, e^{-r(t-t_0)}\, dt,$$

must be compared.

The marginal present value of investment $w/(w-\rho_\lambda)$ is thus the shadow price of investment. Since in the present model average and marginal values coincide, $w/(w-\rho_\lambda)$ is also the shadow price of capital. This shadow price falls to unity only in the limiting case of $\rho_\lambda = 0$ and $\rho = r$, when the production funtion $\rho(\lambda)$, the elasticity of utility v, and the wage rate w combine to make it possible to divorce the savings question from the technique question. At the other extreme, when v goes to zero and $\mathcal{U}$-maximization dictates choosing λ to provide a rate of growth of output and consumption that approaches the maximal feasible rate of growth, ρ_λ goes to w and the shadow price of capital approaches infinity.

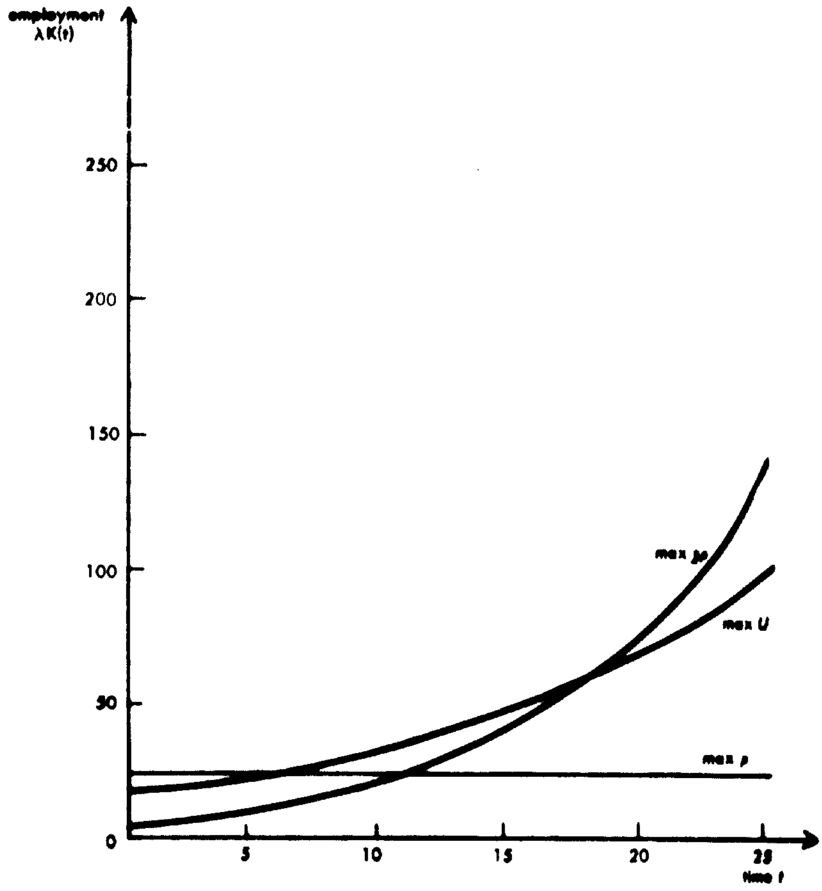
Measurement of the effectiveness of potential investments thus requires a more elaborate evaluation than would be necessary were it not for labour's effective insistence on consumption. Because the choice of the rate of saving cannot be divorced from the choice of technique, investment planning requires not only specification of a discount rate but also specification of a shadow price of capital. The present value of consumption stream resulting from each investment opportunity (including whatever consumption is afforded by reinvestment) must be computed at the social rate of discount, and this present value compared with the capital cost computed with a shadow price equal to the economy's marginal present value of capital. Only in the event that $\rho = r$ for the optimal technique and the conflict between savings and growth, on the one hand, and immediate output, consumption, and employment, on the other, disappears, does this evaluation procedure reduce to the more familiar procedure of comparing discounted present value with the nominal capital cost.

D) Decentralization of choice of technique

It is evident that *laissez-faire* cannot be relied upon to produce the optimal technique under the assumptions of the model. Decentralized *entrepre-*

Figure 4

TIME PROFILE OF EMPLOYMENT RESULTING FROM UTILITY MAXIMIZATION AND FROM ALTERNATIVE CRITERIA



...*eurs* left to their own devices would maximize the private rate of return to capital, $\rho-w\lambda$, as would profit-maximizing state capitalists.

Decentralized "market socialists" of a Lange-Lerner type could be guided to the $\mathcal{U}$–maximizing choice of technique by an order from the planning commission to choose the technique of production to maximize the physical rate of return, $\rho-\rho_\lambda\lambda$, computed with a shadow wage equal to the marginal productivity of labour associated with the optimal technique. This instruction would have to be supplemented by an order to reinvest all surpluses remaining after actual wage costs are paid.

Replacing w by ρ_λ in choice of technique calculations amounts to an "as if" subsidy of $w-\rho_\lambda$ per unit of labour. Choice of the optimal technique could be achieved through payment of an actual subsidy of $w-\rho_\lambda$ to private *entrepreneurs* or state capitalists; but the taxes levied to pay the subsidy must not fall on the workers, for this would violate the rules of the game, which requires consumption of all wage income.[22]

The difficulty with decentraliaztion of decision-making on the basis of a shadow wage is a familiar one: the optimal technique must be known to the planning commission in order to determine the appropriate shadow wage. Hence, there might seem to be little advantage in decentralization. However, the optimal technique and shadow wage could be determined simultaneously by a decentralised *tâtonnement* procedure. If λ is iteratively adjusted according to the formula

$$\lambda^{n+1}-\lambda^{n}=-\theta(\rho^{n}-\rho_{\lambda}^{n}\lambda^{n}-r^{n})\qquad n=1,2,3,\ldots\qquad(42)$$

where ρ^n, ρ_λ^n and r^n are values associated with $\lambda=\lambda^n$ and θ is a positive constant then convergence

[22] The indirect control exercised through the subsidy of wages would have to be supplemented by direct control to ensure reinvestment of all profits remaining after payment of wages and taxes. But private capitalists would presumably tire very quickly of always having their cake and never eating it.

of the sequence $\{\lambda^n\}$ to an arbitrarily small neighbourhood of the optimal labour : capital ratio can be guaranteed by suitable choice of θ regardless of the initial choice of λ.[23] Equation (42) says in effect that the labour : capital ratio should be decreased (in order to increase the rates of saving and growth) so long as the physical productivity of capital exceeds the social rate of discount, and *vice versa*. The social rate of interest would be recomputed from (14) by the planning commission between iterations and transmitted to the decentralized managers, who after computing the values of ρ and ρ_λ would calculate the new value of λ from equation (42) and transmit the associated values of ρ and s to the planning commission. This would in turn suggest a new value of r, which would form the basis for the next iteration.

Conclusions

The basic assumptions of the model explored in this essay are, first, the availability of unlimited supplies of labour, in perpetuity, at an exogenously determined wage rate and, secondly, the consumption of all wage income. A third assumption is that labour neither involves disutility nor is productive without the assistance of capital. Without the second assumption, the choice of technique is a relatively simple affair: the goal is clearly to choose the labour : capital ratio λ to maximize the output : capital ratio ρ. In this case the choice of a rate of saving s (which together with ρ determines the rate of growth of output, consumption and employment) is a separate question. But insistence on the part of labour on consumption of its entire income makes it impossible to divorce the choice of technique from an upper bound on s: savings now can come only from profits. The greater the value of λ and ρ (beyond the point where the marginal productivity of labour ρ_λ falls to the level of the wage rate w), the lower is the upper limit on s. Others[24] have explored the conflict between immediate output and the rate of growth that the dependence of s on λ poses, and it has been pointed out that in general the optimal technique can be expected to reflect a compromise between the maximal feasible immediate output and the maximal feasible rate of growth. The present analysis, couched in terms of maximization of an explicit utility function (chosen for convenience to reflect a constant elasticity with respect to consumption) confirms the wisdom of compromise, but our chief interest has been not in the compromise itself but rather in its implications with respect to wages and interest.

The principal conclusion was stated at the outset of this essay, but it certainly bears repeating: neither the social rate of return (or social marginal productivity) of capital ρ nor the private rate of return $\rho - w\lambda$ is equal to the subjective rate of interest r that reflects the marginal premium on present over future consumption implicit in the economy's utility function—even for the optimal technique and saving rate. The Fisherian balance of opportunity and impatience characterizing utility maximization is implemented instead by the following equality between the physical marginal productivity of capital and the subjective rate of interest:

$$\rho - \rho_\lambda \lambda = r \qquad (33)$$

The physical marginal productivity of capital on the left-hand side of (33) is equivalent to the yield on capital measured by subtracting labour costs evaluated on the basis of a shadow wage (equal to the marginal productivity of labour associated with the optimal technique) from the output : capital ratio. Furthermore, the marginal productivity of labour optimally lies between zero and the actual wage, so that

$$\rho \geqslant \rho - \rho_\lambda \lambda = r > \rho - w\lambda \qquad (34)$$

The private rate of return $\rho - w\lambda$ is equal to the rate of growth of output, consumption and employment, $s\rho$, provided all surpluses remaining after payment of wages are reinvested,[25] so that (34) can be interpreted as setting upper and lower bounds for the rate of interest as, respectively, the output : capital ratio and the rate of growth of the economy. The rate of interest will actually attain the upper bound only in the event that the technology is such as to permit the best of both worlds simultaneously: the maximum output : capital ratio (which implies $\rho_\lambda = 0$) and independent optimization with respect to the rate of saving.

The rate of interest appropriate for discounting the consumption stream generated by any new investment opportunities that may be afforded from time to time is r, for discounting at r is equivalent to weighting consumption at each moment of time by its marginal utility. But the decision whether or not to undertake any such investment cannot be made by comparing the present value of its consumption stream at r with its capital cost. The inability of the economy to optimize independently with respect to the rate of saving means that the marginal rate of substitution of consumption for investment, in other words, the marginal present value of investment at the social rate of discount exceeds the physical rate of transformation of unity at "equilibrium". The present value afforded by any investment opportunity must therefore be compared with its capital cost evaluated at a shadow price equal to the marginal present value of investment in the economy. This marginal present value falls to unity only in the event that $\rho = r$ and the conflict between immediate output and employment, on the

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[23] This proposition presupposes that the optimal technique implies $s = \lambda$. (The more general case can be covered by suitably amending the algorithm embodied in (42).) The proof of the convergence of the sequence defined by (42) to an arbitrarily small neighbourhood of the $\mathcal{U}$-maximizing value of λ requires nothing more than modification of the proof of convergence of a continuous gradient process to allow for discrete changes in the values of variables. See K. J. Arrow, L. Hurwicz and H. Uzawa, *Studies in Linear and Non-Linear Programming*, Stanford University Press, 1958, chapter 10.

[24] M. Dobb, op. cit. (footnote 17 above); O. Eckstein, op. cit. (footnote 18 above) and A. K. Sen op. cit. (footnote 19 above).

[25] Reinvestment of all surpluses [illegible] dition of optimality except in the [illegible] case $\rho = r$, in which event the conflict between immediate output and the rate of growth disappears.

one hand, and savings and growth, on the other, disappears.[26]

Because of the difference between the private rate of return and the social rate of discount, *laissez-faire* could not be expected to lead to an optimal choice of technology. A subsidy on labour costs to private *entrepreneurs* or state capitalists, or an "as if" subsidy to market socialists, would, however, make private and shadow returns coincide. In principle, the size of the subsidy $w - \rho_\lambda$, with ρ_λ the marginal productivity of labour associated with the optimal technique, can be determined along with the optimal technique by a decentralized *tâtonnement* as well as by centralized planning.

[26] The point is a general one. When institutional constraints of any kind prevent optimization with respect to the rate of saving, the social, private and physical productivities of capital will in general differ, and the price, or "opportunity cost" of capital will differ from the purely physical marginal rate of transformation between consumption and investment goods. The question of interest rates and capital valuation for purposes of public investment is explored from a basis that reflects the conditions of mature mixed-enterprise economies rather than the destructive labour-surplus feature of developing economies in two articles: S. A. Marglin, "The social rate of discount and the optimal rate of investment", *Quarterly Journal of Economics*, Howard University Press, 1963, vol. 77, p. 95, and "The opportunity costs of public investment", *Quarterly Journal of Economics*, Howard University Press, 1963, vol. 77, p. 274.

The model on which the conclusions of this essay are based is an extremely simple one. It ignores the existence of a multiplicity of sectors, technologies and outputs in the economy. It ignores foreign trade. It assumes unlimited supplies of labour not simply for the present but in perpetuity. It assumes absolute rigidity with respect to real wage rates and consumption by workers. Moreover, the choice of technique and savings rate are posited as once-and-for-all decisions. Finally, the utility function chosen—besides being extremely simple with respect to total consumption—does not take distribution of consumption into account at all, and distribution is surely an important aspect of the conflict of immediate output and employment against savings and growth. Nevertheless, the propositions we have sought to establish are qualitative rather than quantitative in nature, and for this purpose a simple model suffices as well as a complex one. The precise form of the conclusions will certainly be affected by added doses of realism, but not their nature.

XIII. PRICING PROBLEMS IN INDUSTRIAL PROJECT EVALUATION

by M. Ostrowski and Z. Sadowski*

INTRODUCTION

There are two possible approaches to the problem of pricing in industrial project evaluation; one may be termed the computation approach, the other the policy approach. The computation approach is predominantly concerned with the techniques of computing the value parameters needed for making decisions on investment choice. The elaboration of such techniques necessarily means major pre-occupation with some kind of model-building. It is now commonly admitted that such value parameters as ought to be used for this purpose can best be arrived at by finding the solution for the dual problem in linear programming, the programme itself reflecting the desired development of a given economy. This shows the main line of thinking contained in this particular approach: it is mainly concerned with techniques of optimization.

The policy approach, by contrast, may best be presented when starting with the assumption, unrealistic as it is, of the existence of a perfect set of value parameters for the development of a given economy. Such a perfect set can be termed, for brevity's sake, the set of shadow prices, which necessarily differs from the set of market prices. This being so, it is clear that, even on such an assumption certain policy problems must arise for the Government in the matter of inducing individual decision-makers to use shadow prices instead of market prices in their project evaluations.

In practice, however, it would be unrealistic to assume a perfect set of value parameters which would correspond to the optimum solution of the development programme. While a perfect solution may be found in theory, in practice it is beyond reach, because of the lack of sufficient information.

This leads necessarily to the emergence of a second type of policy problem, arising from the non-existence of a perfect set of shadow prices—or rather from the imperfections of the set of value parameters that can be made available in reality, and which shall be called, for brevity's sake, the set of accounting prices as distinct from the set of shadow prices representing the perfect solution. The accounting prices represent better or worse approximations to shadow prices. Thus the problem of how to make them better instead of worse seems to be an example of the second type of policy problem.

Another such problem can be seen in the need for an assessment of the consequences of the disparities between accounting and shadow prices, that is, of the fact that such approximations as are being made must necessarily include a margin of error. The general result is clearly that the decisions arrived at by means of the accounting prices are not exactly what they ought to be if the optimum development programme is to be implemented. This leads to one more policy problem: that of finding means of neutralizing the effects of errors resulting from disparities between accounting and shadow prices. This can be done either by the use of certain direct controls, or by successive adjustments in the set of accounting prices, or both.

Both of these approaches still require a good deal of work before satisfactory answers can be provided to the multitude of practical problems of development policy and investment decisions. It seems, however, that so far relatively more attention has been paid to what we called the computation approach than to the policy approach. This observation was made in the course of the writing of the present paper, which was intended first to be a general survey, and perhaps a summary, of existing lines of thinking and methods of approach to the problems of pricing in industrial project evaluation. It transpired that not very much could be said in this context about the policy approach to these problems. Yet because the computation approach leads at best to finding more or less adequate methods for more or less adequate but as a rule rather crude approximations, the policy approach becomes all the more important and perhaps deserves even more attention than the former.

A. PROJECT EVALUATION CRITERIA, DEVELOPMENT PROGRAMMES AND SHADOW PRICES

Investment project evaluation is nowadays one of the crucial problems of economic theory and practice, being a form of dealing with the old question of how to make the best use of existing resources. If we imagine a development economy with some kind of central body responsible for preparing a development plan, it is easy to see that for this central body the problem of the best allocation of resources, in any circumstances, means a multitude of decisions as to the particular investment projects that should be selected.

This central body must have a criterion for selection, whose purpose is to indicate the relative advantage involved in each project. We may, then, think of the criterion in very general terms: it is a way of comparing benefits with costs or, still more generally, with sacrifices. The general formula for such a comparison may be written, after Tinbergen:[1]

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* Planning Commission, Warsaw.

[1] J. Tinbergen, "Project criteria", in *Economic Planning*, The Hague, 1963

$$r = \frac{\sum_i q^i dx^i - \sum_j p_j da_j}{\sum_j p_j da_j}$$ [2]

We denote here by dx^i the addition to each of the conceivable aim or target variables, x^i made by a project, while da_j stands for the quantities used of all the sacrifice (cost) items or factors a_j. The total number of aim variables is indicated by I, the total number of factor variables by J.

Thus, in its general form, the problem of finding a criterion for project evaluation is a problem concerning a number of independent elements which have to be brought under a common denominator. Each industrial project can be characterized by these elements. In principle, these independent elements are all the aims and all the factors which appear in the development policy and its instruments.

In these general terms, the first thing to do is to compose a full list of these independent elements. To see the full complexity of the problem involved it is necessary to point out that each of these elements represents (both on the aim and on the sacrifice side) a magnitude variable over time. Thus each specific target variable (such as income or employment) for each particular year to come ought to be treated as a separate variable. The same applies to cost items. Thus the number of independent elements increases with the number of time units considered.

Supposing that it is possible to draw such a full list, the next thing to do is to express adequately, in a common unit, all benefits obtained from and all sacrifices made on behalf of a given project, the benefits being

$$\sum q^i dx^i = q^1 dx^1 + q^2 dx^2 + \dots + q^I dx^I$$

and the sacrifices being

$$\sum p_j da_j = p_1 da_1 + p_2 da_2 + \dots + p_J da_J$$

Finding these expressions is possible if, and only if, we can find (equilibrium) prices p_j for factors and q^i for aims.

For any number of independent aim and cost variables the problem of pricing can find, at least theoretically, a solution. But it can be easily seen that, for any practical purposes of project evaluation and selection, a certain choice must be made, first of all, as to the scope and meaning of all the x^i's and a_j's involved in the general formula. These must be somehow limited so as to embrace only some particular kinds of benefits and some particular kinds of sacrifices. Thus, some simplified form of the general criterion must be chosen.

It follows, then, that in operational terms the general problem of project evaluation can be looked at as embracing two distinct problems:

(a) That of finding a satisfactory form of the criterion, such as would take into account what are considered important elements on both the benefit and the cost side; and (b) that of finding the equilibrium prices for all the benefit and cost items considered in the criterion, that is such prices as would balance a given development programme.

1. *Relationship between the accounting formula and prices*

The problem under (a) may be termed as choosing a particular accounting formula.

The solution to it may be arrived at, on a macroeconomic scale, only by a decision of the planning authorities. The decision is more or less of a political nature. Because of the very complexity of the general problem, the authorities have no choice but to adopt a simplified formula. On the other hand, they do have a choice with respect to the particular simplified form of the accounting formula which they are to adopt. The latter choice must always be made. What may vary is the extent to which the choice is motivated, as well as the degree of consciousness with regard to the full range of consequences of adopting a particular accounting formula.

We shall not he concerned in this paper with the problem of how to arrive at a satisfactory accounting formula. What is important to note here is the fact that, whatever the particular decision, it affects seriously the second problem, that of pricing, at least in so far as it determines the list of items to be priced.

Given the accounting formula, the set of prices enables us to obtain for each investment project a figure representing its relative attractiveness. It is relative because it is valid only on the ground of the adopted accounting formula and the adopted set of prices. We shall be concerned here with the problem of how to arrive at a satisfactory set of prices. But it is now obvious that the set of prices itself is relative with respect to the accounting formula. Hence, the interconnexion between the choice of the accounting formula and the problem of pricing needs closer examination.

But before entering into it one special aspect of this interconnexion seems worth noting. It is clear that in any project evaluation the result depends both on the adopted accounting formula and on the way the problem of pricing is solved. Owing to this, a kind of substitution emerges between the actual shape of the formula and the price relations. Starting from a given situation, we may obtain the same result either by changing the formula or by changing price relations. This fact shows its significance, especially when we have to deal in practice with simplified formulas and approximated, quasi-equilibrium prices. We shall, accordingly, return to it when discussing the problem of the price of capital.

2. *The meaning of shadow prices*

Given a particular chosen shape of the accounting formula, it is necessary to decide what value parameters are to be used for project evaluation.

One obvious possibility would be to use for this purpose the set of market prices. But, considering the general shape of the accounting formula, we see at once that the set of market prices would not suffice even in the technical sense: for some of the in-

[2] This general formula can obviously be rewritten in any continuous function of r (such as $r+1$), which may be more convenient to use but is no more than a technical alteration.

dependent variables, particularly on the benefit side, we could hardly find a market price at all (if, for example, one of the benefit variables is improvement in health); others, representing some kind of future outlay or benefit, would have to be valued at best at some expected future market prices, for which the current set would give no information. But even more can be said against the use of market prices. It is now commonly admitted that they do not properly indicate the actual social values of the relevant benefits and sacrifices, particularly with regard to situations involving the existence of substantial disproportions in the available amounts of various factors as related to aims. Current market prices serve different economic as well as social purposes. In this sense they fulfil several functions. As has been mentioned, they are certainly not equilibrium prices, at least from the long-term point of view. Yet, though faulty, they cannot be totally abolished or replaced for different reasons. This does not mean, however, that the current set of market prices could not possibly be replaced, at least in some respects by some other set of prices created for the purpose, which are subject to some institutional conditions. Such splitting of the "natural" functions of prices forms a basis for advancing the idea of designing and using a special set of prices for a precisely defined aim: to provide a yardstick for long-term evaluation of production factors allocation.

Theoretically, such indications of the actual social values can be found by means of programming techniques, in the form of so-called shadow prices. (For clarity, we shall be concerned here only with the linear form of programmes.) In terms of linear programming, these prices represent the set of parameters of the dual solution to a given over-all development programme. When using the previously introduced donations, we may present an over-all development programme in the general form of:

$$\sum_i q^i x^i = \max$$

subject to the condition $\sum_j b_j^i x^i \leqslant a_j$

and $x^i \geqslant 0$

where b_j^i is the technical coefficient showing the amount of the j^{th} factor needed to produce a unit of the i^{th} benefit item. The dual programme would then be:

$$\sum_j p_j \, a_j = \min$$

subject to the condition $\sum_i b_j^i p_i \geqslant q_i$

The solution of this dual programme gives the shadow prices of the factors p_j.

These shadow prices can now be used, in principle, for purposes of project evaluation, by applying them in the criterion-formula as factor values.

It will be noticed that, in the foregoing procedure for pricing, one set of value parameters—that for benefits—was treated as given, and only the set of factor prices was obtained by solving the dual programme. The possibility of treating both sets as unknown, although theoretically admissible,[3] will be disregarded here because so far it has no practical significance.

Thus, from the point of view of a given development programme, the set of shadow prices represents the value parameters that ought to be assigned to all the "sacrifices" (or simply factors, as the case may be) in order to give this particular programme its optimum solution. The shadow prices show the weight of each of the constraints of the given programme, so that in fact, they show the social values attached to each sacrifice item (or factor) within the given programme.

When using these prices for evaluating a new investment project in a given accounting formula, what we really do is compare the project (that is its benefits and sacrifices) with the conditions of the over-all development programme, out of which the shadow prices were obtained. If its net result, per unit of sacrifice, is greater than zero ($r > 0$ in our general formula), it shows that it would be worth while to readjust our programme in such a way as to include the project in question, instead of something that was previously included. Thus shadow prices, by showing the weights of the constraints, can also be interpreted in terms of showing the opportunity cost of each sacrifice (or factor), always given the development programme.

There is, then, a close link between the actual shape of the accounting formula used for project evaluation and the structure of the development programme which is used to find the shadow prices. Clearly, there would be no sense in evaluating projects by taking into account other aims (and other weights for them) than those that appear in the goal function of the development programme. The shape of the accounting formula must, therefore, reflect the shape of the development programme. The adopted simplification of the formula ought to reflect the adopted simplification of the development programme.

3. *Simplification with respect to aims*

As already stated, the technique of finding the shadow prices of a programme presupposes that the value parameters of the goal function are given.[4] With regard to the formula for project evaluation this can be interpreted in two ways.

It may mean, on the one hand, that, from the point of view of the planning body, all conceivable aims of development are treated as directly commensurable with and substitutable for each other, which would be equivalent to saying that the general aim of development is to maximize one well quantified magnitude (such as the value of the national product); in this case all new projects, irrespectively of the branch of activity which they represent, would be directly comparable with one other by means of the adopted value parameters for aims and shadow prices for factors. Or, alternatively, it may mean that because of the difficulty involved in treating all the

[3] Cf. O. Lange, "Optimal decisions", PWN, Warsaw 1964.

[4] However, the problem is open as to whether the shadow prices thus derived may themselves affect the subsequent process of aim evaluation.

aims as commensurable, the planning body has decided to resolve the general problem of optimum allocation into two groups of problems: (*a*) making a proper choice of directions of investment and (*b*) taking for granted certain directions of investment, making a proper choice of the combinations of factors for future production that are set in motion in carrying out new investment projects.

The latter approach seems nearer to the practical solution in development planning.

When thinking of any strategy of development in terms of building a development programme, the normal situation will be that of having a number of degrees of freedom in choosing the directions of investment. Hence, the decisions concerning this particular question must be arrived at, at least partly, by taking into account not only purely economic considerations. In the programme, such decisions acquire the form of certain constraints of the general type of $X^i \geqslant A_i$, where X^i denotes the future net output of a given good and A_i stands for the minimum amount to be produced. By treating such constraints as given, we are making allowance for the existence of non-economic factors in shaping the strategy of development, and the same time we eliminate the general problems involved in choosing the directions of investment.

Consequently, in our further reasoning, we shall disregard entirely the question of choosing value parameters for aims and concentrate on the second category of problems—that of the value parameters needed for a satisfactory selection of factor combinations in deciding upon investment projects. This means that, in our general formula for project evaluation, we disregard entirely the problems involved in evaluating the expression $\Sigma\, q^i dx^i$ and confine our attention to those of evaluating the expression $\sum_j p_j\, da_j$, more specifically, in finding the proper p_j's for all the kinds of sacrifices involved.

4. *Shadow prices and type of development programme*

There is no general rule about the appearance of a development programme. All we know is that any programme must consist of a number of constraints and of a goal function to be either maximized or minimized. The goal function is not at all the same in all cases of development planning. It must be chosen by the planning body. But, depending on the type of the goal function chosen, the shadow prices will acquire various economic meanings.

There are many possible types of programmes that can be used, depending on the way in which the function of social welfare is understood (or, rather, on the particular simplified form of this function that is chosen for practical purposes. It seems that nowadays there are strong reasons to treat as the main form of a development programme that which uses maximization of the national product as the goal function. The reasons differ for different types of countries, but the maximization of the national product is widely used as an approximation to the maximization of social welfare, whatever meaning is awarded to the latter concept.

However, this maximization of the national product can be considered as a goal either in a direct or in an indirect way. Because of certain difficulties involved in direct maximization of the national product, the goal function may sometimes take the form of minimizing social costs.

Thus it seems that there are two main types of programmes (and goal functions) used in development planning. One is the programme serving to maximize the national product which will be referred to further on as the *A*-type programme. The other is the programme in which the desired value of output appears as one of the constraints, while the goal function is that of minimizing the input of a given factor; this will be denoted as the *B*-type programme. Both types of programmes can be solved in such a way as to find the corresponding set of shadow prices. But in each case the shadow prices will have a different meaning.

Let us consider both possibilities with reference to an aggregated programme in which the factors will be represented only by two items, each of them homogeneous, called labour (L) and capital (K).

The *A*-type programme will then have for its goal the maximizing of the national product (as the sum total of outputs of various goods x^i), subject to two constraints given by the available amounts of capital and labour. This can be written as follows:

$$Z = \sum_i q^i x^i = \max$$

subject to

$$\sum_i b_L{}^i x_i \leqslant L$$

$$\sum_i b_K{}^i x^i \leqslant K$$

with

$$x_i \geqslant 0$$

From this, by writing the dual programme and finding its optimum solution, we can determine the values for $\dfrac{dK}{dZ}$ and $\dfrac{dL}{dZ}$ or their reciprocals. These will represent the marginal productivities of, respectively, capital and labour in the optimum. At the same time, they can be interpreted as shadow prices of capital and labour for this type of programme.

The *B*-type programme (or, rather, family of programmes) may be described as a programme where the goal is either capital minimization or labour minimization, while the other factor and the value of output are the constraints. It is easy to see that the shadow prices derived from this type of programme will represent the price of capital (or labour, depending on which factor appears in the goal function), in terms of its marginal rate of substitution to labour, or *vice versa*. Their general form will then be $\dfrac{dK}{dL}$ or the reverse.

Obviously, the terms "shadow price of capital" or "shadow price of labour" mean different things in each case. They acquire full meaning only when added to whatever type of programme to which they refer. Their similarity is only in the fact that, in each case, they reflect the allocation of productive factors in a development plan. But since in each case they reflect different objectives (although the initial situation may be exactly the same in terms of constraints), they necessarily differ in the kind of information they give. In the former case they indicate what prices ought to be charged to the factors in order to obtain a maximum national product, given the circumstances; in the latter case they indicate the optimum rate of substitution between capital and labour required to obtain a desired level of output, given the circumstances.

Since the two sets are conceptually quite different, they can quantitatively correspond only by chance. Still, there remains the question when or under what conditions a set of shadow prices derived from one programme is equivalent to such prices derived from another one. Given the same initial economic conditions and spectrum of techniques, the solution of the B-type programme would be equivalent to that of the A type only provided that the value of output used as a constraint in the B type is equal to the maximum of the focal function arrived at in the A type. But this can happen only by pure chance.

It may be taken for granted that in most cases the A-type programme would be most suitable for purposes of development programming. But then the question arises as to desirable degree of aggregation with respect to factors to the constraints of the programme.

The assumption of homogeneity of labour and capital obviously cannot be admitted for any purposes other than purely theoretical ones. Moreover, the assumption of a given structure of the product to be maximized creates its own difficulties for the practical approach. Thus the amount of information needed to build up and solve this type of programme is too great for any practical use of it to be possible.

Hence recourse is frequently had to the B type programme, which seems better suited for justifiable simplifications. In this sense, the B-type programme may serve as a substitute for the A type, although its optimum may be treated only as an approximation to the A-type optimum, if the maximization of national product is treated as the desired end in itself. It is only if we arrive at a maximum of the national product in determining the condition for a B type (minimizing) programme that the two solutions would be equivalent. But it would seem rather obvious that the procedure of arriving at a maximum of this kind in the B type models would be very cumbersome.

It must, however, be noted that the B type programme may, in certain cases, be treated as desirable for use not as a substitute for the A type, but on its own merits. In such a case the shadow prices of such a programme would preserve their full meaning, subject only to the simplifications of the programme itself and not having to be treated as a kind of substitute (and approximation) to those derived from the A type programme.

5. *Aggregation of the programme and use of shadow prices*

Since the shadow prices to be used in the formula for project evaluation are entirely dependent for their economic meaning on the type of programme chosen for the purpose of finding the optimum solution, it follows that the degree of aggregation of the shadow prices is also dependent upon the degree of aggregation of the programme. If, for example, we consider a highly aggregated programme of the A type formulated in terms of maximizing the national product subject to the constraints of capital and labour, what we obtain as shadow prices are aggregated value parameters for capital and labour (related to the national product). If, on the other hand, we consider an equally aggregated programme of the B type, where, say, minimization of labour outlay is the goal function, we derive from it the price of capital in terms of saving the labour outlay, that is, a rate of substitution of capital for labour. But if either of the programmes was to some extent disaggregated, for instance, if the capital constraint were presented in the form of several constraints, separately for various groups of capital goods, then we would be able to derive a set of shadow prices from the programme, a price for each of the groups of capital goods.

Let us concentrate on the example of the B type programme and think of the shadow prices in terms of rates of substitution between labour and capital. Of course, it would seem perfectly sound to [illegible] getting individual rates of substitution (capital labour) for every kind of investment goods. That is, we would have instead of one uniform rate p_k a set of rates, p_i, $i = 1, \ldots, I$.

Using one uniform rate would mean that in the accounting formula for project evaluation, the expression representing total cost would take the form:

$$\sum_i p_{pi} \ldots p_K \cdot K + p_L \cdot L$$

But, as p_K is derived from the B type programme as the shadow price of capital in terms of labour, p_L would equal 1 and the whole expression would be simplified into $p_K \cdot K + L$.

Similarly, with differentiated prices for various capital goods, the expression would take the form

$$\sum_i p_K{}^i \cdot K^i + L$$

where $i = 1, \ldots, I$ represents the number of separately treated capital goods. It would [illegible] be desirable to have the set of prices p_K. [illegible]

[illegible] practice of using [illegible] price of capital in terms of labour [illegible] substitution.

But [illegible] p_K [illegible] p_K [illegible] included in K. Therefore the formula [illegible] used in practice may be presented as

$$p_K \cdot K = p_K \sum_i p_i \cdot k_i$$

where k_i represent the quantities of [illegible] goods, while [illegible] their prices [illegible] general [illegible] p_K [illegible]

p_K is a shadow price of capital derived from the given development programme, while the question of finding all the p_i remains open. The practical solution is often to use market prices for the p_i.

A closer look at the practical formula informs us that the final result (the price of capital) is the product of a general price of capital and the prices of individual capital goods.

We may, then, arrive at the same price of capital in two different ways: (*a*) by using different prices p_i and a uniform p_K and (*b*) by using differentiated p_K rates.

The former way seems more practical: there exists always some set of prices more or less reflecting the supply-demand conditions, and the use of the uniform rate is more operational.

But the very observation of the existence of these two ways means underlying the fact, mentioned earlier in general terms, that there exists substitution between the shape of the accounting formula used for project evaluation and the set of prices used in this formula. It may even be safely said that this rule of substitution dominates the field of pricing in project evaluation. This means that, in determining the prices to be used, the shape of the accounting formula should be clearly kept in mind, and vice versa. This is sometimes overlooked by those who are anxious to stress one-sidedly the role of the price structure in project evaluation.

Furthermore, this observation shows that to use one [illegible] aggregated shadow price, such as the p_K in the example given above, [illegible] a satisfactory solution of the [illegible] of pricing [illegible] with market [illegible]. The ultimate effect is [illegible] happen that the [illegible] market prices [illegible] benefits [illegible] using the shadow prices derived from [illegible] aggregate programme.

[illegible] high degree [illegible] permit a high degree [illegible] limited relevance [illegible] with [illegible] fragmented [illegible] very imperfect markets and badly based [illegible]. Then shadow prices derived from such even aggregated models are of limited value.

B. [illegible]

The theoretical solution being known, the question arises how far it is possible to use the shadow prices in actual prices.

The attempts that may be observed all over the developing world to overcome existing structural imbalances and to lay firm grounds for future economic development lead necessarily to the elaboration of development plans. Obviously, too, Governments or special planning agencies will aim as closely as possible at the [illegible] of optimum programmes.

So far, however, it has been impossible to build up a detailed and, in a sense, infallible programme, owing to inadequate information or inability to process available information. Therefore, in practice, the value parameters that are to reflect a certain development programme can be nothing more than approximations to the ideal shadow prices that would be derived from a perfect over-all programme. Among the causes, the following may be cited:

(*a*) The programmes (and, accordingly, the accounting formulas) are simplified by disregarding some of the independent variables on both the benefit and the sacrifice sides;

(*b*) Production factors are aggregated into broad groups and simplified assumptions as to inter-factoral substitution are adopted;

(*c*) The methods of computation are far from precise.

To distinguish between the approximate value parameters that can be arrived at in practice from those that would be derived from an ideal model, we shall call the former "accounting prices" while reserving the term "shadow prices" for the latter.

There seem to be two main features of the actual methods of computing accounting prices as approximations to shadow prices. One is that they are derived from what may be called partial solutions. The other is that they represent aggregative value parameters and as such are subject to the qualifications made above with respect to aggregative shadow prices.

Something, however, may be said in defence of the aggregative value parameters when they take the [illegible] form of accounting prices, namely, that if they were to be disaggregated according to types of factors and time periods, they would have to be currently adjusted. But the very procedure of current adjustment is rendered unnecessary in respect of approximations of a broadly aggregative nature.

It has been observed that "despite the greater potential efficiency of planning decisions made by the use of accounting prices, they have rarely been calculated" and used in planning.[5] The reasons for such a state of affairs are obviously manifold. For instance, the concept of accounting prices is difficult to make plausible and acceptable to non-economists engaged in economic activities. This seems to be linked with an incomplete understanding of the role of planning in the development process. Actual practice in planning should be very useful here and seems to be quite promising. At the same time, accounting prices are not easy to calculate; there are sharp disagreements as to the approach and basis to be used for calculations; moreover, there is a lack of adequate data, and the acquisition of such data is a costly and time-consuming process. Finally, the application of accounting prices presupposes certain

[5] "The use of accounting prices in planning", by G. F. Papanek and Moeen A. Qureshi. Paper presented to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas (E/CONF.39/H/81).

practical conditions as regards economic organisation and policy which are not easy to meet.[a]

Notwithstanding these obstacles, and in the absence of detailed information that would be needed for setting up a comprehensive interindustry programming framework, various methods are suggested in which the rationale of the ideal analytical tool — a model of an optimal development programme — is attempted, to be followed by approximation.

Generally speaking, the essence of all simplifications is reduced to the fact that they are partial solutions. As an alternative to a solution derived from an over-all programme, partial solution means determining the accounting price for each factor separately.

This opens up to the planners a broad range of possibilities and dilemmas. First, they face the question which one of all the conceivable approaches to choose in a given situation and, secondly, how far to go in the refinement of a method to be applied.

As to the procedure, some rationalization stemming from practical experience might be observed in the behaviour of relevant planning authorities as regards the computation of accounting prices.

For example, it seems to be a rule that planners, if they use accounting prices at all, are anxious to compute the prices of those factors which are manifestly in shortage. Thus there are countries which are concerned, above all, about estimating the right rate for foreign exchange; others are most about the capital interest rate, and still others are primarily concerned about the wage rate. It is obvious that each of these approaches depends on the current economic situation and the way of viewing the present and future development of the domestic economy. The latter expresses itself also in the choice of time horizon as a basis for the computation of accounting prices. A close relationship exists between the institutional framework and the picking up process of approximate accounting prices. For instance, in a mixed economy an accounting price of a given factor can be picked up and some actual prices only checked against others. On the other hand, a centralized economy, owing to the uniform price rule, necessarily requires that accounting prices be derived from an economic model.

Although accounting prices, as we mentioned before, have been rarely calculated and even more rarely applied in developing countries, there exists a [illegible] and growing body of [illegible] experience and suggestions as to their [illegible].

It is beyond the scope of this paper to give a detailed and exhaustive survey of all endeavours [illegible] application [illegible]. However, it is possible to point out the [illegible] and approaches used to arrive at accounting prices applied in practice. Motivated by the most general feature of all these calculations — partial solution — we order this outline, first of all, according to the character of resources, that is, capital, labour and foreign exchange. Accounting prices of natural resources are not considered here, since they are computed in practice only sporadically.

1. Accounting price of capital

It is possible to distinguish three most commonly used ways of calculating an accounting price of capital.

(*a*) The first is approving one out of the existing "market" interest rates as a social rate of interest on capital. For instance, in Pakistan the discount rate (of the central bank) has been around 3-4 per cent, the interest rate charged by commercial banks ranges from 4-10 per cent, and [illegible] charge 25-40 per cent or more. However, it appears that at times industrialists and business men obtain funds from each other at rates ranging from 10-[illegible] per cent.[b] The last rate has been chosen on the ground of the [illegible] discount rate and the rates applied to government transactions [illegible] productivity of capital [illegible]. On the other hand, interest rates outside the organized money market tend to be [illegible] elements, high administrative [illegible] risk premiums. It might be possible, however, to find market interests that are [illegible] institutional factors. [illegible] the rate of 10-15 per cent has been regarded [illegible] tional factors and [illegible] rates obtained in some [illegible] way.

(*b*) Another method [illegible] which is indeed [illegible]. It consists of [illegible] multiple current [illegible].

The marginal productivity [illegible] as an accounting [illegible] taining the rate of return [illegible] for the marginal [illegible] calculations are feasible. [illegible] productivity of capital [illegible] taining the rate of return [illegible] ment industrial [illegible] those included in the development programme [illegible] noring [illegible]

[illegible]

[a] For instance, a developing country can take advantage of accounting prices only if there exists a sufficient supply of suitable industrial projects.

[b] G. F. Papanek [illegible]

Generally, the required information will be most readily available on proposed government investments with less [illegible] distortion. In addition, government projects are more likely to include some with returns that are marginal or close to it, since private enterprise will seek high profits while government will undertake some projects it considers desirable though less profitable. Industrial projects are also preferred [illegible] availability and manageability of data. Calculations carried along these prescriptions on the list of industrial projects proposed by the Government under the first five year plan revealed that the rate of return on the projects that could be included in the development plan ranged around 12-15 per cent including some important private investment.[10]

[illegible] accounting price of capital commonly used in a majority of centrally planned economies [illegible] marginal recoupment period. We have placed this method last in our list arranged in an ascending order of refinement of the most commonly used methods of computation of an accounting price of capital, first because this method has been used in several countries for some time and secondly because it has been derived in some interpretations explicitly from two factor model labour capital.

Marginal "recoupment period" represents the accounting price of [illegible] the purposes of [illegible].

Conceptually the notion of the marginal recoupment period stems from the necessity of deciding [illegible] comparing the investment outlay with the current cost [illegible]. It can be assumed that all possible technical variants of constructing the plant can be arranged in order of increasing investment outlay per unit of future product, which at the same time will mean a decreasing order of current cost of production per unit of the product, some technical solutions being disregarded as defective or ineffective. If we assume that the current cost of production is stated in terms of labour only and that there is perfect homogeneity both of labour (as representing current costs of production) and of capital (as representing investment outlays), then the problem is reduced to that of substitution of capital for labour [illegible] along the isoquant representing the desired future output. It is obvious that the solution selected will depend upon the constraints and the goal function of the programme. The solution arrived at will always be characterised by a certain rate of substitution between labour and capital. Given the constraints, the rate that can be adopted for the economy as a whole, when expressed in terms of the number of years necessary to repay the extra amount of capital by the annual saving in current cost, is the marginal period of recoupment.

The concept of the "recoupment period" used in socialist countries for investment project evaluation is sometimes understood as the time needed to recuperate the capital invested, assuming a given amount (in terms of aims) obtained annually.[11]

This understanding would classify the "recoupment period" among different simplified versions of criteria for project evaluation. It is, however, based on a certain confusion, resulting from formal similarity to the general formula of the criterion. In fact, the "recoupment period" can best be interpreted as reciprocal of the interest rate and thus not as a criterion for the choice of projects but as the price assigned to the capital invested.

Indeed, let us recall the general criterion for project evaluation in the form suggested by Professor Tinbergen:

$$\frac{b}{s} = \frac{\Sigma q_i dc_i - \Sigma p_j da_j}{\Sigma p_j da_j}$$

where b stands for the amount obtained (in terms of aims) from a given project and s stands for the cost of carrying out the project, the dc_i representing increments in various aims valuated at q_i while da_j denotes different cost items valuated at p_j. This formula can be simplified in various ways, one of them being such as to make b mean the annual increment in the value of (net) national product while s would mean total annual cost both of capital and labour needed to produce this increment, best understood on the assumption of the homogeneity of each of these factors. With this in mind let us write

$$s = Km + L$$

where K stands for the amount of capital outlay, m for the interest rate and L for the annual cost of labour. Instead we may also write

$$s = \frac{K}{T} + L$$

where T would mean the "marginal period of recoupment" as used in the practice of socialist countries. It is obvious then that T is not per se a criterion for project evaluation but a method of bringing capital outlay to a common denominator with labour outlay, that is, a way of expressing the price of capital.

What may be misleading about it, however, is the very name attached to it. The reason for using it becomes clear when we take into account that, when comparing two variants of a project which, to simplify the reasoning, are both characterised by the same value of b (increment in aim), we may use either of the following two methods:

(1) Using a standard value of the "marginal period of recoupment" find out the relation between the following two expressions

$$\frac{K_1}{T} + L_1 \gtrless \frac{K_2}{T} + L_2$$

which may also be written as

$$K_1 m + L_1 \gtreqless K_2 m + L_2$$

[10] Ibid.

[11] J. Tinbergen, "Project criteria" in Economic Planning, ed. by L. J. Zimmerman, The Hague, Mouton Hill

where $m = \frac{1}{T}$ is a standard rate of interest. Here we would tend to choose the variant with the minimum sum total of costs; or

(b) Use a direct way of comparing the two variants by finding the relation between the extra amount of capital needed to bring about a decrease in the labour cost, that is:

$$\frac{K_1 - K_2}{E_2 - E_1}$$

The above ratio may be interpreted, for any pair of variants, as the number of years in which the extra amount of capital $K_1 - K_2$ is going to be recuperated by the reduction in the annual cost of labour $E_2 - E_1$. Hence it may be called the 'individual recoupment period' for project 1 as compared with project 2 and may be denoted here by T'.

It is easy to see that, for any pair of projects, the magnitude T' represents a rate of substitution between capital and labour. If we imagine that all the projects for a given economy are presented in an increasing order of this rate of substitution, then we necessarily arrive at a maximum acceptable rate which is determined by the existing constraints with respect to the available amounts of both capital and labour. This maximum rate is nothing else but the 'marginal period of recoupment', denoted earlier by T. Thus to choose a variant it becomes necessary to fulfil the condition $T' \leq T$. In this sense, and only in this sense, the period of recoupment may be interpreted as a criterion for choosing investment projects.

It is of some interest to note that the capital interest rate (as the reciprocal of the so-called 'standard recoupment period') commonly used in centrally planned economies varies within the range of 15 per cent.

2. Accounting price of labour

It is well known that "a major difficulty in calculating the accounting price of labour stems from the fact that labour is a much less homogeneous and mobile factor than capital, and institutional considerations are an even more important source of imperfection in labour than in the capital market."[19]

It is commonly admitted that because there are various categories of unskilled, semi-skilled and highly skilled labour and their supply varies in particular areas and at particular times of the year, the only correct procedure would be to calculate the accounting price of labour separately for each set of circumstances. Evidently, this is not feasible nowadays. The pricing problem of labour in project evaluation is being solved in different ways in different countries.

There are countries in which the current market prices of labour, that is, actual wage rates, are used. Project evaluation men reason that, although the labour market is undoubtedly imperfect, actual wages to a considerable extent reflect differing circumstances with respect to skill, seasonality of work and the cost of social overhead facilities. This laissez-faire approach may prove satisfactory in smaller countries with a relatively high mobility of labour. Unfortunately, it is too often used in countries with obviously contrary conditions.

There are countries in which [illegible] adjust a project [illegible] some sort of accounting price [illegible] introducing [illegible] rates of correction of actual wage.

The first approach [illegible] into account the problem of the [illegible] labour. Labour [illegible] categories [illegible].

It is considered [illegible] market wage [illegible]. However [illegible] wage for these [illegible] main disparate groups [illegible] allocation decisions [illegible] accounting prices [illegible] manpower it is sufficient [illegible] rates for those [illegible].

Estimation [illegible] in developing countries [illegible] estimation of its marginal product [illegible]. This is so because the bulk [illegible] new industrial projects in these countries [illegible] agriculture [illegible] productivity of labour in agriculture [illegible] countries may [illegible] be zero [illegible] special cases [illegible] of its quantitative estimation [illegible].

Generally speaking, attempts [illegible] geographical labour [illegible] evaluation can be met more often. The method of reflecting labour [illegible] in wage rates used in accounting formulae may be illustrated by [illegible] of wage correction methods applied in centrally planned economies.

Two methods have been suggested of taking into account social costs caused by uneven [illegible] distribution, especially in those countries where the latter phenomenon is prevalent:

(a) The differentiation of wage rates in accounting formulae by regions according to labour market situation:

(i) In regions of labour shortage, current wage rates are to be multiplied by a coefficient greater than 1;

(ii) In regions of excess labour supply, current wage rates are to be multiplied by a coefficient lower than 1;

(b) The differentiation of the recoupment period in the accounting formula:

(i) In a region of labour shortage, the recoupment period in the accounting formula T' is to be longer than the 'standard recoupment period' $T' < T$.

[19] [illegible] and M. A. Qureshi, op. cit. (see footnote 5 above).

(ii) In a region of labour excess, T' is to be higher than T or $T' > T$

Both methods give the same results, as can be seen from the "basic" form of the accounting formula commonly used in some centrally planned economies

$$\frac{I}{T} + K = \min$$
$$P$$

where I = investment outlays
T = the standard "recoupment period"
K = production costs
P = output

3. *Accounting prices of foreign exchange*

Practical experience shows that the use of the accounting price for foreign exchange, for both cost and return side, substantially change the relative priority of some industrial projects.

Several approaches have been developed which, it is understood, can be applied in different situations in order to obtain the practically useful accounting price for foreign exchange. We confine ourselves in the following summary to only a few of the most important and interesting methods of its computation.

First, in an exchange system which relies exclusively on multiple exchange rates to maintain the balance of payments equilibrium, the weighted average [illegible] would give an [illegible] indication of the accounting exchange rate. Similarly, in a system with [illegible] exchange rate but with reliance upon tariffs and subsidies, the total amount of [illegible] duties collected plus subsidies paid out [illegible] proportion of total imports plus exports should indicate the under-valuation of foreign exchange [illegible] that there are no long-run gains [illegible] in exchange reserves. These approaches [illegible] direct control [illegible] foreign accounts [illegible] methods [illegible] the [illegible] calculating the accounting price of foreign exchange.

A second approach is based on the application of the purchasing power parity theory. This involves the [illegible] the accounting exchange rate from [illegible] in the country's price [illegible] period of time with that [illegible] other [illegible] which has approximate equilibrium in its [illegible] of payments and no reliance [illegible] restrictions. According to this approach the relative variation in the price levels in the two countries should be proportional to the relative variations in the exchange rates. The main limitations of this approach are: (a) it is difficult to find a suitable period for purposes of comparison, since one must start with a certain "normal" stage in the country's balance of payments; (b) price data are frequently neither adequately comprehensive nor sufficiently comparable; and (c) it takes no account of the fact that over a period of time economic growth and other changes can profoundly alter the structure of demand and of imports and exports of a country.

A variant of the above approach is to compare prices in the country and in the world market for the major domestically produced and consumed commodity or commodities and derive the exchange rate from their relationship. This is, if the country primarily produces and consumes rice, and the price of rice is 1,000 monetary units per ton while it is \$200 per ton on the world market (cif), one would conclude that the accounting exchange rate should be five units to the dollar. A comparison of goods that are largely imported or exported is not of much use for this purpose since their international price and the official exchange rate are the main determinants of their domestic price. This method is therefore useful only when: (a) the country itself produces and consumes one or a few commodities that make up a substantial part of the gross national product; (b) these commodities are traded internationally but are not major imports or exports for the particular country; and (c) there are no serious problems in comparing quality. Even so, the method has substantial weaknesses, since the prices of domestically produced and consumed commodities are often strongly influenced by institutional and other domestic factors which introduce price distortions.[18]

Thirdly, the extent of the necessary adjustment in the actual exchange rate can be obtained by looking at the profitability of exports and imports especially [illegible]. As an illustration of such an approach we shall quote extensively the method applied in Israel.[19] This method rests upon imputing an accounting price to capital and labour and comparing products on the basis of the implied cost per unit of foreign exchange. In practice, and in the absence of better information, labour is valued at its market price and capital is imputed some rate of interest equal, say, to the real marginal cost of foreign borrowing (8 per cent is the accepted government practice). In principle one should then compute the implied cost in domestic resources per unit of foreign exchange earned (in case of exports) or saved (in case of import substitutes) with an [illegible] measure of the accounting exchange rate. If the latter is unknown, all one can do is to list products by order of increasing exchange cost and [illegible] in an upward direction until investment [illegible] exhausted. By [illegible] we confine ourselves to the case of exports.

More specifically, if we suppose that the commodity [illegible] has been broken down into its primary [illegible] and indirect input components, with all [illegible] dollar cost items, including raw material replacement and [illegible] interest on foreign equipment, and [illegible] domestic Israeli inputs components kept [illegible] denote these by C_x

[18] [illegible] Kaparek, op. cit. (see footnote 5 above).

[19] "[illegible] investment allocation criteria under disequilibrium [illegible]" by Michael Bruno, prepared for the [illegible] Conference on Criteria for Investment Policies, Geneva, 1962.

[18] Clearly, if the accounting prices of the various factors were guessed correctly, this method should give the same result as the previous "social profit" calculation.

DIVISION OF PRIMARY INPUTS INTO REAL DOMESTIC AND IMPORTED COMPONENTS

(Auxiliary table for computations)

Total item	Domestic component (C_L)	Foreign exchange component (C_e)	Remarks
1	2	3	4
Breakdown of capital stock			
K_1 — Imported equipment		K_1	
K_2 — Domestic equipment	$+0.80\,K_2$	$+0.20\,K_2$	Based on import component of equipment sector
K_3 — Structures	$+0.86\,K_3$	$+0.14\,K_3$	Import component of structure branch
K' — Inventories	$+0.60\,K'$	$+0.40\,K'$	Import component of change in inventory in 1958
$K_1+K_2+K_3+K'$ = Total capital stock	K_L	K_e	Definition [illegible] above
Costs entering the profitability calculation			
$0.08\,(K+K')$ = Accounting profits	$0.08\,K_L$	$0.08\,K_e$	Based on the 8 per cent profit assumption
D — Depreciation	D_L	D_e	Allocated according to capital[a]
M — Imported raw materials		M	
W — Compensation of employees[b]	W		
$C_e + C_L$	$C_L = 0.08\,K_L + D_L + W$	$C_e = 0.08\,K_e + D_e + M$	Total real [illegible]

[a] Clearly the depreciation rate of the two components of capital [illegible] the same but the error involved in this simplifying assumption [illegible].

[b] We here assume that the market price of labour reflects the real [illegible] involved.

and C_L respectively, all in terms of a commodity unit in domestic prices,[10] then the above table sets out the ingredients of this calculation in a schematic fashion which, we hope, is self-explanatory.

The ingredients of this calculation might be clarified by relating them to the usual exhaustive breakdown of a commodity unit into its primary direct and indirect cost elements: imports (M), compensation of employees (W), depreciation (D), remuneration of capital (P), and taxes net of subsidies ($T-S$). We have

$$M + W + D + P + (T - S) = 1$$

Comparing this identity with total real social costs (domestic + foreign) as derived from the individual components in the above table, we obtain

$$C_L + C_e = 0.08\,(K + K') + M + D + W = 1 - (T-S) - (P - 0.08\,(K + K'))$$

In other words, the difference between total real social costs, as here defined, and total inputs (resources) as defined in the national accounts, lies in the subtraction of net indirect taxes (which do not constitute costs for society) and of the excess remuneration of capital, where the latter is defined as the difference between the actual remuneration of capital and the imputed 8 per cent, as we regard any such "surplus profit" as a transfer payment and not as a real cost item.

All we need now is an estimate of what the unit of commodity in question would fetch on the foreign market. Denote this by R_e, which again in this case was evaluated in I£ at the existing official exchange rate (1.80 I£/$). The cost per unit of foreign exchange earned on that commodity is then [illegible]

$$r_e = \frac{1}{R_e - C_e} \cdot 1.80\ \text{I£/\$}$$

For purposes of illustration this measure was here worked out for a forty-two branch breakdown of the economy in 1958, based on an input-output table of the same order of detail. For planning purposes much greater detail would be required.

Still another method of computation of the accounting price of foreign exchange was suggested in Poland by M. Kalecki and S. Polaczek.[11] The ex-

[10] In the following calculation, based on a 1958 input-output table, C_e is expressed not in dollars but in Israeli pounds converted at the then existing official exchange rate of 1.80 I£/$. The latter was raised to 3.00 I£/$ in February 1962.

[11] *Gospodarka Planowa* 1957 No. 4. In the course of a subsequent discussion, several refinements were suggested, also by the present authors. The main approach remained, however, unchanged. It is presented here in a generalised form.

change rate is obtained, when starting from any initial situation, by comparing the value of a possible extra amount of foreign exchange to be earned (or saved) with the corresponding increase in home market supply needed because of the rise in total wage fund caused by the effort to earn (or save) this extra amount. The increase in the home market supply involves a certain loss of foreign exchange which corresponds to its content of raw materials (either in the form of extra imports or of a fall in exports of raw materials). The latter foreign exchange input to the home market supply is directly comparable to the extra amount earned (or saved), provided that the input per unit of market supply is independently estimated. The rate of exchange obtained in this way depends both on the initial situation and on the situation aimed at. If the initial situation is that of an equilibrated balance of payments, and we aim at preserving this equilibrium, then the result is obtained by assuming that the amount of foreign exchange earned (or saved) must be equal to the additional input of foreign exchange needed to raise the home market supply appropriately. This method of computation seems to be particularly suitable for situations in which foreign trade is administrated mainly by means of direct control, with the state monopoly of foreign trade as the extreme case.

C. IMPACT OF THE INSTITUTIONAL STRUCTURE ON THE USE OF ACCOUNTING PRICES IN PROJECT EVALUATION

Having overcome all the difficulties involved in arriving at some manageable set of accounting prices, the government body in charge of designing and implementing development policy faces two serious problems concerning the application of accounting prices. The first relates to their immediate use for project, especially industrial project evaluation. Any really economy-wide application of accounting prices requires the creation of a suitable information and inducement mechanism able to bring in line all investment decisions at various levels. We can expect that this mechanism will depend largely upon the institutional set-up.

On the other hand, the set of accounting prices arrived at might be used as one of the very important guidelines for an eventual improvement of the market price structure. This aspect of the use of accounting prices must be emphasized, since it is frequently neglected. The use of accounting prices as guidelines would indicate that it was possible to [illegible] set to a [illegible] price set only by a process of trial and error. The use of accounting prices as one of the guidelines for price reform can be of particular importance in countries where at certain time periods there occurs a high concentration of major investment decisions which are bound to determine the future course of economic growth, and also where individual investment decisions are more susceptible to price fluctuations.

1. *Investment decision models*

In any institutional set-up project evaluation constitutes an important element of investment activities. The difference between different set-ups is that of criteria and procedures of evaluation.

To begin with, two extreme investment decision models may be distinguished: that of a market economy and that of a centrally planned economy. Here we shall call "market economy" an economy in which all the investment decisions are made entirely by individual decision-makers, no central strategy for development existing at all. In this case, the individual decision-makers have no alternative but to make their decisions on the basis of: (*a*) current market prices; (*b*) expectations as to future price changes. The outcome of their decisions is a certain development path of the economy, which brings about a definite set of prices after a certain period. Thus, in such a model, we have to deal, for any period of development under consideration, with at least three sets of prices:

(i) The initial set of current market prices;

(ii) The expected set of market prices (which, of course, may not be uniform because of different price expectations of the individual decision-makers);

(iii) The real future set of market prices.

It is the divergence between (ii) and (iii) which leads to the emergence of undesirable maladjustments which possibly may prove some investment decisions to be false. It is unnecessary to enter into this point here.

The other extreme may be conceived of as a fully centralized economy in which no use at all is made of price calculation in its practical investment decisions.

All investment decisions are made by a central board which forms both its entire strategy of development and its judgements about different investment projects solely on the basis of physical balancing. Clearly, certain price sets can be deduced from these decisions, but they are not made an actual instrument of decisions. This decision model offers no practical possibility of optimization and, beyond that, it may be thought of as workable only in very specific circumstances.

Against the background of these two extremes it may be said that neither of them fits nowadays into any kind of reality. The real case lies somewhere in between: it embraces both the central board and the individual decision-makers. The central board is the body responsible for elaborating an over-all development plan; the individual decision-makers are the bodies responsible for particular investment decisions. The difference between particular cases consists in the different endowment of the central board in the matter of instruments for influencing the decisions of the individual decision-makers so as to make them conform with the over-all strategy.

It may be safely assumed that, in any type of economy, the reason for preparing a development plan is to try to carry it out, but this proves to be more or less difficult because of the more or less unsatisfactory degree of manageability of the economy, which in turn has different causes. The non-manageability of the economy means that the decisions of the individual decision-makers are not easily influenced in the desired way by the measures available to the central board. Thus, in any type of economy, provided only that the central board exists and elaborates a certain strategy of development, it must strive to affect efficiently the decisions of the individual decision-makers by:

(*a*) Giving them as much information as will make their decisions consistent with the over-all strategy;

(*b*) Influencing them to use this information in their investment decisions in a socially desirable way.

For the sake of brevity, let us call task (*a*) "information", and task (*b*) "inducement".[18]

Since, by definition, by "market economy" we mean an economy without a central board, we may exclude it from further consideration. It may, however, be worth while to show that, even in this type of economy these two tasks are performed: the individual decision-maker gets both his information and his inducement from the "invisible hand" of the market. This information is imperfect because the invisible hand does not prepare any development plan.

What remains to be discussed is a planned economy in which investment decisions are to some extent decentralized and a mixed economy. The difference between them is in the existence or non-existence of the private sector. In other words, the individual decision-makers may be either public or private enterprises or both. But this does not bring about any great difference to the main economic problem of the central board: how to provide the optimum information to the individual decision-makers. It only affects the techniques of inducement.

The problem of how to prepare the necessary information was treated at some length while discussing the methods of computation of both shadow and accounting prices. Obviously, however, the best information is not enough. In other words, the problem of how to arrange adequate inducement must necessarily arise even if we are dealing with a perfect set of shadow prices (such as can be imagined only in theory).

Let us stress that, in an economy designed by the central board, the accounting prices are to play the same role in investment project evaluation as that played by the expected set of market prices in a market economy. That is, then, the direction in which the inducement mechanism should work. Its efficiency in this particular respect depends on the institutional set up of the economy.

[18] Some developing countries have been subject to repeated [illegible] bursts of price inflation. Such inflationary processes may serve as a serious impediment to efficacy in performing those two tasks. Thus inflation strongly influences two groups of problems connected with project evaluation:

(*a*) It decreases accuracy of predictions of future price trends which preserve their importance when aggregate [illegible] and relatively stable accounting prices are used; this may lead to the falling off of investment;

(*b*) It can seriously reduce the efficacy of the price system as an essential part of the inducement mechanism.

In both cases inflation means increased uncertainty of project and programme evaluation.

2. *Influence of specific investment decision models on the role of accounting prices*

Assuming a given system of information transmitting the strategic ideas of the central board to all the individual decision-makers, the actual system of inducement necessary to make the individual decision-makers use this information in the proper way depends on certain features of the institutional set up of the economy. It seems helpful to distinguish two broad cases: the case of the submissive decision maker and the case of the resistant decision maker.

By a submissive decision maker we mean a low level projecting unit which has no reasons of its own to be unwilling to act according to the information obtained from the central board. In other words, having no individual goals of its own, it is willing to act according to any information received from the central board. It will be understood that such a situation of the individual decision-maker vis-à-vis the central board can hardly be imagined in practice in its pure form. We can, however, think of real cases which are relatively near to it. This happens when the individual interests of the decision maker can have only minor influence on the nature of its projecting work and choices.

By contrast, the resistant decision-maker is the projecting unit which has strong reasons to act according to its own goals instead of submitting to the information received from the central board. It has its own understanding of the current economic situation, its own expectations and its own methods of calculation. An obvious example of the resistant decision maker would be the private firm in a mixed economy. This, however, is by no means the only possible example. The situation is very similar in a planned economy based on public investment, if the investment decisions are to some extent decentralized. The public decision maker may then have its own goal, although differing from that of the private decision maker, but making him resistant enough to the information coming from the central board.

Let us consider first the case of the submissive decision maker. This arises when, owing to the institutional set up adopted for the management of the public sector, investment projects are prepared by special units (projecting agencies) which are entirely disinterested in the future performance of the new plant built according to their projects. The split between projecting work and future economic performance makes the project maker [illegible] to any information coming from the central board. He is entirely uninterested in the particular [illegible] which he uses in his projecting work and in the particular method [illegible] to compute the effects of different project [illegible] is instructed to use the decision [illegible] prices and the criteria [illegible] central board [illegible] is supposed to act on the [illegible] whatever the prices or criterion chosen by the central board. [illegible] they reflect adequately the over-all strategy of development and there would be no ground for using any other data such as current market prices. It is obvious that because of the [illegible] submissiveness of the individual decision-maker, such an institutional system requires high efficiency on the part of the central board in preparing the necessary information. The set of prices given by the central board to the individual decision-makers must indeed reflect very adequately the strategy of development, since otherwise the investment choice made throughout the economy would necessarily become more or less blind.

Thus in the case of the submissive project-maker, accounting prices, as the instrument of information, acquire an absolute meaning in the sense that any set of accounting prices prepared by the central board has the same kind of influence on the actions of the individual decision-makers.

It should, perhaps, be noted that an endeavour to create an institutional system of submissive project-makers has been characteristic of the centrally planned economies with respect to all major investment decisions. On the other hand, minor investment decisions have been decentralized in the sense of being left to individual enterprises. Thus a certain combination of the two cases is, in fact, typical of the practice of a centrally planned economy.

Coming now to the case of the resistant decision-maker, we may simplify the picture by reducing it to the problem of disparity between accounting and market prices. Let us suppose that the information coming from above to the individual decision-maker consists of a set of accounting prices (or, alternatively, of a set of coefficients to adjust market prices, which makes only a technical difference). The individual decision-makers, because they have goals of their own, are inclined to use, in making their choices, the sets of current and expected market prices. The question then arises for the central board of what to do in order to induce the individual decision-makers to use accounting prices instead of market prices.

This question offers wide scope for discussion. The obvious, although crude, way of influencing the decisions of the individual decision-makers is to use tax-subsidy devices to account fully for the disparities between the two sets.[18] What seems important, however, is the necessity of understanding this method in a more indirect way also.

For example, the subsidy intended to induce greater use of unskilled labour (because accounting prices are much lower than actual market prices) must not be paid out directly to the firms. It can also take the form of policies tending to bring down the market price of such labour, for example, through a deliberate policy of low food prices.

Let us consider the simple case when the correction of market prices is limited to the exclusion of taxes and subsidies. Suppose that in a given country cement is taxed at the rate of 10 per cent. By eliminating this tax, we want to pass to the individual decision-makers the information that, from the social point of view, it is advisable to use more cement in their investment projects (as compared, with, say, steel or timber) than it would seem from the relations of market prices. Indeed, if we have to choose between a project that consumes more cement and one that consumes less, other things being equal, we shall choose the latter when using accounting prices, but the former when using market prices.

But what inducement are we to offer to the individual decision-maker so that he will actually choose the project which consumes more cement? The answer is that we must subsidize the use of cement, either directly or indirectly. Direct subsidizing will mean simply repayment of the tax paid by the individual decision-maker on cement. Indirect subsidizing will mean, say, charging an extra tax on steel. But then we want the individual decision-maker also to use as much steel as would be indicated by its tax-free accounting price. In other words, we would have to repay the tax on steel in some form. This brings us to the conclusion that, in order to bring into play all the necessary inducements for the individual decision-maker to shape his demand in a way reflecting the social cost structure (approximated in the tax-free accounting prices), we would have either to remove all taxes and subsidies, in which case the reasoning works the other way round or, at least, to bring all the market prices, by our policy of taxes and subsidies, to exactly the same relative proportions as those existing among the tax-free accounting prices. Thus the use of accounting prices by individual decision-makers involves a broad and complex fiscal policy.

[18] The possible use of tax-subsidy devices raises the question how far it is advisable to use the frequently suggested short cut method of obtaining a kind of accounting prices by eliminating from market prices the taxes and subsidies imposed by government on certain goods, as they have nothing to do with the cost structure.

XIV. SHADOW PRICES IN INDUSTRIAL PROJECT EVALUATION

by J. S. Flemming and M. S. Feldstein*

Introduction

The economic context

The economic context of this paper is essentially pragmatic. Although the analysis is relevant primarily to developing economies in which under-employment and disequilibrium are particularly prevalent, it is by no means restricted to them. Indeed, we assume throughout the existence of a substantial private sector, so that the diversion of resources to the public sector from the private one, the impact on the private sector of public projects, and the allocation by the Government of resources to the private sector for specific projects are all relevant problems.

Furthermore, despite the frequent occurrence of imperfect competition and the existence of taxes and subsidies affecting resource allocation, we shall assume that market prices provide a starting point and a framework for evaluating social benefits and costs on the basis of which more sophisticated shadow prices can be developed.

The administrative context

In addition to an economic context, the paper requires an administrative framework. Central to our analysis is the "planning agency"; this is the body which evaluates projects typically presented from outside, although it may participate in the selection of potential projects for detailed design preparation.

Individual projects, once approved, are assumed to be handed over for operation to managers who may be in either the public or the private sector and whose objectives cannot be assumed to be identical with those of the planners.

The function of the planners themselves can be divided between "project analysis"—the application of economic reasoning to the evaluation of various alternative projects—and the more nebulous tasks of taking decisions which have substantial value implications. We would expect the planners to concentrate on defining the areas in which such decisions were required and to seek guidance from a political level. Nevertheless, we shall refer to "planners' values", meaning values applied by the planning agency which may or may not have originated there.

Reasons for shadow prices

In subsequent sections we discuss the uses of shadow prices and their calculations in particular situations. It is useful here to give a general classification of the circumstances in which they are likely to be necessary.

Where changes in an economy occur so rapidly that the market mechanism fails to adjust, the disequilibrium prices will not reflect true social costs and benefits. It may be possible to calculate equilibrium prices and use them for certain decisions before those prices would have been attained in a free market.

Another case of the inadequacy of market prices occurs with projects which are necessarily large and indivisible. In this situation the project may cause market prices to change, so that it may not be possible to find a single unambiguous market price with which to measure the value of inputs or outputs.

A third reason for using shadow prices instead of market prices is the existence of monopolistic elements in the market, or taxes and subsidies, which cause market prices to diverge from the proper measure of social benefits and costs.

Finally, there is the case in which only a part of the effects of a project can be associated with an exchange of money. There may be either benefits or costs which, for technical, administrative or social reasons cannot be sold or, in the case of costs, paid for in the usual way. Nonetheless such external effects should be evaluated at shadow prices so that they can be taken into account in project evaluation.

A. Basic concept of efficiency prices

1. *Shadow prices*

A shadow price is any price other than an observed market price. For what purposes can such prices be used? Essentially there are three roles for shadow prices: for doing separate accounting in a large organization, where an entity which is being accounted does not buy its inputs or sell its outputs in the open market; for investment and pricing decisions of an entity where it is desired to apply a criterion other than profit or revenue maximization or cost minimization at market prices; and for constructing a set of incentive payments for managers or workers, so as to induce them to operate in a way that accords with given social criteria.

Formally, shadow prices may be identified in the mathematical problem of maximizing or minimizing, subject to constraints as the increase in the optimum value of the maximand (or decrease in the optimum value of the minimand) as made possible by a unit change in a constrained variable. Thus the

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shadow price is the Lagrangian multiplier of the calculus or the values of the "dual" solution to the linear programming problem (see below, section E(1)).

2. *Accounting prices*

Accounting prices are shadow prices which meet a certain standard of administrative feasibility. For example, if one were to price electricity on a strictly marginal cost basis, the optimal shadow price would vary continuously with the scale of load and its geographical distribution. For administrative reasons, it might be laid down that not more than three separate time-of-day prices could be used. Given this constraint, one could then, in principle, identify the optimum set of prices and the periods for which they should operate.

Ideally, the administrative costs imposed by the structure of shadow prices should be specified and the optimal set and structure of prices calculated so that the total efficiency of the system, including the administration, is maximized. In practice this is not likely to be possible and we must accept the probability that, in any context in which we wish to use shadow prices, relatively arbitrary constraints on the structure of the prices will be imposed.

It is important to notice that the best accounting price will depend on the level of output, which will itself depend on the actual prices charged. Thus, accounting prices should be related to the shadow prices appropriate to the market conditions that actually will prevail if the project is operated. In this paper we consider the theory of these sub-optimizing shadow prices; in practice it is to these latter prices that attention should be given in formulating accounting prices.

3. *Incentive prices*

A manager might be required to maximize his accounting profit. If the planner has any reason to believe that managers have any persistent bias tending to reduce their efficiency in doing this, it may be desirable to make the manager's remuneration a function of "accounting profit". The incentive effect could be strengthened if the bias of the manager were taken into account in calculating accounting prices. Suppose, for instance, that managers of building sites are found not to utilize machinery sufficiently to maximize the "accounting profit" of the planners; it may be effective to lower the "incentive price" of machinery to the site manager below the "accounting price" used by the planner.

4. *Assessment of private projects*

The use of shadow prices in project evaluation where those making the assessment will not have responsibility for recurrent decisions poses several special problems. To evaluate the project, the costs and benefits of the project in each year must be estimated at appropriate shadow prices. The value of the project assessed in this way will always be maximised only if the subsequent operational decisions are taken on the basis of the same set of shadow prices. Yet in many cases, especially where planners are assessing the claims of a private enterprise to some scarce resources allocated by the planners, it will be known in advance that this will not occur. Thus, in general, the level of subsequent inputs and outputs will have to be predicted or calculated on the basis of the expected behaviour of the subsequent operators. This might affect the priority given to different projects. For instance, in general, input flexibility is a desirable characteristic of projects. However, if the planners attach a low shadow price to labour, it may be more desirable that a private—profit maximizing—firm should adopt an inflexible process with a fairly high labour intensity than a more flexible process compatible with a wider range of labour intensities. This follows if we recognize that the latter should be evaluated on the assumption that it will be operated at a lower labour intensity by the private firm than it would be by operators who were maximizing profits at the accounting prices of the planners.

5. *External and internal shadow prices*

It is useful to distinguish between "external" and "internal" shadow prices. The first type are those which might reasonably be laid down independently of the particular project being evaluated. Examples of external shadow prices would be a general directive to take labour as free, or to use a certain set of discount rates. On the other hand, internal shadow prices are derived from the characteristics of the particular project. One example is the "transfer price" between different sections of a single complex project. This might be quite important if one attempts to design each component of the project optimally rather than assessing a single design by an "accept/reject" criterion. Another case arises with the selection of construction schedules. Suppose that phase 1 of a project requires a certain site plant which will also be required in phase 3 and that none of this plant would be used on phase 2 if it were costed separately on a weekly hire basis. The fact that the plant is there means that it could be used at little extra cost. It should be apparent that internal shadow prices are relevant only at the project design and work scheduling stages rather than at the stage of appraisal of a "given" project.

B. Project outputs

Before looking at the problems of assigning shadow prices to project outputs it is worth-while considering the problems involved in identifying the set of direct and indirect benefits (outputs) associated with any project. Benefits may, of course, accrue even if there are no associated revenue receipts. In discussing the activities of private firms, it is customary to refer to the benefits (and costs) which do not produce revenue (and money costs) to the firm as spillovers or external economies (and external diseconomies). In the public sector, where the primary output of a project may yield no revenues, the nature of spillovers and externalities becomes blurred. It is nevertheless important that the effects on those not directly served by the project be taken into account. For example, a hydroelectric power plant may produce irrigation and flood control. In addition to the direct and indirect benefits provided, the project may also have the effect of ensuring that certain products will be available if they are wanted in the future and of decreasing certain risks which individuals previously had to bear. Availability itself, and the avoidance of risk may both be considered of value.

Although it is necessary to avoid omitting any benefits and costs, it is equally important to avoid double-counting them. Three types of benefit double counting mistakes have been made in cost benefit studies. First, a benefit stream and an associated change in an asset value may both be counted. If land is irrigated, an increased crop may be grown on the land; this raises the value of the land. Only one of these should be counted as a measure of the value of the irrigation. Secondly, a "national income accounting" mistake may be made by summing the value of intermediate products rather than looking only at the net value at each stage. Thus, irrigation may produce more wheat, which produces more flour, which produces more bread; it would certainly be inappropriate to look at the sum of the additional sales at all three stages. But a third type of error is made by counting the bread instead of the wheat. The value added between the wheat stage and the bread stage is (except in an economy with substantial unemployment or market imperfections) associated with an equal decrease in value elsewhere in the economy.

When the physical quantities of the benefits of the proposed project during each year of its life have been estimated, it is necessary to assign shadow prices to them. For simplicity, we take as the basic unit of measure that which corresponds to the money prices of consumer goods sold in competitive markets in the economy. This allows us, under suitable conditions, to use the money prices at which project outputs are sold as appropriate shadow price measures of their social value. Consumer prices are suitable when the project output is sold in a competitive market and in a small enough quantity that the market price is not affected by the incremental output. The competitiveness of the market does not require that exactly the same product be sold by a large number of other producers but only that there are competing close substitutes and/or ease of entry into the product market. Thus a government fertilizer plant adding only slightly to national supply might generally take its selling price as an appropriate measure of the output's value.

In the remainder of this section we shall concentrate on methods of evaluating benefits when market prices are not appropriate. It will ease analysis to consider separately sales to other producers and to final consumers.

1. *Intermediate benefits*

Projects often produce benefits which accrue to producers rather than directly to consumers. We may call these intermediate benefits to stress their similarity to the intermediate products of microeconomic theory. Four approaches to evaluating intermediate benefits may be distinguished.

(a) ***Market price paid for substitutes already sold under suitable market conditions.*** If private producers previously used coal and now substitute electricity produced by a project, the value of the substituted electricity is the decreased coal costs or, equivalently, the amount firms are willing to pay for the electricity. While in the case of electricity which is sold to the firms, it is not necessary to use a roundabout measure in terms of decreased alternative expenditure, there may be other benefits (such as irrigation) that are not sold but that replace private activity. The problem is more complicated if the quantity used of the new product is more than sufficient to replace the previously used input (see (c) and (d) below).

(b) *Social cost of substitutes already used.* A benefit distributed to private producers which permits a decrease in some alternative input for which these firms did not previously pay an economic price (for example, substituting road transport for subsidized rail transport) should be valued at the marginal social cost of providing the previous service; that is, the decrease in social cost due to smaller demands now being placed on the railways. Again this is suitable only to the extent that the new service does not provide more than a substitute for the old.

(c) ***Minimum cost of alternative inputs not already used.*** We are led naturally by the previous two approaches to ask: if the project produces benefits which more than replace a firm's previous inputs or expenditures, how shall these extra benefits be valued? One possibility would be the minimum cost for which the firms could have obtained equivalent factor services before the project. If the project produces electricity and the previously cheapest source of fuel was coal, we may estimate the cost of the coal that would have been necessary to provide the additional heat and power now obtained from the electricity. It must be emphasized that this over-estimates the value of the additional electricity and should be considered only as an upper limit to its value.

(d) *Indirect evaluation.* When the project outputs are used by firms not merely to replace a previous input but also to increase their output, it may in some cases be possible to estimate the physical increase in output due to the additional input. Past experience, engineering or agricultural technology or statistically estimated production functions may indicate the appropriate relation. The increased output of these products can then be valued at the market prices at which they are sold, or, if they are final consumer goods, [illegible] below.

2. *Consumer benefits*

We now consider the method of assigning shadow prices to those benefits which accrue directly to consumers. These include not only the output products and services of all enterprises but also the external benefits that individuals may enjoy because of a project. For example, improved rail transport may benefit not only its users but also those who will enjoy less congested roads. The time saved by road-users and the decreased motor vehicle costs must therefore be brought into the evaluation of the rail service improvement.

Those products or services which the project sells to the public in direct competition with a large number of other sellers, and in such quantities that the market prices are not influenced by the additional output, may be valued at market prices. Although these requirements are unlikely to be met for many public projects in developed economies, many developing countries may sponsor projects that produce consumer goods for sale on the domestic market.

When market prices are not appropriate, we must consider a method of finding shadow prices. The first three approaches discussed above in relation to intermediate benefits, may also be applied to final consumer goods.

(a) ***Market price paid for substitutes already sold under suitable market conditions.*** This may not be substantially different from selling a product in competition with private producers of the same product, in which case the shadow price obtained would be equivalent to the product's selling price. But two cases arise in which it is necessary to look at the market price paid for substitutes. First, if the product of the project is not sold, the relevant criterion is the saving on previous substitute purchases. Secondly, the quantity of the product sold may be such that the selling price is substantially different from what it would have been had the project had a much smaller output: a measure of the value of the project's output to its intramarginal consumers is given by the prices which they previously paid to achieve the same satisfaction. It must be emphasized that this method assumes that all output simply replaces previously purchased goods (for example, a substitution of electric heating for coal heating), and that consumer demand for the type of good (heating) is completely price inelastic. When project output does more than replace a previous consumer good but is not sold in a competitive market, we must be able to estimate the value to consumers of this incremental output. This is discussed in (c) and (d) below.

(b) ***Social cost of substitutes previously used.*** If the good or service previously used had a social cost higher than its market price, that social cost should be used to measure the value of the replacement. The relevant cost is the marginal or escapable social cost, that is the saving due to the replacement of the old good by the new. Even if the consumers valued the old good less than its social cost, the relevant value for the replacement is the reduced resource use and not the consumer satisfaction.

(c) ***Minimum cost of alternative provision not previously used.*** As already explained in paragraph 1 (c) above, an upper limit to the appropriate shadow price of a net increase of a good can be obtained by measuring the lowest cost alternative method of providing the same consumer good or service.

(d) ***Willingness to pay (surplus criterion).*** In general, we try to shadow-price the project's output in terms of the amount consumers would be willing to pay, regardless of whether or not they are actually made to pay. This underlies each of the approaches mentioned above, except for the case where consumers had previously been paying less than the social cost of providing the good or service.

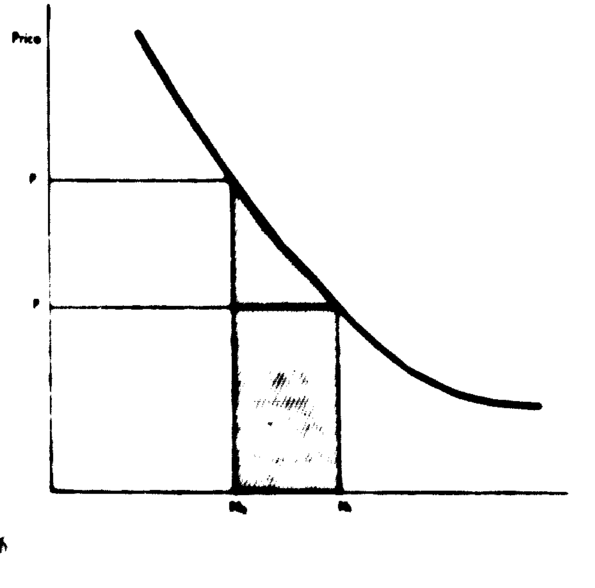
Difficulty arises in applying the "willingness to pay" rule whenever the good is sold but the project output is large enough to cause a fall in price, or the good is not sold to those who benefit from it.

Consider a project that produces shirts. Figure 1 represents the demand curve, DD, for shirts and shows the price (P_o) and output (N_o) prevailing before the shirt factory is built. Now assume that for technical reasons the project must produce a minimum number of shirts per year so that the total number would increase to N_1 and the price fall to P_1. This raises the problem, how shall we value the (N_1-N_o) shirts? At price P_o, or P_1, or some other price? Although P_o is the price that a consumer would be willing to pay for the "first" shirt, the "last" consumer values a shirt at only P_1. Thus $P_o(N_1\text{-}N_o)$ overvalues the output while $P_1(N_1\text{-}N_o)$ undervalues it. The appropriate value would be the entire shaded area under the demand curve between N_1 and N_o. If a simple shadow price were wanted, it would not be unreasonable to use an average of P_o and P_1 (as long as the difference were not so great that non-linearity might be significant).

It must be stressed that the approach of estimating the total that consumers would be willing to pay for the incremental output—that is, the entire consumers' surplus—is appropriate only when the incremental output is indivisible. If it were possible to produce a smaller quantity than (N_1-N_o), the use of the consumer surplus method to evaluate the entire N_1-N_o output would be inappropriate. Valuing intramarginal output in consumer surplus terms would overestimate the benefits of the project in comparison to the output of private firms.

Figure 1

NUMBER OF SHIRTS PRODUCED



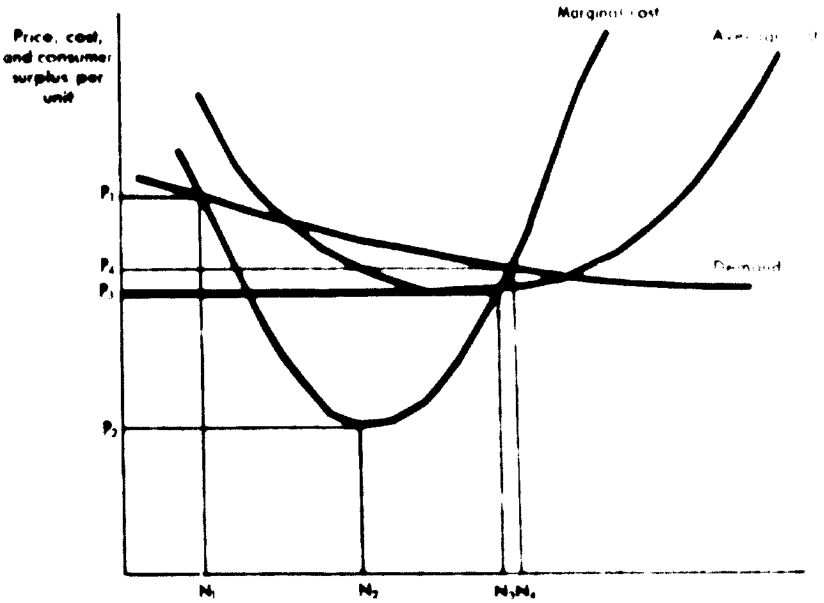
The proper shadow price is generally the average consumer surplus of the marginal indivisible block of output units. But even if output could be varied continuously, there are certain cases in which (notwithstanding what has already been said) it is appropriate to value the entire output at consumer surplus shadow prices. First, if a project produces several different types of benefits in a way that does not allow the individual types of benefits to be varied separately, the smallest possible increase in one type of benefit may yield a much larger change in another type of benefit; the latter should therefore be evaluated at consumer surplus shadow prices. Secondly, consider a project that produces only one type of output but does so under conditions of decreasing cost. This is shown in figure 2, where marginal costs fall until N_2 and average costs until N_3. It may be that the high unit costs of a small output (less than N_1) are not justified by the benefits, but, as unit costs fall even more rapidly than consumer surplus per unit, there is some larger scale of project at which total consumer surplus exceeds total cost. In this case the intramarginal consumer surplus is relevant. But it would still be inappropriate to extend the level of output beyond the point at which marginal consumer surplus exceeded marginal cost (N_4).

The estimation of the demand curve relevant for a consumer surplus calculation is easiest when the product is marketed. In this case the surplus calculation is required because the project output causes a fall in price. As we have seen, an appropriate basic shadow price can generally be computed as an average of the "before" and "after" prices.

The demand curve estimation problem is more difficult if the benefit is not sold. Although the principles of when and to what extent consumer surplus shadow prices are relevant remain the same, the demand curve must now be estimated without direct reference to market prices. Market research type studies may indicate the prices that different proportions of individuals would be willing to pay for the benefits received. In some cases, however, this may not be possible. If individuals fear that they may be specially charged or taxed in relation to their own valuation of the benefits received, they will not provide an honest assessment of the benefit's value. Even when they are not inhibited from providing an honest valuation of benefits received, many individuals may be unable to put a price on benefits of a type that they are not accustomed to buying, such as time saved in travel because of improved transport facilities. When, for these reasons, a direct estimate of the demand curve cannot be made, it may be possible to estimate the demand curve by discovering, for example, what individuals do "pay" for time saving in other situations.

Figure 2

NUMBER OF UNITS PRODUCED



It is, of course, easier to estimate surplus values when the project's output has only a small proportionate effect on total supply. When, in contrast, it is necessary to estimate not just a marginal section of the demand curve but the entire demand curve, a more detailed set of estimates is required.

(c) *Social values versus private values.* All the approaches that have been described, including those for shadow pricing intermediate benefits, rest ultimately on the implicit assumption that any product's value is determined by the price that consumers would be willing to pay for it. There are a number of cases in which "society" rejects the individual's assessment of a product and alters the price to the consumer in a way that encourages consumption (free libraries, schools, or health care) or discourages consumption (high taxes on alcohol and tobacco). When society acts in this way it is generally because the consumer lacks the knowledge or foresight to make the appropriate decisions. More paternalistically, the Government may replace private valuations by social ones in the belief that individuals' tastes are inadequately developed to make "right" decisions and that altering the prices that individuals pay is more efficient than using [illegible] resources to educate consumers. In these cases, the appropriate shadow prices are the Government's valuation of the products.

Even in the case of a project producing a single such output it may be useful to force government officials to state a shadow price (or schedule of prices) for the good. Many projects undertaken because government officials believe that the benefits [illegible] important [illegible] may be rejected as extravagant [illegible] shadow price is explicitly stated. In [illegible] cases where a project produces a [illegible] benefit [illegible] even more important that [illegible].

[illegible] *Special problems*

[illegible] problems have been omitted [illegible] shadow pricing outputs [illegible] brief and direct [illegible] now in order to [illegible] provide any detailed [illegible] shadow prices.

[illegible] An individual may be willing to [illegible] some future time he will [illegible] some good or service such as ad[illegible] transportation between [illegible] the benefits accruing to [illegible] project's output [illegible] that everyone would be [illegible] availability of the output [illegible] does not [illegible] its output but [illegible] a probability of, say, one half of obtaining the output when they want it, the appro[illegible] benefit is the amount that [illegible] would pay for a probability of one half of obtaining the output. This need not equal one half the amount they would pay for the availability benefit [illegible] probability of one.

[illegible] *Risk reduction.* Related to the availability benefits is [illegible] notion that the reduction of risk confers a benefit. A project which either as its primary function or as a by-product of hydroelectric power generation provides flood control decreases not only the expected amount of flood damage but also the uncertainty of those whose property is protected. Two types of benefits are therefore ignored if the flood control is valued only in terms of the decrease in expected flood damage. The nature of these benefits may be seen by considering the motives of an individual who pays an insurance premium greater than the expected value of his loss. First, because of the diminishing marginal utility of money to an individual, the expected disutility of a large loss may be greater than the disutility of a small premium, although the money value of the premium is greater than the expected money loss. Secondly, the individual prefers to reduce the uncertainty about his future "losses" and therefore to substitute a known stream of premium payments for an unknown stream of losses. This type of risk aversion can also be seen in the individuals' portfolio selection behaviour, where assets of a given yield and risk may be preferred to others of higher yield and greater risk. Although, in the case of flood control, the same risk reduction benefits could be conferred by an insurance scheme without undertaking the physical project, in other cases the project may reduce the uncertainty of specific physical benefits or losses as well as of financial losses. The provision of local hospital services provides a risk reduction that could not be provided simply by insurance against financial loss.

(c) *Location and income distribution.* The Government may wish, as a matter of national policy, to discriminate in favour of or against certain locations. In these cases it may be desirable to weight benefits and costs on a basis of the location of the project or of the recipients. The arbitrariness of this method, which places a tax or subsidy on public but not private projects in an area, must be recognized.

Similarly, the Government may wish to assign different weights to benefits received by individuals in different income classes. An implicit valuation of relative marginal utilities of income is suggested by the progressiveness of the tax structure. Policies to favour other specific groups may also be adopted.

(d) *Public goods.* Economic analysis defines "public goods" as those goods the enjoyment of which by one individual does not decrease the ability of others to enjoy them. The elimination of a disease vector from an area (e.g., destruction of malaria-carrying mosquitoes) simultaneously confers benefits on everyone in that area. The appropriate demand curve for use in assessing the benefit of "public goods" is the sum over price of the individual demand curves, that is, the schedule telling the total amount that everyone together would be willing to pay for each additional unit provided. This demand curve is appropriate both for marginal decisions (small increments to supply) and for surplus calculations (when there are substantial indivisibilities).

(e) *Incommensurables and intangibles.* Although shadow prices should be assigned to benefits and costs whenever possible and an approximate value is generally more useful than none at all, there are situations in which benefits and costs should be accepted by the project analyst as incommensurable or intangible. It is important to distinguish between these two situations. An intangible benefit or cost, such as the improvement of a landscape by a park or its spoliation by a power line, is characterized by the inability to measure it on any scale. In contrast, incommensurable benefits may be measured in physical units but cannot be readily converted to money or any other common unit of measure. These include such things as decreases in death or sickness. Although the project analyst could assign arbitrary values to such benefits, it would be better to admit their incommensurable nature and describe the benefits and costs of a project in terms not only of money but also of specific physical effects. A final cost-benefit report would thus contain information about the net social value of those benefits and costs to which shadow prices can be assigned, together with an itemization of the incommensurable physical benefits and costs associated with the project and a description of the expected intangible effects.

The presence of incommensurable effects makes the final selection of projects more difficult. When the number of incommensurables is not large, choice may be facilitated by examining the sensitivity of the decision to differences in shadow prices. It may well be that for all "reasonable" shadow prices of the incommensurables the project is acceptable and superior to available alternatives. Even where this is not the case, one can specify the precise value of the shadow price which will make the project acceptable or make one alternative preferable to another.

C. Project inputs

The set of "inputs" associated with a project should include both direct inputs (the resources used by the project) and indirect social costs (the "negative spillovers" or "external diseconomies") that cause inconvenience, expense or other forms of disutility to individuals and firms other than those operating the project.

1. *Direct inputs*

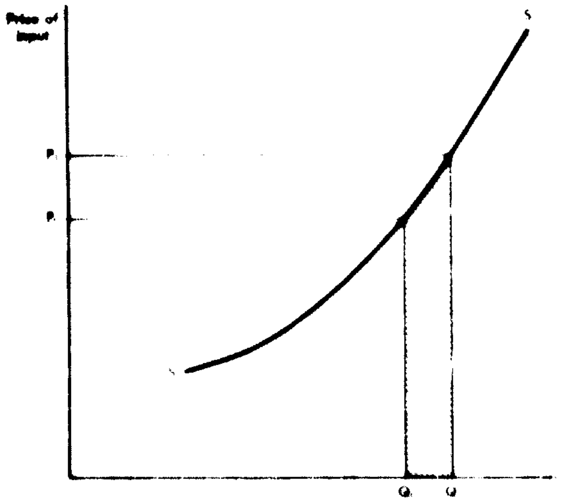
Resources used directly by a project should be valued at their social opportunity cost, that is, their value in the best alternative use to which they would have been put.

When a public enterprise buys its inputs in a competitive market, and does not buy a large enough quantity to influence the market price, the price paid can be taken as a measure of the social opportunity cost of the resources. When either or both of these two conditions—competitive market and relatively small purchases—remains unfulfilled, a shadow price must be found for the inputs.

(a) *Government purchase altering market price.* If the Government purchases goods or services in a competitive market but in such quantity that the price is increased, the appropriate shadow price for each unit is the price that the Government as a discriminating monopolist would have had to pay. This type of situation may commonly arise in the hiring of local labour for a large project. In figure 3, line SS is the input supply curve. Without the input purchases required for the project, the total quantity sold of the input was Q_0 and the price was P_0. The project requires an input of $Q_1 Q_0$, raising the market price to P_1. If P_1 were used as a shadow price for the entire quantity, the social opportunity cost of the resources would be overestimated; the converse would be true if price P_0 were used. The appropriate value on the resources is the entire shaded area under the supply curve—in effect the

Figure 3

QUANTITY OF INPUT

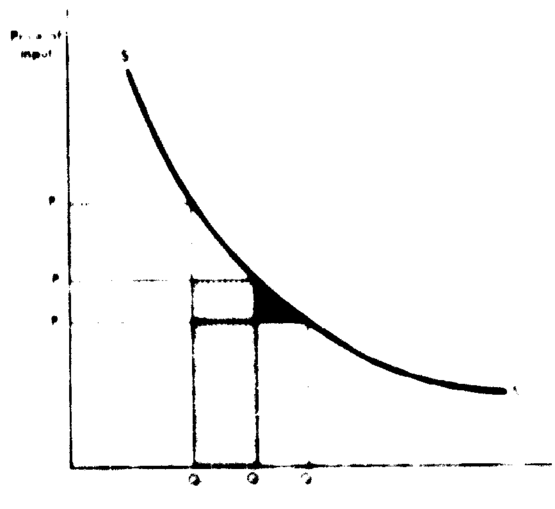


appropriate shadow price is weighted average of the prices between P_0 and P_1. For simplicity, if the price change is not great we might assume a linear supply curve and take the average of P_0 and P_1 as an approximate shadow price.

If the project causes an expansion of the production of the input good in a way which yields economies of scale and consequently lowers price, the shadow price of the input good should reflect the extent to which lower cost of production reduce prices to previous users as well as to the project. In this way the case of falling price is not parallel to the case of rising price. Figure 4 shows a supply

Figure 4

QUANTITY OF INPUT



curve, SS, which slopes downward to reflect economies of scale. P_0 and Q_0 are the original price and quantity. The project buys $(Q_1 Q_0)$, allowing unit costs and therefore price to fall to P_1. The direct social opportunity cost of inputs $(Q_1 Q_0)$ is there fore $P_1(Q_1 - Q_0)$, the shaded area. But this increased output has lowered the cost to previous users from P_0 to P_1. The saving in resources is therefore $(P_0 - P_1)Q_0$. The net social opportunity cost of the added output is therefore $P_1(Q_1 - Q_0) - (P_0 - P_1)Q_0 = P_1Q_1 - P_0Q_0$. The appropriate shadow price is therefore $(P_1Q_1 - P_0Q_0)/(Q_1 - Q_0)$. What if the new lower price induces additional private users to purchase the good, causing output to rise to Q_2 and price to fall to P_2? In that case the direct social opportunity cost is $P_2(Q_2 - Q_0)$ and the saving of resources consumed by the original purchasers is $Q_0(P_0 - P_2)$. The total paid for the new private purchases $P_2(Q_2 - Q_1)$ underestimates their value to the purchasers. The extent of underestimation is at least equal to the black triangle between the supply curve and P_1 line above the $(Q_2 - Q_1)$ segment. It would be more if some of these private purchasers were willing to pay a price above P_1. In this case, therefore, the maximum net social cost that should be associated with the project's purchase of $(Q_1 - Q_0)$ is $P_2(Q_2 - Q_0) - Q_0(P_0 - P_2) - \frac{1}{2}(P_1 + P_2)(Q_2 - Q_1) = P_2Q_2 - P_0Q_0 - \frac{1}{2}(P_1 + P_2)(Q_2 - Q_1)$.

The reader may note that the asymmetry between rising and falling costs rests on the assumption that where costs are rising price equals marginal cost but when costs fall with output, price equals average cost.

(b) *Taxes and subsidies*. When a project input is bought in a competitive market and in small enough quantities to leave prices unchanged, the appropriate shadow price is the market price including any indirect taxes or subsidies that are included in the price that private firms would have to pay. For example, the shadow price for fuel or labour should include any indirect fuel tax or payroll tax. This ensures that resources will not be used in a project unless they are as productive as they would be to private users. If, however, the inputs to the project are not taken away from private users but rather constitute a net increase to national supply, taxes and subsidies should be ignored. If fuel imports are increased to provide an input for the project, the shadow price of the fuel should not include any [illegible] duty [illegible] policy to discourage [illegible] imported inputs by using a special [illegible] foreign exchange, this general [illegible] shadow price but not the specific [illegible] into account. Although [illegible] marginal productivity of fuel [illegible] public and private sectors [illegible] consequence of sub-optimizing [illegible] private producers [illegible] inputs. The relevant shadow [illegible] cost of the inputs [illegible] alternative use [illegible] under [illegible] market [illegible]

[illegible] market [illegible] the question of what shadow price [illegible] inputs [illegible] If government use causes [illegible] increase in [illegible] use, the market, including monopoly profit, [illegible] the shadow price because it measures the [illegible] the resources in their former use. [illegible] demand [illegible] the monopolist

supplier to increase output, the situation is more complicated. When the quantity produced is changed, average cost of production will change and, for small increases in output, will decrease. If the monopolist leaves the price to the previous purchasers unchanged, the social cost of the increased production for use as the project input should be calculated as the net addition to the monopolist's costs. Thus if average cost falls from C_0 to C_1 when output increases from previous sales (Q_0) to the new total sales (Q_1), the social cost of the additional output is approximately $\frac{1}{2}(C_1 + C_0)(Q_1 - Q_0) - Q_0(C_0 - C_1)$. The demand for the project's inputs can be viewed as a shift in the product's demand curve. If the monopolist does not irrationally keep his price unchanged, the result of this will be to change the quantity purchased by non-project users. The exact result will depend on the nature of the projects's demand curve and the previous demand curve, as well as on the specific cost curves. But in the situation that may be most likely, the price will fall and non-project use expand. In this case the net social cost is the manufacturer's cost of the project inputs minus the fall in cost of producing the original non-project quantity, minus the excess of the value of the additional non-product use over its social cost.

In these cases it is clear that a single shadow price on the inputs is not appropriate. Rather the project analyst should be seeking a shadow cost for the total purchase of inputs.

(d) *Unemployed resources*. If otherwise unemployed resources (usually labour or land) are to be used in a project, their social opportunity cost is zero and a shadow price of zero should be assigned to them. This may be especially important in a developing country or in a period of long-term unemployment. A not uncommon mistake is to measure the cost of otherwise unemployed labour as the difference between the wage rate and unemployment compensation benefits paid by the social security system. Although this indicates the additional money payments required in order to hire labour, it does not reflect the social opportunity cost of the labour. More generally, if labour (or land) is being paid a wage (or rent) exceeding its marginal productivity, the marginal productivity and not the wage should be taken as the social cost of taking it away from its previous employment.

This rule should be qualified in three ways. First, if it is possible to employ the "unemployed" resources in some use other than the project, for instance to stimulate employment by private producers, the productivity of labour in this alternative use and not zero is the most appropriate social opportunity cost. But even were it possible to find productive employment for currently unemployed labour, the required action might be outside the jurisdiction of the project administration. The relevant cost-estimating decision then requires taking the opportunity cost as zero.

Secondly, if employing labour requires additional expenditure on food, clothing and shelter, particularly likely if unemployed labour is moved from rural to urban areas of a developing country, it may be appropriate to treat these expenses as part of the real social cost of the labour. But although this is undoubtedly an increased consumption of real resources, there are two reasons why it may be appropriate to disregard these. One is that it may be possible to produce these goods with other unemployed labour; this is the traditional Keynesian case. The other is that the food, clothing and shelter may be regarded not merely as necessary supplies to the worker (like tools) but as adding to his level of well-being.

Thirdly, any unquestioning application of the zero shadow price rule for direct labour inputs would bias evaluation in favour of labour intensive and vertically integrated projects. If unemployed labour can be used in producing intermediate goods for the project, those goods should be valued at a shadow price less than market price, with the difference equal to the wage component of the otherwise unemployed labour. All labour inputs, direct and indirect, should be valued at the same shadow price.

(e) Other direct input problems. Project inputs that are already owned by the Government should be shadow priced at their value in the best alternative use. Replacement cost is not necessarily the appropriate value; it will be so only if the input good is sold in the market under conditions which make market price equal the input's marginal revenue product.

Inputs purchased from abroad or which otherwise might be exported have a foreign exchange value that may deserve a premium over the value indicated by official exchange rates. See section F below on the use of import-export prices.

2. *Indirect social costs*

A project may cause others to incur inconvenience, discomfort or expenditure. The shadow price appropriate to these indirect social costs ("external diseconomies") is the price that those who suffer them would be willing to accept as compensation and feel neither worse off nor better off.

Measurement is easiest when those affected make expenditures that make them as well off as they were before. In general, the evaluation is similar to measuring the consumer surplus accruing to benefit recipients. A simplified example will illustrate the principle. It is proposed that an airport should be built. If this is done those who live in the area must suffer the discomfort of airport noise. How should this discomfort be evaluated? One approach would be to consider the expected fall in residential land values in the area. The extent of this fall might be predicted on the basis of experience with other airports. A second approach, which would provide an upper limit to the appropriate shadow price for that part of the noise thus eliminated, would be to use the cost of soundproofing the homes so that the noise could not be heard in the house. This might, of course, be impossible, and in any case would relate only to noise within houses and not out of doors. The consumer surplus method requires drawing up a schedule of the amounts that the home-owner would be willing to pay to prevent the building of the airport or equivalently would be willing to accept as full compensation if it were built.

D. Shadow prices for intertemporal choice

So far we have disregarded the problems of time, tacitly assuming that all benefits and costs occur in the present. In practice the problems associated with the timing of benefits and costs are extremely important. Significant public investment choices arising in both the design and final decision stages require intertemporal evaluations. Should we use a technique of production that requires large capital investment but has low operating costs (for example, nuclear generation of electric power) or would the opposite "time profile" of expenditure (conventional power generation) be preferable? Should we select a project with a constant stream of net benefits or one which produces few benefits in early years but greater benefits later? Should we postpone all or part of a particular investment, such as building a narrow road now and widening later?

Time affects our project evaluation in three ways: changes in the market prices of benefits and costs; the relatively greater desirability of consumption in the near future over consumption in the more distant future; the possibility of alternative productive investment of the funds used in a public project and of the benefits received from the project. Each of these aspects of the "time problem" has been the subject of extensive discussion among economists. Although the literature that has evolved is too complex for summary here, some of the basic issues can be reviewed.

Changes in the absolute level of prices (that is, a uniform change in all prices, for example, a general inflationary trend) can be ignored and all calculations made as if the current level of prices remained unchanged. Not so for changes in relative prices. If some prices are likely to change relative to others, this should be reflected in the cost-benefit calculations. For example, it would be reasonable to expect that wages will continue to rise relative to the prices of manufactured goods, raw materials and so on. In calculating the future costs of a public project this relative price change should be taken into account. Other goods may change in price because of changes in the demand for them (due, for example, to the introduction of other new products or to a change in tastes brought on by higher standards of living) or in their supply (due, for example, to changes in technology or import regulations).

1. *Social time preference*

The first and most basic aspect of intertemporal comparison is the measurement of the relative desirability of consumption in different years. In general, as individuals we prefer consumption in the near future to consuming something of the same market value in the more distant future. This preference may reflect an irrational bias in favour of the near future but it also corresponds to the more rational calculation, first, that our incomes are rising and thus decreasing the significance of any given quantum of consumption and, secondly, that death may [illegible] before the more distant date. Although it may be inappropriate for the government's intertemporal calculations to reflect the purely irrational short-sightedness of individuals and their personal expectations of death, it is reasonable for society as a whole to recognize that the standard of living is rising and thus benefits and costs in the more distant future should be given less weight. Establishing a specific quantitative relationship between the significance of a one dollar benefit (or cost) today and a one dollar benefit (or cost) in a future year is an important prerequisite of cost-benefits analysis. The social time preference rate for discounting consumption is a basic external shadow price. Economic analysis can help to elucidate the relation among [illegible] that [illegible] influence the selection of such a social time preference rate: the rate of growth of consumption and population, the pure time preference discounting future utility merely because of futurity, and the assumed elasticity of the utility function. But the specific choice rests on the adoption of parameters that must reflect public policy.

2. Social opportunity cost of capital

If the government is able to influence the rate of private investment, it could pursue a policy which makes the marginal social rate of return on private investment equal to the social time preference rate. This, however, may not be politically possible or may be an aim towards which government policy has been directed but which will not be achieved for a number of years. If so, the social productivity of [illegible] exceed the social time preference rate.

[illegible] use intertemporal choice requires consideration not only the relative desirability of consumption at different times but also the use to which [illegible] would have been put in the private sector. In particular, funds withdrawn from private investment should be valued at a shadow price equal to the present value of the consumption stream that would have resulted, both directly and indirectly, from the foregone investment. This shadow price for the social opportunity cost of private investment will therefore reflect the social rate of return on private investment and the social time preference used for discounting the resulting consumption streams.

When changes in private investment are measured in terms of this shadow price, the benefits and costs [illegible] can be unambiguously evaluated using the social time preference rate.

3. Budget constraints

If the agency does not have to operate under any budget constraint but is able to obtain sufficient funds for all projects that it demonstrates are worth doing, the proper basis for project appraisal is the net present value of the generated social benefits minus social costs. A project is "worth doing" if this net social benefit is positive; as between two mutually incompatible projects that one should be selected which has the greater net social benefit.

If, however, the agency's budget is limited so that there are insufficient funds to do all projects that have positive net social benefits (and are not inferior to other incompatible projects), different criteria of project choice must be used. In effect, a shadow price of the constrained agency funds must be selected.

The appropriate shadow price of a constrained agency's funds is the ratio of net social benefit to constrained funds expected to prevail on the marginal project. In practice this could be estimated on the basis of past experience. It is a measure of the amount of net social benefit that could be obtained by the agency if it had an extra dollar of funds. This shadow price should be recognized as an "internal" shadow price, internal not to the project but to the agency. A similar problem arises when any input is rationed to agencies. Internal shadow prices for each of those factors should be calculated by each agency as the basis for their own choices. The use of these agency's own shadow prices in improving the original allocation is discussed in section E. 3 below.

E. SOME TECHNICAL NOTES

1. Shadow prices and linear programming

Consider the problem of a firm (or project) that produces one or more outputs and uses several inputs. At least one of the inputs is available in only limited quantity and the firm has no opportunity to buy any additional quantity or sell any excess not used; we shall refer to these inputs as "non-purchasables". The values (prices) of a single unit of each output are given. The production process can be described in terms of a fixed amount of each input required per unit of each output. The problem of the firm is to maximize the total net value of the output (the value of the output minus the cost of the resources which are non-purchasable) subject to the constraint inputs. The solution of this maximizing problem implies in general that while there is slack (excess unused quantities) of some of the inputs, other inputs are effective constraints on output. We may then ask of each input "what price could be paid by the enterprise for an additional unit of the input so that the increased output made possible would have a value equal to that input price?" For those inputs for which slack exists the price would be zero (that is, there would be no value to additional quantities of input); but for those inputs which were binding constraints on output a positive price could be paid. This is the shadow price of the linear programming dual associated with the maximizing problem. A second interpretation of the shadow prices would be: the prices that could be paid for the non-slack inputs so that the total shadow cost of non-purchasables in the production just equalled its net output value; the shadow price of the slack inputs is again implicitly zero.

2. On the use of import-export prices

If the domestic markets in intermediate and final goods do not provide a suitable basis for constructing shadow prices, their part in the analysis can sometimes be taken by world market prices: import or export prices depending on whether the good is imported or exported. Indigenous non-tradeable resources—labour and land—should be shadow-priced at either their marginal productivity in the production of exports (or import substitutes) or at zero if they are unemployed. The calculation of marginal productivities may not be practicable on an economy-wide basis. But in those countries in which domestic market prices are unsuitable as a basis for shadow price calculation (primarily the developing countries) it may not be unreasonable to assume that the appropriate shadow price for labour is zero.

If it can be assumed that the aggregate levels of both consumption and investment have previously been determined, so that all marginal capital comes from abroad, it may be rational to evaluate inputs, both initial and recurrent, at their foreign exchange cost, and outputs at their export selling price. This simple form is appropriate only where both import and export prices are insensitive to quantities bought and sold; otherwise the procedure would be to use the marginal cost and marginal revenue respectively.

A problem arises in cases where the inputs to a particular project as initially defined include non-tradeable items, such as electricity, transport or residential services, which have an import component. In these cases it can be assumed that a certain amount of extra capacity, say in generation [illegible] railways or houses, will be needed and this will have a specifiable tradeable import content which should be added to the project as originally narrowly defined. In each case it is important only to charge the appropriate extra cost to the project. The project may require an amount of electricity which it would be costly to generate for that purpose alone, but if the plant can be located near other users of electricity it may be the difference between the cost of 195- and 100-megawatt stations that is relevant, not the cost of a 5-megawatt station.

Similarly if population and housing standards are given, there will be relevant township cost only if the import content of the township varies from site to site.

It should be re-emphasized here that it is inconsistent to use foreign prices for making investment decisions and domestic prices for employment and output decisions. It is even worse to use foreign prices for investment decisions on the false assumption that they will also be used for recurrent decisions. For instance it might well be that agencies were allowed to retain their foreign exchange earnings. In such a case they would have a very strong incentive to export if they were maximizing their foreign exchange "profit". If the planners were to assume this to be the agency's objective they might frame an optimistic estimate of future foreign exchange earnings for the economy as a whole which would be completely invalidated if concerns in fact maximized "profits" at domestic prices.

3 *Iterative multistage factor shadow pricing*

In this paper we have generally assumed that market prices provide not only a starting point for the determination of shadow prices but also the basic allocative mechanism in the economy as a whole. In any particular economy this may not be true for one or more inputs such as [illegible] foreign exchange or specific raw materials in short supply. In such cases [illegible] market allocation is the administrative allocation by the central planning agency to sub-agencies responsible for projects in particular fields. To perform this function efficiently the central agency would have to know the value of each type of resource [illegible] in the next most productive use in each sub-agency's field. The central planning agency is unlike[illegible] sufficient technical information [illegible] values itself. One administrative solution [illegible] arbitrary allocations of the inputs to the sub-agencies. Each sub-agency could then calculate its own "internal" shadow prices [illegible] the way described for capital [illegible] These internal shadow prices would be the result of project evaluations in which project inputs were valued at external shadow prices laid down by the central agency.

The sub-agencies would notify the central agency of their internal shadow prices for each factor [illegible] central agency [illegible] and then redistribute [illegible] factors from those sub-agencies having a low internal shadow price to agencies with a high [illegible] price. After the redistribution the sub-agencies could again calculate their internal shadow [illegible] simultaneously determine the [illegible] would undertake [illegible] the light of the second set of internal [illegible] the central planners might want [illegible] allocation and the process could [illegible] repeated until for each factor the [illegible] price was the same in all agencies.

This process might also be repeated [illegible] levels, each agency's internal shadow [illegible] the result of [illegible] allocation [illegible] to particular plants.

The effective implementation of [illegible] would probably be [illegible] would ensure an optimal allocation [illegible] in question and the selection [illegible] projects.

[illegible]

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XV. APPRAISAL OF FINANCIAL NEEDS FOR NEW INDUSTRIAL PROJECTS

by Charles M. Williams*

Introduction

The focus of this paper is the need for funds to carry out new industrial projects and problems related to the effective forecasting of financial requirements. In order to simplify the presentation of our ideas, we assume in this paper that a new corporate enterprise will serve as the vehicle for carrying out the industrial project.[1]

The point of view in this article is that of a development financing organization. It is premised on the concept that development financing agency officials should see their role as very much more than that of simply approving or disapproving financing proposals proffered by a new industrial firm. If they are to be fully constructive and helpful, they should be willing and able to serve as a source of expert advice and counsel in the development of plans for the new project, with particular emphasis on the financing planning. Where it seems necessary, the agency must participate actively in the formulation and modification of these plans.

Effective work with management of the new project requires a thorough understanding and appreciation of the point of view and problems of the enterprise and its managers. Although the interests of the development financing agency and those of management may conflict in certain respects, they share a basic harmony of interest in the success of the project.

Experience has shown that planning the finances of a new industrial firm is not easy. In fact it is much easier to find instances of inadequate or faulty financial forecasting and planning than to find models of effective performance of this function.

Despite the rapidly expanding literature of business and financial management, literature on the subject of financial forecasting for the new firm is relatively brief and general in nature.[2] Hence, the author [illegible] with case studies of new enterprises [illegible] ideas presented herein.

In the case of new industrial [illegible] effective financial forecasting seeks [illegible] answer [illegible] questions as these:

What funds will be required [illegible] a period of the early years [illegible]

When will the need for funds [illegible]

How long will the need [illegible] be generated from the [illegible] ficient to repay loans

How are the needs for funds [illegible] be met? How much [illegible] investment? How [illegible] side sources

What degree of [illegible] forecast

How would the [illegible] sumptions about [illegible] influence the forecasted need [illegible]

As the above questions imply [illegible] is essentially the [illegible] prise into monetary terms that [illegible] part of the plans of the enterprise [illegible] financial forecasting must be viewed [illegible] but integral part of over-all planning [illegible] planning is impossible unless [illegible] planning of facilities, production [illegible] the entire operating program.

A. Importance of [illegible] of [illegible]

1. [illegible]

Even though the development [illegible] should be prepared to lend assistance [illegible] the basic work of preparing the financial [illegible] should rest with the management of the firm [illegible] Normally considerable time, thought and effort are required on the part of management [illegible] careful job of financial forecasting [illegible] Usually, this financial forecasting [illegible] plished at a time when management of the new enterprise is heavily involved in other aspects of planning and starting the enterprise. [illegible] is preparing a financial forecast [illegible] meeting one of a set of [illegible] requirements imposed by [illegible] agency [illegible] forecast will [illegible]

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[1] The experience of the author has been largely in countries where industry is not government owned and operated. While the frame of reference employed in the paper is that of a capitalistic or private enterprise economy, the author believes that many of the basic points will be relevant to new industrial ventures in any country.

[2] Those especially interested may find the following finance textbooks of value:

P. Hunt, C. M. Williams and G. Donaldson, *Basic Business Finance*, Homewood, Illinois, Richard D. Irwin, Inc., 1961, chapters 3 to 9 inclusive.

Raymond P. Kent, *Corporate Financial Management*, Homewood, Illinois, Richard D. Irwin, Inc., 1960, chapters 5 to 13 inclusive.

John F. Magee, "Guides to Inventory Policy", *Harvard Business Review*, vol. XXXIV, No. 1 (January-February 1956), pp. 49-60.

R. [illegible] and [illegible], *[illegible] Management in [illegible]*, Homewood, [illegible], Richard D. Irwin, Inc., 1963, chapters [illegible], 7, 16 and 17.

Robert W. Johnson, *Financial Management*, Boston, Massachusetts, Allyn and Bacon, 1962, chapter 4.

[illegible] sketchily prepared and consequently have little validity or value to anyone. Actually, im[illegible] to the new industrial firm [illegible] consequence of careful financial forecasting. Managers who appreciate the potential advantages of effective financial forecasting may be expected to do a much more thorough job of financial planning than otherwise is likely. Let us therefore consider some of the direct advantages to the industrial [illegible] and accurate financial forecasting.

[illegible] profits and financing requirements [illegible] financial attractiveness [illegible] owners [illegible]

[illegible] provide [illegible] with the raw materials for [illegible] the feasibility of the whole project [illegible] assumptions [illegible] inventory needed to support [illegible]

[illegible]

[illegible] effect [illegible]

[illegible]

[illegible] secondary [illegible] significant [illegible]

[illegible] further in effect [illegible] forecasting [illegible] needs will help importantly in gaining the confidence of the development financing agency or the potential investors in the firm. Conversely, [illegible] that reflects dubious key assumptions [illegible] stimulate doubts and uncertainties on the part of organizations or groups important to the success of the project.

2. Value to the financing agency

Effective financial forecasting for the new project is essential if the financing agency is to do an effective job in allocating resources and assisting the development of worthy projects. Insistence that would-be borrowers undertake a thorough job of forecasting financial requirements should yield a variety of advantages to the financing agency. Some of these advantages are described below.

The forecasts submitted by management afford officials of the financing agency the means of assessing the ability of the client firm's management to do effective forward planning. In extreme cases, where the job of forecasting financial requirements is so poor that it reveals basic irremediable deficiencies on the part of the promoters of the new venture, it can serve as a useful screening device and give the agency a basis for rejection of the proposed project. Indeed, the very requirement of a specific forecast may serve to end further discussions with visionary *entrepreneurs* unwilling to come to grips with the requirements of detailed planning.

In other cases, the financial forecast submitted to a group planning a new industrial enterprise may reveal serious lack of financial knowledge or ability on the part of a potential management which clearly has production, marketing or other important skills. In such cases, officials of the developing agency are alerted to the need to give detailed instruction and assistance to the *entrepreneurs* in formulating the financial plan for the enterprise. On the other hand, where [illegible] financial competence is demonstrated by the future managers of the new firm, the development agency may be willing to extend itself [illegible] further than would otherwise be appropriate.

An accurate financial forecast provides a clear understanding by all interested parties of the firm's financial needs. This understanding is requisite for a good, workable financing plan with which the enterprise can live over time.

The forecast should make provision for planning future expansion and development if the firm is successful and at the same time give suitable protection against the difficulties and disappointments [illegible] new enterprises suffer in one degree or another.

The financial forecast should help the financing agency get a good measure of the resources required for the project and the financial support that it will be expected to offer the firm. Obviously, the value in this respect of the forecast will depend heavily on the degree of certainty that the development financing agency believes it can attach to the forecast.

Management of the developing financing agency, as well as that of the new enterprise, can make effective use of the forecasts as a standard against which performance can be measured and evaluated. Timely recognition of variance in actual progress from the projected or programmed progress can be highly useful to the development financing agency as well as to the enterprise's management.

3. *Consequences of underestimating or overestimating requirements*

A great many developments can affect the need for finances as the new industrial project moves into operation. Rarely do projects go exactly according to plan or financial requirements prove to be precisely as forecasted. A certain degree of error in forecasting is inherent, and if recognized quickly it can usually be dealt with.

In general the consequences of substantial underestimation of needs are more likely to prove more serious than those of significant overestimation. Underestimation of requirements in the simplest form can result in the enterprise's running out of money and credit and collapsing before the inherent merits of the project have had a chance to show themselves. In other cases underestimation can lead to subsequent stringencies. Resultant efforts to economize on important equipment or other facilities may seriously constrain the development of the firm.

Overestimation of the potential financing requirements for an enterprise could [illegible] understate the potential return on investment in the project that it was prematurely and unnecessarily abandoned. In other instances [illegible] overestimates suggest [illegible] overcapitalization. Where the firm is overcapitalized, valuable financial resources are wasted. There appears to be a tendency [illegible] overcapitalized firms, however, for management [illegible] to find [illegible] use for initially redundant or unneeded [illegible].

Since it appears that the consequences of underestimating requirements for funds are much more likely to have serious, perhaps fatal, consequences for a new industrial project than overestimates, it may be concluded that in case of doubt constructive conservatism [illegible] allowing [illegible] funds for the [illegible].

B. REVIEW OF MAJOR TECHNIQUES OF FORECASTING FINANCIAL REQUIREMENTS

1. *The projected balance sheet method of forecasting: a brief description of the technique*

Two particularly useful methods of organizing the projections for financial requirements are in widespread use. Since each of these methods represents a distinctive approach to the same point, a great many firms employ both techniques, using one to supplement and support the other. The two methods are the "projected balance sheet method" and the "cash flow forecast method" (which is also widely known as the "cash budgeting method"). Let us look first at the projected balance sheet method.

The balance sheet method of portraying future needs for funds is built around a forecast of key balance sheet items as of selected future dates. The investment required in each of the key types of inventory, in accounts receivables, in plant equipment and spare parts, in operating cash and in any other important kind of asset needed to carry out operations as planned is set forth [illegible]. On the liability side of the [illegible] are calculated [illegible] those credits [illegible] may be assumed [illegible] amount of ownership investment [illegible] date. In effect, the assets are regarded as [illegible] sponge [illegible] funds and the liabilities [illegible] accounts as sources of funds. [illegible] the plans of the enterprise will [illegible] investment in the various key asset [illegible] and the enterprise [illegible] sources of credit. The [illegible] business [illegible] of the future [illegible]. If the indicated sources of [illegible] ing the forecasted investment [illegible] the sources must be expanded or [illegible] asset investment contained [illegible] made apparent [illegible] anticipated [illegible] investment in assets [illegible] the cash [illegible] balance needed.

Careful selection of the [illegible] the projection [illegible] essential [illegible] forecasted balance sheet [illegible] balance sheet forecast provides what [illegible] a snapshot [illegible] of the financial condition [illegible] at a particular point in time [illegible] the balance sheet. It does not reflect need [illegible] which [illegible] the maximum need that the new enterprise [illegible] encounter, he should be careful [illegible] for the forecast which will [illegible] of maximum [illegible] greatest [illegible] the peak of seasonal [illegible] [illegible] associated with peak [illegible].

An approach frequently [illegible] projections [illegible] the [illegible] the enterprise [illegible] [illegible] future development and [illegible] needs, financing agency [illegible] [illegible] forecasting [illegible] the size of the [illegible] and the deeper [illegible] judgements regarding the [illegible] certain future [illegible] of a high order of intelligence.

and foresight by managements of both the new enterprise and the financing agency.

2. Key determinants of the need for major assets

Balance sheet projections submitted by the management of a new industrial enterprise should be subject to close review by the development financing agency in order to ensure that the project is technically valid, that no key items have been overlooked and, more importantly, that management's judgements underlying the calculated investment needs in the various assets are sound ones. Commonly, capital resources are limited in amount so that the development agency has a very important stake in maximizing the productivity of the capital it commits to development projects.[4]

To a certain degree the technology of the industry involved and considerations of the economic scale of operations will establish irreducible needs for capital to carry out the project. Nevertheless, it is the rare project indeed in which the need for funds is clearly immutable and beyond question. Often the requirements set forth represent the results of a series of judgements regarding the operations of the firm. Informed inquiry about the judgements behind the various figures may well bring to light satisfactory alternative operating plans which would conserve resources and reduce the net need for funds.

No two new industrial firms, even in the same industry, can be expected to have identical needs. Nevertheless, it is possible to identify certain key determinants that are likely to be critical in shaping the size of the needed investment in each of the major asset categories. Taking each asset category in turn, we shall attempt to do this.

To illustrate the point in this discussion, let us use as an illustration a hypothetical new firm, Progressive Plastics, Inc., organized to make and sell plastic products. In the initial years, the company will concentrate on a line of plastic dinnerware, that is, plates, saucers and the like, to be sold in sets. In later years the company plans to produce to order industrial products, such as the plastic portion of telephone instruments.

Key determinants of the investment in fixed assets

In the case of many industrial projects, the technology of the industry dictates certain requirements for plant and equipment. Thus, Progressive Plastics will certainly require certain compression moulding machines in which the charge of plastic powder is shaped under heat and pressured into the desired form. Additionally, certain grinding and polishing machines will be required to smooth and polish the rough product that comes from the mould. Obviously, certain materials handling equipment and storage facilities will be necessary. If and when the management decides to expand into the custom moulding of industrial products, additional machines, doubtless of the injection type, will be required.

Considerations of economic scale of activity also can be critical in industrial projects. Normally, these set a minimum scale on the productive equipment required for efficient operation. Beyond this minimum, the estimate of potential demand for the products of the firm is critical in deciding how large a productive unit should be. Once estimates of the total market and the market share that can be obtained has been completed, technical personnel can convert the desired output figures into the equipment required to produce that output.

Within the broad limits set by the technology of the industry and the requirements of scale, a variety of decisions related to "make or buy" are commonly important. Many items or services can either be undertaken by the new industrial firm, purchased or subcontracted from outside sources. Progressive Plastics certainly will require the production of moulds to shape the distinctive pieces of dinnerware it will produce. If it decides to do its own mould making, certain facilities and items of equipment will be required that would not be necessary if the firm were to subcontract the production of the moulds. Often the possibilities for farming out important parts of the production process are greater in relatively complex and highly developed economies than in countries in the earlier stages of development. Nevertheless, in most nations the possibility of having work done outside is considerable.

In addition, the requirements for fixed asset investment commonly are importantly influenced by the degree to which the new enterprise finds it necessary or desirable to provide its own supporting infrastructure or facilities not directly central to the production process itself.

In many instances, the basic building and land in which the new enterprise is to be housed can be regarded as a supporting structure rather than a clear-cut requirement. Many enterprises do not need distinctive properties. Conventional industrial buildings may be available for rental at satisfactory rates. In the case of Progressive Plastics, ordinary factory buildings suitable for light industry should be sufficient for its needs so that, if rental space is available, the decision whether to rent or construct its own facilities might well be important. Similarly, the requirements for warehouse space may not be distinctive so that it may be desirable to rent rather than to construct new facilities. In some instances, the question whether the firm should generate its own electric power requirements or buy power from already established utility firms may be an important one. Other items of infrastructure such as facilities for feeding and housing employees can call for large outlays and deserve very careful consideration. A related but different category is that of transportation facilities. The new enterprise might well consider the wisdom of owning its own trucks or other transportation equipment as against the use of common carriers or contract carriers for the purpose.

Of keen significance to the total investment required for a given physical layout is the question of the degree of quality or opulence of equipment and

[4] For a very vigorous presentation of the view that capital may well be more abundant than viable projects in many developing countries, see Sayre P. Schatz, "The capital shortage illusion: government lending in Nigeria", *Oxford Economic Papers*, volume 17, No. 2, July 1965.

facilities to be employed. The difference in outlay between "going first class" on basic facilities and equipment and setting up the facilities with a close eye to economy can frequently be very substantial.

In a great many cases considerations of full control over the operations, convenience and perhaps lowest long term operating costs argue for more complete and expensive facilities and equipment. These considerations must be matched against the need to economize in the use of scarce resources.

4. Key determinants of inventory needs

Not uncommonly inventory needs are projected by use of a rule of thumb drawn from the experience of other firms in the same industry. Such a rule may express the need for inventory in terms of so many days' sales. Thus it might be determined that an inventory equal to forty five days' sales should be adequate for the plastics fabricating industry. In circumstances where the new firm can expect to operate under policies and conditions similar to those already in the field, the short-cut approach to forecasting, of drawing a ratio from the experiences of established firms, may prove satisfactory.

However, in a great many industries the policies and circumstances of operation of different firms vary substantially. Hence an average ratio for existing firms may have little relevance to the distinctive pattern of a particular new firm. The variety of conditions to be found in different countries compounds this problem. Frequently, there may be no other firm in the identical business and industry experience is therefore irrelevant to the circumstances of the new firm. Any effort to project its needs on the basis of ratios drawn from other countries or different kinds of industry in the same country may therefore produce dangerously misleading estimates for the new firm. Moreover, the very fact of newness may make the requirements of the new firm distinctive.

Despite the hazards of blind use of industry figures as a substitute for more painstaking and thorough methods of estimate requirement, it is useful for those in the development financing agencies reviewing forecasts of needs to have the benefit of the experience of others in industry as a yardstick. As a warning to those who would blithely pirate ratios from others, it is interesing to note that the inventory levels of all United States manufacturers at the end of March 1965 was equal to 61.1 days' sales at the rate of sales in the first quarter of 1965. The variation from the over-all averages of differing industry groups was substantial. Thus, manufacturers of aircraft and aircraft parts were carrying inventories equal to 90 days' sales while manufacturers of bakery products had total inventories equal to only 18 days' sales.[4] Doubtless there is also a substantial variation between individual firms within the same industry.

[4] Figures are from "Quarterly financial report for manufacturing corporations, first quarter 1965", Federal Trade Commission, Securities and Exchange Commission, U.S. Government Printing Office, Washington, D.C., 20402.

What are the key factors that commonly influence management's decision to carry inventories equal to sales of 30 days or 90 days? A number of key influences or determinants of inventory levels can be identified.[5]

It is useful to divide inventories into three major classes, and consider the determinants of the [illegible] of each separately. In the case of United States manufacturers in a recent year a breakdown of inventory totals showed that the three categories, raw materials, work in process and finished goods, were roughly equal in value.

5. Key determinants of the investment in raw materials

First, let us review the key determinants of the need for investment in raw materials.

(a) The anticipated rate of usage of the materials in producing finished goods. Obviously, this rate would be related to the anticipated volume of sales.

(b) The volume of safety stocks needed to protect against materials shortages that interrupt production. Several factors are important in the judgement as to how many days' stock of vital raw materials represents enough protection against running out. Procurement lead time, that is the length of time required for an order to be filled, is critical. If the supplier is nearby and customarily has inventory on hand for immediate shipment, a relatively small inventory is indicated. Conversely, if a foreign manufacturer is the source for made-to-order components and he has heavy order backlogs, the procurement lead time for the item may be long and much larger stocks of the component are indicated.

A closely related consideration is the basic reliability of the flow of raw materials from suppliers. The size of stock may vary directly with the probabilities of interruptions in the flow from the supplier because of his own production difficulties, such as strikes or transportation problems. Comparable [illegible] tive hazards are encountered in maintaining the inflow of items which must be imported. For example, where exchange quotas or other restrictions on free import of materials exist, the possibilities of interruption due to changes in government regulations or the availability of foreign exchange suggest the need for larger protective stock.

If particular raw materials can be substituted for others, and particularly if domestic [illegible] substituted for imported [illegible] operate prudently with lower stocks than if the needs are highly specific and substitution difficult.

Speaking generally, the availability of [illegible] terials from a number of satisfactory sources [illegible] the safety [illegible] required [illegible] a single source.

A further consideration [illegible] stocks levels is the [illegible] stock. If the circumstances [illegible]

[5] As an illustration of [illegible] inventory problems at a [illegible] Magee, *Production Planning and Inventory Control*, New York: McGraw-Hill, Inc., 1958.

pany can shift production to other items for a time and/or the marketing situation is such that sales would not be lost by a temporary shutdown, it may be possible to operate prudently with relatively small raw stocks. On the other hand, management of a new enterprise in a highly competitive market may well judge it important that there be no interruption in their ability to service the needs of newly won customers.

(c) A third basic determinant of the size of raw materials stocks is that of economy in purchase. It is often possible to command favorable prices by purchasing in carload or large lots.

(d) An additional determinant is the outlook for price movement in the price of materials. If management estimates that prices will fall in the future, it may well operate with lower levels of stock than if the price outlook is for steady or higher prices. The outlook for price movements is a particularly important consideration in the case of companies importing major raw materials from abroad at a time when the value of the domestic currency is subject to rapid and large changes. Thus a manufacturer in a country experiencing rapid inflation may attempt to protect his costs of imported materials by maintaining abnormally large stock levels. Under conditions of uncertain supply and rising prices it is often hard for an outside analyst to draw a clear line between policies of price "speculation" and of sensible protection of materials supply.

(e) A fifth determinant of raw material inventory levels is the cost of carrying raw material stocks. These include the cost of storage, cost of funds tied up, property taxes, insurance, protection from theft, and the risk of physical deterioration during storage. Less obvious but often of critical importance, particularly in the case of components of industrial products subject to rapid change in design, are the hazards and costs of obsolescence of particular inventory types.

(f) Also of significance to inventory levels, particularly in the case of new enterprises, is the accuracy of procurement and inventory records. It is easy to underestimate the problems of accurate and up-to-date record keeping for fast moving stocks, particularly in cases where the number of different items in inventory is large.

6. Determinants of the investment in work-in-process inventories

As the name suggests, this category of inventory comprises the goods in the process of manufacture. The balance sheet value assigned to working process inventory at any particular date represents a summation of all the costs assigned up to that date to partially completed products.

(a) A key determinant of the size of in-process inventory is the length of time necessary to complete the process of manufacture. As extreme illustrations, consider first the case of a food canning company where the process of grading, processing, canning and labelling and packaging items such as peaches normally takes less than one day. Naturally, the canning company's work in process at any point in time will be negligible in relation to annual sales. In contrast, the manufacturer of large aircraft normally can expect the process of production and assembly of the complicated aircraft to extend over many months, so that the aircraft company might anticipate a sizable continuing investment in goods in process.

(b) The extent to which the production process is a continuous one will also be important in determining the size of work-in-process inventories. For example, the aircraft manufacturer working on an order for 200 aircraft might well try to reduce production costs by making the whole of a minor assembly in one production run, even though many of these assembly items would not be needed for final assembly for many months. Thus, a decision whether to produce components in long or short runs, which is at first thought merely a production problem, has definite implications as to the size of work-in-process inventory. It also should be clear that any interruptions in the flow of work through the industrial establishment will have the effect of boosting work-in-process inventory levels relative to sales. The new firm commonly experiences a variety of unscheduled interruptions in its productive activities, and estimates of work-in-process requirements should take this fact into account.

(c) An additional factor influencing in-process inventory levels is the amount of value added in the process of manufacture. Inexpensive processes, even though of long duration, may not add up to very substantial monetary requirements.

7. Determinants of the investment in finished goods

(a) A basic determinant of the level of finished goods investment is the ability of the firm to mesh production and sales. If the company is fortunate enough to be able to produce only against firm order and to deliver the finished products to the customer as they are completed, an inventory of finished goods may be almost entirely avoided. In this instance it is possible to fit the pattern of sales completely to the pattern of production. At the opposite extreme is the circumstance of the canner of peaches previously referred to who must produce his canned peaches when the fresh fruit ripens. Very likely he will be able to sell over the entire year; consequently he must build up high stocks at the canning season and look forward to their gradual reduction over the calendar year.

(b) The competitive situation of the enterprise in the market will have a major influence on the need for finished inventories. Companies in a highly favourable marketing position, characterized by excess demand, may be able to carry limited stocks of finished goods yet not be badly hurt by occasional inability to fill orders promptly. However, in more competitive circumstances, the manufacturer will not wish to risk the loss of sales that might have been made had he not been out of stock.

(c) The ability to forecast sales with accuracy is a further determinant of the levels of finished goods. If the demand for the company's products is subject to sharp and unpredictable fluctuations, relatively large stocks must be carried in order to prevent the loss of sales should orders suddenly increase. Conversely, sharp and unexpected declines in orders may lead to a rapid accumulation of finished goods, unless production schedules can be adjusted rapidly.

(*d*) The need for finished goods varies also with the competitive need for broad distribution of stocks in its sales territory. Normally, if sales are concentrated in a single geographical area, a smaller amount of finished inventories is required than if a similar volume of sales is made over a very wide area, where it will be necessary to carry substantial stocks in various regional warehouses.

(*e*) In industries or countries where sales on consignments is the custom, inventories of finished goods will include the stocks of distributors. Again, the extent of the distribution network will affect the level of inventories.

(*f*) A sixth factor affecting the size of finished goods inventory is the variety of sizes, shapes and models of the company's output. Generally speaking, the fewer the number of items in the line, the smaller the total volume of inventory necessary to service a given level of sales demand.

8. *Key determinants of the investment in receivables*

As in the case of inventory, it is possible to make rough estimates of the required investment in receivables by reference to the experience of other firms, translated in terms of the number of days the typical account is outstanding before it is paid. Thus, it might be noted that the investment in receivables of all United States manufacturers on 31 March 1965 represented 46 days' sales at the rate of sales achieved in the preceding quarter.[8] Again, however, in cases where more than very rough approximations are required, it is usually preferable to look at the specific circumstances of the particular firm and the factors that are likely to determine that firm's investment in receivables.

Five factors are particularly important in shaping the size of the particular firm's investment in receivables.

(*a*) The first is the terms of credit normally granted customers judged worthy of credit. In theory, each new firm is free to specify whatever terms of sale best suit its objectives and circumstances. Conceivably, it may sell only for cash-on-delivery, in order to avoid tying up funds in receivables and risking bad debt losses. If the demand for its products is strong enough, it may well succeed in selling only for cash.

More commonly, the competitive situation will require that the new firm offer its customers credit terms at least as generous as those offered by competing manufacturers. In the United States and a number of other countries, particular terms of sale have become traditional for many product lines. Thus United States manufacturers of automobiles have sold on terms of cash payment upon delivery to their dealer customers, while manufacturers of steel wire products sell on terms of 2/10 net 30, that is, 2 per cent discount if payment is made in 10 days and net payment is required in 30 days. In a [illegible] competitive market, a new firm may find it necessary to offer substantially longer credits to its customers than the competition in order to attract a [illegible] volume of business.

(*b*) Even new firms eager for business [illegible] will find it unwise to grant credit to [illegible] customers who request it. Instead, certain [illegible] standards of credit worthiness [illegible] potential customers must be established [illegible] credit will be extended. If high standards [illegible] worthiness are required, a significantly [illegible] of outstanding receivables [illegible] anticipated than if loose credit standards are [illegible]. Of course, if unduly severe credit standards [illegible] posed, potential sales may be lost [illegible] willing to undertake a greater credit risk [illegible] in receivables in order to [illegible] high [illegible].

(*c*) A third determinant of the [illegible] investment in receivables is the degree of [illegible] by the firm in its collection policies [illegible]. The closeness with which the new firm follows [illegible] on overdue accounts and the degree of [illegible] brings for prompt action on these accounts [illegible] a material effect on the paying practices of [illegible] customers and hence on the level of outstanding receivables. Laxity in credit administration [illegible] parts of the world, an invitation to customers [illegible] abuse the credit terms and to delay payment [illegible] as they think they can get away with [illegible] important delays in receiving payment from customers will cause the investment in receivables [illegible] huge.

(*d*) The degree of efficiency the new firm [illegible] in the plant and in the office will have [illegible] impact on the level of investment in receivables. Fast and accurate paper work in preparing invoices [illegible] in the maintenace of receivables records and follow-up procedures is important. Effective quality [illegible] and inspection procedures in the plant [illegible] critical since shipments below specifications [illegible] precisely in accordance with order terms [illegible] lead to disputes, and disputes [illegible] payment.

(*e*) The most important determinant of [illegible] volume of receivables outstanding is the volume of [illegible] for credit. If the other factors cited above are [illegible] constant, the level of outstanding receivables [illegible] expected to vary directly with the [illegible]. Thus increases in sales volume [illegible] the [illegible] of funds in receivables.

9. *Determinants of the need for cash balances*

The new industrial firm must expect [illegible] cash on hand and more important [illegible] significant balances in its bank accounts. How large should these balances be? Several [illegible] determinants of the need for cash balances [illegible].

(*a*) All businesses require [illegible] cash for routine operations and [illegible] fund will be needed for change [illegible] payments and disbursed in currency. A bank account is also necessary to facilitate [illegible] receipts in the form of cheques or drafts and [illegible]

[8] Quarterly financial report, p. 15 (see footnote 4 above).

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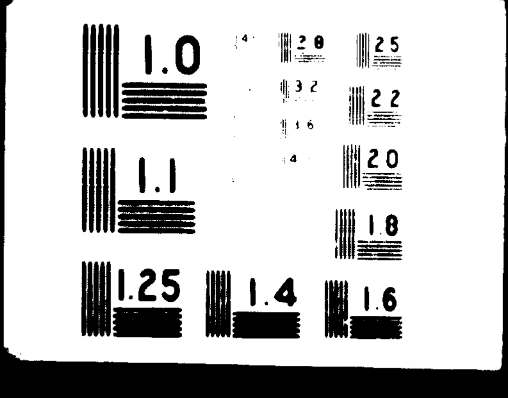

permit payment of major expenditures by cheque or draft. Usually, a portion of the nominal bank balance is immobilized in the bank's processes of collection of cheques and drafts deposited. The projection of the minimum balances required to meet these operational needs seldom is very difficult.

(*b*) A second determinant of the need for cash balances is the extent of routine fluctuations in daily receipts and expenditures. The cash account serves to absorb normal ebbs and flows in funds from day to day and week to week.

(*c*) The bank balances also reflect the desirability of advance accumulation of funds in anticipation of major outlays for such developments as planned expansion of inventories or receivables, income tax payments, debt repayment and purchases of major items of equipment.

(*d*) A fourth, highly subjective and highly important need for cash balances stems from the desirability of maintaining reserves of financial strength and liquidity against major unexpected needs. Accurate prediction of requirements is particularly difficult for the new enterprise, and generous cash reserves can protect against serious underestimation of routine needs. Further, unexpected demands on cash can come from interruptions to production and sales, due to such events as strikes, transportation tie-ups, or fire or storm damage to production facilities. Sudden declines in sales or unexpectedly high expenses may create major cash drains at a time unpropitious for borrowing or for raising further equity. Moreover, a firm may be forced by competition to make heavy expenditures for new, more efficient plant and equipment in order to cut manufacturing costs, at a time when new capital is relatively unavailable. Often adverse developments setting up heavy cash needs are coincident, so that pressures on cash are multiple in nature. In this connexion, it is interesting to recall the wry comment of an American sage, Benjamin Franklin, that "in adversity a man can count on only three reliable friends: a faithful dog, an old wife, and money in the bank".

On the other hand, absolute security is impossible for any enterprise in an uncertain world. Moreover, maintenance of large amounts of unproductive cash against possible needs dilutes over-all return on the investment as well as boosting total financial needs. In the last analysis, the judgement as to the size of the protective cash reserves to be maintained represents a balancing of risk *versus* cost considerations.

Also important in the determination of the optimum size of protective cash reserves is the assessment of alternative methods of providing reserves of financial strength. Thus it may prove on balance more desirable to maintain open but unutilized lines of bank credit against the possibility of unexpected needs. In other cases, equity investors may be able to invest additional funds if the need for such develops. Altogether, the possibilities for developing alternate sources of back-up financial strength should be thoroughly investigated before it is determined that large, protective cash reserves are necessary.

10. *Projecting major sources of funds*

Above we have discussed the manner in which the amount of investment in each of the major asset categories can be forecast. The total of the projected asset investments represents the gross need or use of funds by the enterprise as of the date of the particular projections. Now let us consider the sources of these funds, or in accounting terms, the liability side of the balance sheet. Sources of funds may be usefully divided into three main categories: "spontaneous" sources of credit, negotiated credits, and owners' or equity investment.

(a) *Forecasting spontaneous sources of funds*

The term "spontaneous" sources of funds is a somewhat overstated label for credit that the new enterprise may normally expect to enjoy without special effort or negotiations on the part of its management. These include a broad category of diverse items under the label "accrued liabilities". Usually it is possible for the business to receive certain services before it must pay for them. Thus, in many countries, it is customary to pay executives on a monthly basis after their services have been rendered. The total of such outstanding obligations at any single balance sheet date may be significant. Significant accrued liabilities also arise out of the fact that taxes on the income of business units usually are deducted from income well before actual payment must be made.

More importantly, if the new enterprise has reasonable financing and prospects for success are good, it can ordinarily expect to buy raw materials, components and other routine items on the normal credit terms generally extended by suppliers. If the amounts of purchased materials are large, the level of normal accounts payable will also be sizable. The size of the accounts payable then is a function of the amount of the firm's purchases, the terms of purchase and the promptness of the firm in settling its obligations. Normally, it is prudent to assume that trade payables will be paid when due. If significant cash discounts are offered for early payment, management must decide whether to take the discount and forgo the additional credit that could be obtained from suppliers by forgoing the discount. Unless the costs of capital to the enterprise are extremely high, it is normally advantageous to take all available cash discounts.

(b) *Projecting sources of negotiated credit*

Earlier we have spoken of normal trade credit as an important "spontaneous" source of funds. In a great many instances, potential suppliers of items of plant and equipment for the new industrial establishment are sufficiently anxious to achieve sales of such volume that they will be willing to negotiate special credit deals. Thus the new firm may be able to buy major equipment items on extended terms—as much as five to ten years on important, long-lasting items. Special credit terms may also be available on routine purchases of materials. Normally, the chances of getting generous special credits from suppliers is greatest if the following conditions characterize the supply situation:

(i) The main producers are large and comfortably financed themselves so that they are in a financial position to extend generous credit to their customers;

(ii) A variety of suppliers make products that are essentially similar;

(iii) The major suppliers are operating at less than capacity and additional output can be accomplished at low, marginal cost;

(iv) The additional volume of orders from the new enterprise promises to be significant and continuing.

The main thrust of these comments is to suggest that it is often to the advantage of sales-hungry suppliers to extend special credit to new firms which promise to be valued customers. The possibilities for such special terms deserve thorough investigation as the amounts of potential credit are large.

Commercial bank credit will also represent an important item for most new industrial firms. A reasonably well-financed firm with attractive prospects can normally expect some current credit from its commercial bank. On the other hand, bankers in a great many countries are more familiar with the financial needs of agricultural or trading firms than with those of industry, and may therefore be very cautious in evaluating new industrial enterprises. Consequently, before much reliance is placed on bank credit as a source of funds in the projected balance sheet, it is highly desirable that the attitudes of the commercial bankers be pre-tested and credit arrangements made as precise as possible. Furthermore, it should be kept in mind that bank credit may well be withdrawn if the enterprise encounters difficulties. Thus, for the new enterprise, bank credit is likely to be a significant yet not thoroughly reliable source of funds. Further, as indicated earlier, in many circumstances it may be prudent to develop unused borrowing arrangements against the possibility of unexpectedly heavy requirements in the future.

In the United States and some other countries, life insurance companies and other financial institutions are prepared to make intermediate and long-term loans to industrial enterprises. However, unless the new enterprise has unusually favourable prospects, or can offer some valued security such as tracts of land, the normal uncertainties surrounding new ventures are usually sufficient to turn away long-term lenders.

Where the new firm has been successful in negotiating with a bank or other institutions, the length of term of the loan may well be a measure of the dependability of this source of credit. Management may make firmer plans if the loan is covenanted for a year or more than if it is merely a revolving line of credit.

(c) *Equity sources of funds*

In normal circumstances, the owners of the new enterprise can be expected to provide the bulk of the funds necessary for operation of the business. They will share in the profits above the return of interest to lenders and they must absorb the principal risks of the enterprise. Equity investment for the new business normally takes the form of capital paid in by investors subscribing to new common shares. However, the base capital will be supplemented or reduced according to the projected profits or losses of the firm between the interval of its inception and the dates on which projected balance sheets are set forth. Thus, preparation of the projected balance sheet requires an estimate of a profit and loss for the firm in the interval between its inception and the date of the projections. Seldom is it easy to forecast accurately the operating results of a new firm. However, the requirement of a new profit and loss forecast in order to make a projected balance-sheets forecast of financial requirements should not be viewed as an additional burden. Certainly, it is desirable for planning purposes in any instance to prepare forecasts of the estimated results from operations.

A few useful generalizations can be made regarding the projection of profit-and-loss statements for new ventures. General experience has underscored the importance of conservatism in predicting the results of operations for the new firm in its early months and years. Commonly, the costs of getting started in business are inordinately high, and frequently combinations of unexpected problems force costs well above what might have seemed reasonable estimates. For example, it is normal in the new manufacturing enterprise of any complexity to encounter problems in training labour and supervisory personnel, so that a high order of rejects and materials spoilage must be expected. It seems good general advice to suggest that the projector should expect the unexpected and that such unexpected developments will probably be unfavourable. The thrust of these comments is to urge that the estimates of near-term profitability for the new venture be made on what the projector regards as highly conservative or pessimistic assumptions.

11. *Illustration of the projected balance sheet approach*

Now let us provide a brief and over-simplified illustration of the process of developing a forecast of financial needs by the projected balance sheet method by reference to our earlier example — Progressive Plastics, Inc. The principal promoter of the proposed company is Mr. I. M. Handy, who has been serving as executive vice-president of a plastics firm in a different part of the country. Anxious to be head of his own operation, he has succeeded in persuading friends and acquaintances to invest in his new firm. Total commitments from these friends amount to $300,000, including a $40,000 investment of his own. He has decided to try to make this amount suffice, although two large investors have indicated that they together could supply an additional $50,000.

After careful investigation, Mr. Handy found a large industrial building in which two floors adequate for his needs could be leased. The necessary electric power and basic facilities were already available.

After careful analysis, Mr. Handy determined that the new firm could expect to achieve a sales level of approximately $200,000 a month by the end of the first year of the operation. The sales were expected to remain at about this level for the next two or three years.

Mr. Handy sought to minimize equipment needs by procuring only three new compression moulding machines. A fourth machine would be purchased in the used machinery market for a cost of no more than one half that of the new machines. The used machine would be used primarily to provide stand-by capacity to cover peak-load requirements and breakdowns in the new machinery. To minimize investment in equipment, Mr. Handy planned to operate new machines on a three-shift, 24-hour basis, even though labour on the second and third shifts would be paid somewhat higher hourly wages than for the first shift. Other fixed asset requirements consisted primarily of polishing and grinding machines for the finishing operation, materials handling and office equipment. Since the costs of the polishing and grinding machines for the finishing operation were modest, Mr. Handy determined to buy enough of these so that this part of the operation could be accomplished through single-shift operation, inasmuch as the prospective employees for this operation would be women, who preferred to work daytime shifts. He estimated that total outlays for equipment would come to $263,000.

After intensive negotiation, Mr. Handy was able to arrange deferred payment terms on the new moulding equipment, so that a large percentage of the purchase price could be repaid over a 36-month period.

Mr. Handy decide to forecast his requirements after the company had reached its anticipated level of sales volume, which he believed would represent the time of greatest financial strain for the firm. Since this sales volume would be reached in approximately one year, he decided to project requirements as of one year after the company began operation. It would take some three months to get ready to begin production, so the balance-sheet forecast would be made approximately fifteen months in the future.

Mr. Handy wanted to operate with a level of inventory that would provide reasonable protection against interruption in raw material flows and sudden spurts in sales. With this policy, he hoped to avoid production stoppages. No marked seasonal pattern in sales was anticipated, and Mr. Handy hoped to produce at a level rate once sales had reached a certain volume.

Mr. Handy estimated that raw materials would amount to about 40 per cent of the total cost of goods manufactured, which in turn would amount to about $150,000 per month once the $200,000 sales level was reached. Consequently, raw materials purchases would approximate $60,000 a month. After consideration, Mr. Handy decided to try to maintain a supply of raw materials equal to one month's usage.

The requirements for in-process inventory appeared small. In order to ensure that the labour in finishing the dinnerware would not be left idle due to interruptions in moulding, Mr. Handy decided to carry an in-process inventory of about three days' output of the moulding machines, representing about $12,000 in total value.

Mr. Handy planned to sell his tableware in sets of 30 to 60 pieces. Several different designs were to be employed and in each of the designs six basic colours would be used. These marketing requirements appeared to dictate a considerable stock of finished goods, inasmuch as the competitive situation demanded that the company have finished merchandise on hand for immediate delivery as orders were received from retail outlets. Mr. Handy first planned to carry a finished goods inventory equal to about one month's sales at cost, or $150,000. After consideration of the financial burden, however, he decided to accept a lower target figure of three weeks' supply, or $113,000.

It was the custom in the trade to offer retailers 30-day credit terms. Since some customers might be expected to be slow in payment, even though most of the prospective customers were well-established, well-financed firms, Mr. Handy projected his receivables' investment as one and one third months' sales, or $267,000.

Other asset requirements were expected to be minimal; Mr. Handy decided to make a $5,000 allowance for these.

Mr. Handy was conscious of his earlier assumption that there would be no seasonal fluctuation in sales. However, from experience he had learned that there would be some fluctuations in the rate of incoming orders and certain unexpectedly slack periods of sale might well occur. To provide for such contingencies and routine fluctuations, Mr. Handy decided to maintain a bank account of $75,000, a figure equal to approximately two weeks' projected, normal expenditures. He would have felt much more comfortable with a larger figure, one say, equal to one month's expenditures. However, he did secure the categorical agreement of two investors to invest an additional $50,000 when, as and if needed by the firm, so he decided to rely on this additional commitment as a contingent reserve of financial strength.

The tabulation (see below) of anticipated investment at the end of fifteen months totalled $795,000. Armed with this estimate of probable gross requirements, Mr. Handy turned to the task of generating sufficient sources of funds. First, he undertook a projection of profit and loss for the three months of organization and the twelve initial months of operation. After detailed calculation, Mr. Handy determined that the company would become profitable after about six months of operation and that, in the second six months of operation, the profits would be sufficient to recoup organizational costs and the losses of the first six months. Hence, the owners' investment would be intact by the time of the projected balance sheet. As indicated earlier, Mr. Handy had negotiated a special credit on the new equipment. After allowing for down payment and payments during the first year, an amount of $100,000 would be outstanding on the projected statement date. Accounts payable were expected to consist predominately of payables for raw materials, but some additional supplies would also be bought on credit.

The terms of purchase of the principal materials were net thirty days, so that Mr. Handy projected a figure of $70,000 as a normal level for accounts payable. Accrued expenses would consist largely of accrued rental and accrued wages. While these figures would fluctuate somewhat within the month, they would generally be at a level of about $25,000.

These projected sources totalled $500,000, leaving approximately $300,000 of needs unmatched by sources.

Mr. Handy then investigated the possibilities of bank credit. He found that the local commercial banks were unwilling to make unsecured loans that would be outstanding continuously over a long period, but that one bank was willing to make a revolving credit loan arrangement under which the bank would advance 80 per cent of new receivables of firms of good quality. Since Mr. Handy planned to sell only to firms of good credit, he felt justified in projecting bank credit at $200,000, a figure almost 80 per cent of the total receivables outstanding. Combining the "source figures" in the projected balance sheet, Mr. Handy found that he was still short $102,000. At this point, he faced some unpalatable choices. He was reluctant to reduce the scale of the enterprise, since a smaller operation could expect to have little impact in the market and could not carry an adequate amount of advertising to support sales. Consequently, he decided to take the chances of operating with a two weeks' stock of finished goods, thus reducing the finished goods' investment by $38,000 to $75,000. Next, he considered other possibilities for credit. After investigation, he found a leading supplier of the plastic powder, his principal raw material, who was willing to grant 60-day terms instead of the normal 30-day terms, provided Progressive Plastics' purchases were concentrated with his firm. This made possible an additional $60,000 of continuing credit, or a level of accounts payable of $130,000. A recasting of the projection of sources brought the total to $755,000, so that, if the cash balance were reduced to $73,000, sources and uses would be equal.

On the face of the matter, it appeared that Mr. Handy had a feasible financial programme. Yet he queried whether his financial plans made adequate allowance for unexpected needs and unforeseen problems.

Progressive Plastics, Incorporated

Projected balance sheet as of end of first year of operation

(Dollar figures in thousands)

	Initial projection	*Revised projection*
Cash	75	73
Inventory:		
Raw materials	60	60
In-process	12	12
Finished goods	113	75
Accounts receivables	267	267
Plant and equipment	263	263
Miscellaneous assets	5	5
	795	755
Bank loan		200
Accounts payable to suppliers	70	130
Accrued expenses	25	25
Notes payable—equipment supplier	100	100
Paid in capital	300	300
Earned surplus	0	0
	495	755
Shortfall	300	

12. *The projected cash flow method of forecasting fund requirements*

The most basic and comprehensive method of predicting the amount and the timing of future cash needs is through preparation of a cash flow forecast. Essentially, the cash flow forecast, or "cash budget", is a tabulation of the plans of the firm in terms of their impact on the receipts and expenditures of cash in future periods. The basic theory of the cash flow forecast is simple—it seeks merely to predict when and in what quantity receipts of cash will come into the firm and when and in what quantity payments of cash will be made.

In the cash forecast, all anticipated receipts of cash are included, regardles of whether or not they represent income in the accounting sense. Thus, included along with collection of cash from sales and receivables arising out of sales are cash receipts from such sources as sales of securities or of fixed assets. Similarly, the tabulation of payments should include, along with such routine payments as accounts payable, wages, salaries and rents, any planned payments of taxes, dividends, loan repayments or outlays for equipment or buildings. It should not include expense items which do not represent outlays of cash, such as allowances for depreciation and for bad debts.

The forecaster for a new firm is interested in revealing not only the total outflow and inflow over an extended period, such as a year, but also the timing of the cash flows within this period. In most cash forecasts, receipts and payments are broken down by months, but, if uneven inflow and outgo are anticipated within the monthly intervals, it may be necessary to break the forecast down into weekly or even daily periods in order to expose maximum needs.

As in the case of the projected balance-sheet method, the results of cash-flow forecasts will prove only as accurate and as reliable as the underlying planning on which the forecast is based. And as we have seen, virtually all the significant activities of the firm affect its need for funds. Thus, for complete effectiveness in his work, the forecaster of cash flows needs comprehensive and accurate data on what the operations of the firm are likely to be.

In this discussion of cash-flow forecasting, we will assume that basic plans for the operation of the business have been developed and that the persons constructing the cash-flow forecast will have the benefit of such basic planning materials as the forecasts of anticipated sales broken down into sales for cash and sales on normal credit terms; and, if an important volume of sales on special credit terms is anticipated, a separate breakdown of sales on special credit terms.

From the sales forecast, a schedule of collection of receivables can be prepared. In this schedule, the collections are lagged behind the credit sales by use of appropriate assumptions as to the average time receivables will be outstanding. A next step involves the projection of other receipts; for example, from planned sale of common shares or from anticipated bank loans.

With these data, a schedule of anticipated cash receipts can be prepared which pulls together the projected receipts from cash sales, from collection of receivables and from the other anticipated sources.

In forecasting planned payments, total anticipated outlays are built up from a series of sub-schedules. A first schedule, particularly important in the case of the enterprise just getting started, tabulates the costs of facilities—plant, equipment, spare parts and any other facilities required. This schedule of facilities requirements then must be converted into a schedule of payments for facilities, by lagging the planned payments behind purchase dates according to the credit terms of purchase of the facilities.

Among the important schedules that follow from the planned production schedules is a schedule of planned purchases of raw materials and other production materials. This schedule of planned purchases in turn must be converted into a schedule of payments for planned purchases by timing payments according to the terms of purchase the firm expects to enjoy.

From the production schedule, also, is derived a schedule of manpower requirements. This must be translated into projections of wage expense and in turn into a schedule of wage payments. Similarly, other manufacturing expenses must be converted into a schedule of payment for other manufacturing expenses.

In a similar fashion, a schedule of payments for general administrative expenses can be made along with an additional schedule of "other payments", which lists any other expected outlays not included in the other payment schedules.

The totals for each of the time periods in question for each of the schedules of receipts and expenditures are brought together in a summary schedule of projected receipts and payments. The totals for payments plus the desired bank balance, less anticipated receipts, represents the net cash need forecast for the period. Normally, a cumulative figure for net excess or shortage of cash is carried forward from month to month, so that the net need can be determined as of the end of any forecast periods.

Compared with the projected balance-sheet method, the forecast cash flow approach has some advantages in simplicity of concept and apparent ease of preparation. Actually, in each case much underlying planning is necessary before meaningful financial forecasts can be put together. If common planning assumptions are used in the two approaches, the two should produce identical results. Thus, if we were to prepare a cash forecast for Progressive Plastics covering the period until it begins operation and the twelve months thereafter, the cumulative figure for cash from the cash forecast should equal the $73,000 balance shown on the projected balance sheet for the date one year after beginning operations. In a real sense, each approach supplements the other, and a good set of financial forecasts should include both cash forecasts detailed by monthly periods and projected balance sheets as of month-end for the similar span of time.

C. Some common problems in forecasting needs; approaches to their solution

Case studies of the results of new industrial ventures have shown up widespread weaknesses, often serious ones, in the financial planning associated with these projects. In this section we shall identify some of the most common problems in the forecasting of financial needs and, where possible, suggest approaches by which these problems may be eased or overcome.

1. *Inadequate emphasis on the process of planning by management*

In a great many areas of the world, there is a distinct shortage of highly trained, professional managers, skilled in techniques of business planning. More often the potential managers of new industrial enterprises are men with an orientation towards action rather than towards analysis and planning. Their experience has included little exposure to business planning techniques and they have been accustomed to operating in a manner described as "flying by the seat of your pants". Once they see what they judge an attractive opportunity, they are eager to get started, expecting to improvise and adapt as necessary to make the enterprise succeed. As we suggested at the outset of this paper, planning, particularly with reference to the projection of needs for financing and the mustering of sources of funds, has very real advantages. Work on planning can be extremely productive, not just a matter of meeting bureaucratic requirements of a development financing agency. In the long run, education in business management, a training which will doubtless include emphasis on planning techniques, will instil an appreciation of the usefulness of formalized planning. In the short term, however, it seems widely necessary that the development financing agency undertake a continuing missionary effort to promote a greater managerial interest in planning and planning techniques. At the same time, it can insist on the preparation by management of meaningful, forward plans as a prerequisite to its financial support. The broad educational effort and the rigorous requirement should go hand in hand, since the quality of the planning effort will be much greater if management is convinced of the importance of the value of the effort to itself as well as to the financing agency.

2. *Limitations on the capacity to plan future operations*

Even where management is impressed with the desirability of careful planning, lack of skill due to inexperience may limit its capacity to plan effectively. As suggested earlier, even a trained manager may be experienced primarily in marketing, production or general administration and have had little exposure to operational planning. We have emphasized over and over again the point that financial planning is simply an adjunct or a follow-on aspect of over-all planning for the enterprise. Thus, a great many of the financial requirements will relate directly to the volume of sales achieved. Yet management may have had little or no training in market research or other techniques useful in projecting realistic estimates of attainable sales volume. Where the need for the project is great or where management has other skills that are impressive, the development financing agency should be willing and able to lend active assistance in the development of the forecasts and in the total planning function. Technical assistance of this nature may prove to be a more valuable contribution to the success of the project than the money provided by the agency. Many development financing agencies do not appear to be sufficiently well staffed to provide this assistance at present. It seems to us highly desirable, indeed essential, that they equip themselves to render management a high quality of assistance in this area.

In other situations, uncertainties inherent in the environment may effectively limit the capacity to plan operations. In many instances, for example, the action of the Government relative to tariffs or other import restrictions may be of great importance to the forecasting of sales by a new domestic enterprise, yet changes in these government policies and attitudes may be extremely difficult to anticipate. In such circumstances, accurate planning is impossible. It is very important to recognize the degree of uncertainty behind forecasts, since blind reliance on inherently tenuous assumptions may lead to results worse than if no planning at all had been attempted.

One useful approach in situations where inherent uncertainties are great utilizes multiple projections based on different assumptions about the more important variables influencing future conditions. These can lead to tabulations of minimum and maximum requirements, as well as to an estimate of most probable requirements. Even if plans are based on the most probable rather than the maximum requirements, management and all concerned are alerted to the possibility that needs might well be at the maximum rather than at the most probable level.

3. *Failure of projections to reflect the distinct circumstances of the particular project*

As we have indicated earlier financial projections must reflect the circumstances, the environment and the plans and expectations of the management of the particular venture. The use of standard ratios drawn from the experience of other firms under different conditions and under particular operating policies can be dangerously misleading. Thus a United States manufacturing firm undertook the establishment of a new plant in the Far East. Drawing ratios from its domestic experience, the total requirements for plant and equipment and working capital were projected at $2 million. A variety of distinctive local conditions, including the expectations of customers for long-extended credit, caused actual needs to amount to between two and three times the original projections.

Somewhat similar hazards obtain when the job of preparing the financial forecasts is turned over by management to outside accountants. Even if the outside accountants are skilled in the mechanics of forecasting, they often have proved reluctant to question management closely and thoroughly regarding its particular plans for the future. Consequently, the forecasts have been mechanically perfect yet have failed to represent what management actually planned to do and hence have proved sterile and misleading. Certainly it is permissible, perhaps desirable, for people skilled in accounting to prepare the detailed forecasts, but in such circumstances top management participation in and detailed acceptance of the implicit operating plans built into the forecast is essential. Often, it is useful for development financing officials, examining projections submitted to them, to review the forecasts with the top management of the new enterprise, in order to verify the relations of the projections to the actual operating plans and expectations of top management.

4. *Widespread tendency toward underestimating financial needs*

As noted earlier, underestimation of actual requirements is much more common than is overestimation of financial needs. Perhaps this stems from the natural optimism that one would expect in men willing to undertake the challenge of a new enterprise. While a certain optimism is perhaps an essential ingredient for entrepreneurship, it becomes a weakness of financial planning unless it is tempered with realism. As we have indicated earlier, higher than expected fixed plant and equipment expenditures, tardiness in starting up operations, slippages in production schedules once operations are under way, higher than anticipated costs, and problems in achieving targeted sales levels and collection schedules are extremely common. Failure to allow an adequate margin of error for unexpected, as well as predictable difficulties, is unfortunately common.

Case studies indicate also a widespread tendency towards underestimation of the total burden of financing working capital. Often the management experience has been in the technical end of the business and the needs related to plant and equipment can be visualized and easily accepted. The need for inventories, accounts receivables and cash reserves, however, is less obvious than the requirements for physical facilities and commonly receives inadequate emphasis. Often this underemphasis takes the form of blithe assumptions that working capital needs can be matched by trade credit and bank loans when, in fact, these sources will be grossly inadequate to match total gross working capital needs. The solution to this problem seems to lie simply in orderly and thoughtful forecasting of working capital needs and related sources. Once this process is accomplished, the net needs should be evident.

Many firms have succeeded in financing the initial sales volume projected, only to encounter difficulties when the company has subsequently achieved a substantially higher volume of sales. As we have seen, the investment in receivables and inventory tends to increase roughly in relation to the growth in sales. While some offset to the net increase in gross working capital needs due to expanded volume is obtained from the boost in trade credit related to increased purchase volume and from higher profits as a result of the higher volume, these commonly are inadequate to match the higher investment required in inventory and receivables. Thus, working capital stringency may be encountered at a time when the company is enjoying an unusual prosperity measured in terms of sales and profits. Known as the "prosperity squeeze on working capital", this phenomenon needs more widespread recognition and explicit reflection in financial forecasts.

5. *Failure to provide sufficient uncommitted reserves of financial strength*

In a number of instances, enterprises quite promising for the long term have failed because their managers did not provide sufficient reserves of financial strength to permit them to overcome immediate difficulties. As indicated in the discussion of the functions of cash reserves, a balance must be struck between a risk of failure due to inadequate reserves and the problem of raising enough funds to get the enterprise started. Wherever possible, however, specific and substantial reserves of financial strength should be built into the financial projections. This can be done by making highly conservative estimates of funds requirements at each point in the forecast, by maintaining substantial cash reserves, by making explicit arrangement for additional sources of funds when needed, or by a combination of two or more of the above. Speaking broadly, the size of the uncommitted reserves of financial strength should vary inversely to the flexibility of operating plans of the venture. Thus, firms operating according to a highly inflexible schedule should plan for greater reserves of financial strength. For example, a promising venture in the construction of prefabricated houses in the north-east United States went into bankruptcy after less than one year of full operations. This firm had experienced management and an excellent product. Operation was to be built around assembly line production of large wall, roof, floor and partition panels with major economies anticipated from continuous large-scale production and volume purchase. Yet it was apparent that the success of the plan depended upon continuous production at a high volume and that any interruption to the production or sale of houses, or to the collection of the sales receivables, would cause inventories and receivables to pile up and financial requirements to skyrocket. Actually the firm did encounter significant production and sales difficulties and problems of financing the operation quickly became acute, since little provision had been made for additional unplanned needs. The failure of this company might well have been avoided had the original planning recognized the inflexibility of operating plans and the consequent need for a flexible financing plan.

6. *Methods of reducing needs for funds*

In seeking to maximize the productivity of available funds, financing agency officials should develop skill in bringing to light alternative approaches or devices of management minimizing the need for funds. It may well be that the easiest way to "raise funds" is to take measures to avoid the need for them. A formal checklist of ways of reducing net capital requirements may be useful. Where the situation suggests that particular need-cutting methods from the list might be applicable, these can be raised for consideration of the promoters of the new firm.

More as a means to stir thought which will lead to very much more comprehensive lists, we present below a number of questions designed to expose fund-conserving possibilities. Some have been mentioned before in this paper; others are added.

(1) In considering location of plant or office facilities, is appropriate attention given to the availability of such infrastructural items as feeding, housing, transport, educational, and recreational facilities for personnel? water and sewerage facilities? road, air, rail, or water transport facilities? electric and steam power facilities?

(2) Is leasing a satisfactory alternative to ownership of factory buildings, office facilities, warehouse facilities?

(3) What are the possibilities for subcontracting operations requiring very expensive or infrequently used equipment: operations at peak load periods; operations which require unusual skills?

(4) What possibilities exist for increasing usage of expensive equipment or facilities by multiple-shift operation?

(5) Have the possibilities been investigated for joint-ownership and use with other firms of high-cost facilities such as computer centres?

(6) Are opportunities for employing used machinery effectively exploited?

(7) Have the possibilities of use of air freight been taken into account in minimizing spare parts' inventories?

(8) Have considerations of credit availability been weighed appropriately in selecting equipment sources?

(9) Are the plans for equipment thoroughly suitable to local circumstances such as the costs of labour, maintenance skills etc.?

(10) In the design of products, is maximum use made of standard components or materials and of domestic materials available from suppliers' shelves on short notice?

(11) Are vigorous methods used to keep stocks of various items in balance, recognizing that the utility of inventories may be limited to the level of the lowest vital item?

(12) Are the routines of receipt, stock-record keeping and issue thoroughly methodical and fully disciplined?

(13) Are the shortest procurement lead-time assumptions and leanest stock levels employed consistent with reasonable safety?

(14) Are the procurement offices and production scheduling offices working closely together, so that changes in production schedules are quicky reflected in material orders?

(15) Are routines established to get production orders set aside in the plant back into the productive process and the goods into salable condition?

(16) Is vigorous action taken to dispose of obsolete, surplus or otherwise unfit materials or components?

(17) Are constant efforts made to shorten production cycles? Do existing methods ensure full recognition of all costs and risks of inventory in the decisions as to length of production runs?

(18) Have full efforts been devoted to development of multiple sources to replace sole-source suppliers?

(19) Can special price cuts be used more quickly on slow-moving finished goods?

(20) Are maximum efforts being made to flatten out seasonal sales patterns that bulk up inventories?

(21) Are devices that show movement of goods from retailers' shelves being used to provide timely warning of changes in sales at retail level?

(22) As new items are added to the company's line of products, are organized, continuing efforts being made to delete items so as to prevent needless proliferation of inventory items?

(23) Has the feasibility of air delivery to customers been analysed recently as a substitute for decentralized stocks of high-value, slow-moving inventory items?

(24) Will competitive conditions permit insistence upon deposits or advance payments against customer orders? This is most likely to be a possibility in the case of orders for special products taking a long time to produce.

(25) Would use of prompt payment discounts materially reduce the level of outstanding receivables?

(26) Are procedures for the swift investigation of customer complaints and expeditious resolution of disputes with customers in effect?

(27) Are office routines adapted to prompt invoicing of deliveries?

(28) Is the follow-up on overdue accounts vigorous and continuing?

(29) Are receivable accounts reviewed periodically to expose chronic slow-paying customers who could be put on cash terms?

(30) Have all possibilities for getting customers' cheques into the bank rapidly, such as use of banks as collection points, been investigated?

XVI. MANAGERIAL REQUIREMENTS AND THEIR APPRAISAL IN INDUSTRIAL PROJECT EVALUATION

by William H. Newman*

Introduction

Able executives are one of the crucial requirements for the success of any enterprise.[1] No matter how sound a project may appear, unless good managerial talent is available to run it, it is doomed to failure.

On the other hand, judgement regarding future management is often difficult to make at the time of project evaluation. The subject lacks public glamour and therefore may receive little attention. At the same time, the personal ambitions of individuals who would like to run the project are involved, so that the subject must be handled delicately—or gently side-stepped. Even when it is acknowledged, making wise and objective appraisals of future executives calls for subjective judgements, and these are difficult to discuss and defend in public.

The subject of this paper, then, is both vital and hard to perform. No formula or well-recognized steps exist for its easy solution. These characteristics—importance combined with difficulty—make careful and systematic analysis of potential management one of the crucial aspects of project evaluation.

This paper deals with the assessment of executive qualifications needed to manage a project after facilities are in place. We are assuming that the economic and political soundness of the project has been settled, and that problems of design, financing and other aspects of preparing the project for operation are being considered in other parts of the over-all evaluation. Our specific question here is: what kinds of people will be necessary to operate the project successfully after the facilities are in place, and what are the prospects for attracting and retaining such qualified persons?

We shall consider this question from the point of view of those engaged in the actual evaluation of proposed industrial projects; thus this is neither a theoretical treatment nor a report on scientific research. Many of the suggestions are based on such studies, but the purpose here is to translate what is known into operational terms and to express ideas clearly with a minimum of technical jargon. While the approach recommended is applicable to all sorts of situations, the focus is on industrial projects in developing countries.

The analytical framework proposed extends from the needs for executive personnel arising from the project itself to the means for fulfilling those needs. In the actual evaluation, the steps will not, of course, be followed in rigid sequence; the evaluator must assemble data from numerous sources, and he will often base his ideas upon other aspects of the project evaluation. Nevertheless, some framework is valuable in organizing such diverse information and in ensuring a thorough and systematic review of all important aspects. The following points should be considered: realistic statements of managerial tasks necessary for successful operation of the project; tentative managerial organization to perform the identified tasks; appraisal of potential staff to fill positions described; possibilities of training men to fill managerial jobs; difficulties arising from different cultural backgrounds.

A. Realistic statements of managerial tasks necessary for successful operation of the project

Managerial requirements arise from the project itself—its mission, size, degree of integration, novelty, affiliations, and other values. Some aspects of management will be similar to those found in other enterprises. Grave danger will be encountered, however, if lists of tasks are merely copied. Instead, the first question is: what managerial tasks must be performed well in order to make this particular enterprise a success? Some suggestions can of course be obtained by examining similar enterprises; but each enterprise is unique, and the particular array of activities necessary to the project under consideration should be carefully studied. A list should be made of the total tasks to be performed together with an indication of those requiring exceptional skill.

The following outline, while not intended to be comprehensive, suggests several points of view which should be considered with respect to every project.

1. *Making technological decisions*

Within an executive staff, there should be considerable knowledge regarding the technical processes and the general "know-how" involved in the particular line of business. Oil refining, steel making, or leather tanning obviously call for distinct knowledge and judgement. In this broad field of technological decisions, it is often helpful to distinguish between two types of problems:

(*a*) Process design and modification: decisions of this sort are typically made only occasionally and are often highly technical in nature;

(*b*) Technical operating decisions: here we are concerned with maintaining conditions that ensure

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[1] The term "enterprise" is used to designate the venture or business—public or private—which is being evaluated. Thus, "project" and "enterprise" have the same meaning.

efficient operation of, for example, a loom or an open-hearth furnace.

In view of the rapid changes taking place in the technology of many industries, an ability to keep up with new developments, in addition to familiarity with current technology, should be possessed by at least some of the executives.

2. *Maintaining effective external relationships*

Every business is both dependent upon and contributes to a variety of external groups. These relationships must be maintained so that the mutual exchange operates on a continuing basis. A breakdown on any one front may jeopardize the entire operation of the project. The external groups with which good relationships are essential to every enterprise include customers; co-operating industries such as suppliers, transport, services, bankers; government and regulatory agencies; worker representatives; local communities, schools, and the like.

The basic point here is that every new enterprise will become an active part of its economic, political and social environment. Being new, it will probably be the agent of significant changes in one or more features of that environment. Consequently, the success of the venture will depend, in part, upon having executives who can effectively foster successful relations between the new business and the "outside" world.

3. *Internal administration*

The largest volume of managerial work in terms of man-hours typically deals with internal administration. For purposes of evaluation, a threefold breakdown of internal management is helpful.

(a) *Creating goods and services*

Here, we are concerned with management of the main production functions of the enterprise: the creation of goods (or services) of the right quality, at the right time, at a reasonable cost. These may be steps in a process or, for a diversified venture, activities relating to various products. Because these activities are the justification for the existence of the enterprise, they normally will be easily identified.

(b) *Providing necessary auxiliary functions*

Managers must also deal with a variety of activities necessary to facilitate and support the basic functions of the enterprise: accounting, finance, personnel, maintenance and other services. In remote areas and in non-industrialized countries, the variety and importance of these auxiliary functions increases. The project plan should not only indicate what auxiliary activities are necessary but should also make sure that the executive talent needed to direct them is included in the evaluation.

(c) *Managing operations*

The functional breakdown suggested in points *(a)* and *(b)* above emphasizes the subjects in which competence is needed in the executive corps of the enterprise. Cutting across these functional fields is managerial skill, which involves the ability to plan, to organize, to select and train personnel, to supervise and to control.

The reason for giving specific attention to these managerial processes is that a man may be an expert in, say, accounting or personnel, but lack managerial ability in applying such knowledge to an operating situation.

4. *Integrating various activities into balanced, timely and effective action*

In addition to making technological decisions, maintaining effective external relations and managing operations, another highly important task of management is "integration". A good manager must take into account a variety of factors which are often quite different in nature. Issues relating to technology, external relations and internal administration are interdependent: usually changes cannot be made in one without affecting another. The manager must provide a balance in the weight given to various considerations and do this in terms of a sequence or flow of operations, without merely comprising one for the other. Instead, to use a chemical expression, he achieves a synthesis which produces effective results with a minimum of economic and social cost.

This integrating task is dynamic. It deals with changes in the external environment and within the enterprise. Consequently, it involves a never ending process of adjustment. Also, if done well, the integration anticipates changes and prepares to meet them; the mechanism for doing this may be long-range planning or informal forecasting and adjustment. Furthermore, management may initiate change with respect to markets or other conditions closely related to the enterprise. Obviously, some projects will be expected to carry a greater burden of dynamic leadership than others. In today's world, a management must have at least some capacity to adapt and change if the enterprise is to survive.

The central theme of this section is that an evaluation of management must rest on a clear understanding of what the managers of the specific enterprise are expected to do. No ready-made list of duties is satisfactory for this purpose. Each enterprise varies not only in the scope of its internal activities, but also in its external relationships and the position it occupies in the economy and the society of its country. Therefore an imaginative analysis of the various aspects of the enterprise is a necessary first step.

B. Tentative managerial organization to perform identified tasks

Since our object is the evaluation of manpower, the managerial tasks identified in the preceding analysis must be translated into jobs that will be filled by people.

1. *Combining tasks into managerial jobs*

Analysing and organizing are not the same thing. For example, motion study is a powerful tool for improving methods of work, but we have learned through bitter experience that the narrow subdivisions helpful in an analysis are rarely the best way to assign tasks to individual workers. The same principle applies to managerial jobs.

The tasks identified in the analysis suggested above can be combined in numerous ways. Some activities will be so important and so specialized that they should be assigned to a single individual. Less important tasks may be grouped with several others to form a single job. Still other activities may be divided among several executives. But, in this process of combining tasks into jobs, each necessary task should be ensured adequate and specific attention.

A vital part of the organizing process is relating the various jobs to each other. Channels of communication, influence and authority are essential to coordinated action. Consequently, the various jobs need to be fitted together into some form of organizational structure.[2]

2. Successive refinements in organizational planning

When a project is in its preliminary planning stages, the projected organization is likely to be vague. For example, if economic feasibility is the central issue and skilled manpower is readily available, the entire question of management evaluation may be deferred. However, in many countries managerial manpower is a critical and scarce resource. In such situations, a tentative organization plan, or perhaps alternate organization plans, should be prepared when it is decided to give the entire project careful evaluation.

As plans for the project are refined, and especially as certain key individuals are selected as future executives of the project, the organization plan should become more definite. Frequently, the scope and perhaps the nature of a project are modified as planning proceeds. This leads to successive refinements of the organization plan.

The purpose of these organization plans is not to impose a rigid structure on the executives who are finally selected to manage the enterprise. Instead, they are projections which are necessary to define managerial manpower requirements—just as physical operating plans are necessary to predict raw-material requirements.

3. Distinguishing between full-time and part-time jobs

Most positions in an effective organization should be filled by executives who devote their full time to the enterprise. Occasional exceptions may be warranted, especially for small ventures that cannot afford to hire technical talent on a full-time basis. Members of boards of directors, scientific advisers and representatives living in foreign countries are examples.[3]

Use of part-time executives has drawbacks. These men may get out of touch with the current operations of the enterprise, they may not be available when needed, and they may not have the same degree of commitment to the enterprise that its full-time executives normaly exhibit. Nevertheless, in projecting an organizational structure, a few part-time executives may be the only practical way to provide for all the tasks that will be necessary.

4. Recognizing feasible compensation levels

Most projects are planned in a spirit of enthusiasm and high expectations. While in this mood, we are likely to project managerial jobs that can be filled only by men of exceptional ability, and we tend to overlook the salaries that will have to be paid to retain the active interest of such individuals. The question whether it is practical to think in such terms must be faced realistically.

An enterprise has better prospects for success if it can make its positions attractive to at least a group of highly qualified executives. Generally speaking, the salaries paid by enterprises associated with government to key personnel tend to be too low. This practice tends to lead able men to take positions in several different enterprises at the same time, or to other questionable means of receiving compensation. Nevertheless, we must recognize that there may be political restraints on high salaries, and also that not many enterprises can support the burden of high pay for more than a few key individuals. These facts must be kept in mind when projecting a tentative organizational structure. If the plan is to be realistic, it must be suited to the kind of executive that can, in fact, be attracted to the enterprise.

The end product of this stage of analysis is a list of managerial positions that need to be filled if the enterprise is to prosper. Associated with each position are the tasks that must be performed effectively if the organization is to function properly, and the appropriate salary range. While in practice there undoubtedly will be some adjustments in the allocation of tasks among members of the managerial team, this list provides the standard by which the available manpower will be evaluated. Its purpose is comparable to the specifications for the machinery to be obtained and the budgets of the capital that will be necessary.

C. Appraisal of potential staff to fill positions described

Having identified the managerial tasks to be performed, and having grouped these into realistic managerial positions, the project analyst has a basis for evaluating the people who will be needed. However, the appraisal process itself deserves careful attention.

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[2] For a discussion of how to build an administrative organization, see W. H. Newman, *Administrative Action*, Englewood Cliffs, New Jersey, Prentice-Hall, Inc. 1951 and 1963 (also available in Spanish, Portuguese, Italian, Dutch and Japanese translations).

[3] Perhaps a group of distinguished citizens, forming an "advisory council" or "list of sponsors" may also be established. The primary role of such groups is to provide endorsement and secure popular support for the enterprise. They may also give advice on proposed changes or other actions, but normally they do not initiate action. Executives of the enterprise are expected to keep track of problems and opportunities and to bring such matters to the attention of the advisory group. In other words, an advisory board may serve a very useful function but is not really part of the managerial organization.

1. *Translating job descriptions into manpower specifications*

A job description normally sets forth tasks to be performed but does not describe a person. Consequently, we have to make a translation from tasks to man specifications. Such specifications often include four interrelated aspects.

(a) *Formal training*

Some jobs require a technical expertise that can be acquired only by formal training, for example, civil engineering or accounting. Formal training of a more general nature is highly desirable for many other jobs. Most managerial jobs will have some minimum educational requirement.

In practice, formal education often receives undue weight. Certificates of degrees are an easy and widely recognized measure of a person's educational background. However, we know that a man with a degree does not necessarily possess managerial ability; only recently have universities attempted to provide managerial training as well as technical and substantive training. Thus, while formal training may be a necessary preparation for many positions, additional qualifications are also important.

(b) *Desired experience*

A second convenient way to check qualifications is in terms of experience. For instance, we might stipulate that a plant manager should have had at least six years' experience as a supervisor of production operations, or that a quality control director have had three years' experience as an inspector.

Again, practical difficulties arise. Frequently it is unreasonable to expect a man to have had experience in performing the specific tasks contained in the job description. For example, a man with experience as an inspector certainly will know something about the practical problems of quality control; but that experience does not ensure that he can perform the tasks of a quality control director, which are different from those of an inspector. Furthermore, many development projects deal with a new kind of activity, and past experience will be even less directly related to the new work. Successful experience is probably the best indication we have of how a man will perform in a new job, and it normally should be a part of man specifications. However, we may become unrealistic if we press this kind of requirement too far, and in doing so we might eliminate some of our best potential executives. A useful practice is to stipulate "X years of experience as ———, or equivalent". The last two words provide flexibility in the application of the measure.

(c) *Demonstrated performance skills*

Since formal training and experience are often inadequate, although helpful, guides to a man's ability to perform a new job, we turn to more indirect evidence. Key aspects of the job can be singled out, and we can try to judge whether a man has the skill to perform these features of the work. Examples are: his ability to budget his expenses and then live within his budget; his capacity to work effectively with labour unions; or his skill in anticipating consumer needs. Note that the specifications are stated in terms of results: what a man can do. Even though a man may have training and experience, we scrutinize the evidence to see whether he has these particular performance skills.

(d) *Personal qualities*

Even more indirect is the listing of the personal qualities which a man should possess to fulfil a given position effectively. Such qualities might include decisiveness, physical vitality, ethical standards, dedication to the objective of the project, objectivity and emotional maturity, empathy, intellectual capacity and the like.

The difficulty in preparing a list with such qualities for specific positions is that experience indicates that executives with quite different characteristics may achieve the same results. Scientific evidence as to the qualities needed for particular types of work has not yet been developed. On the other hand, when we are dealing with a completely new kind of project, or jobs that are new to the country, we may have to rely primarily upon a list of qualities believed to be important for the job. No better alternative exists.

Man specifications for each position, then, normally will consist of some combination of desired training, experience, performance skills and personal qualities. These specifications should not reflect an abstract notion of what makes a good executive; instead, they should be based directly on the tasks the executive will be expected to perform. Incidentally, since it is often difficult to find executives who fulfil all specifications, the usual practice is to distinguish between those requirements which an executive must possess when he takes the job and those which he can develop by study and experience after he takes on the job.

2. *Appraisal techniques*

Information about potential executives is typically obtained in several ways. Some information, such as degrees received from schools and colleges and titles of jobs held, will be readily available. Other information will require more investigation.

(a) *Performance analysis*

The objective here is to find out what a prospective executive actually has accomplished in his previous jobs. This requires considerably more information than mere job title. What were the duties of the particular job? How did the job fit into the rest of the organization? Was the job newly created or could it be carried on by following previous practice? How successful was the man in the job? Are there any reports or objective measures of his achievements? What reasons led to promotion or transfer to other jobs? Is there any evidence of unusually good performance or of difficulties arising out of the performance?

How far an analyst should go in obtaining such "facts" will depend upon their availability, direct relevance to the new position and the importance of the position the man might occupy in the new enterprise. Judgement will be needed in interpreting these data, because performance will obviously be influenced by the help received from other people and by the difficulties encountered, and on such matters the views of various people may differ. Nevertheless, a thorough understanding of what a man has done is very helpful in predicting his future potential.

(b) *Gathering opinions of others*

Valuable information about a man's capacity can be obtained from people who have worked closely with him—former supervisors, associates, subordinates, staff and outsiders with whom he has had close contact. Interviews with a large number of such people are rarely necessary or feasible. Nevertheless, some cross-section view from such sources is particularly useful in assessing performance skills and personal qualities.

(c) *Multiple interviews*

Personal interviews with prospective executives are highly desirable. Occasionally it is not diplomatic to reveal the purpose of such interviews, but contact can still be arranged on some subject of mutual interest. Reactions of one person to another are strongly influenced by subjective feelings and personality preferences. Consequently, interviews by two or more people of a prospective key executive is common evaluation practice. Information from all of the above sources is then related to the main specifications outlined in the previous section. Normally, two or more people will take part in this evaluation stage.

(d) *Special assignments and qualifying tests*

In an enterprise already in operation, trial on a series of jobs or special assignments is a common means of evaluating an executive for a new post. Occasionally, qualifying examinations are given to men outside the enterprise when technical knowledge is a major criterion. Except in unusual circumstances, neither of these appraisal techniques are suitable to a new project that is still being evaluated. However, if the project is a modification or extension of an existing enterprise, or if the project is a pilot operation, some of these other appraisal techniques may be feasible.

Executive appraisal suggested in the preceding paragraph clearly involves more than a one-page *curriculum vitæ* and a ten-minute interview. A considerable amount of searching out of facts and their analysis is implied. Even so, the amount of work required is modest compared with efforts devoted to economic and engineering analyses. To be sure, many of the final judgements must be subjective, but these judgements should nevertheless be based on the best relevant data that can be assembled.

3. *Prospects for attracting and retaining a dedicated team of managers*

The type of managerial appraisal we have been discussing focuses on the adequacy of potential executives to perform essential management tasks. By implication, we have assumed that the individuals appraised would be willing to work for the enterprise and that they would fit together into an effective team. These assumptions may not be valid. Having identified men who are qualified, we must now ask ourselves whether these particular individuals can be attracted to their proposed positions.

(a) *Providing necessary inducements*

Will the new enterprise be able to attract and retain the men deemed qualified for the executive positions? Important considerations in this regard are: salary (and bonus); pension, housing, automobiles; prestige; social contribution; enjoyable work.

An occasional project may be of such pre-eminence in its particular country that almost any qualified man will be glad to work for it. Much more often, men with the qualifications desired in executives will have several attractive alternatives. Consequently, an important part of the evaluation is a comparison of the inducements offered by the new enterprise with those of other employers. On the basis of this comparison and the value placed upon desired executives, a prediction of what proportion of prospects would accept jobs must be made. For some projects, the services of two or three particular individuals may be so crucial to success that their willingness to serve should be discussed with them. An important part of the evaluation is their personal interest in the project.

(b) *Building an effective team*

Not only must individuals of the needed competence be willing to work for the new enterprise but they must also be prepared to function as a team. The group as a whole should be reviewed in terms of:

Balance: not all should be engineers or external contact men but an appropriate mixture of different talents and temperaments;

Leadership: at least some key individuals should be present with sufficient initiative and prestige to push continually for the objectives of the enterprise;

Co-operativeness and personal commitments: the members should demonstrate a willingness to submerge individual ambitions and work together towards designated objectives.

Obviously, it is very difficult to predict whether the executives who will actually work in the enterprise once it is established will form an effective team. Negative predictions are easier. We can often guess that a particular collection of individuals will not work well together. This might be due to personality clashes, problems of social status, previous relationships, age differences or similar causes. If such difficulties are known to exist, then the manpower considered to be available should be reduced to men who presumably will be able to work together effectively.

4. *Identifying gaps between managerial requirements and available personnel*

We are now in a position to compare needs with resources. The analysis of managerial tasks and their combination into positions in a tentative organization provide a statement of needs. Then, the appraisal of potential executives against these specific requirements—discussed in the present section of this paper—provides a review of the persons available. Frequently, when a comparison is made of specific positions and available men, gaps will be found.

When managerial personnel is plentiful, the gaps are likely to be minor and probably can be overcome by adjustment in the organization plan. However, if executive manpower is not plentiful and shortages appear in particular types of work, the success of the project is in serious danger. Some ways of overcoming such gaps are discussed in the following section. Nevertheless, objective and honest evaluation requires that the potential difficulty be frankly recognized in the over-all evaluation.

The appraisal of potential executives for a projected enterprise involves several phases: describing the kind of man needed for each position, that is, setting up man specifications; gathering information about individuals and deciding how they measure up to these specifications; estimating the likelihood of attracting the men who are found qualified to take jobs in the enterprise; and then summarizing the conclusions by comparing projected needs with good prospects and realistically noting gaps between needs and resources. Lack of systematic attention and sound judgement on any one of these phases may result in serious error in over-all evaluation.

D. Possibilities of training men to fill managerial jobs

Managerial manpower evaluation will reveal gaps between needs and resources for most projects. The gaps may be serious, especially in developing countries. While this indicates trouble ahead, it does not always mean that the project should be abandoned. Training of needed executives is a possibility, and temporary measures for management may be adopted while the training is being completed.

A systematic examination of executive development is beyond the scope of this paper. Nevertheless, we must look briefly at some of the possibilities because they determine how serious a lack of executive personnel really is.

The need for executive development is almost always greater than appears at the conclusion of the first matching of needs and resources. Experience shows that not all men will be as capable as predicted. The discrepancy may be due to mistakes in judgement or problems of health; off-the-job difficulties may sap the man's effectiveness. Also, there will be some attrition, through death or resignation to take other jobs, or the inevitable clashes that arise during operations. Predicting how much safety margin is needed is hazardous because such turnover is inherently uncertain. For a new enterprise, a turnover in executive positions of 20 per cent during the first two years is a low figure, and if the enterprise runs into difficulty this turnover may be much higher.[4] Consequently, realistic plans for filling gaps should also provide for some turnover.

1. *Long lead times involved in managerial training*

Executives are not made in a day. They may be given a title but the knowledge, judgement, skill and other attributes take time to develop. For example, an analysis may reveal that a country has university graduates but lacks men trained in the particular field needed by the new enterprise. Six months to a year are often required to identify good prospects who have the necessary interest, native ability and background training (language, mathematics etc.) and to arrange for them to start formal training. In the more technical subjects, particularly if the training is taken abroad, two years, full time, is often required. After the man returns, another two years may be needed for him to learn the particular characteristics of the enterprise and to get some experience in dealing with specific problems in his new field. In this example, four or five years was the minimum lead time before the man was ready to take over an executive position. Not all jobs will take so long, but the example does suggest the order of magnitude.

Lead times are important in project planning. The longer the lead time, the sooner must action be initiated. One of the reasons for early evaluation of managerial manpower is this long period required to fill gaps. If a shortage exists, it should be identified early and steps taken to overcome it. There may be many uncertainties about the nature of the job five years hence, and how particular individuals will develop, but there is no way to avoid such uncertainties if the gap is to be filled.

2. *Use of foreign consultants as trainer-executives*

One way of overcoming a shortage of executives without long delays for training is to use foreign consultants as temporary executives. The foreign consultants perform managerial tasks, while at the same time training nationals to carry the full load.

Many variations of this arrangement are possible. The consultants may have full responsibility for operation of the enterprise, with nationals serving as their assistants and advisers. The consultants may occupy only those positions which cannot be filled locally. Responsibility may be shared by a consultant and a national with some arrangement for resolving differences of opinion when prompt action is necessary. Formal authority may be placed in the hands of local executives with an understanding that they are to rely heavily upon the "advice" provided by the consultants. The particular arrangement adopted will depend, of course, upon the extent and nature of the manpower gap, the urgency of getting the project in operation, the competence of the consultants available and similar considerations.

A significant distinction in all such arrangements is between technical and local matters. More precisely, the distinction is between impersonal things

[4] Some of this turnover will be caused by promotions to fill vacancies in higher positions, but executive development work is needed regardless of the cause of the turnover.

and systems and personal relations and social pressures. Knowledge and judgement regarding impersonal matters is much more readily transferable among countries than social skills. This distinction is rarely clear-cut; technical decisions often have social impact and the local trainee may need counsel regarding effective social action. Nevertheless, generally the trainer-executive arrangement is more likely to be satisfactory if it focuses on impersonal matters.

Every executive-trainer set-up is a delicate arrangement. Inevitably, there are problems of status, relative salaries, language, total cost and many subtle relationships. A full exploration of such matters is normally separated from a management evaluation, and is beyond the scope of this paper. Nevertheless, we must be very sensitive to the problems if we wish to use the outside consultant as a solution to a shortage of executives.

3. *Use of part-time nationals*

To some extent, the gap between manpower needs and resources may be filled by nationals who have other jobs but can arrange to spend some time with the new enterprise. We are speaking here of a different and additional group of part-time executives from the technical advisers and members of the board of directors discussed in section B(3) above, who will continue to serve the enterprise on a part-time basis indefinitely. Instead, we are now speaking of temporary assistants who will provide managerial help during the period when the regular full-time executives are gaining experience and training.

The use of part-time nationals during the early stages of a project is appealing for two reasons. First, starting a business poses more difficult problems than maintaining it after it is already a going concern. Each problem is new and policies have to be developed; employees are just learning their respective roles and how to work with one another and prompt managerial action is needed on many fronts at the same time. Secondly, a variety of social and economic changes inevitably occur within the community, with customers and with other outside groups. During this period there is need for respected sponsorship and confidence in the executives who are initiating the change. If experienced national executives are active in the new enterprise, they will be better prepared to cope with such problems, and they may be able to enlist public support more easily.

Unfortunately, arrangements for part-time executives often do not work well. At least two requirements must be met.

(*a*) Experienced executives who can really be effective on a part-time basis must be found. Many men are excellent executives in companies they know well, but are quite ineffective in a situation in which they spend only a few hours a week. Unless they have quick perception and rapid discernment, they may be more of a burden than a help.

(*b*) Able trainees, who have basic background and talent, should be active in the situation. They are the ones on whom the detailed administration falls, and, after a "breaking in" period, they are the ones who will have to carry through the initial decisions. Without such strong support, the busy part-time executive is rarely able to carry on what should be a full-time position.

In evaluating potential management of an enterprise, then, the use of part-time nationals during the early stages of a project can be an important supplement to inexperienced management. However, if the organization analysis indicates that a full-time executive is really needed, a man with a potential for moving into that job in the near future should work with the part-time executive. It is not practical to assume that even a good part-time executive can hold down a full-time job alone.

One of the most sensitive parts of a managerial evaluation is deciding whether the means for bridging the gap between needed and available manpower are adequate. Men can be selected and trained, but this often takes a period of years, and allowance should be made for attrition. Foreign experts may be brought in as trainer-executives to fill the gap temporarily, or part-time nationals may be used in a similar manner. Both of these arrangements, by their very nature, require a delicate blend of abilities and personalities. They need to be investigated carefully, and even if financially possible should not be regarded as an easy or sure way out of a managerial manpower shortage.

E. Difficulties arising from different cultural backgrounds

The preceding sections of this report have outlined steps for evaluating managerial manpower available for a proposed enterprise. Also, in each section problems deserving special attention have been noted. The present section differs in character. It focuses on the people who participate in the evaluation and notes a basic source of confusion in this difficult process. These final comments, therefore, apply to any or all of the steps outlined above.

Many sharp clashes about the adequacy of management arise from rather fundamental differences in viewpoint. Most of us have opinions regarding management that arise from the kind of work, the type of business, and the underlying culture in which we work. The following examples indicate differences commonly found among people participating in project evaluation.

Engineers, treasurers and sales executives, for example, not only stress different things but often conceive of the managerial process quite differently. The engineer tends to be mechanistic; the treasurer tends to reduce the entire process to decision-making and financial terms; the sales manager is much more likely to think in terms of people and their reactions, and to carry this point of view over to the entire management process.

Civil servants and *entrepreneurs* are likely to have quite different views about what makes a good executive. The civil servant quite naturally thinks of complex and proceduralised activities; the *entrepreneur* typically is impatient with detailed procedures, makes decisions on less voluminous evidence and takes more chances.

Differences in national culture make a subtle difference. For example, a person with Nordic background normally thinks in terms of sharp definition of duties, individual accountability, and an authoritarian hierarchy. Persons from Latin countries tend to personalize issues; they rely on personal relations, and pay less attention to timing. A man from the East is too polite to enjoy rough-and-tumble debates, and normally prefers group rather than individual responsibility.

Many other and perhaps more important differences may be found. These brief examples do indicate how a person's background may strongly influence what he considers to be a good executive.

These normal differences in views about managing an enterprise may lead to divergent evaluations, affecting a man's judgement regarding:

(*a*) Recognition of needs: both his identification of important management tasks and his tentative organization of those tasks;

(*b*) Appraisal of individuals: his estimation of the characteristics he considers desirable;

(*c*) Ways of filling the gap: his insistence on formal training and his willingness to rely on expedient measures.

Such differences may result in clashes of opinion between various people participating in a management evaluation. Gathering additional data will not necessarily resolve the clash, because the differences arise from "value premises".

Awareness of the effect of cultural background on management appraisal is valuable both because it puts us on guard about possible biases which may lead to too rigid or too relaxed an evaluation, and because it helps us understand why a person may hold a particular point of view.

A cosmopolitan view is clearly desirable. More specifically, in technical areas we need the judgement of men who appreciate what is really required in each area, for example, production, finance, or marketing. Also, we need to recognize local attitudes towards authority, responsibility and similar matters; and on such subjects the opinion of someone intimately familiar with the local culture should be sought. To be sure, we then find ourselves evaluating the evaluators (a problem not unique in managerial appraisal, but one that arises in all phases of project evaluation). However, manpower evaluation involves so much subjective judgement that a cosmopolitan view is the safest, and probably the wisest.

XVII. INDUSTRIAL PROJECT EVALUATION IN THE UNITED STATES, THE UNITED KINGDOM AND FRANCE

by *The Economist* Intelligence Unit*

Introduction

This report is a broad review covering all phases of project preparation and evaluation and aims at highlighting and discussing the problems experienced by companies and agencies in the developed countries. It is hoped that the information it contains may enable the developing countries to profit from the lessons learnt in the advanced countries, by appraising their projects in such a way as to achieve a more rational allocation of resources and a higher rate of economic growth.

The project was directed from London by Mr. C. B. Edwards, industrial research consultant; interviews were conducted in New York, Washington, Brussels, Paris and London. The interviews were arranged by the offices of *The Economist* Intelligence Unit (EIU) in New York and Paris; the Paris office also arranged for questionnaires to be sent to a number of French companies and financing agencies. Details of the methods of reseach used to discover the practices employed in the three countries are set out below.

United Kingdom

Postal survey

The following questionnaire was sent to 100 of the largest quoted public companies:

Questionnaire "Project Evaluation"—for projects above £100,000

Note The questions have been grouped together so as not to inhibit your answers by the size of the gaps between the questions. Please write all your answers below Q.9.

1. When evaluating capital expenditure projects, do you distinguish between "expansion" and "replacement" projects and if so, why?
2. On average how far ahead do you forecast cost and revenue flows for (*a*) Expansion projects and (*b*) Replacement projects?
3. What methods of evaluation do you use for comparing expenditure proposals? (*a*) Qualitative? (*b*) Quantitative. State briefly the reasons for choosing the method you favour
4. Do you allow for differences in risk and uncertainty between the various proposals? If so, by what methods?
5. If you use a quantitative method of evaluation when assessing a project's worth, do you calculate the pay-back period or rate of return on an after or before corporation tax basis?
6. Following on from question 5, do you take outlays in the form of working capital (stocks and debtors) into account?
7. What minimum pay-back period or rate of return, if any, do you look for before approving expenditure projects?
8. Do you generally carry out post-mortems on projects in order to compare the realized with estimated profitability?
9. Is there a company policy which limits the annual expenditure to internally generated funds (i.e. to depreciation and ploughed-back profits)?

The companies were selected from each of the manufacturing and service industries, as listed in the main Standard Industrial Classifications, 1958. Thirty-seven usable replies were received but the author places little reliance on the postal questionnaire as a medium of reseach since it is well known that such questionnaires have a number of disadvantages. First, since those who do not respond may have different characteristics as a group from those who do, "there is no assurance that information obtained by mail is derived from an unbiased selection of respondents".[1] Secondly, as with certain forms of personal interviews, there is no assurance that the respondents understand the questions and, likewise, no guarantee that the researcher understands the answers. A considerable amount of double-checking should therefore be made to ensure that there is common understanding of the terms used. Thirdly, even where the respondent understands the questions, there is a possibility that he may, for a number of reasons, give false or "prestige" answers. As was stated by a team of management consultants in the booklet, *Investment in Machine Tools*,[2] "it is our experience—again borne out by the present inquiry—that sometimes a company genuinely believes it is doing certain things which in fact it is not doing, or sometimes its answers may be coloured by what it knows it should be doing but is not doing".

For these reasons, and because the research has aimed at discovering not only which methods of project evaluation are used but also why they are used in preference to alternative methods, it was decided to place as much emphasis as possible in the time available on the results of personal interviews. The results of the questionnaire and of other published surveys were used to supplement the interviews.

Personal interviews

Interviews were held in London and at a management conference in Brussels with more than thirty

* London.

[1] G. Katona, *Psychological Analysis of Economic Behaviour*, New York, McGraw-Hill.

[2] National Economic Development Council, *Investment in Machine Tools*, London, HMSO, 1965.

five people employed by: the Department of Economic Affairs; the Treasury; the Ministry of Power; the Ministry of Transport; one of the largest merchant banks in the United Kingdom; eleven public companies, all with net assets in excess of £20 million at the end of 1960; four of the nationalized industries, and a British overseas development bank.

Other surveys

A number of surveys of investment appraisal procedures used in the United Kingdom were studied and, where relevant, these are referred to in the text, with acknowledgements given in footnotes.

France

Postal survey

Ninety questionnaries, translated from that shown above, were sent to a selection of large companies, nationalized corporations, municipal undertakings and four of the largest merchant banks.

Although the questionnaires were dispatched at the same time as those in the United Kingdom, only eleven usable replies have been received. Eight were received from companies, one from a municipal undertaking, and two from nationalized corporations. It is difficult to account for the difference in the response rate between the United Kingdom, where it was over 35 per cent, and France, where it was under 15 per cent. French businessmen, however, were generally more reluctant to be interviewed, and this may reflect a greater degree of secrecy on their part. On the other hand, once interviewed, they were as frank as their British counterparts, and generally as helpful.

Personal interviews

Personal interviews were held in Paris and Brussels with twenty-five people belonging to: five large French companies; the Ministry of Transport; the Société nationale des chemins de fer français (SNCF); Electricité de France (EDF); the Commission de l'énergie, one of the vertical commissions belonging to the Commissariat général du plan; CEGOS, a large management consultancy organization, the Institut européen d'administration des affaires (INSEAD), the European Business School at Fontainebleau, and a French development bank.

Other surveys

Only a few surveys of French investment appraisal procedures have been carried out in recent years; where relevant, references to these have been made in the text.

United States of America

Postal survey

In accordance with the terms of reference, no postal survey was conducted in the United States. This was not thought necessary, because a large number of surveys have been carried out in the United States in recent years. These were studied.

Personal interviews

Interviews were held in New York and Washington with more than thirty executives in the following organizations: Touche, Ross, Bailey & Smart, management consultancy firm; Chase Manhattan Bank; First National City Bank; Irving Trust Bank; New York Graduate School of Business; International Bank for Reconstruction and Development (IBRD), Export-Import Bank; International Finance Corporation (IFC); Agency for International Development (AID) and the Pan-American Union (PAU); the Brookings Institution; Inter-American Development Bank (IDB), and three of the largest industrial companies.

Other surveys

Where relevant, reference has been made to the many surveys published on this subject in the United States.

A number of companies and agencies interviewed and a number replying to the questionnaire were not willing to allow their names to be disclosed. In many cases it has not, therefore, been possible to give the name of the company or agency giving the information.

Conclusions

Objectives and planning

The financial institutions (the British and French development banks), the International Bank for Reconstruction and Development (IBRD), the United States Agency for International Development (AID), the Inter-American Development Bank (IDB), the International Finance Corporation (IFC), and the Export-Import Bank, in appraising industrial projects in developing countries, stressed the importance of: resource and demand analyses to reveal priorities within a developing country and pre-feasibility studies to reveal alternatives.

The financial institutions complained of a shortage of worth while projects.

It is rare for corporations (companies and nationalized industries) or financial institutions to compare alternative projects; the American companies are more selective than the British or French.

A capital rationing policy is followed by companies in the three countries.

There is a presumption by companies that replacement expenditure is more necessary.

Evaluation

Only about one third of the largest companies — defined as those with net assets of above [illegible] £50 million — in the United Kingdom and France use discounting techniques to measure the value of industrial projects. The gap between theory and practice is large, as is the gap between the best and worst practices. The largest American companies use more sophisticated methods, but the illogical use of data is widespread in all three countries. In fact it seems that many companies are trying to use methods which they fail to understand.

The French nationalized industries generally use theoretically correct methods of appraisal: those in the United Kingdom are less consistent.

The financial institutions, especially the multilateral agencies, are aware of, and use, methods of appraisal closely approximating to theory, although some complained that too much emphasis was put on the technical appraisal.

The financial institutions, and the few companies that used them, stated that check-lists were helpful as an aid to more accurate forecasting and appraisal, and sensitivity analysis was useful in assessing the effects of selected variables.

Much importance was attached to the acquisition of data, especially that relating to the cost of non-manufacturing facilities, the cost of working capital and the gestation period; and the correct use of data once collected.

CONTROL, MANAGEMENT AND POST-AUDIT OF PROJECTS

The place of simple management techniques, such as budgetary control and critical path scheduling, in the control of expenditure, was emphasised.

The most progressive companies thought that project appraisal and control should be the specific responsibility of one person or department in the organization.

The financial institutions thought that the minimum team for a feasibility study should consist of an engineer, an accountant and an economist; and that the supervision of projects was best left to the sponsors.

Post mortems are not generally carried out. Few companies thought that the examination of individual projects was worth the cost of the investigation.

SUMMARY

The lessons that can be drawn for the developing countries from this report are as follows:

To take an objective look at all aspects and alternative ways of carrying out a project;

To relate individual projects to the economy of the country or region concerned;

Not to be sidetracked by esoteric discussions of the relative advantages of various discounting methods, but to make a correct use of whichever measure of appraisal is chosen;

To collect adequate data for an objective appraisal; the use of check lists will be helpful in this respect; and

To discover the importance of variables by using sensitivity analysis and to concentrate attention on the critical variables.

A. OBJECTIVES AND PLANNING

Capital investment is an important determinant of economic growth by raising the level of labour productivity and through its income-generating characteristics. How important this contribution is, and to what extent different rates of growth in various countries can be accounted for by differences in the ratio of capital investment to gross national product, is a matter of controversy among economists.[3]

However, it is accurate to say that, together with industrial organization and technological change, capital investment is the main factor in economic growth. Moreover, because for the developing nations any sacrifices in present consumption entail greater hardships than the equivalent sacrifices by countries with advanced economies, every effort should be made to ensure that resources are directed towards the most productive ends.

Not only have the poorer countries a lower labour productivity in all sectors, but they also have a concentration of employment in the sector in which labour productivity is lowest, that is, in the primary sector. One of the features of economic progress is the shifting of employment from the primary to the secondary and tertiary sectors. The object of planning the economy is to ensure that this shifting of employment is accompanied by steady and stable growth, and that any imperfections in the working of the economy are counterbalanced as far as possible by government action and direction. Owing to the absence of the classical conditions for equilibrium, it is now generally agreed that the Governments of poor countries have a responsibility for guiding economic development by channelling investment in specific directions. They begin by trying to create a climate which is favourable to private investment in both agriculture and industry (*a*) by making the necessary infrastructural investment; (*b*) by sponsoring or encouraging private investment wherever the latter offers the likelihood of favourable results, and (*c*) by undertaking projects itself in the absence of private initiative.

Planning at the national level helps the Government to decide the directions in which it should guide investment; planning at the level of the firm similarly helps to define the objectives of the firm and to co-ordinate the means so as to achieve those objectives. In the questionnaires and personal interviews, companies and agencies placed considerable emphasis on the relationship between an individual project and the national or company plan and it is for this reason that the need for planning and the clear definition of objectives is stressed.

1. *Objectives*

For a nation as a whole, the main objective will be to maximize the gross national product per head of the population, given the existing resources.

For the firm operating in the private sector and financed by risk or equity capital, the prime objective is, theoretically, to maximize the long-run earnings to the present ordinary or equity shareholders: theoretically, because the actual behaviour of companies (at least in France and the United Kingdom but to a lesser extent in the United States) seems to approximate what has been referred to by a number of writers as satisfying behaviour. For example,

[3] Aukrust, *Productivity Measurement Review*, February 1965, OECD Paris and A. Shonfield, "Obstacles to growth—not enough capital?" *The Statist*, London, 8 June 1962.

Carter and Williams have stated that "a quiet life; the enjoyment of public esteem and power; a reluctance to experiment; a reluctance to change the organization; these may all militate against profit maximization".[4] However, the divergence of objectives from profit maximization is smaller the greater the pressure on profits (through competition or countervailing power); and the greater the importance in the company of a specialist function for creating and evaluating technical and market possibilities.

For other corporations (such as nationalized corporations or semi-public companies) or for the financing institutions, the objectives are usually set out in the acts or agreements establishing them.

2. *Resource and demand analysis and national planning*

Once the nation, bank, company or other decision-making unit has decided on the objectives at which to aim, the next stage is to analyse the relationship between the resources available and the demand for those resources.[5] The demand will have been determined to some extent by the definition of the objectives. The importance of an initial resource and demand analysis lies in identifying priorities for two kinds of opportunities, namely opportunities for quick and substantial gains, through, for example, multi-shift operation, seven-day working and the more efficient use of existing resources, and opportunities which have a long lead time, that is, investment opportunities.

Time and again, the development agencies, especially those dealing with large industrial or infrastructure projects such as the AID or IBRD, stressed the economies that could be effected through the more efficient use of existing resources.

AID and the Brookings Institution placed much importance on (*a*) planning by stages, (*b*) resource and demand analyses, and (*c*) pre-feasibility studies in indicating the general order of priorities and pinpointing the opportunities and alternatives. They both stated that the high cost of a detailed feasibility study might and almost certainly had sometimes biased the decision as to whether or not to go ahead with a project.

Once a Government has prepared a general plan for the economy and carried out a resource and demand analysis, this will help it to allocate resources intelligently, since no project can be correctly evaluated in isolation. Even when put in the context of an economic plan, it is difficult to assess the economic worth of some projects especially those coming under the general heading of infrastructure projects. A number of studies have been carried out and models prepared, in the fields of transport,[6] water resources[7] and others,[8] but the evaluation of non-industrial projects is still to a large extent a relatively new field of applied economics. It was, therefore, no surprise to hear from the British Treasury, the French Energy Commission, the Brookings Institution and other organizations that the intersectoral allocation of investment resources was made largely on the basis of political judgements.

Once, however, this intersectoral allocation of funds has been made, it is important to ensure that as far as possible the net marginal social productivity of a project is equal to that of all other projects within the same sector. This means that all potential projects should be the subject of some form of feasibility study.

As stated above, it is essential to seek out and pinpoint opportunities by analysing the relationship between available resources and the demand for such resources.[9] Opportunities may be discovered as a result of (*a*) simple input-output matrices which set out the relationships in physical terms between the imports, consumption and exports of major product groups, and (*b*) making outline studies of the comparative economies of various product groups and the relationship of cost to the production volume of such products.[10] Once a number of alternatives have been suggested, further, more detailed, feasibility studies can then be carried out on the lines suggested in section B, below.

3. *Planning at the level of the firm*

(a) *The search for opportunities*

The classical problem of economics [illegible] of scarce resources to competing ends [illegible]

[4] Carter and Williams, *Investment in Innovation*, Oxford University Press, 1958. See also R. Wright, *The Investment Decision in Industry*, London, Chapman & Hall, 1964.

[5] An excellent outline of a resource and demand analysis is given in *Manual of Industrial Development with special application to Latin America* prepared by the Stanford Research Institute, California, for the International Co-operation Administration, June 1958.

[6] See C. Foster and M. Beesley, "Estimating the social benefits of constructing an underground railway in London", *Journal of the Royal Statistical Society*, series A, vol. 126, 1963. Also *Proposals for a Fixed Channel Link*, Cmnd. 2137, HMSO, London, September 1963. Also a study currently conducted into the economic effects of a new underground railway in [illegible] and numerous studies carried out in the United States, e.g. Mohring and Harwitz, *Highway Benefits: an Analytical Framework*, North Western University Press, 1962.

[7] See R. N. McKean, *Efficiency in Government through Systems Analysis with Emphasis on Water Resource Development*, New York, Wiley, 1958, and J. Hirshleifer and others, *Water Supply: Economics, Technology and Policy*, University of Chicago, 1960.

[8] See the study prepared by the Brookings Institution and edited by Robert Dorfman entitled "Measuring benefits of government investments", 1965.

[9] This analysis [illegible] country but can be prepared [illegible] the Brookings Institution [illegible] economic integration of major product [illegible] of South America [illegible] stages in [illegible] a study [illegible] demand [illegible] and supply functions [illegible] supply and demand [illegible] such as exchange rates and inter-governmental agreements. [illegible] integration the IDB seeks opportunities [illegible] industries that [illegible] country or the region as a whole and gives [illegible] such projects where the [illegible] *Application of Investment Criteria in a Development Bank*, [illegible] (IDB), April 1964.

[10] Reference to other feasibility studies [illegible] *Industrial Investment Information and Opportunities*, AID, Washington, D.C., 1963; see also [illegible] C. Norton, *A Pre-investment Study* [illegible] *Industry*, IBRD, 1964.

than one half the interviews with the companies in France and the United Kingdom, it was stated that projects were rarely compared one with another.

The general pattern of capital planning by companies in France and the United Kingdom[11] seemed to be on the following lines:

(i) An estimate of the capital that would be available within the next financial year at reasonable cost: that is, the cash flow that the company expected to generate plus the capital that could be raised externally on "favourable" terms;

(ii) The allocation of the available capital between subsidiaries, divisions and departments on the basis of past profitability and, to a lesser extent, future market prospects;

(iii) The allocation within a subsidiary, division or department of the budget as decided in (ii). This allocation between subsidiaries was, to a greater extent, decided on the basis of future profitability, but even here the companies gave little impression of making choices amongst a number of competing alternatives.

For companies, there are a number of problems associated with the evaluation of projects, such as the criteria to use (see section B), the interdependence of projects (see section C), and the difficulty of quantifying the benefits arising from certain types of projects, for example, research and development or welfare facility investments. By failing to compare alternative possibilities, however, the allocation of resources is hardly likely to be improved. An executive in a British chemical company suggested three main reasons why British companies considered fewer alternatives than American companies: first, British companies spend proportionately less time and money on looking for opportunities and surveying markets; secondly, there is less inclination on the part of British managers to take risks[12] and thirdly, American companies appraise and analyse their investment possibilities in a much more detailed and logical manner.

The executive of a French tyre manufacturer, who had worked in the United States for five years, thought that large American companies were more selective in their choice of projects than comparable French companies. He thought that this was partly due to the predominance in American companies of specialist departments or committees whose sole responsibility was to seek out and evaluate new investment potential, and to the greater degree of competition in the American economy.

(b) *Budgets*

In an unpublished survey into the methods of capital budgeting used by companies in the United Kingdom carried out by C. B. Edwards in 1962-1963, the extent of planning was investigated among a sample of sixty-five companies. It was stated that "it seems fairly safe to assume that only a minority of companies plan their capital expenditure in broad outline for much more than two or three years ahead, and it seems likely that there is little detailed planning of capital expenditure, especially amongst the smaller companies, defined as those with net assets of less than £10 million as at the end of 1960". This analysis seems to accord with Tibor Barna's survey.[13] Williams, however, in his study states that "the definiteness of planning was not ... a guide to the efficiency of investment".[14]

In the Smith and Remmers study of the investment decisions of nineteen companies in French industry it stated that "about two-thirds of the firms visited spoke of a three-to-five-year plan", but that "... the planning was indicative rather than detailed. A sales figure or segment of the market was ordinarily set as the objective. This was arrived at by such means as projections of current market and sales trends, economic studies, the fourth plan's indications and management 'feel'."[15]

The length of time the plan covers will of course depend on the gestation period and the ability of the firm to forecast. It may be a mistake, however, for a large company to think of five years as long-term planning, for as Baker says "it may take that long to acquire land".[16] In the United Kingdom, the Central Electricity Generating Board plans ahead for ten to fifteen years, the Coal Board attempts to forecast demand for up to twenty years, and therefore in very large-scale organizations, "twenty-year planning would seem to be generally necessary".[17]

(c) *Stabilized investment*

In the United Kingdom, Barna found that each stage of expansion was usually regarded as a separate event. It is preferable, however, that planning be regarded as a continuous technique; this will facilitate the co-ordination of policy and ensure that fluctuations are minimized. Investment decisions tend to be based to an undue extent on business "sentiment" (see section B) and, because of this, fluctuations are greater than they would be were project assessments more rational. Dean,[18] however, has shown that there are many defensible rational arguments for investing during booms, although the strength of these arguments vary with: (i) the amplitude of the business cycle, (ii) the rate of discount used, and (iii) the economic life of the asset. These

[11] This pattern would also seem applicable to a certain extent in the United States, for H. M. Weingartner states in *Mathematical Programming and the Analysis of Capital Budgeting Problems* that "a majority of corporations tend to set a limit to the funds available before looking at demand" (New York, Prentice-Hall, 1963).

[12] This is in agreement with D. Granick's remarks at the beginning of part II of his book, *The European Executive*, New York, Doubleday, 1962.

[13] T. Barna, *Investment and Growth Policies in British Industrial Firms*, Cambridge University Press, 1962.

[14] Williams, *International Report on Factors in Investment Behaviour*, OECD (Organisation for Economic Co-operation and Development), 1962.

[15] P. L. Smith and N. Remmers, *Investment Decisions in French Industry*, Paris, INSEAD (Institut européen d'administration des affaires). The companies interviewed for this study ranged widely in size of total assets, from about F 25 million to F 2,000.

[16] Baker, *The Management of Capital Projects*, London, Bell, 1963.

[17] *Ibid.*

[18] Joel Dean, *Capital Budgeting*, New York, Columbia University Press, 1951.

arguments against spending during recessions emphasize the need for government inducements and action designed to reduce fluctuations in the business cycle.[19] For even in the United States, where plans are generally longer,[20] forecasting more accurate, and evaluation of projects more "scientific" (see section B), "quick and unpredictable changes in capital investment plans are the order of the day".[21]

One of the most important causes of fluctuations in capital investment is the fairly widespread practice of rationing the investment to internally generated funds or a ratio thereof. For example, Dean states that fluctuations in private capital formation in the past can quite largely be accounted for empirically by changes in current corporate profits and in corporate profits one year earlier. It seemed from the interviews and questionnaire replies that a number of companies in the United Kingdom and France were making a less stringent examination of projects using internal funds, than of those requiring outside capital. Many companies both in France and the United Kingdom stated in their replies to the questionnaire that their expenditure on replacement was geared to their allowances for depreciation. This would imply that the replacement expenditure of some companies was not evaluated as carefully as the expenditure on expansion projects

(d) *Classification of projects*

Most companies, more than 75 per cent of those replying in the United Kingdom and the majority of those in France, stated that they used, as a minimum, a replacement/expansion classification of their expenditure. A variety of reasons were given for this classification, the most often quoted ones being: "We would expect a higher return from an expansion investment owing to the greater risks and uncertainties". "There is a different market 'strategy' behind each type of investment." "The classification gives a guide to the sort of information which management expects to see on the evaluation form." "Replacement is a must if we are to stay in business." "The distinction enables us quickly to examine the lists of replacement projects and thereby to deal first with those which are essential." "The power to authorize replacement expenditures is delegated to a greater extent."[22]

The general attitude in France and the United Kingdom seems to be that replacement requires little or no economic appraisal because of the fewer uncertainties involved and because of the interdependence of the project with a larger production unit. This seems to be a dangerous attitude since the replacement/expansion distinction is largely arbitrary, as some companies hastened to point out. The attitude seems to imply that, because replacement expenditure is easier to assess in economic terms, it is automatically more profitable, and therefore necessary.

B. EVALUATION AND APPRAISAL OF PROJECTS

This section assumes that the necessary data for an evaluation are available and that there is no uncertainty attached to the data and no risk connected with the project. The problems of how to obtain the data, the misconceptions to avoid, and the methods of assessing the effects of risk and uncertainty will be discussed in section C.

The present section is divided into two parts. The first part deals with the appraisal of projects in terms of their commercial profitability, the second deals with the appraisal of projects in terms of their national profitability.

1. *Commercial profitability, the theory*

It is here assumed that the prime objective of the managers of a company is to maximize the long run earnings to present equity shareholders. In order to maximize these earnings, the management must obviously aim at channelling expenditure into the most profitable outlets. It is clear from the interviews, questionnaire replies and other surveys that the theoretically correct methods of appraising capital expenditure projects are rarely used.

There are basically four methods of appraising the worth of a project used by company management in France, the United Kingdom and the United States. Because definitions vary widely in the field of economics, they are briefly explained below

(a) *Pay-back*

This is defined as the length of time required for the stream of cash flows of an investment to equal the original cash outlay. Its principal advantage is its simplicity both in concept and calculation. It has two principal disadvantages: that it does not measure the profitability of the project and that it takes no account of the time pattern of earnings within the pay-back period

(b) *Book rate of return*

The rate of return on capital is defined as the ratio of profit (net of depreciation) to capital. The method has a host of variants. G. Terborgh[24] reports attending a conference where fourteen companies reported fourteen different methods of calculating this type of return. The two most common methods are

The expected or normal profit as a percentage of the average capital employed over the life of the project: this is often called the "book" method.

[19] The investment reserve scheme currently in operation in Sweden might be one method of stabilizing investment.

[20] See Mack, *The Flow of Business Funds and Consumer Purchasing Power*, New York, Columbia University Press, 1941; D. Istvan, *Capital Expenditure Decisions: How They are Made in Large Corporations*, Bureau of Business Research, Indiana University, 1961; also M. Gort, "The planning of investment: a study of capital budgeting in the electric power industry", *Journal of Business*, University of Chicago, April and July 1951.

[21] Solomon, *The Management of Corporate Capital*, Illinois, Free Press of Glencoe, 1959.

[22] See also R. Nield, "Replacement policy", *National Institute Economic Review*, London, November 1964: "They (firms) often delegate replacement decisions to a greater extent than new investment decisions and set aside separate budgets for the two purposes."

[24] G. Terborgh, *Business Investment Policy*, Machinery and Allied Products Institute, Washington, D.C., 1958.

The expected or normal profit as a percentage of the initial capital employed; this is often called the "engineer's" method.

The main defects of this method are:[24]

The difficulty of defining the normal profit where the profit may not be constant over the years;

The difficulty of defining capital outlay where investment allowances are given and where working capital forms a large proportion of the capital invested;

That no allowance is made for the fact that £1 tomorrow may be worth less than £1 today.

(c) *"Postponability", "necessity" and other "non-documented" evaluations*

The inadequacies of "hunch" methods are obvious. Only rarely will these methods lead to an optimum allocation of resources, and yet they seem to be in widespread use in the United Kingdom, France and the United States.

(d) *Discounting methods*

The cash flows generated by an investment should be sufficient to repay the initial outlay and to pay an adequate rate of interest on the outstanding balance. The discounting methods measure the capacity of a project to do this, since they take account of the time value of money—that is, they take account of the fact that a given sum of money now is worth more than an equal and certain sum at some future date, because it permits profitable investment or consumption in the meantime.

The discounting methods can be classified as shown below.

(i) The internal rate of return (IRR), otherwise referred to as the interest rate of return (Weaver and Reilly), the yield (Merrett and Sykes), the investors' method (Hill and Gregory), rate of return (Fisher), discounted cash flow or DCF (Dean), and the marginal efficiency of capital (Keynes). The internal rate of return represents the highest rate of interest an investor could afford to pay without losing money, if all the funds to finance the investment were borrowed and the loan, principal and accrued interest were repaid by application of the cash proceeds.

(ii) The net present value (NPV). The NPV of a project is found by discounting at an interest rate (e.g. the opportunity cost of capital) all future net cash flows arising from the project. In the example below, the NPV of the project at a 10 per cent discount rate would be calculated in the following way: it is assumed that the project requires an initial outlay of £1,000 and that it generates an income of £415 *per annum* for an assumed life of three years:

Year	*Cash flows attributable to the project (£)*		*10 per cent discount factors (see appendix I)*	*Present value (£)*	
	Outlay	*Income*			
0	(1,000)	—	1.00	(1,000)	—
1	—	415	0.91	—	378
2	—	415	0.83	—	344
3	—	415	0.75	—	311
				(1,000)	1,033

If the project were financed by a loan at an interest rate of 10 per cent, £33 is the net gain attributable to the project after paying the interest and repaying the loan.

(iii) Annual capital charge (ACC). Wherever a capital investment is made which gives rise to a constant, or approximately constant, net cash flow it is possible to make use of the annual capital charge method. Extensively used by Grant and Ireson,[25] the ACC method aims at charging depreciation on a sinking fund basis, such that the full capital invested in a project will be recovered at the end of the project's life. This method will lead to a rational allocation of resources, as long as the cash flows are constant. Whenever there is any irregularity in the net cash flows, the ACC method is forced into the difficulty of turning them into regular cash flows of the same present value.

(iv) Various other discounting methods have been developed but, since they are even more rarely used than the IRR, NPV or ACC in the assessment of projects requiring an initial outlay of more than $250,000, it will be sufficient here merely to note them. They are various replacement formulas, such as those developed by Alchain[26] and Terborgh,[27] and the "future method".[28]

The IRR method suffers from two disadvantages. First, in certain cases it is possible to find more than one solution rate. Soper[29] has shown that this cannot happen provided the capital outstanding is non-negative during each year of the project's life. Again, where a choice must be made between two mutually exclusive projects, the project giving the highest internal rate of return will not necessarily be the one that will maximize profits.

It can therefore be proved that, under the classical conditions of a perfect capital market, the NPV approach is the most suitable measure of a project's

[24] See A. M. Alfred and J. B. Evans, *Discounted Cash Flow*, London, Chapman & Hall, 1965, p. 10. This is a manual prepared for use by those at Courtauld's concerned in making the financial appraisals required in connexion with investment decisions.

[25] Grant and Ireson, *Principles of Engineering Economy*, New York, Ronald Press, 1960.

[26] Alchain, *Economic Replacement Policy*, Rand Corporation, California, 1952.

[27] Terborgh, *Investment Policy, a Challenge to American Management*, Washington, D.C., MAPI, 1964. An excellent description of this method (often called the MAPI method after the Machinery and Allied Products Institute) is contained in K. A. Middleton, *The Economics of Capital Expenditure*, Australian Society of Accountants, July 1964.

[28] See Robert H. Baldwin's article in *The Harvard Business Review* of May-June 1959, "How to assess investment proposals", also R. Beyer and D. J. Trawicki, "The proposed plant—a profit-maker or not", in *The Controller*, New York, November 1960.

[29] C. S. Soper, "The marginal efficiency of capital—a further note", *The Economic Journal*, Cambridge, England, 1959, vol. 69, pp. 174 to 177.

worth, since the cost of capital[30] will then represent the alternative use of the funds to the economy after adjustments for risk. But under realistic conditions of capital rationing and uncertainty, the internal rate of return will be a more useful measure. There is, however, no reason why both methods should not be used together, since once one has been calculated, the additional calculation required to arrive at the other is negligible.

2. *Commercial profitability; the practice*

United Kingdom

The replies to question 3 of the questionnaire were analysed as follows:

Method of appraisal	*Number of companies using method*	*Number of companies using the method as a primary measure*
Pay-back	13	1
Book rate of return	18	16
Discounting methods	14	11
	45	28[a]
Number of companies analysed	32	—
Non-classifiable replies	5	9
	37	37

[a] In four replies, no primary measure was indicated.

In the author's 1962/1963 postal survey the methods of investment appraisal stated by the companies to be used were as follows:

Method of investment appraisal	*Number of companies*			
	Large[a]	*Medium*[a]	*Small*[a]	*Total*
Pay-back	9	2	2	13
Book rate of return	22	16	11	49
Discounting methods	9	2	—	11
Others	--	4	11	15
TOTAL	40	24	24	88
Number of companies	24	19	22	65

[a] The size of companies was defined as follows:

	Net assets at the end of 1960
Large	more than £50 million
Medium	more than £10 million but less than £50 million
Small	more than £5 million but less than £10 million

Twelve companies were common to both surveys and nine of these gave essentially the same answers in both surveys.

Other surveys[31] into the methods of investment appraisal used in the United Kingdom seem to come to roughly the same conclusion, namely, that managers of companies in the United Kingdom use methods of investment appraisal which are only likely to lead to the optimal choice of projects by coincidence. For example, one of the principal findings of the *Investment in Machine Tools* study is that "the methods of investment appraisal in use by most of the companies in the engineering industry are either non-existent or inaccurate and misleading. Twenty two per cent of our sample used no established method, while of the remaining 78 per cent all employed the pay-back method for appraising normal investments, but only 5 per cent took tax allowances into account."[32]

In the two postal surveys conducted by the author, the extent to which sophisticated methods are used is probably overstated. This is because, in two of the personal interviews, it was discovered that although the companies used some sort of discounting method, the way in which they arrived at their data was, to put it mildly, illogical. After working through one project which had been rejected by a large engineering company, the internal rate of return, calculated on the basis of correct economic principles, was double that calculated by the company's method. Indeed, the controller admitted that, if the economic worth of the project had been calculated correctly, the company might have approved the project instead of rejecting it.

It is therefore likely that a number of companies who stated in their replies to the questionnaires that they were using discounting methods did not in fact use such methods correctly (see section C). Even assuming that they are, it is probable that over two thirds of the annual gross fixed capital formation by the private sector in the United Kingdom is evaluated by methods which will lead to an optimum allocation of resources only by chance.

Bruce Williams[33] has listed three possible reasons why discounting methods are not used: because competitive pressure is so weak as to leave ample room for non-profit goals; because the firms concerned are inefficient, and because the factors involved are too complex to be summarized numerically.

Each of these reasons is probably valid to a greater or lesser extent depending, first, on the size of

[30] Defined by John F. Childs as "the over-all composite per cent net cost rate (after allowing for underwriters' compensation and expenses of financing), which investors require to induce them to provide all forms of long-term capital in a competitive market, on an average over a period of years". See *The Controller*, New York, February 1964.

[31] See (*a*) *Thrusters and Sleepers*, PEP (Political and Economic Planning), London, Allen & Unwin, 1965, a survey of forty-seven small firms in six industries. (*b*) R. Nield, *Replacement Policy*, NIER (National Industrial Equipment Reserve), November 1964, a survey conducted among participants in a conference held by the Production Engineering Research Association, (*c*) H. Hart and D. Prussman, *A Survey of Management Techniques in the South Hants Coastal Region*, University of Southampton Department of Commerce and Accountancy, December 1963 ("Southampton Survey"), (*d*) *Investment in Machine Tools*, National Economic Development Council, London, HMSO, 1965, an interview survey of companies in the machine tool industry, (*e*) G. H. Lawson "Criteria to be observed in judging a capital project", *The Accountants' Journal*, May and June 1964, a postal survey of 120 companies, (*f*) D. Corner and A. Williams, "The sensitivity of business to initial and investment allowances" *Economica*, London School of Economics and Political Science, February 1965 ("Exeter Survey"), (*g*) J. B. Goodlad, "Management accounting and industrial accounting", *Management Accounting*, June 1965, a postal survey of twenty-five companies in the Nottingham area, (*h*) B. R. Williams, *Information and Criteria in Capital Expenditure Decisions*, University of Manchester, Centre for Business Research, 1964, a study of the investment procedures in thirteen companies.

[32] See footnote 2 above.

[33] See footnote 32 (*h*) above.

the firm, since large companies tend to use documented, sophisticated analyses; secondly, the nature of the industry, since the oil, chemical and vehicle-producing companies tend to use theoretically correct methods of appraisal, whereas the food, drink, tobacco, non-electrical engineering and distributive companies tend not to use discounting methods, and thirdly, the nature or type of project to be evaluated.

The objectives of the nationalized industries have, in the past few years, been increasingly defined in terms of financial targets.[34] Indeed, in the Select Committee's Report on the British Overseas Airways Corporation it was stated that "Your Committee found the financial direction by the Board of BOAC had been defective in a crucial respect, namely, they had not consistently enforced the test of what was the corporation's strict commercial and financial advantage."[35] The boards managing the industries are appointed by the responsible minister and since 1956 all external finance, apart from advances from the banks, has been provided by Exchequer advances.

Merrett and Sykes[36] state that the annual capital charge method is commonly used in the British nationalized industries. From interviews and other sources, however, it seems that a great variety of methods is used. The Post Office, for example, stated that discounting methods had been employed for the past forty years, whereas other nationalized industries seemed to use unsophisticated methods of evaluation. In fact, there seemed to be a wide gulf between the best and worst practices in the nationalized industries, and an executive in one of the ministries stated that "the biggest problem is that of improving the practices of the worst". There currently seems to be much thought applied to the subject and the Treasury has been holding meetings with representatives of the various industries in an attempt to achieve some improvement and standardization of appraisal procedures.[37] From the interviews, muddled thinking, similar to that in the private sector, was evident (see section C).

Having arrived at some index of the economic worth of a project, companies and nationalized industries seemed to use a variety of cut-off rates as a guide in deciding whether to accept or reject a project. Since the capital market is an imperfect market, the theoretically correct cut-off rate to use is the marginal efficiency of capital, that is, the rate of return which can be earned from the best alternative use of the resources. However because of the difficulty of measuring the return from certain types of projects and because of other factors, such as the timing of investments, much guesswork is involved in arriving at the opportunity cost of capital. Nevertheless there seemed to be a general consensus among experts interviewed in France, the United Kingdom and the United States that a figure of between 7 and 10 per cent[38] reflected the opportunity cost in those countries.

All the British companies using the internal rate of return used a cut-off rate of 7 to 10 per cent as a guide. They emphasized (*a*) that this might alter with the change to a corporation tax and (*b*), to quote an employee of an oil company, that "because in the last resort, any investment decision is made on the basis of business judgement, the part played by analysis and technique may be small, however sophisticated the procedures that are laid down". The other companies used guidelines varying from 25 per cent before tax (expressed as the ratio of "expected" profit to initial outlay) to "the rate earned by the company at present".

One or two of the nationalized industries stated that they generally took their financial objective[39] as a guide. The objectives differ according to the circumstances and prospects of the different industries, but in general they are equivalent to between 6 and 8 per cent.[40] Since the nationalized industries obtain their capital from the Exchequer and are subject to capital rationing, the money cost of capital will usually differ markedly from the opportunity cost of capital. Given the risk associated with the investments of the nationalized industries, 6 to 8 per cent probably reflects the opportunity cost of capital, but here again there is a certain amount of muddled thinking, since the objectives were not established for the purpose of reflecting the opportunity cost of capital.[41] In order to avoid misconceptions of this sort, it would be better to restate the financial objectives year by year in terms of a cash surplus to be earned by the various industries.

The concept of opportunity cost of capital is an important one for the developing countries to bear in mind, since the difference between the money cost of a loan from a financing agency and the opportunity cost of capital in a developing country will usually be considerable. The developing country should be aware that the money cost of capital is largely irrelevant to the investment decision.

France

Approximately half of the French companies replying to the questionnaire used some sort of discounting method to evaluate the worth of a project. Again, however, there seemed to be misuse of the methods. One company claiming to use the net present value method stated that it deducted depreciation from

[34] See *The Financial and Economic Obligations of the Nationalised Industries*, Cmnd. 1337, April 1961, in which it was stated that "although the industries have obligations of a national and non-commercial kind, they are not, and ought not be regarded as social services absolved from economic and commercial justification".

[35] Vol. 1, June 1964, p. 103.

[36] A. J. Merrett and Allen Sykes, *The Finance and Analysis of Capital Projects*, London, Longman, 1963.

[37] The Treasury has prepared an excellent booklet (unpublished) to provoke further thought on the subject: "Appraisal of nationalised industry investment projects".

[38] Calculated on an internal rate of return basis.

[39] To implement the policy set out in the White Paper (Cmnd. 1337), five-year financial objectives were agreed with most of the industries concerned.

[40] 8 per cent is the rate stated by the Treasury as corresponding "broadly to the prospective opportunity cost of capital for large economic undertakings" (quoted from "Appraisal of nationalised industry investment projects"; see footnote 38 above).

[41] See R. L. Meek, "Investment choice in the electricity supply industry—some recent developments", *District Bank Review*, March 1965, and Samuel Brittain, *The Treasury under the Tories, 1951-1964*, Penguin Books, 1964.

the cash flows before calculating the NPV at a discount rate of 8 per cent. Another company, using the future value method, calculated it on a different basis from that established by theory. After deducting these two companies, it seemed that four of the eleven companies replying to the questionnaire were using discounting methods correctly. The general impression gained from interviews was that the largest French companies were beginning to use advanced methods, the impetus coming from the Common Market. An executive of a large company manufacturing heavy engineering products spoke of a conference in January 1965 at which 90 per cent of the companies attending had stated that they used discounting methods. This statement is difficult to reconcile with the findings of Smith and Remmers. In their survey they state that "qualitative classifications such as 'very important', 'important', 'less important', continue to be the operative categories into which the majority of businesses sort their possible capital expenditures", and they go on to say that "the basic difficulty was the lack of adequate cost data . . . As a consequence the factor considered to be of the greatest practical importance was the ranking given to an item by the department manager concerned . . . The managers were engineers and they seemed reluctant to admit that there could be a need for any justification beyond the promptings of their good sense".[42]

The impression gained from the interviews was that projects are generally given a very complete technical study. Discounting methods seem to be more widely used than in British companies of similar size. This is supported by the experience of a French management consultant who stated that discounting methods were generally used in French companies with an annual sales turnover exceeding F100 million. French companies are generally engineering-oriented, whereas British companies tend to be more influenced by accounting considerations, and this may explain the French use of discounting methods as opposed to traditional accounting methods.

Large French companies generally placed much emphasis on "the influence of government action on their investment decisions". By "government action" they seemed to mean the direct influence which the government exercised through incentives and purchasing power. As was stated by Political and Economic Planning in the booklet, *French Planning—some Lessons for Britain*, the incentives have introduced into the planning system the notion of a contract between individual firms and the state which requires a much greater degree of intervention in the internal affairs of firms than has up to now been accepted by British industry".[43] On the other hand, little importance was attached to planning as an influence on investment policy.

The proportion of national investment directly controlled by the State in France is equal to approximately 50 per cent. Gaz de France, Electricité de France, and SNCF (French railways) use discounting methods, and Charbonnages de France stated that they used the NPV method, comparing the actualized value of the results with the initial investment.

Companies in France, as in Britain, use a wide variety of cut-off rates as guidelines for the approval or rejection of projects. The nationalized industries, on the other hand, generally use, as a guide, the rate set out in the French plan. For the fourth plan this was set at 7 per cent, but it was thought that this would be raised to 8 or 10 per cent for the fifth plan.

The appraisal practices used by the French nationalized industries probably correspond closely to the theory because "a majority of French economic theorists are associated in one capacity or another with the nationalized industries, some in the highest managerial posts".[44]

United States of America

In *Topics of Cost Accounting and Decisions*, Bierman states that "in fact, this (cash pay-back) is the most common method in use at the time this book is being written".[45] In *Management of Corporate Capital*, Hill says "The committee found that a surprising number of companies had no system of evaluating or justifying capital expenditures, but depended entirely on the judgement of their executives".[46]

In a survey of 127 American companies reported in the NAA (National Association of Accountants) Bulletin of June 1960,[47] 116 were found to have used some form of return: 66 had used pay-back, 59 the book RR and 38 one of discounting techniques. Professors Brockie and Grey, in a survey of fifty-seven large American manufacturers' investment,[48] found that 85 per cent of the respondents used some form of pay-back method. An informal survey of about thirty manufacturing companies made by a vice-president of Thomas Edison Industries found that "the most universal standard employed by enlightened management is the return on investment the particular product will provide".[49] Eisner found that the average return on initial cost was commonly used for major as well as minor investment and he expressed distress that the élite of American businessmen used this "crude" formulation of the rate of return.[50]

[42] *Investment Decisions in French Industry* (see footnote 15 above).

[43] London, PEP (Political and Economic Planning), September 1963, p. 308.

[44] T. Marschak, 'Capital budgeting and pricing in the French nationalized industries', *Journal of Business*, University of Chicago, vol. 33, 1960.

[45] New York, McGraw Hill, 1963.

[46] Illinois, Free Press of Glencoe, 1959.

[47] "A glimpse at practice in calculating and using return on investment", NAA Bulletin, June 1960.

[48] *Economic Journal*, Cambridge, England, December 1956, pp. 662-676.

[49] *Dun's Review*, New York, January 1957, p. 39.

[50] Eisner, "Determinants of capital expenditure", Merrill Research Foundation Project, 1951-1952. Published in *Studies in Business Expectations and Planning*, No. 2, University of Illinois, 1956.

In Istvan's more recent survey of forty-eight companies,[51] all but seven stated that some minor proportion of their capital expenditure was treated as "absolutely necessary". Sixteen of the companies used discounted cash flow (DCF) for at least some of the projects (see below).

Method of investment appraisal	*Used as* Primary measure	Secondary measure
DCF (including the MAPI formula)	7	9
Book RR	24	8
PB	13	21
Others	4	44
TOTAL	48	

Istvan states that "there is apparently a direct correlation between the use of this measure of acceptability (DCF) and a generally superior capital expenditure programme". In the Minneapolis project, Heller discovered considerable use of pay-off formulas but diversity and irrationality "in the method of calculation and in the treatment of income taxes and interest".[52] De Chazeau also finds "stubborn resistance of businessmen to scientific economic formulae for the timing of capital outlays",[53] and Gort finds the use of illogical methods (for example, deduction of depreciation from income but not from capital) which may not reduce the level of investment because of the adjustment of the cut-off rate, but which almost certainly will lead to the wrong choice of investments.[54]

On the basis of a number of surveys, Solomon concludes that "most large firms do not use refined capital rationing techniques, though there may be a correlation between systematic capital budgeting, size, and separation".[55] Separation here means the divorce of ownership from control.

Norman E. Pflomm in a more recent study of the experiences of 346 manufacturing companies states that "the pay-back period is the most commonly used financial measure of capital projects among operating companies".[56]

On the basis of the above surveys and the interviews, it appears that companies in the United States tend to use more formalized techniques than French or British companies, but less than half of the large companies (those with net assets exceeding, say, $30 million) use discounting techniques. The largest companies, and particularly those in the capital intensive industries, such as oil and chemicals, tend to use the most advanced techniques, and here the pattern is similar to that of the United Kingdom and France. An executive in an American chemical company stated that the gestation period for projects in these two industries was generally longer than that for projects in most other industries, and he thought that that made those companies time conscious, thereby inducing them to use a method of appraisal which took account of the time value of money.

3. *National economic profitability; the theory*

Tinbergen[57] has pointed out three respects in which the appraisal of a project's worth to the community differs from the appraisal from the viewpoint of the individual firm.[58] First, whereas the firm will calculate the economic worth of a project using the market prices of production factors, the evaluation from the community's viewpoint should use prices which reflect the scarcity of these production factors. Market prices may not measure the marginal productivity of production factors because of imperfections in the market, and "shadow" prices may therefore have to be imputed. Secondly, the "community evaluation" should take into account such factors as the indirect or secondary benefits or costs attributable to the project. Thirdly, the evaluation will measure the net return to the economy, by relating benefits to total costs,[59] rather than to any particular factor. The evaluation is therefore calculated in terms of the social rate of return.[60]

The relationships between projects, industries and sectors of the economy may be assessed by means of input-output models. Work is in progress, for example, on the preparation of an input-output table for 500 to 600 sectors of the American economy based on the census of manufacturers for 1963.[61] A social accounting matrix (SAM) of the British economy has been prepared by Richard Stone and his colleagues at the University of Cambridge, England.[62] Statistics for these kinds of models are obviously not available in the developing countries, but even very elementary statistical analysis may be useful for outlining priorities.

Some particular factors that should be considered in assessing the economic soundness of a project are listed below.

(a) *"Shadow" prices*

Attention has already been drawn to the difference between the money cost and the opportunity cost of

[51] Istvan, *Capital Expenditure Decisions - How they are Made in Large Corporations*, University of Indiana, Bureau of Business Research, 1961.

[52] Heller, *Harvard Business Review*, March 1951, p. 101.

[53] De Chazeau, "Regularization of business investment", in *Problems of Capital Formation*, vol 19, Conference on Research in Income and Wealth, National Bureau of Economic Research, Princeton University Press

[54] M. Gort, "The planning of investment—a study of capital budgeting in the electric power industry", *Journal of Business*, University of Chicago, April/July, 1951

[55] M. Solomon, *Investment Decisions in Small Businesses*, Kentucky University Press, 1963

[56] Norman E. Pflomm, *Managing Capital Expenditures*, New York, National Industrial Conference Board, Study No. 107, 1963

[57] *Investment Criteria and Economic Growth*, Centre for International Studies, Massachusetts Institute of Technology, 1961.

[58] For a study showing the adjustments required to reflect macroeconomic rather than microeconomic values, see Murray D. Bryce, *Industrial Development*, New York, McGraw-Hill, 1960. See also Harral and Kuhn, "Transport planning in developing countries" (unpublished), Brookings, 1965

[59] See S. Enke, *Economics for Development*, Prentice-Hall, 1964.

[60] For a discussion of social marginal productivity, see A. E. Kahn, "Investment criteria in development", *Quarterly Journal of Economics*, Harvard University Press, February 1951

[61] See Wassily W. Leontief, "The Structure of the U.S. Economy" *Scientific American*, April 1965

[62] See the series published under the general title of "A Programme for Growth" by Chapman and Hall.

capital for a developing country. If therefore, an evaluation is made using the NPV technique, costs and benefits should be discounted at a rate which reflects the alternative use of the capital.

The price attached to labour inputs should again reflect the alternative use of the resources. If the market price does not reflect the marginal productivity of labour, the labour cost should be adjusted.

For various reasons, such as exchange controls or temporary loans, the official exchange rate may not be an equilibrium rate and it may therefore be helpful to evaluate the project at various "penalty" rates of exchange.

(b) *Secondary benefits*

Projects which have significant backward and and forward linkage[63] effects may have a greater attraction for developing countries than projects without the same effects. The benefits arising from this sort of effect will usually be impossible to quantify, and it will only be possible to note the effects of the project on other sectors of the economy.

"A significant consideration in appraising a project is the extent to which it will result in the introduction into a country of new and advanced techniques.... When new techniques are introduced, there often arises a problem of the existing industry which will be rendered obsolete, with the consequent loss in value of existing investment, cost of training new workers, dislocations, possible immediate decrease in total employment, increasing economic concentration and so forth."[64] Again these factors are difficult to quantify and the emphasis is diverted to considering the project in relation to the economy as a whole.

Another non-quantifiable factor which may be worthy of consideration is the extent to which the project gives rise to "external economies". These may be defined as arising "wherever the output of a firm depends not only on the factors of production directly employed by it but also on the output and factor use of other firms".[65] Such external economies arising from common service functions can only be evaluated by considering the project in relation to the economy or particular sectors or regions of the economy.

4. *National economic profitability; the practice*

What factors are taken into account by financing agencies when a project proposal is being considered? As is to be expected, the criteria differ according to the nature and objectives of the agencies.

United Kingdom

A director of an organization established to provide investment finance to firms in the United Kingdom stated that the main criterion was the creditworthiness of the project, although, for the more risky type of projects, a few members of the industrial staff of the organization spent two or three days with the sponsor checking on cost and market estimates. Some weight was also given to the promotion of exports, but no formal study was made of the effects on the balance of payments.

A merchant bank stated that it, too, assessed projects on primarily qualitative grounds. For example, the quality of management, the degree of risk in the industry or country, and the business background were all factors which might be considered.

A government-sponsored development bank stated that the main criteria employed were whether the project fitted in with the government's plans; whether it was commercially profitable; whether it was technically feasible, and whether the sponsors were "politically acceptable" in their own country.

No discounting analysis is carried out by the bank and the main economic criterion again seems to be the repayment of the loan, although the quality of management is an important consideration. The bank operates through a number of "development companies" in various territories and, for the guidance of such companies, a check-list has been prepared with fifty-two points raised under the headings of "sponsor's status", "suitability", "stake in the project", "general" (place in the bank's policy and development of the country), "process", "management", "marketing", "finance" and "terms of agreement". The check-list is shown in appendix 2.

A policy which has been used by one of the bank's development companies is to work up "agreed proposals" with the sponsor which contain full details of the project and the basis on which the development bank is prepared to invest. It appears that this scheme has been working well, because the "agreed proposals" are in a form which both the development bank and the sponsors are prepared to sign as representing full details of the project as agreed by all parties, but subject to the approval of the respective boards.

France

Interviews were held with three employees of a government-supervised French development bank. From these, it appears that loans are generally given for industrial rather than infrastructural or agricultural projects and are often channelled through development banks in the particular countries. The prime consideration is the creditworthiness of the borrower, although it is thought that the bank pays more attention than commercial banks to the secondary economic effects of the project.

An assessment of the market is carried out and even though the market analysis is limited to one or two years ahead it enables the bank to avoid favourite "prestige" projects, such as cement works and airlines. Cost-benefit analyses are not usually carried out, but consultants are occasionally employed to carry out technical appraisals. Only rarely are projects compared one with another. The bank had prepared a check list for the use of the sponsor and this asked for the sponsor's economic and financial background and position, and details of the

[63] See W. W. Rostow, *The Economics of Take-Off into Sustained Growth*, International Economic Association, 1964.

[64] For a further discussion of this point see James A. Lynn, *Temas del BID*, April 1964.

[65] See J. E. Meade, "External economies and diseconomies in a competitive situation", *Economic Journal*, Cambridge, England, vol. 62, No. 1, March 1952.

project's finances extending over the period of the loan. This is shown in appendix 3.

United States of America

The main criterion used by the commercial banks when investing in overseas development banks or projects again seems to be the ability of the sponsor to repay the loan. However, when an "equity" investment is made, the banks calculate some sort of return. One bank stated that the ratio of the average annual return to the initial outlay was calculated. When comparing one project with another, the same bank stated that risk and "social worth" were the chief factors to be considered if the profitability of each project was more or less equal. Again, no detailed cost benefit or profitability analyses are made, but the bank has prepared a "check-list for project investments" for the guidance of applicants. The check-list asks for details of the applicant company's background; an outline of the project to be financed and its contribution to economic growth; details of the quality of the management, materials and labour supplies; markets; operations and financial results ("for at least the first three years of operations"); the investment climate; taxation; the sources of capital requirements; and finally, details of any feasibility studies carried out in connexion with the project. The check-list is reproduced in appendix 4.

The other financial institutions interviewed, that is, the Export-Import Bank, the International Bank for Reconstruction and Development, the Agency for Industrial Development, the Inter-American Development Bank and the International Finance Corporation, generally make detailed studies of projects.

AID, for example, has prepared a capital assistance manual covering all phases of project preparation, evaluation and control; this consists of a few hundred pages of small type. A shorter booklet entitled, "Feasibility studies, economic and technical soundness analysis—capital projects",[66] sets out the requirements of S.611 of the Foreign Assistance Act of 1961,[67] and S.101 of the Foreign Aid and Related Agencies Appropriation Act of 1963 and then goes on to detail the steps to be taken when assessing the economic and technical soundness of various types of projects. The analysis for industrial projects is shown in appendix 5. According to the statements made, discounting methods are sometimes used and the screening mainly depends on the personal assessment of the head of the particular capital development office dealing with the project. The importance of pre feasibility studies and two-stage analyses was stressed, and it was thought that too much emphasis had, in the past, been placed on technical appraisals to the detriment of the economic appraisal. More stress should also be placed on the comparison of alternatives,[68] although formalized procedures could not be established owing to the diversity of projects. AID stated that it worked closely with multilateral agencies such as the IBRD, the International Development Association (IDA), the Inter-American Development Bank (IDB), and the European Development Fund (EDF).[69] The *Capital Assistance Manual* states that "the role of AID should be viewed as that of a catalyst and supplement to other alternative sources of financing".

The techniques of development lending which have been evolved by IBRD are set out in a booklet published in 1960.[70] The booklet consists of five chapters entitled "Introduction", "Creditworthiness", "Selection of Projects", "Appraisal of Projects" and "Supervision of Projects". "In general", the booklet states, "the project appraisal has to answer three main questions which involve the investigation of the project from six different points of view. The first of these questions is: are the goods or services to be produced by the project needed by the economy for consumption or for export? In order to answer this question, the project must be investigated from the economic point of view. The second question is: is the project properly designed and planned? To answer this question, the project must be examined from four different points of view, namely, the technical, the managerial, the organizational and the commercial. The third question is: is the proposed method of financing the project appropriate and (where relevant) are the earnings prospects satisfactory? This requires an examination of the project from the financial point of view."

A form outlining the information required by IBRD on light industrial projects is reproduced in appendix 6. Again it was thought that there has, in the past, been an overemphasis on technical appraisals. The Economic Development Institute of IBRD has however, been holding a series of industrial project evaluation courses which attempt to explain the principles, and give some examples, of the preparation, evaluation and control of capital projects.[71]

[66] Agency for International Development, Washington, D.C., October, 1964.

[67] This requires that sufficient engineering, financial and other plans necessary to carry out the proposed capital activity, together with a reasonably firm estimate of the cost of activity to the United States Government, shall be completed before any funds are obligated.

[68] After studying a number of transport feasibility studies commissioned by AID (Agency for International Development), Tillo E. Kuhn comes to the conclusion that "many of the transport studies sponsored by AID in effect seek justifications of predetermined decisions as opposed to 'evaluations' of meaningful alternatives". See page 190 of "Transport planning in developing countries" by Clell G. Harral and Tillo E. Kuhn of the Brooking Institution, 1965 (unpublished); see pages 191-193 for other criticisms.

[69] The impression gained from the interviews with the financial agencies was that conflict between agencies very rarely occurred. This is usually because either the agencies finance different types of projects or their efforts are co-ordinated by the Development Assistance Committee of the OECD or through more *ad hoc* organizations such as financial consortia and consultative and co-ordinating groups. For example, consultative groups organized by the IBRD (for Colombia and Nigeria) aim at bringing actual and potential donors together to consider the development efforts and external assistance needs of a specific recipient country. For details of other co-ordinating arrangements among aid donors, see the 1964 review of "Development assistance efforts and policies" published by OECD

[70] See *Some Techniques of Development Lending*, IBRD, Washington, D.C., September 1960.

[71] CEGOS, the French management consultancy firm, will be holding a conference in the last quarter of 1965 with the

The other financing agencies interviewed, that is, the International Finance Corporation, the Inter-American Development Bank and the Export-Import Bank seem to carry out detailed studies of industrial projects.[72] Some of the points stressed by these institutions are as follows:

"More importance is attached to the institutional framework than to theoretical concepts. Development banks are viewed as a particularly useful part of the institutional framework."

"The effect on the balance of payments is usually quantified since foreign exchange is almost always a constraint."

"New industries are generally preferred owing to their linkage effects."

"It is essential to study the economics of the country as a whole so as to reveal bottlenecks and the general stability of the economy. Every study shows the relationship of the project to the economy, although 'shadow' prices as such are generally not used."

"The Du Pont formula[73] is generally used in the appraisal of a project, although discounting techniques are used for irrigation projects."[74]

"There is usually an incentive to invest in infrastructure projects because ot the greater ease of getting a government guarantee for these projects."

"Cost-benefit analyses are not usually documented, but we do try to take account of such factors as: the effect of the balance of payments, both directly and indirectly through the action of the multiplier; the labour intensity of the project; the linkage effects; the diversification effects on production and exports; the impact on income distribution; the promotion of technical skills .... Very seldom do we use shadow prices as such, but comparisons are made with a similar type of project in another country or with a simulated 'challenger'."

"Most projects are suggested on grounds of 'political expedience'. The problem is to find alternatives, and introduce objectivity into the analysis—that is, we act as an educational pressure-group."

There seems, among the international agencies, to be a rapidly growing concern that assistance funds be used more effectively, but it was stated many times that three formidable obstacles were barring the way to such an improvement: first, the application of political prejudice to investment decisions; secondly, the difficulty of collecting data on which to base a detailed appraisal, and thirdly, the shortage of projects.[75]

C. COLLECTION OF DATA; SOME COMMON MISCONCEPTIONS; AND A DISCUSSION OF RISK AND UNCERTAINTY

1. *Collection of data for assessment of commercial profitability*

United Kingdom

"Few would complain that the British manufacturer has neglected the use of market research in home markets; membership of the British Market Research Society is approximately 1,500 and total expenditure on all forms of domestic research consumer and industrial markets, trade, media and advertising and sales—must now be in the neighbourhood of £15 million a year".[76] So states Mark Abrams. An expenditure of £15 million a year,[77] however, represents less than 0.5 per cent of the turnover of these manufacturers. Moreover, Carter and Williams have said "in our case studies we found relatively few firms with efficient arrangements for market research".[78]

On the basis of a survey conducted among members of the British Market Research Society in March 1965, reported in the *Financial Times Review of British Industry* (July 1965), it is stated that "it is highly unlikely that British industry spent as much as £1 million on overseas market research in 1964; more probably the figure was barely £500,000". The report also says that a majority had used "desk research", which did not involve interviewing. The respondents were drawn mainly from large and middle-sized firms with some interest in overseas markets.

If Jacques Lesourne's[79] division of marketing studies into predictions and structure analysis is used, it would seem, on the basis of the *Financial Times* Survey, the questionnaire replies and the personal interviews, that the majority of British companies rarely use structure analysis when making market forecasts.

The fact that companies pay little attention to market research in general is reflected in the lack of market research applied to individual projects. For expansion projects, for example, companies in the EIU survey generally forecast for five to ten years ahead, whereas replacement projects are generally appraised on their first year's savings. Quite extensive technical data are collected but rarely translated into detailed costs. In some cases the profitabilities of projects are not assessed at all (see section B);

general title of "Techniques d'étude économique du projet industriel", and a number of banks and companies are attempting to close the gap between theory and practice in the field of project appraisal by holding courses.

[72] See James A. Lynn, *The Application of Investment Criteria in a Development Bank, Temas del BID*, April 1964. The minimum information required by the Export-Import Bank from proposers is listed in Bryce, op. cit. (see footnote 59 above), appendix 1. The International Finance Corporation also has a detailed check-list setting out the information required under eleven main headings.

[73] This was originally defined as the average income or benefit divided by the average capital employed.

[74] Following the memorandum of President Kennedy dated 15 May 1962 and S.101 of the 1963 Foreign Aid Appropriations Act, cost-benefits studies are required for water or related land-use projects.

[75] See chapter I and pages 210-211 of "Transport planning in developing countries" (see footnote 59 above).

[76] See M. Abrams, "The role of market research", the *Financial Times Review of British Industry*, July, 1965. This article also contains a model or check list for overseas market research.

[77] In a survey carried out in 1960 by the British Institute of Management, total expenditure on market research, that is, both domestic and foreign, was estimated at £18 million.

[78] *Investment in Innovation*, Oxford University Press, 1958.

[79] *Economic Analysis and Industrial Management*, Prentice-Hall, 1963.

subsidiary measures are often used. This is particularly true of replacement projects, where comparisons in terms of labour productivity are often made. Three of the companies interviewed make extensive use of check-lists[80] to try to ensure that a reasonably accurate estimate of the capital outlay is obtained.

Many of the organizations in the survey, in fact, more than one third of those questioned, made "errors of principle" when collecting data. Some of the more common pitfalls are listed later in this chapter. When these "errors" (for example, the allocation of existing overheads to a new plant) were pointed out, some of the executives could not understand that they were, in fact, "errors". They assumed that they had been using the methods correctly.

All thirty-seven companies giving replies to the questionnaire stated that outlays for working capital were included in an estimate of the capital outlay. However, a number of the companies interviewed merely apply the present ratio of current-to-fixed assets to project estimates and one company stated that credit received from suppliers was ignored.[81] Rarely, it seems, are detailed estimates made of the build-up of inventories or credit given to customers in relation to individual projects.

In the postal survey, fourteen companies stated that they looked at the worth of a project after deducting company tax; sixteen stated that the return was usually calculated before tax. Other replies were vague and could not be classified; the vagueness arose from the introduction of corporation tax. One reason commonly given for estimating rates of return on a pre-tax basis was because rates of taxation and of tax allowances were constantly changing (the reply of a non-electrical engineering company). Of the sixteen "before tax companies", seven stated that they would have regard to the benefit of capital allowances and in particular the "subsidy" which might arise from investment allowances. In fact, comparing the various surveys[82] on this point, it is difficult to come to any definite conclusion as to whether or not the investment allowances have their designed effect. It can, however, safely be said that the effect of tax allowances on a project's worth is rarely examined by discounting techniques, and it is probable that the allowances do not have their intended effect.

Four of the organizations interviewed have attempted to assess explicitly the effects of a project on the total profitability of the enterprise. For example, one oil company is attempting to set up models which would show more clearly the effects of a project on the other operations of the company. A large chemical company requires that the pre-extension price and cost structure of a division of the company be compared with the post-extension structure of the division on the project proposal form. The electricity industry is also accustomed to studying the effect of an individual project on the existing activities of the industry because a new generating station affects the merit order of all other stations.[83] Some investments may, of course, have their own demand curve due not only to the size of the investment but also to the uniqueness of the product or service produced. The effect of large projects on the demand curve for existing products is rarely assessed, with the notable exceptions of the organizations listed above.

France

Of the organizations surveyed in France, the majority forecast between five and ten years ahead for expansion projects above $250,000, whilst for replacement projects a shorter period is generally considered. Only two of the organizations indicate that forecasts are made for the economic life of the project. The impression gained from the interviews is that the market study is generally made in more detail than the marginal cost study; yet the market study is generally limited to desk research. French organizations are even less market-oriented than their British counterparts. The cost structure of existing plants within the organization is all too often assumed to apply to new expansion projects. Where the project involves the replacement[84] of existing assets, the comparison between the "defender" and "challenger" is usually conducted in terms of technical data.

The desk market research, for the companies interviewed, usually involves a mere extrapolation of price and volume trends. Only rarely are analyses made of price elasticities and future trends of imports, or of the effects of competitors' likely reactions. Indeed, the prime motive for a study of an expansion project seems to be a lengthening order book or the need to maintain a certain rate of growth or share of the market. A few companies use standard forms for the presentation of projects but only rarely do these ask for detailed cost or market breakdowns. Only one of the companies interviewed uses an information check-list, although the majority said that they were about to introduce them.

The Smith and Remmers study sheds little light on the forecasting techniques used by French com-

[80] Examples of check-lists are given in *Perry's Chemical Engineers' Handbook*, section 26-16, in the July 1958 edition of *Petroleum Refiner* and in *The ... of Engineer* of January 1963.

[81] Even though, in the balance sheet of this company for the year ending 31 December 1964 the figure for creditors was greater than that for debtors.

[82] Cf. para. 310 of the Richardson report, *Turnover Taxation*, Cmnd. 2300, HMSO, March 1964, the "Exeter Survey" by D. Corner and A. Williams reported in *Economica*, February 1965, the "Southampton Survey" (see footnote 32 above), the information presented to the Radcliffe Committee by the Federation of British Industries (see *Principal Memoranda of Evidence to the Committee on the Working of the Monetary System*, vol. 2, pp. 118-121), and "Replacement Policy", *National Institute Economic Review*, London, November 1964.

[83] F. Brown and R. Edwards, "The replacement of obsolescent plant", *Economica*, August 1961. If, however, the amount of capital to be invested is greater than the amount required to meet demand the difference is known as "optional capital" and "it would normally be sanctioned only if it could show a return of about 10 per cent net (about 16 per cent gross)": see the *Report from the Select Committee on Nationalised Industries*, House of Commons Paper 236-1, May 1963.

[84] The distinction between replacement and expansion projects is an arbitrary one, but, as stated in section A, it is commonly made by companies in the three countries.

panies, but it states that "it was almost always the technical considerations that were at the forefront of any choice".[85] The study also states that "expansion (in some cases) was intended to ensure that the firm could maintain its share of a developing market".

Very few of the executives interviewed had a grasp of the economic principles involved in the appraisal of a project and some of the more common misconceptions are detailed below.

Eight of the organizations stated, in reply to the questionnaire, that they took working capital requirements into account but, on further investigation, it seemed that, in many cases, the existing ratio of current to fixed assets was applied to the new project.

Approximately one half of the companies surveyed looked at the return on a project before tax. One of these companies stated that incentives channelled through the Fonds de développement économique et social were always considered.

The companies interviewed seemed to assess the effect of the project on the total organization, but this was not usually documented, and the assessment was usually made subjectively at the level of the board of directors.

The nationalized industries seem to make more detailed forecasts and analyses of projects. The Commission de l'énergie made forecasts for the fourth plan of the demand for energy in coal equivalent up to 1985, assuming certain price levels. After making certain adjustments for other factors such as the cost of retraining coal workers and the security of supply, forecasts were made of the investment required to meet the forecast demand at the lowest possible cost.[86] When attempting to forecast the total demand for fuel, the elasticities of price and income were assumed to be constant as between fuel and other sectors of the economy. However, when the total fuel demand was apportioned between the various types of fuel, a number of forecasts were made for various price levels.[87]

When appraising large projects, the French nationalized industries, especially those operating in the energy sector, generally study the effect of the project on the total organization. This is especially necessary for Electricité de France, since a new power station will affect the merit order of other stations.[88]

For some very large projects, detailed studies have been made by the gas and electricity industries and for some problems, linear programming and operational research techniques have been used.[89]

United States of America

Since American companies generally use more sophisticated measures in project appraisal, and the planning horizon is longer, there is a presumption that their forecasting is more refined than that of French or British companies. This, however, can only be a presumption since the number of companies interviewed was too small to give good grounds for generalizations and the published surveys generally ignore the methods used to arrive at the data which form the basis for the project appraisal. However, the three companies interviewed stated that, when collecting information for appraising projects involving an outlay of more than $250,000, very detailed analyses were usually made. [illegible] analyses involve a study of market structure rather than trends, and a build-up of costs from technical data. Two of the companies use detailed check-lists but no copies were made available.[90] All three companies (one petroleum, one chemical, and one [illegible] company) stated that they often employed consultants to carry out market and technical studies, especially for overseas projects.

A management consultant in New York [illegible] that large American companies (defined as those with sales turnover above $100 million a year) are very conscious of the need to check on sources of information, and he knew of "at least a dozen companies which had special project teams whose responsibilities included not merely the appraisal of projects but the complete phasing of projects from the initiation to the *post mortem*". When the interviewer pointed out that, compared to British and French companies, there seemed to be a greater awareness among the three large American companies of the need to check on the accuracy of information behind a project appraisal, the consultant said that he thought that this was [illegible] greater use of probability techniques and [illegible] analyses by American companies.

The three companies interviewed stated that working capital and start-up costs were always estimated, although how precise such estimates were depended on the relative importance of such elements in the total project cost. They also stated that tax implications were included in the proposal form. When investing overseas, there seem to be five stages in the appraisal of a project which the paper and petroleum companies follow once the [illegible] project has been revealed.[91]

[85] *Investment Decisions in French Industry* (see footnote 15 above).

[86] See L. Gouni, "Rapport général de la commission de l'énergie", *Revue française de l'énergie*, Paris, No. 139, April 1962.

[87] For details of the models used by the Commission de l'énergie for the third plan, see J. Lesourne, op. cit. (see footnote 80 above), chap. 7.

[88] For example, the EDF stated that the practice was to evaluate the effect of a particular project on the complex of existing projects and that the method employed was that of actualized balance sheets, the rate of actualization being 7 per cent.

[89] See P. Massé and R. Gibrat, "The application of linear programming to investments in the electric power industry" [illegible] Monge [illegible] structure optimale de l'industrie [illegible] transports de produits pétroliers [illegible] Paris, November 1958, and P. Massé [illegible]

[90] For some examples of [illegible] companies, see Norman [illegible] 57 above), pp. 117-24.

[91] The French, British and American companies and banks revealed a variety of [illegible] a study of [illegible] market [illegible] high levels of imports of particular products [illegible] branches of the organization, approaches from other companies with a view to starting a joint venture, approaches from development banks or government agencies, articles in trade journals, consultants, machinery [illegible]

First, a study of the over-all investment "climate"[92] and an economic forecast for the next five to ten years;

Secondly, a study of the incentives or disincentives to investment, such as exchange control, restrictions on the expatriation of dividends, tax allowances, grants, subsidies and tariff protection;

Thirdly, a study of the size of the market, its relationship to the economic size of plant, the estimated percentage utilization of capacity, and the effect on existing and forecast exports of the company to the country;

Fourthly, a broad evaluation and general analysis of the project; and

Fifthly, if such analysis is promising, a detailed feasibility study.

The interdependence of projects is taken into account by these companies by requiring that the corporate effect of a project be included in the proposal. The petroleum company gave an example of how a marketing and distribution expansion programme might necessitate an expansion of the refining facilities. Related investment is in fact estimated and included as a cash flow in the year in which it is expected to be incurred.

2. *Common misconceptions*

Some of the more common "errors of principle", besides those already mentioned, which companies make when collecting data and appraising projects were found in the survey to be as described below.

Profit after depreciation is used for calculating the internal rate of return on a project by a large non-electrical engineering company in the United Kingdom and by a metal manufacturing company in France.

Book values of plant to be replaced are often taken into account when in fact they are irrelevant, unless of course they happen to coincide with the value of the assets in the best alternative use (many examples of this mistake were discovered in the United Kingdom[93] and France).

Current overhead ratios are allocated to the new project by a machine tool manufacturer in France. Clearly only the marginal benefits or costs are relevant to the appraisal.

Studies are often carried out on a "before after basis" rather than on a "with without basis". If it is estimated that, without the project, profits will increase, this increase in profits should not be attributed to the project. The comparison should be conducted in terms of what will happen with and without the project.

Development expenses, already paid, were included in the appraisal by a British engineering company. Clearly past costs are irrelevant, except in so far as they are a guide to the future.

Interest payments are deducted from the cash inflow in the analysis and in addition are expected to be covered by the cut-off rate by a French tyre manufacturer.

Forecast sales prices included an allowance for inflation, whereas factor costs did not, or vice versa.[94]

The gestation period is ignored by a French chemical company when discounting the cash flows.

The company's own labour used in construction is not charged to the project by a British textile manufacturer, even though such labour could profitably be used for other purposes.

3. *Collection of data for assessment of national economic profitability*

The development banks in France and the United Kingdom and the international agencies in Washington stressed the need for careful forecasting of the market. It is important to study the market for the particular product which is going to be produced by the project, rather than for the group within which the product is classified.[95]

The agencies stated that they used check lists so that first, information was received in the form in which it was required and, secondly, common pitfalls were avoided. Some of these check lists have been referred to in section B and examples are given in the appendices. The institutions stressed the importance of pre-investment studies and comparisons with similar projects to check on the information given. In answer to the question, "Which in your opinion are the variables for which estimates are most commonly incorrect?", IBRD, AID and IFC gave capital costs and, in particular, costs of non-manufacturing facilities,[96] estimates of working capital and pre-production expenses, and gestation periods. It was thought that the use of check lists, feasibility teams and comparisons with pre-investment surveys would improve the accuracy of these forecasts.

4. *Common misconceptions*

Some of the mistakes said to have been made in the past by sponsors and feasibility teams are described below.

Taxes, duties, and subsidies have been included as economic benefits or losses to the community, whereas they are transfer payments and therefore irrelevant to the economic worth of the project. This does not, of course, mean that the fiscal effects of a

[92] The importance of the investment "climate" is stressed by Bryce, op. cit. (see footnote 30 above), p. 34. A study is currently being conducted of the investment climate in a number of developing countries by the Business and Industry Advisory Committee of OECD.

[93] See *Special Report of the Select Committee on the Nationalised Industries—the Gas Industry*, House of Commons Paper No. 218, 1962, para. 42, and *Report from the Select Committee on Nationalised Industries—British Railways*, House of Commons Paper 254, London, July 1960, paras. 210-225.

[94] Very few of the companies interviewed made any explicit allowance for inflation, although two companies (one British and one American) stated that they assumed a rise in real wage costs. This assessment was implicit, however, the companies stating that, other things being equal, more capital intensive methods would be preferred.

[95] For an illustration of a project failing in Puerto Rico because of an imprecise market study, see Bryce, op. cit. (see footnote 30 above), p. 112.

[96] For details of non-manufacturing facilities commonly required for chemical projects, see *Critical elements in reducing the risks of chemical ventures*, Arthur D. Little Inc., Cambridge, Mass.

project should be ignored. Taxes, especially in developing countries, may perform a very useful function as "forced savings". Nevertheless they should not be considered as a direct economic benefit attributable to the project.

Increases or decreases in the price of land as a result of the implementation of the project have often been included in assessments. If the factors leading to the increase or decrease in the price of the land have already been included in the project appraisal, there is of course an element of double counting. Land has on the other hand often been assumed to be a free factor, and yet it should be valued at its alternative cost, that is, the next best use the community could make of it.

Capital has often been valued at its money cost, whereas, as was emphasized in section B, it should be valued at its social opportunity cost.

Sometimes, when foreign exchange has been scarce, it has been rationed to projects to the possible detriment of them all. A better course would have been to abandon some of the least worth while projects.

A "fault" mentioned by IBRD was the emergence of excess capacity through "copying". With the lack of innovators' ability and the attraction of high profits there has been a tendency in some developing countries to imitate successful enterprises. Reference was made to Saudi Arabia in this respect.[97]

5. *The impact of risk and uncertainty*

So far in this report a high degree of certainty has been assumed when discussing the methods used for appraising project. In fact, however, there is considerable element of uncertainty in any forecast and a certain risk attached to any project. Economists generally distinguish between risk and uncertainty but, since few organizations have made this distinction, the two will be treated together under the collective title of uncertainty.

In 1957, Roberts stated that "the most serious deficiency in the present state of knowledge about capital budgeting is the absence of a satisfactory framework for incorporating uncertainty into the analysis".[98] Since 1957, much has been written on the subject,[99] although few definite conclusions have been drawn from the analyses.

Basically, there seem to be five main methods of measuring the impact of uncertainty on a project. These are:

The subjective method: that is, the degree of risk is "assessed" by the board of the company;

Classification into risk types: projects are classified according to their risk characteristics; a higher or lower financial return is required for each risk grouping;

Minimax: this "method" was developed by Wald (*Statistical Decision Functions*, New York, Wiley) and Savage (*Foundations of Statistics*, New York, Wiley); the minimax analysis merely sets out the maximum gain or loss that can result from a given project; the analysis then permits the decision taker to choose that project which will lead to the minimum loss in the event of adverse circumstances;

Probability theories: various methods attempt to attach probabilities to ranges of variables, thereby presenting the decision taker with a range of profits and losses and the probability of achieving them;

Sensitivity analysis: this is a method which attempts to calculate the sensitivity of the worth of a project to fluctuations in the data; it enables decision takers to see the effect on the project's worth of variations in sales levels, price levels, input-output ratios, capital cost etc.

H. Aubrey questions whether [illegible] approach is suitable for investment decisions in developing countries, since, instead of large number [illegible] turning ignorance into knowledge, we are faced [illegible] a kind of uncertainty [illegible] ignorance".[100]

The most suitable form of analysis will probably be twofold. In order to show the loss resulting from the total failure of the project, a capital recovery analysis showing the percentage recovery of capital through time will be appropriate. On the other hand, in order to show the effect of fluctuations in [illegible] of costs or to pinpoint the variable for which more information is required, a sensitivity analysis will generally be most useful.[101] For example, if, as a result of such an analysis, it is discovered that the price of a material is crucial to the worth of a project, it may be worth while trying to negotiate a contract or guarantee for the price [illegible] in order to reduce the risk of the project. Similarly, a sensitivity analysis can be useful for [illegible] the minimum tax allowance [illegible] required by the government to make the project [illegible].

Sensitivity analyses, however, [illegible] organizations in France and the [illegible] where the various methods stated [illegible] the following:

[97] See the "General survey report on the development of industries in Saudi Arabia" prepared by Lachmeyer and [illegible] Frankfurt, Germany, 1961.

[98] H. V. Roberts, "Current problems in the economics of capital budgeting", *Journal of Business*, January 1957.

[99] See for example, S. W. Hess and H. A. Quigley, "Analysis of Risk in Investments using Monte Carlo techniques", Chemical Engineering Symposium Series No. 42 (New York, American Institute of Chemical Engineering, 1963); Frederick S. Hillier, "The derivation of probabilistic information for the evaluation of risky investments", *Management Science*, April 1963; and David B. Hertz, "Risk analysis in capital investment", *Harvard Business Review*, January-February 1964. There are, of course, discussions about the treatment of risk and uncertainty in recently published textbooks on capital budgeting and investment appraisal.

[100] H. G. Aubrey, "Investment decisions in underdeveloped countries", [illegible] *Capital Formation and* [illegible] (New York, National Bureau of Economic Research, [illegible]).

[101] This is the method favoured [illegible] see footnote 88 above [illegible] Development Institute.

Risk "assessed"	Organisations in United Kingdom	France
Subjectively	36	9
By classifying and requiring different rates of return or pay-back periods for various "types" of investment	6	2
By measuring the return on the capital at risk or by means of explicit probability or sensitivity analysis	10	4
Total of companies and nationalised industries interviewed and surveyed	52	15

A number of the companies and organizations using sensitivity analysis have prepared computer programmes for calculating the worth of an investment and a mere few seconds of the computer's time are required to calculate the effect of a change in one or more of the variables.[108] However, as the Courtauld's manual points out, "variations on the main underlying assumptions made for the project often do not necessitate complete re-calculations of the DCF return".[109] The effect of the change is merely calculated in cash terms; the net present value of these cash flows is calculated; the net present values for the project are then discovered, and a new discounted rate of return is then found by interpolation.

Sensitivity analysis seems to have been only recently applied by the companies using it. For example, the manager of planning operations in a British computer company stated that "we are taking the first steps towards allowing for differences in risk. This is done by ascribing quantitative percentages to major factors and evaluating the results with the upper and lower confidence limit used. We have a company model expressed in the form of a computer programme. This enables many possibilities to be evaluated rapidly. It also means that all factors can be changed by set amounts to establish those factors which have the greatest effect on the final result. The factors so determined receive special attention."

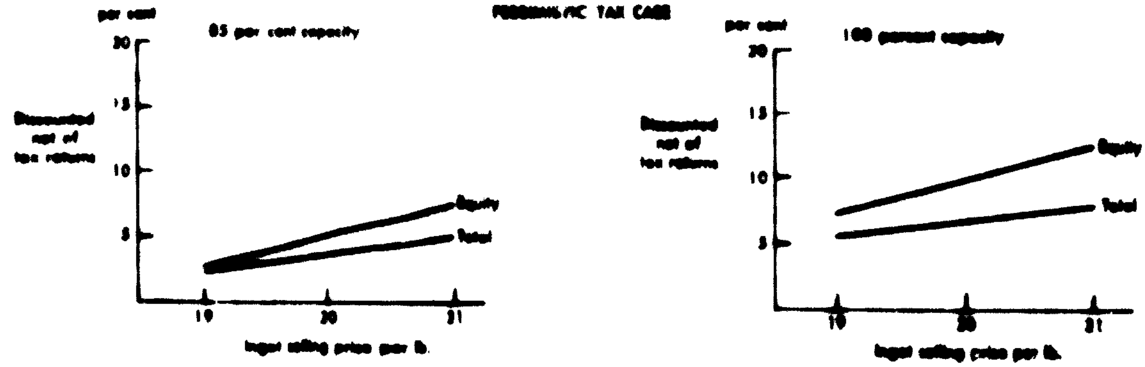
The Commission de l'énergie has used sensitivity analysis for the fourth plan to assess the effects on the energy programme of changes in prices, costs, imports and exports of various types of fuel. Companies stated that they had used it in connexion with overseas investments to determine the minimum price for a contract, or tax allowance from a Government, that could be accepted whilst leaving the project economically viable.

Companies made extensive use of charts to show the effect of various assumptions on the profitability of a project. In the example below a company has shown the rates of return earned on equity and total investment for a project depending on the level of the selling price, the tax payable and the utilisation of capacity. The company emphasised that the use of charts could save time in negotiations with customers, suppliers or the Government, and would reveal the "critical" variables to be further investigated. Attention could then be directed towards unearthing more information, or discovering methods of reducing risk arising from fluctuations in such

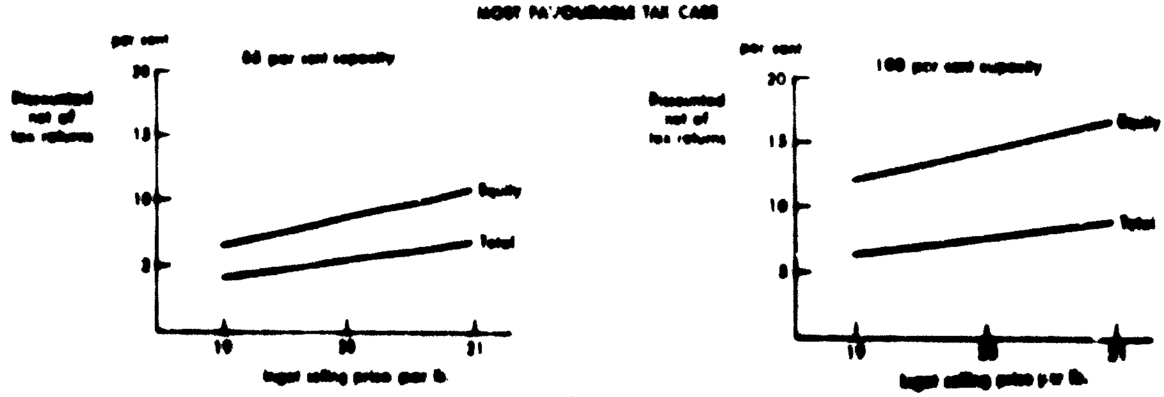
[108] See *The Times*, London, 29 April 1965, "Estimating profits by computer" for a reference to the use of analogue computers in DCF analysis.

[109] Alfred and Evans, op. cit. (see footnote 24 above) p. 28.

PESSIMISTIC TAX CASE



MOST FAVOURABLE TAX CASE



variables. Some of the methods stated to have been used by companies for reducing the risk of a project, especially an overseas one, are:

Contracts with suppliers or customers: turnkey contracts for the construction of plant were said to be especially useful for reducing uncertainty;

Joint ventures with other companies for part or the whole of the project;

Government tax, tariff or subsidy guarantees or compensation guarantees in the event of a devaluation;

Government-backed capital loans or, better still, local equity investments;

Flexible commitments, as when a plant is designed so that it can use more than one type of raw material.

Where some of the capital "tied up" in the project has a high value in alternative uses (for example, if resold), the project will obviously be less risky than one which utilizes capital specific to itself, since, if the project fails to be profitable, losses can be cut by using the assets in the alternative use. For example, most of the capital sunk in oil exploration is "at risk", whereas a retail shop will usually have a high alternative value relative to its cost, and therefore only a small proportion is at risk. One company stated that it did not use the pay-back method in the assessment of risk because of its failure to measure the return on the capital at risk.[104]

The American companies interviewed all used some form of probability or minimax analysis in conjunction with sensitivity analysis.

The international agencies generally favoured sensitivity analyses for the appraisal of projects; they did, however, differentiate between the risk and uncertainty attributable to a project. For example, some risks could be insured against,[105] whereas by definition the range of uncertainty was unknown. It was emphasized, however, that sensitivity analysis could be very useful in revealing the effects of various ranges of shadow prices on the economic profitability of the project.

D. CONTROL, MANAGEMENT AND POST-MORTEM APPRAISAL OF PROJECTS

The appraisal of an industrial project can be split into four parts. Assuming that a plan has been worked out for the company or country, a plan in the context of which the individual project can be appraised, the stages in the appraisal of a project will be: initiation and pre-feasibility study of the project; evaluation of the benefits arising from a project, comparison with the alternatives, and its authorization or rejection; scheduling and control of the project; post-mortem of the project.

In the previous three sections, the discussion has ranged from the initiation of potential opportunities to the evaluation of a project. The present section discusses the methods used by companies, nationalized industries and financial institutions to control, manage and post-audit projects.

1. *Control of projects*

In its reply to the questionnaire, a large British pharmaceutical manufacturer wrote: "The questionnaire makes no reference to one of our biggest difficulties: that of controlling costs once a project has been approved." Another company, a paper manufacturer, stated that "once a project is commenced, it is a question of strict control of expenditure and one of the fundamentals is detailed specifications to ensure that quotations are on a comprehensive basis; this requires to be accompanied by close contractual arrangements—preferably of a recognized character. The United Nations general conditions for the supply of plant and machinery for export could probably be adapted. To keep expenditure under close surveillance, we make a practice of having a formal monthly review with the production of cost control sheet showing the various items as in the estimate and an up-to-date revised 'anticipated final cost'. In our experience, projects tend to get out of control from a cost point of view when work commences on site and we recommend if at all possible the avoidance of 'time and material' contracts. There must also be a strict control of the delegation of authority to place orders on site."

Two of the companies interviewed in Paris emphasized the importance of project cost control and the benefits to be derived from using simple management techniques (such as budgeting and critical path scheduling)[106] to control the cost. All three companies in the United States stated that they used network analysis (another name for critical path scheduling) to plan and control project construction time and expenditure. Two stated that they were developing network based cost analyses to facilitate decision making in the event of the project cost exceeding the estimate.

It was emphasized that project planning helped not only in controlling expenditure but also in improving cash forecasts. One British company stated that "we find basing requirements on the knowledge of due dates from quotations, etc., results in forecasting requirements before actually required." Cash forecasting was pointed out as being particularly beneficial when capital was scarce or expensive. Since project construction costs are difficult to control, especially in overseas territories, companies generally favour turnkey contracts. If it were not

[104] For a description of a method which tries to measure the return on the capital "at risk", see Merrett and Sykes, *The Finance and Analysis of Capital Projects*, London, Longmans Green and Co. Ltd., 1963, p. 190.

[105] One agency stated that it sometimes insured against the erosion of its loan through local currency inflation by requiring that repayments be made in dollars.

[106] The critical path method (CPM) was devised by the Central Electricity Generating Board research section in 1957. In 1958 a similar system was adopted in the United States, where it has been notably successful in planning the design and manufacture of Polaris missiles. The use of these techniques is said to have shortened the Polaris project by more than two years. Variants of CPM such as programme and evaluation review technique (PERT) and resource allocation and multi-product scheduling (RAMPS) have been developed and in its various forms it is used by a number of companies in the United Kingdom, the United States and France. (For examples of application in Britain, see *Critical path [illegible] eighteen [illegible]*, British Productivity Council, [illegible].)

possible to arrange such contracts, companies emphasized that strict control was essential, with proper use being made of material requisitions, works orders and other control procedures.

2. *Management*

"The commonest type of capital budgeting organization", say Merrett and Sykes, "is that where the capital budgeting decision is largely taken or at least almost all the investigation and analysis is performed by that department primarily interested in the project".[107] This would seem to be confirmed by the Smith and Remmers' study and it is almost certainly true of the small and medium-sized companies. Large projects (those above £100,000) in the larger companies (those with net assets above £50 million) are usually appraised by specialist committees or departments.

If the appraisal and presentation of a project proposal is assigned to the originating department, the job of project evaluation is almost certain to be made more difficult, especially if there is no standard form of presentation and analysis. It is probably because so few firms have formalized capital budgeting procedures that there are few in which the analysis and evaluation of projects is a special management function. Those companies which had assigned the comparison, analysis and evaluation of projects to one person or department thought that this meant that a more objective analysis of the project would be made than if the job were assigned to a person or department with other responsibilities.

Most of the large organizations in the United Kingdom and France, that is, the nationalized industries and the ten or so largest companies, have departments whose sole responsibility is to plan, analyse and recommend control procedures for capital expenditure. The three American companies have similar departments, known as planning departments.

The international agencies and the English and French development banks generally differentiate between the management required for a feasibility study and for the supervision of a project.

The agencies found it difficult to generalize on the ideal team for a feasibility study but thought that the minimum team should consist of an accountant, an economist and an engineer. IBRD and AID stated that it was difficult to eliminate bias from reports and studies, but it was thought that, with the use of check lists and pre-investment studies, the risk of bias on the part of the feasibility team or member of the team could be reduced.

IBRD stated that the number and quality of applications would be improved if there were some standardization of arrangements for financial and technical assistance.

As far as the supervision of projects is concerned, IBRD states in its booklet *Some Techniques of Development Lending*: "Experience shows that at least for a lender, there are strong arguments against the method, at first sight attractive, of supervising a project by means of a resident representative. The main disadvantage of this type of supervision is the risk that the leader will unintentionally but inevitably become involved in management decisions which should be the responsibility of those running the project. On the other hand, there are risks involved in depending exclusively on written reports submitted by the borrower. Such written reports are certainly necessary for the efficient management of the project, and should therefore be readily available without the need for special procedures".[108]

The agencies were generally against their own staff supervising the project or interfering with the project in any way; and this emphasized the importance of the project appraisal. There were usually objections by developing countries to the employment of foreigners in positions of management responsibility. Industrial development banks were therefore often used by agencies to provide services that would otherwise have been provided by expatriates.

3. *Post-mortems*

The answers to question 8 in the questionnaire were analysed as follows:

	Number of companies	
	United Kingdom	*France*
No post-mortems on individual projects	14	4
Post-mortems on "most large projects"	10	4
Other answers: "post-mortems in the early days of production"; "on samples of projects"; on "very large projects", etc.	8	2
Non-classifiable	5	1
	37	11

The classification of answers was, to a large extent, arbitrary.

Most companies seem to have a follow-up procedure on expenditure, but it is not clear how thorough are the investigations of differences between the actual and estimated expenditures. It is likely that few companies check the actual date of expenditure with the scheduled date. This would seem to be true of American as well as of British and French companies, for, of the forty-eight firms studied by Istvan, only twenty-one included an audit of the time dimension in their capital expenditure programmes.[109] Since capital will generally be committed to a project from the time of the decision to go ahead with that project, any delay in the construction will cost the firm money. For example, if \$500,000 is "tied up" for only six months by a company with an opportunity cost of capital of 10 per cent, the cost to the company in terms of the alternative foregone will be \$25,000.

In the Smith and Remmers' study of French companies it is stated that "most firms did not attempt any subsequent review of capital expenditures once they had been made . . . The largest firm in our sample had a department whose main function was to calculate *a posteriori* the profitability of the most important projects, and find out the reasons for any

[107] Op. cit. (see footnote 37 above).

[108] IBRD, Washington, D.C., September 1960.

[109] Op. cit. (see footnote 20 above).

deviations from the original estimates. In a few other cases, certain investments selected at random were followed up. But in all the instances in which some kind of review was being carried out, considerable leeway was allowed before any explanation was demanded from those responsible."[110]

It seems from the postal survey and interviews[111] that few companies or nationalized industries in France or the United Kingdom have any systematic procedure for examining the results of individual projects. A variety of reasons were given for not examining projects individually. The main reason given was "it is often impossible to isolate the results of individual projects due to their interdependence with other activities". In this respect one reply from a British fertilizer manufacturer was fairly typical: "once a new process has become embedded within a works total, redistribution of overheads makes a strict comparison of profitability hardly worth-while. An over-all measure of profit before tax to assets at replacement value is preferred." Most companies seemed to review and "control" the profitability of projects by building the project estimates into the total budget and, in the words of a British confectionery manufacturer, "thus a cycle of plan, budget, achievement, plan is maintained".

Other reasons given for not following up projects individually were: changing circumstances; cost inaccuracies; conflict of personalities; lack of managerial time. Indeed, the post-mortem of individual projects is rarely a specific responsibility, and the task is usually carried out when management has some spare time.

Some companies, however, notably two American companies, had made the post-mortems of projects a specific responsibility. Post-mortems in these companies seemed to be detailed but limited to a sample of projects or those above a certain value. Even in those companies, however, comparisons in terms of profitability were rare, and were usually made by looking at certain "critical" variables. Post-mortems were stated to be useful by a few companies. One French producer of natural gas observed that useful lessons could be drawn from them in regard to new projects.

Generally, however, little importance was attached to the post-mortems of individual projects, although the majority of organizations emphasized the importance of budgetary control and "management by exceptions", that is, the method of control whereby the management of an organization directs its attention to deviations from pre-determined targets.

An executive in AID stated that "rarely are detailed post-audits carried out" in the territories for which he was responsible. IBRD, the Export-Import Bank and IDB stated that detailed post-mortems were carried out where projects had failed, but not as a matter of course. The general absence of, and difficulty of carrying out, post-mortems on individual projects emphasized the importance of the close control of the assets of the organization as a whole and the careful appraisal and planning of projects before any capital is committed.

[110] See footnote 15 above.

[111] Tibor Barna found in his survey (see footnote 13 above) that "one firm in four in the sample conducted occasional inquests into the success of projects" and that "regular scrutinies of the results of investments are few and cursory".

APPENDIX 1

Present value of £1

Year	*Percentage* 4	6	8	10	12	14	16	18
1	.96	.94	.93	.91	.89	.88	.86	.85
2	.92	.89	.86	.83	.80	.77	.74	.72
3	.89	.84	.79	.75	.71	.67	64	61
4	.85	.79	.74	.68	64	.59	55	52
5	.82	.75	.68	.62	.57	52	48	44
6	.79	.70	.63	.56	51	46	41	37
7	.76	.67	.58	.51	.45	40	35	31
8	.73	.63	.54	.47	40	.35	31	27
9	.70	.59	.50	.42	.36	31	.26	23
10	.68	.56	.46	39	.32	.27	23	19

$Vn/r = (1 + r)^{-n}$ —to determine the present value of future cash flows

APPENDIX 2

Project appraisal: a suggested check-list

It is clearly impossible for any list such as this to be exhaustive, since the possible variety of candidates for appraisal is infinite, and the key to a project's viability may be a factor not here mentioned. Similarly, the emphasis to be placed on the various factors will vary from project to project and the presence of one or more undesirable but inevitable features does not necessarily preclude a project's viability.

Check list

I *Sponsors*

A *Status*

1 General business standing bankers' references, Dun & Broadstreet report, local trade opinions, etc

2 Are any political objections to the sponsors likely (from government, governing party, trade union, devco investors)?

3 If sponsors are a company or partnership

a) What is paid up capital?

(*b*) Do memorandum and articles contain any undesirable features?

(*c*) Have legal requirements been complied with as regards registration, returns etc.?

(*d*) Who are the directors, auditors, bankers?

(*e*) Is an audited balance sheet available?

B. *Suitability*

1. Past or present experience with the type of project proposed. Other experience.

2. General business ability.

3. Enthusiasm and drive.

C. *Stake in the project*

1. How much will the sponsors have at stake?

2. Are the sponsors involved in the management of the project?

3. Could the sponsors have an ulterior motive in promoting the project? What are their other business interests?

II. *Project*

A. *General*

1. Would investment in the project conflict with the stated policy of the devco? (Other policy objections if any, will come to light through the clearance in principle procedure.)

2. Does the project show promise of aiding the economic development of the country?

3. Does the project conflict with government policy as stated so far? Are there any indications that government policy might change in this respect?

4. Does the project provide for the comprehensive training of local citizens to all levels?

B. *Process*

1. Are there any legal restrictions on the proposed manufacture/construction/cultivation?

2. Are the topographical/ecological/climatic conditions of the site suitable?

3. Has appropriate land tenure been secured?

4. Has the necessary infrastructure been established? Communications, power, water supply, etc.?

5. Is adequate labour available? Are proposed conditions of work in accordance with employment regulations?

6. Is the supply of raw material assured? Are supply arrangements subject to import controls or duty? Are they 'at arm's length'?

7. Is an outside technical appraisal necessary?

8. Is a pilot scheme desirable?

C. *Management*

1. Is there proof of the ability of the proposed management?

2. Is there adequate provision for the supervision of technical aspects at all levels?

3. Is accounting staff adequate?

4. Is management's remuneration appropriate?

D. *Marketing*

1. What statistics are available for local and overseas products? Are any local or world trends observable? Is an outside analysis desirable?

2. What competition can be expected?

3. What is the extent of management's knowledge of proposed markets?

4. What are details of selling arrangements?

5. Have any significant contracts already been secured? Can any government business be expected?

6. Can any tariff protection be obtained in the local market?

E. *Finance*

1. Is capital gearing suited to the project?

2. Are estimates of development and running costs reasonable? Could devco investment be serviced?

3. What contingency provisions have been made?

4. Is adequate working capital provided?

5. Is devco asked to provide a disproportionate amount of the total financial requirement?

6. Have any other development institutions been approached? What were their reactions?

7. Has short-term bank finance been considered?

F. *Terms of agreement*

1. Finance to be provided by sponsors.
2. Finance to be provided by devco; rate, repayment, security, limitation of right to create other charges.
3. Drawings; against schedule or certificates of work done.
4. Investigation/negotiation/commitment fees.
5. Provision of end finance.
6. Early repayment.
7. Pre-emption rights.
8. Insurance.
9. Appointment of auditors.
10. Inspection of books.
11. Right to receive accounts, progress reports.
12. Board representation.
13. Legal fees.

APPENDIX 3

CHECK-LIST TO BE COMPLETED BY PRIVATE UNDERTAKINGS REQUESTING DIRECT LOANS*

A. *Economic position*

1. Company's background.
2. Sites of production centres and description of means of production (equipment and existing plant), with information concerning their production capacity, condition and age.
3. Staff employed (number and breakdown).
4. Business development in the course of the last few years: volume of production or of jobs completed and turnover for the past five financial years. Markets and marketing arrangements.
5. Details concerning branches or firms belonging to the same group.

B. *Financial position*

1. Growth of capital.
   Modes of latest capital acquisition.
   List of principal stockholders, with information concerning their share in the company's capital.
2. Audited balance sheets, operational accounts, profit-and-loss acounts, statements of distribution of profits (for past five financial years).
3. Current financial situation and estimated earnings for current financial year.
4. Detailed analysis of last certified balance sheet and financial statement.
   Description and breakdown of principal posts;
   Explanation of changes in those posts;
   Short-, medium- and long-term credits already obtained by the company and terms (rates, repayment modalities, security offered).

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*Submitted in French.

5. Details of market value of fixed assets, plant and stock.
6. Preferred claims on the company and commitments undertaken by it, particularly in the form of performance bonds.
7. Matters in dispute: suits in progress for or against the company (subject and magnitude).

C. *Note pertaining to the request for credit*

1. Programme currently envisaged (production goals and future prospects as regards supplies and markets.
2. Detailed account of projected equipment programme. Breakdown and cost of investments required.
3. Means of financing envisaged for the part of the investment programme for which the company retains responsibility.
4. Repayment plan.
5. Projected means of amortization:
   While the investment programme is in progress.
   After completion of the programme.
6. Surety offered: mortgages, securities . . .

D. *Annexed documents and information*

1. Certified up-to-date statutes.
2. Composition of board of directors.
3. References concerning sponsors and management.
4. Extract from minutes of board meeting at which it was decided to request credit and accord the necessary powers to the designated agents.

APPENDIX 4

A. Check-list for project investments

1. *Company to be financed*

(*a*) Describe the (proposed) company, its capital structure, location and nature of major activities. Give biographical notes of promoters, principal stockholders, directors, management and bank references. If going concern, submit current balance sheets, earnings statements, financial history.

2. *Project to be financed*

(*a*) Describe the project: is it an expansion, modernization or a new undertaking? State and describe costs of plant and equipment. Describe products, their economic justification and contributions to the host county, i.e., what will make it welcome in the host country? (Will it generate dollar income, save foreign exchange, utilize local raw materials or local labour?)

3. *Management*

(*a*) State what experienced corporate entity will construct and operate the plant, its competence and foreign experience.

(*b*) What local independent professional services will be used (lawyers, accountants, engineers, marketing experts, etc.)?

4. *Raw materials and labour*

(*a*) List raw materials, source and cost. May they be freely imported?

(*b*) What are labour requirements: local and expatriate, skilled and unskilled? What provision is there for training and advancing local labour?

5. *Markets*

(*a*) State projected demand and sales for next five years. What is the statistical basis of the projections? Where imports or exports are part of the market, show quantities and value by country.

(*b*) What is the competition, domestic and foreign?

(*c*) Are there import restrictions, duties, or other government regulations which may affect sales either in the host country or in export markets? Does the company have long-term sales contracts?

6. *Operations and financial results*

(*a*) Submit:

(i) Projections of output, cost, revenues, taxes and profits for at least the first three years of operations or for the period foreign debt will be outstanding. State construction and start-up time. (Cost items should include raw materials, labour, power, administrative expense, sales expense, depreciation and taxes.)

(ii) Cash flow statement, showing source and disposition of funds during construction and for period corresponding to (i) above.

(*b*) What provision is made for overruns in construction and start-up costs?

7. *Government environment*

(*a*) What role will government have in the project?

(*b*) What incentives will it offer? What is government policy regarding repatriation of profits, dividends, interest and capital, entrance and residence of foreign technicians and other factors which may affect the project?

8. *Taxation*

State the effective rate of taxation, giving details of each tax, its rate and any tax preferences.

9. *Capital requirements and financial plan*

Show in detail by source and currency how minimum capital needs will be met; include working capital and interest during construction. State efforts, if any, made to raise the required capital and approaches made to potential lenders or investors.

10. *Independent studies*

If independent technical, cost, market or other studies have been made, submit these; if none made, state what such arrangements will be made.

B. Projected cash flow

	Construction and start-up period 1 X months	*First year operations*	*Second year operations*
Cash receipts			
Paid in equity . .			
Suppliers' credits			
Long-term debt . .			
Short-term loans . .			
Increase in accounts payable			

B. PROJECTED CASH FLOW (*continued*)

	Construction and start-up period 1 - X months	*First year operations*	*Second year operations*
Increase in sundry current liabilities			
Net profit after taxes			
Add back:			
Non-cash charges occurring before			
Net profit after taxes			
Depreciation			
Reserve for bad debts			
TOTAL CASH RECEIPTS			
Cash disbursements			
Capital expenditures			
Replacements			
Debt repayment			
Short-term loans			
Long-term debt			
Suppliers' credits			
Inventory increases			
Increase in accounts receivable			
Increase in sundry current assets			
Dividends			
TOTAL CASH DISBURSEMENTS			
Net cash generated during period			
Accumulated cash position			

C. PROFIT AND LOSS PROJECTION

	Construction and start-up period 1 - X months	*First year operations*	*Second year operations*
Net sales			
Less: Cost of goods sold			
Depreciation of plant and equipment			
GROSS PROFIT			
Less: Selling, general and administrative expenses			
NET OPERATING PROFIT			
Less: Interest			
Miscellaneous charges			
Royalties			
Management fees			
Sundry taxes			
Reserve for bad debts			
NET PROFIT BEFORE TAXES			
Less: Income taxes			
NET PROFIT AFTER TAXES			
Legal and other reserves			
Net available to stockholders .			
Dividends			
TO EARNED SURPLUS			

APPENDIX 5

ECONOMIC AND TECHNICAL SOUNDNESS ANALYSIS IN INDUSTRIAL PROJECTS

(Plants for production or processing of commodities or manufacture of products such as cement, steel, fertilizer, food, textiles, wearing apparel, chemicals etc., including expansion of existing plants.)

(All topics in this outline should be considered in the analysis, in so far as they are applicable to the project. Others should be included as necessary to complete the demonstration of the economic and technical soundness of the particular undertaking.)

(For a detailed discussion of a step-by-step procedure for developing an industrial-type project, analysing its technical and economic feasibility and estimating both its commercial and national economic profitability, the reader is referred to *Industrial Development — A Guide for Accelerating Economic Growth*, by Murray D. Bryce, New York, McGraw-Hill, 1960. Copies of this book will be available to all United States AID missions, for the use of applicants for AID financing.)

1. *Summary*

Type of plant and kind and quantities of commodities to be produced.

Location, illustrated by map showing surroundings and tie-in with transportation facilities and existing utilities.

Distances to sources of supplies and raw materials and to markets.

Relation of project to applicant's present operations, if any. Benefits, cost and profitability.

Reference to any applicable reports (attached or readily available elsewhere).

2. *Commercial economic aspects*

(a) *Markets*

Local or regional market trends during past five years for each major product and any closely related products, tabulated to show:

Domestic production; imports and exports; net local consumption, and anticipated development of the local market.

Present *per capita* consumption in country, and comparison with other countries.

Local laws, regulations or customs affecting marketing of proposed products, including import and export duties, tariffs, quotas, restrictions and subsidies.

If part of proposed production is intended for export, show for each major product:

Number of units expected to be exported; proposed markets and costs of transport and import duties.

(b) *Applicant's present operations, if any*

Description of present operations, including those of subsidiaries or parent companies.

Complete financial statements, including balance sheets, profit and loss statements and dividends paid for past five years (see annexes C, D, and E; annual reports are usually acceptable in place of annex C if reasonably equivalent information is given).

Present production capacity for each product.

Sales volume and value of each product for past five years, showing separate figures for domestic and export sales.

Domestic and export prices, fob plant for past five years.

Estimated production of each major product in present plant for next five years.

Estimated additional production required to meet over-all demand for next five years including intended exports.

(c) *Competitors*

Names, location, present and future output, production costs and selling prices of present local competitors in the same field of production.

Information as to any anticipated changes in competition, such as expansion, modernization, new plants, new competing products, etc.

Information as to foreign competition and any anticipated changes in laws or regulations which might affect volume of imports.

(d) *Competitive position*

Selling prices to be met in domestic and export markets.

Estimated transportation costs and export expenses.

Maximum competitive selling prices fob plant.

Competitive advantages of proposed project:

Relative availability and cost of labour; availability and quality of raw materials; efficiency of modern production equipment and processes; quality of products; dependability of supply to consumers.

(e) *Summary of commercial prospects*

Schedule showing forecast of sales volume for the domestic market and each export market, and percentage of total market claimed in each case, with full explanation and justification.

Justification of proposed capacity of plant to be constructed.

3. *Engineering aspects and technical soundness*

(a) *Design*

Plant lay-out, including storage for raw materials and finished products and provision for possible expansion.

Tie-in with transportation systems.

Type and size of major installed equipment items and structures, and justification of the selection of units and processes. (Avoid both obsolescent and experimental technology.)

Function performed by each major unit.

Process flow sheet.

Auxiliary capital equipment (standby, spare parts, transport, materials handling, etc.).

Patents and licences involved.

Planned capacity and build-up of output after start-up.

Estimated output as percentage of plant capacity for each of first five years of operation.

Anticipated use of consultants on special phases of final project design.

(b) *Utilities available or to be provided*

Requirements, source, availability, cost and reliability of all utilities. Pertinent data on each system, and reason for selection of source in each case including comparison of advantage of purchasing against in-plant production.

Power requirement in peak kW demand and annual kWh consumption, initial and future.

Electrical system shown by single line diagram covering major power uses.

Fuel for heat, steam and plant processes.

Water balance of plant where applicable. Problems relative to water treatment, disposal of effluents (liquid and gaseous), including any which may be noxious or dangerous.

Transportation facilities for raw materials and finished products.

(c) *Materials for use in manufacturing process*

Quantity, specifications, source and availability of raw and semi-finished materials.

Proved reserves in case of minerals.

If semi-processed materials are to be obtained from another plant, evaluate the technical and economic soundness of such plant.

Estimated costs, possible cost variations, custom duties, any preliminary agreements on price and delivery and details of any contracts entered into for supplies and major raw materials.

Available facilities for handling and storing.

(d) *Plans and specifications*

Preliminary plans for all construction work in sufficient detail to permit calculation of work quantities.

Outline specifications for equipment and construction, defining particularly those standards of quality which will have a significant effect on the cost of construction, with specific justification for any unusual standards adopted to conform with local conditions.

(e) *Construction labour, materials and equipment*

Manpower requirements and availability, including skilled and unskilled labour, and technical and supervisory personnel.

Local availability of cement, steel, aggregates, water for concrete, building stone, lumber and other construction materials.

Types of construction equipment required for the work, indicating what is available locally and what must be imported.

(f) *Special construction problems foreseen*

Climatic conditions, especially time and length of wet and dry seasons as they affect construction schedule and equipment use.

Necessity of keeping an existing plant in service.

Time required to obtain delivery of imported materials and equipment.

(g) *Plan for execution of project*

General construction plan.

Proposed methods of contracting for engineering, construction, and construction supervision.

Tests to be performed on completed plant.

Equipment guarantee to be required.

Engineering and construction schedules.

(h) *Operating organization and quality of management*

Description of organization which will manage the business and supervise its operation, accompanied by organization chart, present and projected.

Required number and qualifications of management and technical employees.

Experience records of available key management and technical personnel.

Number, qualifications and availability of required operating employees.

Plans for recruiting and training.

Provisions for competent management and maintenance throughout the life of the proposed loan.

(i) *Over-all technical soundness*

Justification of selection of location for project.

Proved reliability of plant processes and equipment.

Superiority of adopted processes.

Analysis of any adverse factors and measures to overcome them.

Assurance that plant described will produce the quantity and quality of products specified, on a continuing and dependable basis.

4. *Financial aspects*

(a) *Estimated capital cost*

Estimates of cost of land, engineering and construction.

Total estimated capital cost in US dollars and local currency.

To be financed by applicant;

To be financed by loan grant.

(b) *Working capital requirements*

Amount required at start-up of plant and at the end of the first, second and third years of operation, to cover raw materials, spare parts, auxiliary materials, goods in process, finished goods, accounts receivable and cash on hand.

Sources and availability of local and foreign currency funds required.

Anticipated occurrence of seasonal peaks in working capital requirements and method contemplated to meet such peak financial requirements.

(c) *Production cost* (broken down to local currency and dollar costs)

An estimate of the direct cost of producing each of the major products and any intermediate products, supported by detailed calculations (see annex F for suggested form).

Adopted wage rates and production factors used in production cost analysis, taking into account legal wage and salary scales, including all fringe benefits such as social security, vacation pay, medical allowances, displacement allowances and travel pay, etc.

Provisions included for personnel facilities such as transportation, housing, subsistence, recreation, medical care, etc.

Number of shifts and days of operation per year used in calculations, and basis for determination.

Government preferences or allowances taken into account such as: exemption from or deferment of any general or specific taxes on products; exemption from or deferment of corporate or local taxation; any special depreciation allowances for tax purposes.

Estimated effect of possible wide fluctuation of any cost factors entering into computations.

Where applicant is producing the same or equivalent products in an existing plant, show present production cost in same general form.

Availability of foreign exchange to permit necessary imports of materials and supplies.

(d) *Costs of distributing and selling*

Description of methods of distributing and selling products and estimate of costs thereof.

Cost of advertising.

Administrative expense.

(e) *Selling prices*

Proposed selling prices in domestic and export markets.

Deduction for cost of selling, distributing and transportation.

Net selling prices at the plant and adjustments that might be made in case of wide fluctuation of any of the cost factors.

(f) *Profitability*

Analysis of predicted profit and loss and forecast of earnings, receipts and expenditures, prepared as per annex E.

Estimated level of production and sales at break-even point.

Estimate of net annual foreign exchange earnings from exports, if any.

General conclusions as to commercial profitability of the enterprise, including percentage of returns on total investment and on owner's equity.

5. *National economic benefits*

List of benefits which will accrue to the economy, in addition to the profits earned by the project owners, such as: taxes paid to the Government by the industry and import tariffs included in proposed sale prices of products.

More effective utilization of labour as compared with other available occupations.

Provision of a market for local raw materials.

Foreign exchange gain if products are exported, after taking into account any foreign exchange costs in project operation.

Benefits to consumers on account of lower prices or more dependable supply of goods.

Stimulation of other industrial efforts.

Training of people in factory operation and management.

Evaluation of above and other possible benefits in monetary terms where feasible.

ANNEX C*

Industrial or commercial project

Balance sheet

Attach comparative balance sheets for the past five years, according to the following breakdown.

Assets

1. Current assets:
   - (*a*) Cash.
   - (*b*) Marketable securities.
   - (*c*) Notes receivable (show separately amounts owed by subsidiaries; directors, shareholders, their families and agents; all amounts other than normal commercial debts).
   - (*d*) Accounts receivable from customers.
   - (*e*) Inventories.
   - (*f*) Other assets (describe).
2. Investments:
   - (*a*) In subsidiaries.
   - (*b*) Others (describe).
3. Capital assets:
   - (*a*) Land.
   - (*b*) Building and site facilities.
   - (*c*) Machinery and equipment.
   - (*d*) Construction in progress.
   - (*e*) Others (describe).
4. Gross assets (1 to 3 inclusive).
5. Depreciation reserves (state method of amortization).
6. Net capital assets (3 to 5 inclusive).
7. Intangibles (patents, licences, good will, trademarks, formulas, franchises, etc.).
8. Other assets (specify).
9. Total assets (6 to 8 inclusive).

Liabilities

10. Current liabilities (due within one year).
    - (*a*) Notes payable:
      - to banks or other short-term lending agencies
      - to holders of long-term debt maturing within one year
      - to directors, shareholders, their families and agents.
    - (*b*) Accounts payable to commercial creditors.
    - (*c*) Contractors' bid and performance bonds.
    - (*d*) Royalties.
    - (*e*) Other current liabilities (describe).
11. Long-term debt (over one year) (indicate terms).
12. Construction costs payable.

Capital and surplus

13. Capital (authorized, issued and paid-in).
14. Reserves (describe).
15. Surplus:
    - (*a*) Revaluation surplus,
    - (*b*) Earned surplus (or deficit),
    - (*c*) Net surplus (or deficit).
16. Total liabilities and capital.
    (10 to 14 inclusive, minus or plus 15).

* Annexes A and B are omitted.

ANNEX D

Industrial or commercial project

Financial information

1. Capital structure (present and planned)
   - Authorized capital.
   - Issued capital.
   - Subscribed capital.
   - Paid-up capital.
   - Capital surplus (if any) arising from assets revaluation.
2. Distribution of shares.

	No. issued	*Total nominal amount*	*Total paid-up amount*	*No. of votes per share*
Ordinary				
Preference				
Deferred				

3. Indicate number and type of shares held by any individuals and/or group controlling more than one fifth of the votes. Indicate relationship of such individuals and/or group to the company. If held by a holding company or other industrial enterprise, provide balance sheets, profit-and-loss statements and capital structure information on such enterprises. If held by individuals, provide general and financial information on such individuals.
4. Outstanding debentures (term of issue and redemption, interest rate, etc.).
5. Outstanding mortgages and other long term debt (terms of issue and repayment, interest rate, etc.)
6. Bank borrowings. Give details of amounts owed, interest rates, terms, renewal arrangements and unused credit limits.
7. Pending litigation either by or against the company.
8. Contingent liabilities, guarantees or endorsements.
9. Method of valuation of inventories. Note any departure from stated procedure affecting past profits as shown in attached statements.
10. Book value and estimated current market value of inventories for the past four years, adjusted to a comparable basis.
11. Give the book value of fixed assets for the past four years according to the following breakdown:
    - Book value of fixed assets at beginning of year (describe basis of valuation)
    - *Plus* acquisitions during the year, at cost
    - *minus* retirements during the year, at book value
    - *minus* normal depreciation (state normal depreciation method and rates used by major categories of assets)
    - *minus* extraordinary depreciation or write-offs (or *plus* any shortfall below normal depreciation)
    - *plus* revaluation of fixed assets
    - Book value of fixed assets at end of year
12. (*a*) Give the average annual amount written off on bad debts during the past four years.
    (*b*) Give the total amount of claims overdue as of the date of the latest balance sheet and percentage of nominal value at which claims are recorded in the balance sheet.

ANNEX B

Industrial or commercial project

Forecast of earnings, receipts and expenditures

	Present operation			*Construction years*			*Operating years*					
	1959	*1960*	*Etc.*	*1962*	*1963*	*Etc.*	*1964*	*1965*	*1966*	*1967*	*1968*	*Etc.*
A. *Earnings from operations*												
Revenue (separately for each major product or category of sales)												
1. Annual sales (units per year)												
2. Unit sales price												
3. Gross revenue from sales (1 × 2)												
4. Other income (describe)												
5. Total income (3 + 4)												
Cost of operations, net income and profit												
6. Operating expenses:												
(*a*) Manufacturing												
(*b*) Maintenance												
(*c*) General administration												
(*d*) Distribution and marketing												
(*e*) Short-term interest												
7. Depreciation allowances (show basis)												
8. Taxes (describe)												
9. Total cost of operation before interest on long-term debt (6 to 8 inclusive)												
10. Net income before interest on long-term debt (5-9)												
11. Interest on long-term debt												
12. Net profit (or loss) (10-11)												
B. *Sources of funds*												
13. Net income before interest (item 10)												
14. Depreciation allowance (item 7)												
15. Increase in paid-in share capital												
16. Borrowings:												
(*a*) Existing DLF or AID loans												
(*b*) AID loan proposed herein												
(*c*) Other long-term borrowings (each loan separately)	(show terms)											
(*d*) Anticipated short-term loans												
17. Other receipts (describe)												
18. Total receipts (13 to 17 inclusive)												
C. *Use of funds*												
19. Construction expenditures:												
(*a*) This AID project												
Foreign currency												
Local currency												
Total AID project												
(*b*) Other construction												
(*c*) Total construction expenditure												
20. Current assets (minimum expected) (see annex C)												
21. Fixed, intangible and other assets (see annex C)												
22. Debt service:												
(*a*) Amortization of principal												
1. Existing DLF or AID loans												
2. AID loan proposed herein												
3. Other borrowings												
(*b*) Interest												
1. Existing DLF or AID loans												
2. AID loan proposed herein												
3. Other borrowings												
23. Other expenditures (describe)												

ANNEX E (*continued*)

	Present operation			Construction years			Operative years					
	1959	1960	Etc.	1962	1963	Etc.	1964	1965	1966	1967	1968	Etc.
D. *Cash flow*												
25. Annual cash surplus (or deficit) (item 12)												
26. Cash to reserves												
27. Cash to dividends												
28. Cash balance, end of period (25-26 and 27)												
E. *Balance sheet, end of period*												
Assets												
29. Current assets (see annex C)												
30. Investments												
31. Capital assets (see annex C)												
32. Gross assets (29 to 31 inclusive)												
33. Accumulated depreciation												
34. Net fixed assets (32 to 33)												
35. Intangible assets (see annex C)												
36. Total assets, end of period (34 + 35)												
Liabilities												
37. Current liabilities (due within 1 year)												
38. Share capital (authorised, issued, paid-in)												
39. Reserves (describe)												
40. Surplus:												
(*a*) Re-evaluation surplus												
(*b*) Earned surplus or deficit												
41. Total liabilities (37 to 39 inclusive + or — 40)												

ANNEX F

Industrial project

Production cost

Cost per unit of output (pound, ton, thousand, etc. based on ——— units per day or ——— units per year)

Item	*Quantity required per unit*	*Price*	*Cost per unit of product*
Labour (classes and rates)			
Raw materials (list)			
Power			
Fuel			
Utilities			
Supplies			
Supervisory and technical salaries (classes and rates)			
Other direct costs			
Total direct plant cost			

APPENDIX 6

OUTLINE OF INFORMATION REQUIRED BY IBRD ON LIGHT INDUSTRIAL PROJECTS

The following questions should be answered when they are pertinent:

1. Borrower:

(*a*) Name and address.

(*b*) Nature and location of enterprise.

(*c*) Corporate organization—whether privately or publicly owned, by whom shares held, brief details of affiliation to any other company or group.

(*d*) Quality of management, business and technical experience, knowledge of this industry.

(*e*) Plant description, production capacity, condition of facilities, etc.

(*f*) Operational and financial history:

(i) Record of production and sales for past four years;

(ii) Financial statements balance sheets and profit and loss statements and distribution of earnings records for past four years.

(*g*) Financial position—analysis of most recent balance sheet, including comments on capital structure, nature of reserves, valuation of inventories and fixed assets, etc.

2. Project:

(*a*) Description of entire project, including that part, if any, financed from other than IBRD funds, indicating expected results, increase in production capacity, increase in efficiency, reduction in production costs, etc.

(*b*) Are qualified personnel available for the engineering and installation, maintenance and operation of the equipment? Will technical services be required?

(*c*) Total cost of the project, showing cost of fixed assets (in suitable breakdown) separately from working capital requirements. Indicate foreign exchange requirements included in total cost.

(*d*) List of goods to be acquired. Will competitive bids be obtained for this equipment?

(e) Construction and installation schedule

(f) Proposed sources of raw materials, labour, power, water, transportation, etc.

(g) Present status of the project
   (i) Expenditures to date
   (ii) Equipment on order
   (iii) Problems, if any

(h) Market
   (i) Information on existing markets and plans for supplying and expanding them. Imports in past years.
   (ii) Estimated itemized production costs as compared with selling prices of competition, indicating customs duty for raw materials and finished goods, transportation costs, etc.
   (iii) Methods of marketing the product and adequacy of the present or planned distribution set-up. Export possibilities.
   (iv) Information available on existing or expected competing plants, such as their capacities and locations, sales territories, etc.

(i) Operating and financial projections (if applicable)
   (i) Estimated unit production for each of the first three years of operation
   (ii) Estimated sales revenues, costs and expenses (showing interest, depreciation and taxes separately) and net profits for each of the first three years of operation. Profits should be related to all financial charges, including probable dividend payments
   (iii) Cash flow estimate for each construction year through the first year of normal operation (see annex)
   (iv) *Pro forma* balance sheets as at the completion of the project and first year of normal operations

(j) General economic justification of the project (if applicable)
   (i) Over-all benefits to the country
   (ii) Utilization of unemployed natural resources
   (iii) Employment of labour
   (iv) Foreign exchange savings
   (v) Economic diversification
   (vi) Benefits to other industries

(k) Any other relevant information, e.g. on necessary government licences, consents, effect of tariffs, taxes, etc.

3. Proposed loan
   (a) Amount requested
   (b) Proposed term of loan. Repayment schedule, specifying proposed grace period
   (c) Security available for loan
   (d) Credit standing of proposed guarantors, if any
   (e) Any special legal, tax or corporate considerations

Information to be submitted with first (or only) application for withdrawal in respect of credits between $5,000 and $25,000

1. Name and address of borrower
2. Type of business
3. New project or expansion, etc. of existing project
4. Amount of credit
5. Terms of repayment, interest rate
6. Brief description of goods to be financed
7. Brief description of project
8. Name of commercial bank granting project
9. Reference number of credit
10. Has the borrower benefited by any previous credit under the capital goods import programme? If so, give amount and date
11. Amount of this withdrawal application

ANNEX

Cash flow

Sources of funds		
Net income before taxes and interest		xxx
Depreciation		xxx
Total cash generated from operations		xxx
Sale of capital stock		xxx
Increase in long-term debt		
IBRD	xxx	
Other	xxx	xxx
Increase in short-term debt		xxx
Increase in other current liabilities		xxx
Decrease in current assets (other than cash)		xxx
Other (itemize)		xxx
		xxx
Application of funds		
Investment in fixed assets:		
IBRD project	xxx	
Other construction	xxx	
Renewals and replacement	xxx	
Interest during construction, if capitalized	xxx	xxx
Interest		
Short-term debt	xxx	
IBRD } excluding that which	xxx	
Other long-term debt } is capitalized	xxx	xxx
Amortization		
IBRD	xxx	
Other long-term debt	xxx	xxx
Taxes		xxx
Dividends		xxx
Decrease in short-term debt		xxx
Decrease in other current liabilities		xxx
Increase in current assets (other than cash)		xxx
Other (itemize)		xxx
		xxx
Cash surplus or deficit for year		xxx
Cash balance at beginning of year		xxx
Cash balance at end of year		xxx

XVIII. SURVEY OF LITERATURE ON COST-BENEFIT ANALYSIS FOR INDUSTRIAL PROJECT EVALUATION

by A. C. Harberger*

Introduction

The field of industrial project evaluation is a relatively new branch of economic analysis, and as such is still in its formative stages. Numerous gaps still exist in the available literature, and in many cases alternative approaches to problems have been suggested which entail differences of concept that are as yet unresolved. These facts have determined the design of this survey. An attempt has been made here to take a constructive and forward-looking approach, focusing on gaps, weaknesses and unresolved issues in the field and attempting to contribute to an improvement of existing procedures wherever possible.

Because the great bulk of the literature available in the United States concerns project evaluation in predominantly private enterprise or mixed economies, the present study has been confined to such cases, making no attempt to consider the case of completely centrally planned economies. But it is recognized in what follows that social benefits and costs do not always coincide with private pecuniary benefits and costs. Indeed, it may be said that one of the principal concerns of cost benefit analysis is to appraise costs and benefits from a social point of view in cases where these diverge from the pecuniary costs and benefits perceived by the individuals in the market-place.

Section A focuses on the controversial problem of the relevant rate of discount for use in cost-benefit analysis. First the advantages and disadvantages of the internal rate of return are discussed and it is concluded that, though useful as a summary indicator of a project's profitability, the internal rate of return should not be used as the basic criterion for project evaluation. Then market rates of interest on bonds, the "social rate of time preference" and the marginal productivity of capital in the private sector are considered. It is concluded that the optimal rate for use in discounting costs and benefits, in a market economy, is the marginal productivity of capital in the private sector of the economy, defining this marginal productivity in such a way as to include all social benefits and costs in the calculations. Finally, the question of the variation of the discount rate through time is considered. It is concluded that the appropriate discounting of flows of benefits and costs should normally be done at rates which may vary from year to year, the principle being that flows occurring in year ten should be discounted back to year nine at the marginal productivity of capital expected to prevail in year nine, that these flows, in turn, should be discounted back to year eight at the marginal productivity of capital expected to prevail in that year, and so [illegible]

This principle of a variable discount [illegible] sary in order to reach proper decision [illegible] timing and scale, and is particularly [illegible] reaching valid decisions in years in which [illegible] funds are either particularly abundant or particularly scarce relative to existing investment opportunities.

Section B focuses on the measurement of [illegible] and costs and particularly on how [illegible] path of expected benefits and costs through [illegible] Initially, the basic principles underlying [illegible] projections are reviewed and subsequently [illegible] ciples underlying the projection of [illegible] wage and other costs are considered [illegible] of section B is that it is necessary to project [illegible] prospective costs and benefits of [illegible] year through the entire expected [illegible] incorporating expected changes in [illegible] directly into the analysis [illegible] evaluated and compared [illegible] of discounted benefits over [illegible] projected. Particular importance [illegible] fact that in a developing [illegible] expected to rise relative to product [illegible] eral, so that the excess of the price of [illegible] output (which is the [illegible] approximation measure of its benefits per unit of output [illegible] may frequently be expected to decline [illegible] wages rise through time. Attention is also paid to the problem of projecting the path through time of the exchange rate and of cost components other than wages. Finally, the problem of measuring the indirect [illegible] and benefits of a project is briefly surveyed.

Section IV discusses [illegible] in project evaluation. It finds that [illegible] between social costs and market prices can be [illegible] in many cases, and [illegible] the use of accounting prices. The [illegible] section is however to discuss the [illegible] of estimating accounting prices.

In the case of labour, the need for [illegible] tinct accounting prices for labour of different [illegible] and types and in different regions is emphasized. It is suggested that a minimum estimate of the accounting price for urban labour of a given type may often be obtained from the wage rate received by labour of that type employed within the urban complex in activities in which wages are not influenced either by minimum wage legislation or by union agreements. It is explicitly concluded that the marginal productivity of labour in agriculture is not a relevant measure of the accounting price of urban labour.

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The method of setting the accounting price of foreign exchange is then outlined, the principle involved being the estimation of the market value of the goods that would probably be imported as a consequence of the availability of additional foreign exchange. The possibility of using accounting prices for materials inputs is then examined, the conclusion here being that, although accounting prices may in some cases be justified for such inputs, equivalent results are achieved by generally valuing all materials inputs at their market prices, and considering separately, as indirect benefits of the project, any surplus of benefits over costs generated in the material-producing industry as a direct consequence of the project in question.

Finally, the question of accounting prices for the output of a project is considered, the focus being particularly on cases in which this output is subject to indirect taxation. The conclusion is reached that, except in unusual instances in which the indirect tax was itself placed on the product in order to counteract an existing external diseconomy associated with the product's production or consumption, the social benefit associated with the output of a project is to be measured by its price including tax.

A brief addendum to section C considers the possibility of obtaining appropriate accounting prices through the use of linear programming models for the entire economy. Here it is concluded that in order to make a linear programming model for the whole economy feasible, the characteristics of the economy must be so drastically oversimplified as to make the resulting accounting prices highly unreliable.

In section D, problems of timing are considered. First, the influence of high discount rates on projects of different productive lives and gestation periods is reviewed, then the question of when to construct a given project is considered, and finally the question of how to deal with risk is faced. The key conclusions are, first, that the timing of the construction of a project is a problem of considerable importance. Construction should not be undertaken at the moment when the present value of benefits exceeds the present value of costs, but should be delayed to the point where the excess of the present value of benefits over the present value of costs is a maximum. For a particular class of cases, it is shown that this rule entails the delay of a project until such time as the benefits of its first year of operation exceed the interest charge on the capital investment in the project. Secondly, if benefits and costs are appropriately projected, so as to take account of possible reductions in the value of benefits of a project stemming from future improvements in productive technique, there is no need to add a risk factor to the discount rate used in cost-benefit analysis.

In section E, interrelations among projects are considered. The importance of analysing separately the contribution of all separable components of a project is emphasized. Finally, the principles for deciding which of a set of interrelated projects should be undertaken are briefly set out.

A. Present value criteria versus the internal rate of return

1. *Advantages and defects of the internal rate of return*

The internal rate of return on a project (P) is obtained by the solution of the following quotation:

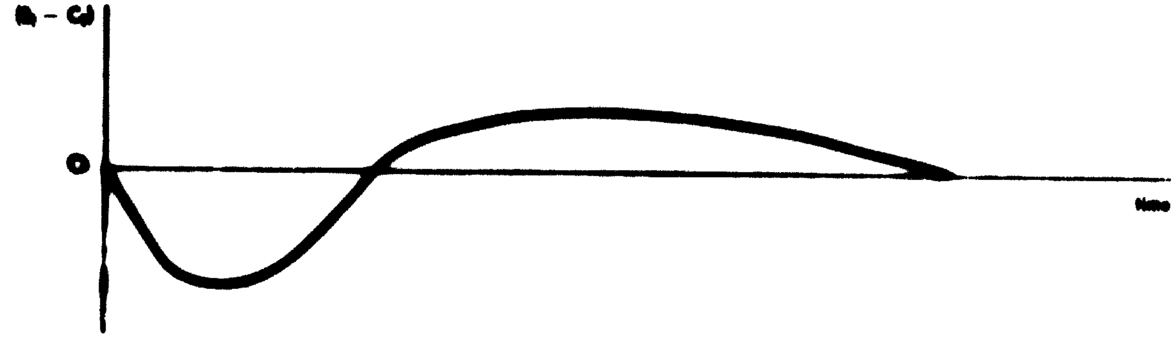
$$\sum_{t=0}^{N} \frac{B_t - C_t}{(1+\rho)^t} = 0,$$

where B_t represents the benefits anticipated to accrue in year t of a project's life and C_t represents the costs anticipated to be incurred in year t. N is the length of life of the project. Costs are defined to include capital outlays, labour, materials, energy and transport costs, and maintenance and repair expenditures. Costs do not include depreciation charges or actual or imputed interest charges, as the internal rate of return itself reflects the implicit "net interest yield" of the project, and in this sense allows for the depreciation of the project's cost. Thus, if a project has a capital cost of 100 in year 0, and yield a benefit of 120 in year 1, with an operating cost of 20, the net effect of the operation of the project would be -100 in year 0 and $+100$ in year 1. The capital invested would be just barely recovered one year later. Such a project would have an internal rate of return of zero, indicating that no more than capital recovery can be expected from it. On the other hand, if the project were to have a benefit of 130 in year 1, with an operating cost of 20 in that year, its internal rate of return would be 10 per cent, indicating that the capital invested in the project will produce a yield of 10 per cent after allowing for capital recovery. Finally, if the benefit in year 1 were merely 110, together with an operating cost of 20, the value of $B_1 - C_1$ would be 90, and the internal rate of return would be -10 per cent, indicating that the project is incapable of yielding sufficient benefits to cover the cost of the invested capital.

The great advantage of the internal rate of return lies in the fact that it can be calculated on the basis of project data alone. In particular, its calculation does not require data on the opportunity cost of capital which, as will be seen below, is critical to the present value technique and can often be exceedingly difficult to estimate. Thus, when a project evaluator has several different projects to be surveyed, he may independenly calculate the internal rate of return on each, and use the resulting figures as one basis of comparison among the projects.

The disadvantages of the internal rate of return are severe, however—so severe as to warrant the greatest caution in its use. In the first place, there are some projects for which it is not possible to determine the internal rate of return uniquely. Figure 1a shows the time-profile of net benefits ($B_t - C_t$) for a typical project. In it an initial period of investment, during which the value of $B_t - C_t$ is negative, is followed by a period in which the net benefit of the project is always positive. For all cases of this type there is a unique solution for the internal rate of return. However, if the time-profile of net benefits

Figure 1 a



crosses zero more than once, there will be multiple solutions for the internal rate of return. Examples of such projects are cases in which major items of equipment must be replaced relatively frequently, giving rise to negative net benefits, say, every five years when these replacements are accomplished (see figure 1 b); or cases in which the termination of a project entails substantial net costs (such as restoring rented facilities to their former state) (see figure 1 c).

Figure 1 b

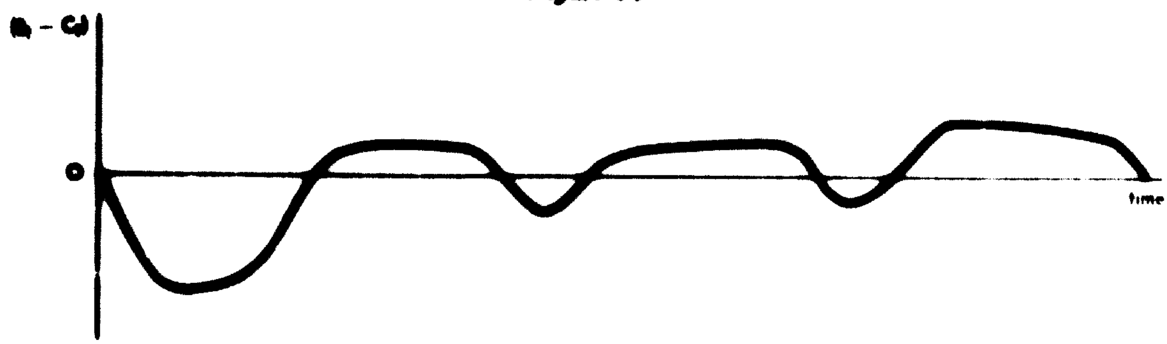
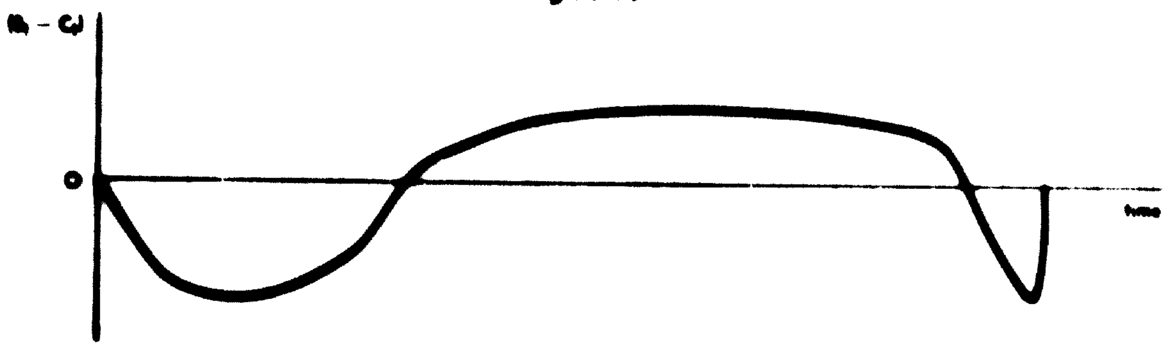


Figure 1 c



All cases of the types illustrated in figures 1 b and 1 c will yield multiple solutions for the internal rate of return; these multiple solutions are a mathematical necessity and present a problem of choice from which there is no escape. Consider the simple case of an investment of 900 in year 0, a net benefit of 1,900 in year 1, and a net cost of 1,000 in year 2. Obviously, one solution for the internal rate of return is zero, for at a zero discount rate the present value of benefits is just equal to the present value of costs. But another solution is a 11.11 per cent rate, for setting

$\left(\frac{1}{1+\rho}\right) = .9$, and $\left(\frac{1}{1+\rho}\right)^2 = .81$ we obtain

$$-900 + \frac{1900}{1+\rho} - \frac{1000}{(1+\rho)^2}$$
$$= -900 + 1710 - 810 = 0.$$

Even where the internal rate of return can be unambiguously calculated for each project under consideration, its use as an investment criterion encounters other difficulties when some of the projects in question are alternatives to each other. Consider first a case in which all projects are strictly independent. In such a case, the internal rate of return criterion will work well. By arranging the projects in descending order of internal rates of return, one can select first that project with the highest internal rate, then that with the next highest, etc., proceeding in this way until the available investable funds are exhausted. Suppose that the last project qualifying under this procedure has an internal rate of return of 8 per cent. Then 8 per cent will represent the opportunity cost of investable capital, and it becomes appropriate to evaluate the costs and benefits of all projects using this rate. Given that all the projects accepted under the internal rate of return criterion have internal rates higher than 8 per cent, and assuming these internal rates to be unique (i.e., assuming that the projects have net benefit profiles of the kind shown in figure 1 (a)), the present value of all accepted projects, evaluated at 8 per cent, will be positive, and the present value of all rejected projects, again evaluated at the 8 per cent rate, will be negative. In this case the internal rate of return criterion leads to no contradictions.

Now, however, consider a case in which two projects are alternatives. Let project A have an internal rate of return of 20 per cent and project B have one of 12 per cent. The internal rate of return criterion would lead one always to choose project A, yet it can be shown that B might very well be preferable. If the available investable funds are exhausted, as in the previous example, at an 8 per cent rate of return, we take 8 per cent to be the opportunity cost of investable capital, and calculate the net present values of all projects using this rate. It can very well occur that project B, in spite of its lower internal rate of return, has a higher present value than project A. For example, suppose that project B has a net benefit of \$240,000 per year in perpetuity on a capital investment of \$2 million, while project A has a net benefit of \$64,000 per year in perpetuity on a capital investment of \$320,000. The present value of project B's benefits, evaluated at 8 per cent, is \$3 million, while the project cost is \$2 million, yielding a net excess of benefits over costs of \$1 million. On the other hand, the present value of project A's benefits is \$800,000 from which, deducting the project cost of \$320,000 we obtain a net excess of benefits over costs of \$480,000. In spite of project A's higher ratio of benefits to costs, project B is preferable because if \$320,000 is invested in A rather than \$2 million in B, the best alternative use for the \$1,680,000 thus saved is a "marginal" investment with an internal rate of return of only 8 per cent, on which the excess of benefits over costs, evaluated at the opportunity cost rate of 8 per cent, would be nil.

Discussions of the internal rate of return as a criterion can be found in Friedrich and Vera Lutz, *The Theory of Investment of the Firm*[1] in Roland N. McKean, *Efficiency in Government through Systems Analysis*[2] and in J. Hirshleifer, "On the theory of optimal investment decision".[3] All these writers recognize the disadvantages indicated above.

2. *Choice of discount rates for use in connexion with a present value criterion*

(a) *The marginal productivity of capital in the private sector*

It was shown above that the use of capital in a given project was justified if the benefits of the project exceeded its costs, evaluated at a discount rate reflecting the opportunity cost of capital. One highly recommended measure of the opportunity cost of capital is the expected marginal productivity of typical capital investments in the private sector of the economy. If a public sector project is to be financed by borrowing from the private sector, it is to be presumed that the funds so mobilized could, in the absence of this project, have been used to finance private sector investments; hence in this case there is a direct sense in which private-sector investment can be considered as the relevant alternative to the project. When, on the other hand, the funds to be used are part of the savings of the public sector, the connexion between a public sector project and its private sector alternatives need not be so clear cut. If the funds available to the public sector investment authorities are sufficiently ample, it may work out that, in order to use all the available funds within a given set of projects being considered, the public sector authorities make investments having a yield of 5 per cent, even though capital in the private sector has an expected rate of marginal productivity equal to 10 per cent. Given that the yields in both cases are worked up on the basis of social benefits and social costs, the acceptance of public sector projects with rates of return lower than those to be anticipated from additional private sector investments must be considered uneconomic. It would be preferable in this case to accept only those public sector projects exhibiting a social yield of 10 per cent, or more, and to invest any remaining public sector funds in financing additional private sector investments with an expected yield of 10 per cent or more. Thus in this case the optimal use of the funds available to the public sector leads to a result in which the private sector investments are the relevant alternatives to marginal investments in the public sector.

One case in which the marginal productivity of investments in the private sector might not be the appropriate criterion for public sector decision-making is where the investible funds of the public sector are so severely limited that they can be exhausted on public sector projects, all of which have a higher expected yield than a typical private sector investment. In such a case, if the limitation on public sector funds is a binding constraint, the relevant opportunity cost for public sector investments would be that rate of discount which, when used as the basis of a present value criterion, would result in the acceptance of a group of projects whose cost was just barely sufficient to exhaust the available funds. For example, in a case of severe budgetary strin-

[1] Princeton University Press, 1951, pp. 16-48.

[2] New York: John Wiley, 1958, pp. 89-92.

[3] *Journal of Political Economy*, University of Chicago Press, August 1958.

gency, it might turn out that, using a 16 per cent rate of discount, the projects yielding a positive excess of benefits over costs would not fully exhaust the available funds, but that, using a 15 per cent rate of discount, sufficient additional projects would pass the present value test so as just to exhaust the given budget. In this case, the opportunity cost of capital for a public sector project would be 15 per cent, in spite of the fact that private sector investments have an expected marginal yield of only 10 per cent. However, this result occurs only when the budgetary restriction on public sector projects is binding. Otherwise, in a case such as that just described, the optimal result can be achieved by the public sector authorities accepting all projects having benefits greater than their costs, evaluated at a discount rate of 10 per cent, and borrowing the required additional funds from the private sector.

Thus, the opportunity cost of capital is best measured by the marginal productivity of capital in the private sector in virtually all cases, the only serious exception being the case of a binding budgetary constraint on the investable funds of the public sector, in which case the private sector marginal productivity of capital still remains as a lower limit to the discount rate relevant for public sector investment decisions.

We turn therefore to the problem of estimating the marginal productivity of private sector capital. Consider any line of activity in the private sector, the line of activity being defined as including all operations producing a given product by similar production methods, for sale in the same market. An increase in the amount of capital invested in such a line of activity will augment the supply of the product in question, and may affect its price. If it does affect the price of the product, it will alter the marginal productivity of the capital previously invested in the line of activity in question, but it will similarly affect the rate of return perceived by the owners of this previously invested capital. Thus, where the newly invested capital is of the same type as that already existing, the private rate of return to capital in the line of activity in question may be taken as a rough first approximation to the marginal productivity of capital in that line.

Some problems must, however, be noted immediately. If a technological advance has occurred, it may be true that new investment, using the new technique, will have a marginal productivity, and a rate of return, equal to, say, 20 per cent, but the introduction of this technique may reduce the price of the product to the point where the return on capital invested in the old technique is but 5 per cent. The rate of return on all capital invested in the industry will be a weighted average of the 20 per cent rate on the new technique and 5 per cent on the old. And indeed it will be true, if no other complications enter into the calculation, that the marginal productivity of capital is 20 per cent for that invested in the new technique and 5 per cent for that invested in the old technique. The over-all marginal productivity of capital in the activity in question will also, in this case, be a weighted average of 20 and 5 per cent, and will be measured (again barring additional complications) by the rate of return on the total capital invested in that activity.

The problem here is that any new investment that occurs will use the new technique, so that the marginal productivity of capital that is relevant for current and future decisions is that 20 per cent rate obtainable from the new technique. The use of the observed rate of return in the entire activity (on both old and new techniques) therefore underestimates the rate relevant for the evaluation of current and future projects.

This error could be avoided by considering the two techniques as separate lines of activity and using, in the calculation of the marginal productivity of capital to be used in project evaluation, only the 20 per cent rate arising from investment in the new technique. The difficulty with this approach stems from the way in which the available data typically appear, i.e., from the financial accounts of enterprises. In these accounts, there is no way of distinguishing how much capital is invested in a new technique and how much in an old one, and likewise there is no way of allocating the income earned by an enterprise into a part attributable to a new and a part attributable to an old technique. Thus the data automatically yield rates of return which are, in our example, weighted averages of the 20 per cent and the 5 per cent rate, and it must be recognized that these estimates are biased downward when significant technological advances have recently occurred.

A second source of bias in estimating the marginal productivity of capital on the basis of observed rates of return is the presence, in some lines of activity, of monopoly elements. The effect of monopoly is to restrict production of the monopolized product and to raise its price. As a consequence, the value of the marginal product of all factors of production is raised above their respective prices. If prices are raised 10 per cent above costs, the consequence would be an element of monopoly profits consisting of 10 per cent of the wages paid, 10 per cent of the cost of materials used, and 10 per cent of the true cost of capital. The difficulty presented for measuring the marginal product of capital by the observed rate of return is that the profits appearing on the accounts of a company include the full amount of monopoly profits plus the true cost of capital, whereas for a proper measurement of the marginal productivity, they should include, in this example, only 110 per cent of the true cost of capital. Thus the measured rate of return tends to overstate the true marginal productivity of capital when monopoly elements are present.

The construction of series on the rate of return to capital in the private sector is dealt with in some detail by George J. Stigler in *Capital and Rates of Return in Manufacturing Industries*[4] and by John W. Kendrick in *Productivity Trends in the United States*[5] the latter dealing principally with the problem of measuring the stock of capital. The literature on the subject is as yet very weak on the

[4] Princeton University Press, 1963, appendix A.

[5] Princeton University Press, 1961.

problems of measuring the social as distinct from the private yield on private sector capital.

There are a number of possible sources of divergence between the social and private benefits of private investment; but of these, by far the most important consists of taxes. Corporation income taxes typically account for between 25 and 50 per cent of the income generated by capital in the corporate sector; the social yield of capital (including the corporation income taxes) can thus easily be 12 per cent, even though the private yield is only 6 per cent. It would accordingly be erroneous to proceed on the assumption that the private yield on capital reflected its full opportunity cost. Of two investments with the same private yield, one of which generates coroporation income tax payments equal to its private yield, and the other of which generates no tax payments at all, the former is clearly socially preferable, as it either enables the public sector to have more command over real goods and services or, alternatively, it permits the public sector to reduce some other tax and thus permits the private sector to buy more real goods and services. The indicated procedure is therefore to include corporation tax payments generated in any industry as part of the social return to capital in that industry. And if the social rate of return to capital is estimated for the private sector as a whole, the entire yield of the corporation income tax should be added to the income perceived by private enterprises in order to convert the latter to a social concept of "income generated by capital".

Where indirect taxes exist on a final product, they lead to a situation in which the value of the marginal product of each factor of production involved in that good's production exceeds the income earned by that factor by the percentage rate of indirect tax. In this case, the income from capital (gross of corporation income tax) should be augmented by a fraction of the receipts from the indirect tax, the fraction being capital's share in the value added in the industry in question.

Other sources of divergence between the private and the social rate of return on capital can arise out of divergences of the market prices of factors of production from their opportunity costs. These will be discussed in section C, below, in some detail.

For an attempt at estimating the social rate of return to capital in a developing country, in which explicit account is taken of the effects of taxes and of certain possible divergences between market prices and opportunity costs, see A. C. Harberger, "Investment in man versus investment in machines: the case of India".[6]

(b) *Market interest rates*

The conventional way of converting costs and benefits to present values is by the use of some market rate of interest. Market rates of interest generally substantially underestimate the opportunity cost of capital, because they fail to reflect the taxes that are paid on account of the profits of private sector projects, and because they neglect other external benefits generated by private sector investments, particularly where there are divergences between market prices and opportunity costs of factors of production or goods.

Two examples of the conventional view follow:

> "It is recommended that estimates of benefits and costs accruing at various times should be made comparable by adjustment to a uniform time basis through the use of projected long-range interest rates. Pending the development of such rates, the average rate of return i.e., yield, on long-term federal bonds over a sufficiently long period of time to average out the influence of cyclical fluctuations is considered appropriate for uniform application by all agencies on the condition that adequate allowance has been made for uncertainties and risks."[7]

> "Interest rates are a measure of the value attached to time differences and, hence, provide a means of converting estimates to a common time period. In calculating the costs of developing a project, interest should be charged on the project for its entire economic life and reduced to an annual basis in order to compose annual costs and benefits. The rate of interest to charge a project depends upon the rate you must pay for financing the project. Generally, government financed projects can be financed at a lower rate than private industry. The government rate of borrowing is relatively risk free because the security is the general taxing power and because the over-all degree of security for the loan is relatively certain. In view of these considerations, it is recommended that the expected average long-term government bond rate be used as the basis for calculating public investment costs and that higher rates be used for private investment costs."[8]

The approach reflected in both of the above quotations fails to appreciate the difference between the market interest rate on bonds and the opportunity cost of capital. Tinbergen, in advocating the use of accounting prices, has a much clearer appreciation of this distinction. He says that

> "[accounting prices of factors of production] represent the value of the marginal product to be obtained with their aid.... The interest rate to be applied should express the real scarcity of capital, to be derived from the marginal yield of projects as well as from the marginal rates to be paid for foreign loans."[9]

Tinbergen suggests the use of a 10 per cent interest rate, which is far above the rates applying to government bonds in most countries, and which undoubtedly lies closer to the opportunity cost of capital than the government bond rate.

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[6] In C. A. Anderson and M. J. Bowman, eds., *Education and Economic Development*, Aldine Publishing Co., 1965.

[7] United States Inter-Agency Committee on Water Resources, *Proposed Practices for Economic Analysis of River Basin Projects*, Washington, D.C., Government Printing Office, 1958, p. 24.

[8] H. W. Singer, "Development projects as part of national development programmes", in *Formulation and Economic Appraisal of Development Projects*, United Nations publication, Sales No.: 51.II.B.3, pp. 123-124.

[9] J. Tinbergen, *The Design of Development*, Baltimore, Md., Johns Hopkins Press, 1958, pp. 40, 42.

Likewise, the United Nations Industrial Development Division recognizes the unsuitability of bond rates:

"More specifically, . . . accounting interest rates may be set at least double the rates on government securities or on international loans, and possibly at as high as 20 per cent."[10]

(c) *Other methods for setting discount rates*

Some of the theoretical literature rejects both the rate of interest on bonds and the private sector marginal productivity of capital in favour of what is called the "social rate of time preference" or the "social rate of discount". This concept attempts to represent the relative valuation which society puts on a marginal amount of consumption in different time periods. For example, if "society" considered $1.10 of extra consumption next year to be subjectively equivalent to $1.00 of extra consumption this year, the social rate of time preference between the two years would be 10 per cent.

The main ground on which this part of the literature rejects market rates of return is the belief that the market, which reflects the resultant of individual, atomistic savings and investment decisions, does not give any weight to the preferences of future generations and hence tends to save "too little", with the result that the market rate of return on investment is "too high".

As Eckstein puts it:

"Social policy, as derived from the political process, may prefer rejection of present intertemporal preferences in favour of a redistribution of income towards future generations. Much of the conservation philosophy can be interpreted in these terms. Resource development is a field particularly suited to this kind of redistribution because there are genuine opportunities for making investments, part of the benefit of which will accrue in the far future. And perhaps equally important is the fact that it is in the resource area that the idea of making provision for the future of the country has caught the imagination of the public. It is not logically inconsistent for the same person to be willing to borrow at high interest rates to increase his present consumption while voting to spend tax money to build a project from which future generations will benefit, for in the case of a vote to tax, he can be sure that the other individuals in the society will be compelled to act similarly. . . . Our notion of efficiency is relative to the distribution of income; should we seek to redistribute income to future generations, the interest rate loses its meaning as an efficient price."[11]

More detailed discussion of this view may be found in O. Eckstein, "Investment criteria for economic development and the theory of intertemporal welfare economics".[12] A somewhat similar position is expressed by Stephen A. Marglin in "The social rate of discount and the optimal rate of investment"[13] and by A. K. Sen in "On optimizing the rate of saving".[14]

The difficulty that emerges from the Eckstein-Marglin-Sen position is that, when the social rate of time preference is low, its use in evaluating benefits and costs is likely to lead to the acceptance of a great many projects—in all likelihood more than can be financed.

Eckstein says:

"I propose the following compromise, which is designed to preserve the long term perspective of the federal programme, yet would ensure that only projects are undertaken in which capital yields as great a value as it would in its alternative employments: let the Government use a relatively low interest rate for the design and evaluation of projects, but let projects be considered justified only if the benefit-cost ratio is well in excess of 1.0."[15]

Marglin, in a more elaborately developed discussion than Eckstein's, develops formulas for measuring the opportunity cost of public investment when the social rate of discount lies below the marginal productivity of capital in the private sector. His formulas depend on the manner in which the public sector funds are raised; he considers the "cost" of $1 of public funds raised at the expense of current consumption to be $1, while the cost of $1 of funds raised at the expense of investment is considered in his basic model to be $\$\rho/r$, when ρ is the marginal productivity of capital in the private sector and r is the social rate of discount. This assumes that $1 of private investment would have a perpetual yield of $\$\rho$ per year which, discounted back to the present at the social rate of discount, would have a present value of $\$\rho/r$. If the fraction θ of public funds is raised at the expense of investment, and the fraction $(1-\theta)$ at the expense of consumption, the present value of the foregone alternatives of a dollar of public funds will be $\$[(\theta\rho/r) + (1-\theta)]$. Marglin then proceeds to recommend that the present value of the benefits stemming from a dollar of public investment should be at least equal to $\$[\theta\rho/r + (1-\theta)]$.[16] A somewhat similar approach is followed by Peter O. Steiner in "Choosing among alternative public investments in the water resource field".[17]

The solutions reached by Eckstein, Marglin and Steiner are all subject to a single, decisive criticism: they may lead to results in which the rate of return to investments in the public sector lies below that which could be obtained by placing the same funds

[10] "Evaluation of projects in predominantly private enterprise economies", *Bulletin on Industrialisation and Productivity*, No. 5, United Nations publication, Sales No.: 62.II.B.1, p. 30.

[11] Otto Eckstein, *Water Resource Development: the Economics of Project Evaluation*, Cambridge, Mass., Harvard University Press, 1958, pp. 99-100.

[12] *Quarterly Journal of Economics*, Cambridge, Mass., Harvard University Press, February 1957.

[13] *Ibid.*, February 1963.

[14] *Economic Journal*, Cambridge, England, September 1961.

[15] Op. cit. (see footnote 11 above), p. 101. See also J. V. Krutilla and O. Eckstein, *Multiple Purpose River Development*, Baltimore, Md., Johns Hopkins Press, 1958.

[16] See Stephen A. Marglin, "The opportunity costs of public investment", *Quarterly Journal of Economics*, Cambridge, Mass., Harvard University Press, May 1963.

[17] *American Economic Review*, Evanston, Ill., Northwestern University, December 1959.

at the disposal of the private sector, or by investing directly in private sector type activities. Future generations lose, rather than gain, if funds are used for a 5 per cent public sector investment rather than for a 10 per cent private sector investment. The public sector can, and in many countries does, provide both equity and debt financing for the private sector, and can thus assure itself that its financing of private sector activities does not entail the granting of a subsidy to the private sector but rather simply enables the public sector to obtain the same rate of return that prevails on private sector investments. Once the public sector is prepared to accept this degree of flexibility in its use of investable funds, the criterion for project evaluation reduces once again to the marginal productivity of capital in the private sector of the economy, discussed in A.2 (a) above.

The fact that the social rate of discount may lie below the marginal productivity of capital proves only that the rate of investment should be expanded; it does not prove that, for a given rate of investment, capital should have different marginal rates of productivity in the public and private sectors. The end result of an optimal investment policy, with the social rate of discount taken as given, would therefore be a situation in which the marginal productivity of capital in both the private and public sectors was equal to the social rate of discount. During the transition from a position in which the marginal productivity of capital in the private sector lies above the ultimate social rate of discount to a position where these are equal, the optimum path would entail so allocating the investable resources of the economy as to maintain continuing equality of the marginal rates of productivity of capital in the public and private sectors, with these rates declining together from their initial (high) level to their ultimate (lower) level as a consequence of a stepped-up rate of investment.[18]

(d) *Changes in the relevant discount rate through time*

The case cited in the preceding paragraph gives only one of many possible ways in which the relevant discount rate may vary through time. Another possibility—more optimistic from the standpoint of economic development—is that through adoption of superior techniques, through better management and organization, and through an improved mix of social overhead investments, the marginal productivity of capital might rise rather than fall through time. This corresponds, in technical economic language, to upward shifts in the production function through time, which more than outweigh the downward pressure on the marginal productivity of capital stemming from the effects of increased capital-intensity of production.

Actually, for those countries for which it has been possible to estimate the marginal productivity of capital over substantial periods of time, there appears to have been no very significant upward or downward trend in this magnitude. Stigler, for example, finds the private rate of return to capital in United States manufacturing to have fallen in the 1930s to less than half the level of the late 1920s, then to have risen in the late 1940s to about 1½ times the level of the late 1920s, and finally to have fallen by the late 1950s to approximately the same level as that of the late 1920s.[19]

This experience is suggestive of the possibilities that may emerge in other contexts. In the 1930s, the conditions of the United States economy were such that an abnormally low rate of return on capital prevailed; in the late 1940s, on the other hand, the need to restore the capacity for production of non-military goods created a situation where an extraordinarily high yield on investment could be obtained. In neither of these instances could it reasonably be expected that the then-prevailing rate of marginal productivity would be maintained indefinitely into the future.

Similarly, it may occur that a developing country may face a situation in which investable funds are abnormally scarce relative to investment opportunities (as when large debt service payments are due and available investment opportunities are particularly good) or in which investible funds are abnormally abundant relative to opportunities (as when the country receives a particularly large amount of foreign aid, or when its main export product experiences a temporary large increase in price, without investment opportunities expanding correspondingly).

In circumstances like these, the country should attach a "price" to the use of investable funds which is higher than the expected future price if funds are relatively scarce, and lower if funds are relatively abundant. This can be done by attaching to each year a discount rate that corresponds to the expected marginal productivity of capital in that year. Thus, if we have a project with an expected life of three years, we would discount benefits and costs expected to accrue one year hence at the rate r_1 to bring them back to the present. Likewise, we would discount benefits and costs accruing two years hence by the rate r_2 to bring them back to one year from now, and then by the rate r_1 to bring them back to the present. Thus, the acceptance or rejection of a three-year project would turn on whether the sum

$$(B_o - C_o) + \frac{(B_1 - C_1)}{(1 + r_1)} + \frac{(B_2 - C_2)}{(1 + r_1)(1 + r_2)} + \frac{(B_3 - C_3)}{(1 + r_1)(1 + r_2)(1 + r_3)}$$

was greater or less than zero. The general form of this criterion, for a project of N years duration, is

[18] This view is supported in a recent paper by Arrow, who says that, so long as public investment can be financed by bonds or taxation, "the rates of return in the two sectors (public and private) should be equated at every instant of time but the government through its bond and tax policies should aim at driving the common rate towards the natural rate of interest. The optimal policy may well involve negative bond financing, i.e., government lending or retirement of the national debt" (Kenneth J. Arrow, "Discounting and public investment criteria", paper presented at the 1965 Western Resources Conference, Seminar on Water Resources Research, 6 July 1965).

[19] Stigler, op. cit. (see footnote 4 above), p. 203.

$$(B_0 - C_0) + \sum_{i=1}^{N} \frac{(B_i - C_i)}{\prod_{t=1}^{i} (1 + r_t)}$$

It is unfortunate that the great bulk of the literature on cost-benefit analysis has been based on the simplifying assumption of a constant discount rate, because this assumption fails to give guidance as to how to overcome periods of unusual stringency in the supply of capital funds or how best to take advantage of a temporarily large availability of such funds. One notable exception is the work of Pierre Massé, in which changing discount rates are discussed explicitly, and in which the analyses are carried out in such terms.[20]

B. Measurement of benefits and costs

1. *Projections of demand for the affected product*

Projections of demand for the affected product are an important element in estimating the economic feasibility of a project and determining its appropriate scale. The techniques of projection appropriate to any given case can be only determined by a careful study of the case itself, but certain general statements can be made.

(*a*) The potential market for the product must be ascertained (local, regional, national, international).

(*b*) Factors influencing the intensity of demand for the product in this market must be isolated and projected.

(*c*) On the basis of (*b*), the over-all level of demand for the product must be projected.

(*d*) The prospects of expansion of existing alternative sources of supply must be examined and corresponding projections made.

(*e*) The prospects of new sources of supply appearing in the future must be evaluated and, if they are likely to appear, supply from these sources must be projected.

For any market, a key factor influencing demand is the level of income, and the projection of this magnitude is therefore of key importance. Unfortunately, there is no touchstone to estimating the rate of growth of income. In particular, the rate of growth of income is not directly tied to the rate of capital accumulation in the community, but is the resultant of many factors, of which capital accumulation is only one.[21]

This fact introduces considerable uncertainty into all income projections, and suggests that basing such projections mainly or exclusively on capital-output ratios is unwise. The most appropriate procedure appears to be to assess the relative contribution of certain key factors (capital formation, labour force increase, improvement in labour force quality and technical advance) to past economic growth, to assess their probable future strength and to estimate the likely rate of income growth on this basis.

Having projected the rates of growth of income, population and so on, the problem of estimating demand for a particular product depends on the nature of the product. For most consumer goods, income and relative price appear to be the key determinants of demand; so that demand, expressed as a function of price, can be projected once the course of income is known. However, for products which are materials or intermediate goods, the best procedure is to estimate the demand for each type of end-use separately, and to project the demand for the material according to the projected growth of each of its corresponding end uses.[22] Care must be taken, however, to allow for possible future changes in the quantity of the material used per unit of each end-use product. Capital goods demand should be projected on the basis of the amounts expected to be required for replacement, plus the additional amounts needed to produce projected increases in the final product of the activity in which the capital goods are used.[23] Once again, it is important that prospective development of improved and competing types of equipment be taken into account.

2. *Projections of product prices*

Since the market price of the output of a project is the principal element in estimating the benefits to be obtained, it is important that a project analysis should include projections of the probable path of this price through time. Project analyses need not be concerned with possible movements in the general level of all prices (i.e., general price inflation or deflation), as a parallel movement of all prices and costs would not alter the real cost benefit relationship. However, movements of relative prices can have a determining influence on the worth-whileness of a project.

The best general procedure for projecting the prices and costs relevant for a project's analysis is to project their movements relative to the general price level. Concerning the price of the output of a project, one must therefore attempt to judge whether the price will move more or less than the general price level and, if so, by how much. Having projected in index form the relationship P_t/P_{gt}, where P_t is the price of the project's output, and P_{gt} the general price level, for each year of the expected life of the project, this index is then applied to the initial year's product price, P_{t0}, in order to express future year'

[20] See Pierre Massé, *Optimal Investment Decisions*, Englewood Cliffs, N.J., Prentice-Hall 1962, pp. 10-20. For an earlier discussion of the same problem, see Irving Fisher, *The Theory of Interest*, New York, Macmillan, 1930.

[21] See, for example, R. M. Solow, "Technical change and the aggregate production function", *Review of Economics and Statistics*, August 1957, and E. F. Denison, *The Sources of Economic Growth in the United States and the Alternatives Before Us*, New York, Committee for Economic Development, 1962.

[22] See United States President's Materials Policy Commission *Resources for Freedom*, Washington D.C., Government Printing Office 1952, vol. II chap. 22, "Projection of 1975 materials demand". United Nations Economic Commission for Latin America (ECLA), *Analyses and Projections of Economic Development* vol. I, United Nations publication, Sales No. 55.II.G.2, pp. 32-33 and the ECLA *Manual on Economic Development Projects* United Nations publication, Sales No. 58.II.G.5, p. 24.

[23] For an example, see "Projection of demand for industrial equipment" in *Industrialization and Productivity Bulletin* No. 7 United Nations publication, Sales No. 64.II.B.1.

prices in monetary units of the initial year's purchasing power. Thus the projected price series would be of the form $P_{io}(P_{it}/P_{io})(P_{go}/P_{gt})$.

The factor $(P_{it}/P_{io})(P_{go}/P_{gt})$, will average out to unity over the whole economy when the appropriate weighted average is taken for

$$\sum_i \frac{Q_{io}P_{io}}{(\sum_i Q_{io}P_{io})} \cdot \frac{P_{it}}{P_{io}} \cdot \frac{P_{go}}{P_{gt}}$$

$$\frac{\sum_i Q_{io} P_{it}}{\sum_i Q_{io} P_{io}} \cdot \frac{P_{go}}{P_{gt}} = \frac{P_{gt}}{P_{go}} \cdot \frac{P_{go}}{P_{gt}} = 1.$$

Thus for a typical commodity, the projection of a constant product price is likely to be justified. However, relative prices exhibit substantial variations over time, and it is important to attempt to identify situations in which a particular price is likely to rise or fall relative to the general index of prices. In general, for industrial products, the course of prices will be the resultant of changes in input costs on the one hand and improvements in technology (including economies of scale) on the other. Since the wage component of input prices is likely to rise over time, the question largely centres on whether future technological advances will be sufficient to offset this force. In many industries, some indication of the likely force of future technological advances can be obtained from the processes that today are being studied for possible future application, and projections can be made on that basis. In some cases, the present market for the product may be found to be abnormal, in the sense of a current shortage of output causing an unusually high price or a current glut of supply causing an unusually low price. It is particularly important that such situations be identified, as in these cases it is highly unlikely that the assumption that the price will remain at its present level will be warranted.

Although most discussions of cost-benefit analysis pay lip service to the principle of taking expected price changes into account, they generally do not go beyond this. Probably the most extensive treatment of the problem—itself not very extensive but at least attempting to face the major issue—is to be found in the ECLA *Manual*, pp. 26-28.[24]

3. *Projections of cost components*

(a) *Wages*

One of the gravest deficiencies in the existing literature on project evaluation is its failure to allow, explicitly and systematically, for the expectation that wage rates will rise regularly in the future, relative to product prices. In an economy experiencing successful economic development, it can be anticipated that real wages will rise at a rate of 2 per cent per year or more. Thus, whereas the price of the average product will change in accordance with movements in the general price level, wages will increase at a significantly greater rate. The rise of wages at a greater rate than that of prices is possible because of the continued improvement of productive techniques.

But in a given project, the technique of production is often determined by the design of the project itself. In this case, labour requirements will be determined by the lay-out of the plant, the types of machinery installed, etc. Future rises in wages will not in this case be accompanied by reductions in labour requirements, hence project costs will increase to reflect the rise of real wages.

A proper evaluation procedure should surely take into account expected rises in real wages. In cases where future labour-saving innovations are anticipated, which will be applicable to the project in question, these may be taken into account, including in the project analysis the expected cost of introducing the innovations as well as the reduction in labour requirements that is expected to follow.

(b) *The exchange rate*

The exchange rate is an exceedingly important factor in project evaluation, and an adequate projection of its expected future course through time is therefore necessary. As with other types of prices, what is of interest is movements of the exchange rate relative to the general price level. Three key questions should be borne in mind in developing exchange rate projections.

First, does the present exchange rate reflect the normal forces of demand and supply, or are certain abnormal forces present which produce an exchange rate that is unlikely to be maintained in the future? Abnormal forces might reflect unusually high or low prices for key export (or import) commodities, unusually large capital movements and/or receipts of foreign aid, etc.

Secondly, what are the likely trends in the basic demand for imports and the supply of exports? Here one must take into account not only the effects of secular income growth, but also the effects of the changing composition of production. Thus projected expansions of export production, or of import substitutes, would influence the probable future course of the exchange rate.

Thirdly, what are the likely changes in government policy with regard to import restriction? Here one can expect that the liberalization of trade controls will produce a higher price of foreign currency, and their tightening a lower price, than would be the case with unchanged policies.

(c) *Other costs*

The prices of inputs that are manufactured products can generally be projected by the same method as was suggested above for projecting the price of the output of a given project, that is, as a resultant of expected changes in input costs and expected improvements in the technique of production. This procedure is based on the generally valid assumption that the prices of manufactured goods are largely cost-determined.

Minerals and agricultural products, however, are not typically as elastic in supply as manufactured goods. Hence their projection requires an analysis of the likely movements in both supply and demand. Moreover, because of the characteristically low price-elasticity of demand for these products, it can

[24] See footnote 22 above.

readily occur that the price observed currently is far different from the price to be expected in the longer term future, after the level of production can be adjusted to accommodate the demand situation.

(d) *"Annualized" benefits and costs*

The many possibilities listed above of prices and costs changing over time, as well as the likelihood (discussed in section A) that the relevant discount rate will itself change over the life of a project, indicate the necessity of carrying out project evaluation by projecting expected benefits and costs on a year-by-year basis, and then discounting them back to the present by the appropriate discount factors. The often recommended procedure of attempting to put all benefits and costs on an annualized basis[25] entails the possibility of dangerous oversimplification. As it leads one to presume that all the relevant components of benefits and costs will be (comparatively) constant over time, the "annualization" approach tends to distract attention from the whole set of problems considered in this section.

4. *Indirect benefits and costs*

In addition to its direct benefits and costs, a project may induce a series of indirect effects, which in principle should be taken into account in its evaluation. These indirect effects are the result of changes that take place in the rest of the economy as a consequence of the project in question having been undertaken. Obviously, any project is likely to have some perceptible effect on the demand and supply of goods produced by other industries, the main effects of this type being in the industries which supply the materials used by the project, and the industries which supply goods which are either complementary to or competitive with the project's output. If, as a consequence of a project, changes occur in the output of an industry for which, at the margin, social benefits equal social costs, no adjustment need be made. But if changes occur in the output of industries for which benefits exceed or fall short of costs, at the margin, an adjustment is in order. The appropriate adjustment is the difference between marginal social benefit and marginal social cost, per unit of output in the industry in question, times the change in the output of that industry which is induced by the project under consideration.

The task of measuring indirect benefits can thus be reduced, first, to ascertaining those industries or activities in the economy for which marginal social benefit (MSB) is likely to differ from marginal social cost (MSC); secondly, estimating the magnitude of the difference, for each such industry, per unit change in its output and, thirdly, estimating the likely change (ΔQ) in the output of such industries as a consequence of the project being evaluated. Having done this, the estimation of indirect benefits can be calculated by the formula $\sum_i (MSB_i - MSC_i)\Delta Q_i$, where the subscript i varies over all industries for which $MSB_i \neq MSC_i$.[26]

[25] See ECLA *Manual* (footnote 22 above), pp. 198 ff.

[26] See United States Inter-Agency Committee on Water Resources, op. cit. (see footnote 7 above), p. 8.

C. Use of social or accounting prices in industrial project evaluation

The early work on cost-benefit analysis did not recommend the use of social or accounting prices. An example is the following:

> "Ideally, measurement standards in project evaluation should reflect the interest of society as a whole; as such, these standards should be concerned with 'real' costs and benefits. However, it is not practicable to establish and apply 'real' costs and values. Estimates would be in theoretical terms rather than in terms of a monetary unit. All things considered, the most satisfactory approach would result from using prices estimated as they are expected to be at the time when costs are incurred and benefits received . . . . This procedure is recommended as the best available method. It permits a useful working relationship with repayment determination. It takes account of future prices and price relationships based on the best judgement at hand."[27]

This view is in marked contrast with the tone of the more recent literature, as represented by the following:

> "The market price would represent the true value of goods and services if the law of supply and demand operated freely, under perfect competitive conditions, with full employment of all resources and complete mobility of all factors. If, because of any interference, obstacles or regulations, these conditions do not exist, then the price system will be distorted; it will not correspond to that ideal system of equilibrium nor represent the value of the factors from the point of view of the community as a whole. It is therefore considered necessary to correct market prices in order to obtain what has been termed the 'social cost' of the factors."[28]

> "As in the choice among sectors, the basic criterion that is recommended for comparing projects is the social return on the capital invested in each alternative use . . . . Labour, imported materials and export and import substitutes are valued at accounting prices. The remaining inputs are valued at market prices except for a few important elements, such as electric power and transport, for which the market price may seriously understate the amount of resources used in their production. In these cases, accounting prices should be calculated also."[29]

> "Under the circumstances, a selection of projects based on market prices will result in a misallocation of resources, in the sense that there will be a heavy strain on the resources that are under-priced while part of the resources that are over-priced

[27] H. W. Singer, "Development projects as part of national development programmes", in *Formulation and Economic Appraisal of Development Projects*, United Nations publication, Sales No. 51.II.B.4/vol. 1, pp. 121-122.

[28] ECLA *Manual* (see footnote 22 above), p. 203.

[29] Economic Commission for Asia and the Far East (ECAFE), *Formulating Industrial Development Programmes*, United Nations publication, Sales No.: 61.II.F.7, p. 30.

will be left idle, so that the aggregate yield of the selected projects will fall short of the maximum yield that could have been obtained from the available resources. It is thus necessary to introduce into the evaluation procedure a device intended to restrain the use of under-priced factors and stimulate the use of the over-priced ones. This can be accomplished . . . [by basing] the evaluation on 'shadow' or 'accounting' prices instead of the market prices. The accounting prices are intended to reflect as accurately as possible the intrinsic values of the factors involved."[30]

There can be no doubt that the recent trend towards consideration of accounting prices represents in principle a substantial advance over the alternative position, since it attempts to take into account the effects of divergences between market prices and social costs, while the alternative approach does not. However, the problem still remains of obtaining adequate estimates of the appropriate accounting prices to use, and it must be admitted that this aspect of the problem has not been thoroughly explored in the literature. We turn, therefore, to the examination of this question for the main types of prices.

1. *Accounting prices for labour*

The "shadow wage", or accounting price of labour, is an elusive magnitude to estimate, particularly because of the great variety of skills and types of labour, and because of regional immobility of that factor. It can therefore readily occur that the opportunity cost of agricultural labour may be quite low, while the opportunity cost of employing the same labour in industrial projects in the cities is considerably higher. It is necessary, when considering the accounting price of labour, to be specific both as to region and as to skill, and to recognize that it is generally not possible to obtain even the most unskilled labour in urban areas at wage rates similar to those paid such labour in rural places. Thus the accounting price of urban labour should not be considered to be the actual wage received by similar labour in rural employments, but should rather be based, first, on the wage that is required in order to attract this type of labour from rural to urban employment, and secondly, on an adjustment factor reflecting the higher costs of providing social overhead facilities for urban as against rural workers and their families. It is not correct, as suggested on page 205 of the ECLA *Manual*,[31] to consider the agricultural wage as the opportunity cost or accounting price of labour diverted to urban employment.

Similarly, the existence of unemployment should not be taken to mean that the accounting price of labour is zero, unless the unemployment is so widespread as to include substantial fractions of the labour force of every type and skill. In general, it is likely that the more highly skilled grades of labour will have accounting prices at or very near to their market prices, as these grades of labour are typically in relatively scarce supply, even in periods when the unemployment rate for the total labour force is relatively high. Even for the lower skill grades, the phenomenon of unemployment cannot be taken as direct evidence that the accounting price of labour is substantially below its market price. The unemployment rate must be viewed as the outcome of a number of forces: plant shutdowns, normal labour force turnover, migration to the city and so on. Suppose that, as a consequence of these forces, 6 per cent of the urban labour force is at any moment unemployed, and that a new project is established which will occupy 1,000 workers. This new project will also have plant shutdowns, seasonal variation in its demand for labour, normal turnover, etc., and it can very well be that over the year this new plant will engender for these reasons an average unemployment equal to 6 or more per cent of its own labour force. In this case it might be concluded that the opportunity cost of labour for the new plant was given by the market wage rate, in the sense that at that wage rate it would be drawing 1,000 workers from the market, who would have been employed 94 per cent of the time and unemployed 6 per cent of the time, and it will itself employ them 94 per cent of the time and leave them unemployed for the remainder.

It is not contended that the above type of calculation should be used as a guide in attempting to arrive at accounting prices for labour; it is merely presented as an example of a case in which the existence of reasonably significant unemployment might plausibly be interpreted as being consistent with an accounting wage equal to the market wage.

Actually, the estimation of accounting wage rates for labour classified by different skills, types and regions is an extremely complex and important area of research which deserves much deeper study than it has had. Such research should take into account not only the forces of seasonality, normal turnover and shutdowns mentioned above, but also should investigate the forces which are operating to keep the market price of labour above its opportunity cost. These latter forces include wage rates set either legally or by union agreement, but often there are large segments of the labour force which are unprotected by either of these means. It is generally to be presumed that in these segments of the labour force the wage rate reflects opportunity cost; and such wage rates can often be taken as minimum estimates of the accounting prices of labour of similar skills and types in the industries and activities in the same region in which labour is protected by minimum wage rates and/or union agreements.

Attempts to specify the nature of the discrepancies between market and accounting prices for labour are necessary for another reason as well—the projection of how these discrepancies are expected to change in the future. It is to be anticipated that, in a developing economy, gross differences between market and accounting wages will tend to be eliminated over time, but the process and speed by which this occurs depends upon the source of the initial discrepancy. In any event, it is reasonable that a cost-benefit analysis should allow for at least the gradual reduction over time of such discrepancies—thus confronting us once more with the importance

[30] "Evaluation of projects in predominantly private enterprise economies", *Bulletin on Industrialization and Productivity*, No. 5, United Nations publication, Sales No. 62.II.B.1, p. 29.

[31] See footnote 22 above.

of carrying out a project analysis through a year-by-year protection of benefits and costs rather than attempting to summarize these solely through annualized estimates largely based on the current situation.

2. *The accounting price of foreign exchange*

Whereas labour is characterized by great heterogeneity and substantial immobility, foreign exchange, at least in a world of convertible currencies, is a basically homogeneous commodity that can readily be shifted from one use to another. Thus, where in principle numerous accounting prices will be required for labour, only one will typically be required for convertible foreign exchange. Nonetheless, serious difficulties arise in estimating this accounting price, owing to the many distinct uses to which foreign exchange can be put. This can easily be seen by considering a tariff structure in which some items are not taxed at all, while others are taxed at, say, 20 per cent, and still others at, say, 50 per cent. If the exchange rate is 5 rupees to the dollar, a dollar spent on imports of category 1 will bring in goods having an internal value of 5 rupees, while a dollar spent on category 2 will bring in goods having an internal value of 6 rupees, and the same dollar spent on category 3 will bring in goods having an internal value of 7½ rupees. The value produced by the dollar thus varies with its use.

The key to estimating the accounting price of foreign exchange is to estimate the likely pattern in which incremental dollars would be distributed over the various categories of goods. If it was anticipated that extra dollars would be spent 50 per cent on category 1, 30 per cent on category 2, and 20 per cent on category 3, then the internal value of a marginal dollar would be $(.5)(5) + (.3)(6) + (.2)(7.5)$, or 5.8 rupees.

This procedure for estimating the accounting price of foreign exchange can also be applied to goods which are subject to licensing or other restrictions rather than tariffs, but here one must estimate independently on the basis of available market evidence what is the internal value of a dollar's worth of each type of goods so restricted.

The basic difficulty with the suggested procedure is estimating the pattern in which incremental foreign exchange will be distributed among imports, but this can be at least roughly estimated on the basis of past marginal distributions of foreign exchange, for instance, by ascertaining from import statistics how the increase in foreign exchange availabilities from, say, 1960 to 1965 was in fact used. More accurate estimates could be obtained by serious econometric study of the demand for different categories of imports. In some cases, the exchange licensing authorities might themselves have a policy indicating how they would allocate any additional sums becoming available.

The procedure outlined above assumes that the incremental foreign exchange will be used to augment the total supply, that is, that it will not force down the price which exporters receive for foreign currency. If it does this, then the above procedure would be applied to estimate the value of the net increment to the supply of foreign currency, and the rate of exchange applicable to exports would reflect the value attaching to the use of incremental foreign currency for displaced exports.

This procedure is closely attuned to the economic reality; as such it is far preferable to the procedure recommended in the ECLA *Manual* (p. 204) of arriving at the accounting price of foreign currency on the basis of a purchasing power parity formula. The great difficulty with the purchasing power parity approach is that it is valid only when the causal factors at work between the two situations being compared were completely monetary, as in the case of differential rates of inflation in the two countries whose currencies are being compared. But the function of the exchange rate in cost benefit analysis is basically as a guide to resource allocation. Rather than looking backward to a base year and being concerned with monetary changes having taken place in the past, cost-benefit analysis looks at the present and the future, and attempts to evaluate alternative projects in "real" terms. There can be no doubt that a direct effort at estimating the value to the economy today of the goods an extra dollar is likely to buy forms a better basis of judgement of the value of foreign exchange than a mechanical extrapolation from some past year. By the same token, the analysis of the current value of foreign exchange, in the manner indicated above, provides the most reasonable starting point for the projection of the time path of this variable in the future.

3. *Accounting prices for inputs of materials*

The problem of arriving at accounting prices for materials is in some respects similar to that for foreign exchange. Suppose that the market price of a material is $5 and its social cost of production is $4. A project under consideration will use some of this material, and the question arises of setting the appropriate accounting price. The problem that faces us can be summarized by considering two extreme possibilities. On the one hand, the output of the material may remain constant, and the supply for the project under consideration may be diverted from other uses. In this case the appropriate accounting price is the market price which can be taken to represent the marginal value of the material in its other uses. On the other hand, the project's demand for the material might be met by increasing its supply: in this case it appears that the appropriate accounting price is $4, the true economic cost of producing each added unit.

This apparently plausible conclusion, however, is not always correct. For, suppose that the materials-producing industry were to augment its output by the same amount, in the absence of the project being considered. This increased output could, presumably, be sold at prices in the neighbourhood of $5 — say, between $4.90 and $5.00 — on the open market. Some reduction in price would presumably have to occur to induce additional sales, but unless the demand of the project in question were very great indeed relative to the initial level of production of the material, or unless the over-all demand for the material were very inelastic, the required reduction in price would not be very great. Thus even if the production of the material expands in response to the project's additional demand, the opportunity cost of the project's use of the material can be approximated by the market price of the material rather than by its social cost of production.

The use of the market price of materials as their social or accounting price has another advantage in avoiding the double-counting of benefits among projects. Suppose that project *A* is a construction project, in which substantial amounts of cement will be used. Suppose, further, that project *B* is a project to expand capacity in the cement industry. If cement is valued at its market price in evaluating project *B*, and is also valued at its market price in evaluating project *A*, we can be sure that there will be no double counting of benefits. But if cement is valued at \$5 in evaluating project *B* and at \$4 in evaluating project *A*, the difference of \$1 per unit will be counted as benefits for both projects—clearly a dubious procedure. In order for \$4 to be a valid accounting price for the cement used in project *A*, project *B* must meet two stringent conditions: first, present value of benefits equals present value of costs, when the cement is priced at \$4 and, secondly, the cement produced by project *B* must have a value no greater than \$4 in alternative uses (other than project *A*).

Having thus indicated the grounds for preferring the use of market prices for materials inputs, it is imperative to qualify this preference by noting that when the output of a material in fact expands as a consequence of a given material-using project, and where that material does not have an alternative use in which its value lies above the cost of producing the material, and where the market price is nonetheless above the cost of producing the material, an accounting price equal to the cost of production of the material is appropriate for use in evaluating the material-using project.

Examples of cases meeting these conditions can indeed be found. Perhaps the clearest case is one in which, first, the material has an infinite elasticity of supply at a price equal to its unit cost of production and, secondly, a tax exists which makes the market price higher than unit production cost. In this case, any expansion in the industry has social benefits greater than social costs by the amount of the additional tax collections. Moreover, even though with a cost of \$4 and a market price of \$5 (=\$4 plus \$1 tax), added production of the material could be sold if offered at a price of \$4.95, it will not be so sold because this would entail a loss to the producers. In fact, the expansion of output of the material is strictly contingent on the emergence of additional demand at a price of \$5 and, so long as the tax remains at \$1 and the net-of-tax supply price remains at \$4, each increment of demand at the price of \$5 will in fact generate the additional supply necessary to meet it. And, assuming the supply price truly reflects the social costs involved, the net-of-tax price can in such cases be used as the accounting price of the material.

Even in such a case, however, it might be preferable to use the market price of the material in the basic calculations of the direct costs and benefits of the material-using project, and to count the extra tax payment generated by the project on account of the expansion of material supply as an indirect benefit of the project. The two procedures amount to the same thing, and counting as indirect benefits the excess of benefits over costs generated in other activities as a consequence of a given project permits the adoption of the standard rule that accounting prices of materials should always be their market prices.

4. *Accounting prices for the output of a project*

Where products are freely sold at the market price, the social benefit attaching to such products should be measured by their market prices. Where, however, goods are subject to rationing or licensing, accounting prices different from market prices are indicated. In this case the accounting prices should attempt to reflect the intrinsic value of an increment of output to those who purchase it.

Where products are subject to indirect taxation, the market price inclusive of tax should be used as the measure of benefits. This is seen clearly by the United States Inter-Agency Committee on Water Resources:

> "To the extent that taxes are reflected in the market prices of goods and services, such taxes . . . will have been considered in estimating the value of the goods and services produced by . . . development projects. No deductions for taxes in market prices should be made, since this would reduce the value of benefits below the actual appraisal of the market as indicated by consumers' preferences of willingness to pay."[32]

The ECLA *Manual*, on the other hand, recommends elimination of taxes and subsidies on the ground that "greater or lesser customs duties or sales taxes cause variations in selling prices, unrelated to the effort involved . . . Thus variations in the amount of sales tax, or the list of goods to which it is applicable, can vary the apparent productivity of projects employing such goods or services, distorting their relative position in the priority scale, although there have been in fact no changes in productivity. Similar observations can be made for subsidies, inasmuch as they are 'negative taxes'."[33]

The position taken in the ECLA *Manual* is difficult to interpret as it does not distinguish clearly between taxes upon materials inputs and taxes upon the output of a project. In the example given, the reference appears to be to materials inputs. If correction for taxes and subsidies on materials inputs is all that is meant, then no exception can be taken to the statement. Taxes on materials, as indicated above, mean that benefits exceed costs in the materials-producing industry, and a project can in this case legitimately consider the additional taxes generated on account of its increased use of materials to be an indirect benefit of the project.

On the other hand, if the statement is taken to refer to taxes on the output of a project as well as on materials, one must take exception to it, the value

[32] Op. cit. (see footnote 26 above), p. 30.
[33] Op. cit. (see footnote 22 above), p. 203.

to purchasers of the product being the price that they pay for it, which clearly includes the tax.

The only exception to the general rule that taxes paid on the product of an activity are to be included in the benefits of that activity is the case in which the taxes are designed to correct a previously existing disequilibrium between social benefits and market price. Thus, if an activity produces a product with a price of $1, but the consumption or production of that product engenders external diseconomies of $.10, the market equilibrium will be one in which, at the margin, consumers of the product receive a benefit of $1, but others suffer an added cost of $.10 for each unit consumed. In this case a tax of $.10 would be indicated as a corrective measure. The price, including tax, would be $1.10, the consumers of the product would have a benefit, at the margin, of $1.10, but other consumers would lose $.10 per unit, so that the total social benefit would be $1 per unit, in this case being the market price less the tax. Since in fact virtually no taxes are levied for the purpose of overcoming the external diseconomies associated with the consumption or production of a product, the general rule should be to measure benefits by market prices including taxes, and to deduct from such benefits any identifiable external diseconomies.

In short, since no presumption can be established that the existing taxes are an appropriate measure of external diseconomies, or that existing subsidies are an appropriate measure of external economies, market prices gross of taxes should be taken as the proximate measure of benefits, and in the project analysis itself the attempt should be made to correct for external economies or diseconomies associated with a project, either in the production of the project's output or in its consumption. It is to be anticipated that cases of significant external effects of this type will be rare, and not closely related to the amounts of tax or subsidy on the product in question.

5. *Accounting prices obtained from linear programming models*

It has sometimes been suggested that accounting prices be obtained on the basis of a linear programming model.[34] This approach has proved highly valuable in the programming of activities within a firm, and its successful extension to problems of greater scope is a distinct possibility. However, it is unlikely that this technique will be able to yield relevant accounting prices for a national economy as a whole. In principle, this would require an accurate description of all actual and potential productive processes within the economy, and an accurate inventory of its resources. Moreover, it should also entail a study of the transferability of resources from one category to another (i.e., how many factory operatives could work effectively as carpenters? how many could be trained to do so at a given cost? etc.). These requirements of basic data go far beyond the foreseeable possibilities.

As a consequence, the application of linear programming techniques in practice requires that the problem be drastically oversimplified by assuming that one or two or three processes can describe the activities available to an industry by aggregating industries into a few broad groups, by considering all labour to be homogeneous, and so on. The resulting "shadow prices" that emerge from the analysis can, unfortunately, be very sensitive to the way in which the simplification is done, and as a consequence little faith can be placed in the results of any particular simplification. Since drastic simplification is an unavoidable necessity in using linear programming models for an entire economy, there is no way of avoiding serious uncertainty as to the validity of the resulting "shadow prices".

D. Problems of timing

1. *Choices among projects of different productive lives and different gestation periods*

As the analysis of section *A* showed, the problem of placing projects with different time profiles on a comparable footing is reduced to the problem of obtaining an appropriate set of discount rates, reflecting for each point in time the opportunity cost of capital at that time. Once this set of discount rates ($r_1, r_2, \ldots, r_N$, for years 1, 2, ..., N in the future) is obtained, the relevant criterion for project choice is to maximize the net present value of the entire investment operation, considering investments to be made this year as well as investments to be made in future years.

The particular relevance of the pattern of discount rates to choices among projects lies in the fact that high discount rates weigh heavily against projects with long gestation periods and long productive lives. Thus a project with a one year gestation period and a total cost of $1,000 would have to yield $200 per year in perpetuity in order to be justified at a 20 per cent discount rate, starting a year from now. But a project whose construction costs were spread out over five years, in equal quotas of $200 per year, would have to yield $318 per year in perpetuity, starting five years from now, in order to pass the 20 per cent test. The required absolute benefit increases rapidly with the length of the gestation period; if the same $1,000 of investment were spread evenly over a ten year gestation period, the required yield would be $559 per year in perpetuity in order to make the investment worth while at a 20 per cent rate of discount.

By the same token, the length of duration of the benefit stream takes on less importance at high discount rates than at low ones. The present value of $100 per year, in perpetuity, at a 20 per cent rate, is $500; but the present value of $100 per year for just the next ten years is $419, or nearly as much as that of the perpetual stream.

These considerations come to be of crucial importance when the relevant discount rates are high, which is likely to be the case for most developing countries. Not only is it true that the private rate of return tends to be high (probably 10 per cent or more) in these countries, but this rate of return has also to be adjusted upward to reflect both taxes attributable to capital and differences between the

[34] See H. B. Chenery and Paul G. Clark, *Interindustry Economics*, New York, Wiley, 1959, chap. 11

market prices and opportunity costs of associated factors of production, in order to arrive at an estimate of the social rate of return. In particular, any substantial excess of the market price of labour over its opportunity cost is likely to raise the social rate of return to capital significantly above the market rate. This point is clearly seen by Tinbergen, when he says, "Very probably the equilibrium level of wage rates will be considerably less than market wages. On the other hand, equilibrium interest rates probably are much higher than market rates."[35]

Considerations of gestation periods and productive life are important in the choice of the scale of a project as well as in choosing among different projects. Obviously, the scale of a project will affect the pattern of both costs and benefits through time. The optimal scale for a project at any given point in time is that for which the present value of benefits minus costs is a maximum. If scale is a continuous variable, then optimum scale is reached when the increment to the present value of benefits stemming from a small expansion of scale is just equal to the increment in present value of costs associated with that same expansion.[36]

2. *Criteria for deciding when to postpone a given project*

The existing literature on cost-benefit analysis typically is not at all explicit on the question of when to initiate a project. Failure to consider this choice can lead to serious mistakes, however. Suppose, for example, that a project could be constructed this year for a capital cost of $1,000, and would then produce a stream of expected net benefits having a present value of $1,050, evaluated at the relevant set of discount rates. It appears that this project is worth doing. Yet suppose that the same project, constructed next year, would have an expected capital cost of $1,050, and an expected present value of net benefits of $1,150. The net present value of the project would be $100, evaluated as of next year, or $100 $(1 + r_1)$, evaluated as of this year. Obviously, it pays to postpone construction of the project, so long as r_1, the rate of discount applicable for comparisons between this year and next, is less than 100 per cent.

The solution to the pure timing problem, as to when to do a particular project, is simply an application of the general present value rule. Let N_i be the net present value, evaluated as of today, of the project in question if it is to be constructed in the year i. The optimum construction time is then that year i^* for which N_i is at its maximum. N_i can vary with i because the capital costs of the project will depend on the date of its construction, and/or because the net benefit accruing in any future year will vary, depending on the date of construction (that is, depending on the age of the project), and/or because by postponing a project for a year we lose the first year's net benefits and gain an extra year's net benefits at the end of the project's life. All these elements are incorporated in the calculation of N_i for various starting times, and in the procedure of choice which choses i^* to maximize N_i.

A particularly simple special case of the timing choice occurs when net benefits accruing in any year depend only on the year (in the sense of calendar time) and not on the age of the project, and in which the anticipated capital cost of constructing the project does not change through time, and in which the project has an infinite life. In this case, provided that the net benefit stream is an increasing function of time in the neighbourhood of the optimal construction date, the optimal construction date is that point in time i^* in which the first year net benefits of the project are just equal to its cost of construction times the interest rate r_{i^*+1}.

The reasoning behind this is simple. Regardless whether the project is constructed in the year 0 or in year 1, it will be in operation from year 2 onwards. Therefore all net benefits from year 2 onwards will be present in either case, and the decision whether or not to postpone the construction of the project from 0 to 1 cannot depend on them. The postponement decision turns simply on the question whether the net benefits to be obtained in the year 1, which will be enjoyed if the project is already constructed by then, are sufficient to compensate for the cost of constructing the project one year earlier (in year 0 rather than year 1). The cost entailed in constructing earlier is simply the interest rate reflecting the opportunity cost of capital between 0 and 1, which we have denominated r_1. Thus the fact that net benefits will increase in the future does not justify the construction of a project now. The time to construct the project is when the immediately forthcoming benefits are sufficient to justify the immediate use of the capital funds in question.

In a slightly less simple case, if construction costs are expected to increase between this year and next, the requirement for construction this year is that the net costs of postponement (which now consist of the net benefit of year 1 plus the increase in construction costs between year 0 and year 1) be less than r_1 times the capital cost of constructing the project in year 0. Thus a project whose capital costs are expected to increase with postponement will qualify for earlier construction, while one whose capital costs are expected to decrease with postponement will require further delay of construction than was indicated in the previous example, which assumed capital costs not to vary with the date of construction. These modifications can be of some importance, for in some industries expected improvements in technology can lead to reduction over time in the capital cost of a project, while in other lines expected rises in labour and materials costs can work in the opposite direction.

An excellent discussion of the timing problem, including a consideration of the case of projects of finite life, which reveals only minor differences from that just outlined for the case of infinite life projects, is to be found in Stephen A. Marglin, ***Approaches to Dynamic Investment Planning***.[37]

[35] Op. cit. (see footnote 9 above), p. 39

[36] On these points, see Friedrich and Vera Lutz, op cit. (see footnote 1 above), pp 22-32, and Pierre Massé, op cit. (see footnote 20 above), pp. 42-81

[37] Amsterdam, North Holland Publishing Co., 1963, see especially pp 9 to 34

3. *The relation of investment decisions and timing to uncertainty and risk*

The conventional approach to making allowance for risk is well reflected in the following quotation:

> "It is recommended that net returns exclude all predictable risks, either by deducting them from benefits or adding them to project costs, usually on a present worth or annual equivalent basis. Allowance for uncertainties or unpredictable risks in benefit accrual should be made indirectly by use of conservative estimates of net benefits, requirement of safety margins in planning, or including a risk component in the discount rate."[38]

The difficulty with this statement, and indeed with most discussions of the subject, is that it is not explicit on how to cope with uncertainties or "unpredictable risks". Virtually all writers agree that predictable risks of fire, hazard etc., should be dealt with on an insurance basis. But when it comes to other types of risk or uncertainty, a wide divergence of opinion emerges. Eckstein argues that a premium in the interest rate is "the most useful adjustment for risk in project evaluation"[39] and Hirschleifer comes to a similar conclusion.[40] Arrow, however, argues[41] that the Government should display risk aversion, that is, should not incorporate a risk premium in the discount rate it uses, and Marglin maintains[42] that where the net-benefit stream is rising over time, the criteria arrived at in section D, 2, above, give appropriate guides to investment decisions and their timing, without adjustment for uncertainty.

The issue in question appears to be in large part (although not entirely) semantic. Eckstein asserts that future changes in technology will, if they occur at all, be improvements, reducing the net benefit to be obtained from an investment made today (which would in this case become obsolescent). Clearly, if the probability of such changes has not already been taken into account in the estimation of future net benefits, it must be considered at some point, and one way to do this is to give relatively less weight to future benefits by raising the discount rate applicable to them. Likewise, if future technological changes have not been adequately foreseen, taking them into account may alter the shape of Marglin's rising net benefit stream, and turn it into one which first rises and then falls, or one which falls uniformly with time. In this case the fact that next year's net benefits covered the interest cost on this year's investment in a project would not be a sufficient basis for justifying the project's construction; there would have to be further checking to see whether the present value of the (adjusted) net benefit stream was in fact greater than or equal to the capital cost.

In principle, Arrow and Marglin appear to be closer to the truth than those who would place an explicit risk premium on future net benefits, but this assumes that all estimates of future benefits and costs have been adjusted to incorporate our best guesses as to expected changes in these magnitudes. It may be concluded that an adjustment of the discount rate for a risk premium on future benefits is, by its nature, likely to be applied quite generally, implicitly assuming that "unadjusted" calculations of future benefits should be adjusted in the same way regardless of the type of investment, line of activity etc. Since expected changes in product prices and factor costs, and expected improvements in technology as such are likely to be very different for different types and lines of investment, the adjustment for these changes should be carried out by as detailed as possible an extrapolation of individual cost and benefit items on each project separately, rather than being dealt with by a global risk premium attached to future discount rates.

The procedure suggested here implicitly assumes that the Government does not have risk aversion as such, which appears to be a fair assumption since the wide variety of governmental investments ensures a substantial amount of risk reduction through diversification. Moreover, the private sector investments which yield the marginal productivity of capital that should be used as the discount rate in public investment decisions are themselves extremely widely diversified, and when taken in the aggregate as distinct from individually, appear to entail very little risk. Thus with both the public sector package of investments and its private sector alternative being widely diversified and therefore of relatively low risk, the assumption that the public authorities are neutral to risk appears quite reasonable.

E. Interrelations among projects

1. *Separability of components of a project*

Like the choice of scale of a project, the problem of dealing with separable components is readily handled using the present value rule. As the United States Federal Inter Agency Committee on Water Resources puts it:

> "Net benefits are maximized if the scale of development is extended to the point where the benefits added by the last increment of scale or scope are equal to the cost of adding that increment. The increments to be considered in this way are the smallest increments on which there is a practical choice as to inclusion or omission from the project. The same principle applies when selecting a number of projects to form a programme or system of projects to meet a given objective. To be justified for inclusion in a plan each project in a group, each purpose of a project and each separable segment of a project should add as much or more benefits as it adds costs."[43]

This principle is indeed the correct one to apply so long as all projects having a positive excess of benefits over costs can be financed, a proviso that we have assumed to be met, given the possibility of government borrowing. However, it is important

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[38] United States Inter-Agency Committee on Water Resources, op. cit. (see footnote 7 above), p. 23.

[39] Op. cit. (see footnote 11 above), p. 90.

[40] "Risk, the discount rate and investment decisions", *American Economic Review*, Evanston, Ill., Northwestern University, May 1961.

[41] Op. cit. (see footnote 18 above).

[42] Op. cit. (see footnote 16 above), pp. 31, 71-72.

[43] Op. cit. (see footnote 7 above), p. 14.

to recognize that the principle applies to large as well as small components of a project. A case in point occurred in the evaluation of the benefits of the publicly owned beet-sugar refining industry in Chile. Here large benefits were attributed to the indirect effect of the extension services given to farmers upon their general efficiency of operation. On the presumption that similar extension services could be given even if no sugar-beets were cultivated, the benefits in question should be attributed to the extension operation and not to the over-all sugar-beet project. Thus the extension operation could be viewed as a separable component, and evaluated separately from the rest of the project. When this was done, the main project turned out to be of dubious validity, even though the extension component was quite clearly worth-while.[44]

The careful examination of possibilities of separating components from a project is as important an aspect of appropriate design and evaluation procedures as the study of possibilities of adding components. It is, moreover, an aspect of cost-benefit analysis which has not received sufficient attention to date.

2. *Criteria for the evaluation of groups of projects*

The evaluation of groups of projects is quite similar in nature to the problem of dealing with separable components. There is no need to consider groupings of projects when their benefits and costs are independent, but when the benefits or cost associated with one project is to be different, depending upon whether or not another project is undertaken, the analysis of the projects so related should be done jointly. The appropriate method is shown below.

Let $PVB\ (A)$ stand for the present value of the benefits of project A if it is undertaken alone, and $PVC\ (A)$ stand for the present value of its costs (including both capital and operating costs) if undertaken alone. Correspondingly, $PVB\ (B)$ represents the present value of the benefits of project B, undertaken alone, and $PVB\ (AB)$ represents the present value of benefits of A and B taken together. A similar notation will be used for costs. Two projects are independent on the benefit side when $PVB\ (AB) = PVB\ (A) + PVB\ (B)$; they are independent on the cost side when $PVC\ (AB) = PVC\ (A) + PVC\ (B)$. The projects are:

(*a*) Complementary on the benefit side when $PVB(AB) > PVB(A) + PVB(B)$;

(*b*) Substitutes on the benefit side when $PVB(AB) < PVB(A) + PVB(B)$;

(*c*) Complementary on the cost side when $PVC(AB) < PVC(A) + PVC(B)$;

(*d*) Substitutes on the cost side when $PVC(AB) > PVC(A) + PVC(B)$.

Let $N = PVB - PVC$ be the net present value of any project or group of projects. The principle of choice is to maximize the total net present value. Thus if there are three projects which are interrelated on either the demand or cost side or on both, there will be seven possible options. A, B, or C can be undertaken alone, or A and B together, A and C together, or B and C together, or, finally, all three projects together. The criterion for choice in this case is reduced to finding which of the following seven magnitudes is the largest: $N(A)$, $N(B)$, $N(C)$, $N(AB)$, $N(AC)$, $N(BC)$, $N(ABC)$, and investing in that project or combination of projects.

This criterion for choice among groups of projects can be extended to any number of interrelated projects. It automatically takes account of the effects of any given project on the benefits and/or costs of other projects in the group. Moreover, it can also handle the problem of timing, simply by including as separate projects in the list the possibilities of constructing a given project at different times. Thus if we had two projects, A and B, and were considering the benefits of constructing either or both of them, with options of timing in years 1, 2, and 3, there would be fifteen possible options whose net present values would have to be compared: A_1, A_2, A_3, B_1, B_2, B_3, A_1B_1, A_1B_2, A_1B_3, A_2B_1, A_2B_2, A_2B_3, A_3B_1, A_3B_2, A_3B_3, and the problem would be reduced to finding which of these options had the greatest net present value, when the benefits and costs of all of them were discounted back to the same point in time.

[44] See Ernesto R. Fontaine, "Un analisis de los costos y beneficios sociales de la industria azucarera nacional, S.A.", in *Estudios de Economia*, Santiago, Catholic University of Chile, 1961, pp. 31-32.

XIX. FOLLOW-UP PROCEDURES AND PRACTICES

by H. T. Parekh*

INTRODUCTION

The framework of the work in the follow-up division of a development bank is the appraisal document and the heads of agreement governing a project. The appraisal document defines the project in terms of cost, means of financing, schedule of construction, the cost of producing its output and, assuming a rate of work, the profitability of the project. The heads of agreement, besides defining the project for which finance is provided, lay down the basis of the legal relationship between the development bank and the company being financed.

However, in the final analysis, the relationship between bank and company is a business relationship. While an appraisal estimates the cost and working of a project, such estimate is based on assumptions that might not turn out to be correct: the evolution of the project might turn out in practice to be on altogether different lines. Moreover, the ultimate justification of a development bank's operations is the success of its operations, and this cannot be had by recourse to its legal rights against a company. Follow-up work, therefore, requires of those involved in it a thorough understanding of a company's changing operations as it responds to the actual economic conditions prevailing in the country, and their approach must be flexible enough to enable the company to meet them.

India is a planned economy with a substantial role allowed to private initiative, particularly in medium industry. The operations of the Industrial Credit and Investment Corporation of India (ICICI) are concentrated in this area. Because the operations are in the private sector, follow-up on the working of the project needs to be done carefully.

Follow-up work commences immediately a project is sanctioned finance. When a project is sanctioned finance, ICICI requires the company to submit regular progress reports. These progress reports form the basis of the operations of the follow-up division.

There are two main phases of a project: construction and production. The problems in each of these phases vary. In ICICI, it is the practice to require the company financed to submit reports every quarter during the construction phase; every month in the initial stages of production, and every quarter subsequently. These reports are obtained both on the physical and the financial progress of the company. The information is then compared with appraisal estimates and scrutinized to anticipate problems that might require attention from the development bank.

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A. CONSTRUCTION PHASE

The problems in the construction phase relate to the arrangement of finance, delays in completing construction, overruns in costs beyond initial estimates and weak management.

Arrangement of finance

Because the projects financed by ICICI are in the private sector, arrangement of finance is not a matter of budgetary allocation. In a developing economy such as India's, the rate of saving is low, investment habits are not well developed and the institutional structure for providing industrial finance is limited. Consequently, arrangement of finance requires effort on the part of the promoters.

Besides providing the initial finance, ICICI assists in the above process in two ways: first, it supplies to other likely financiers its own appraisal of the project to enable them to arrive at a decision; secondly, where there is a marginal shortfall in the arrangement of total finance required for a project, ICICI comes in with additional financing to cover the shortfall.

Delays in construction

Since India is a planned economy, the Government exercises control over various economic matters. Government approval is required for raising capital, for importing items of equipment and for allocating controlled commodities such as steel and cement. As a result, a United Nations team calculated for example that a nitrogenous fertilizer project takes a year more to set up in India than in advanced countries. These procedural requirements also affect ICICI-financed projects.

In framing the construction schedule for a project, ICICI takes into account the requirements of government permission and provides for a construction schedule accordingly. However, even then, the completion of projects is delayed, partly because permissions are not obtained within the time estimated, acquisition of land is not made in time, building materials do not flow in as estimated, or delivery schedules of equipment become prolonged.

Many ICICI-financed projects have confronted delays for various reasons. Of the *228* projects[1] financed by ICICI, delays have been determined in *202* cases, as shown in the following table.

[1] The sample refers to *228* projects financed by ICICI, 1960-1965, and referred to in detail in the ICICI paper on appraising an industrial project in India. Of these projects, as at the end of June 1965, ninety four had been completed and 134 were at various preliminary stages.

TABLE 1. DELAYS

Delays	*Number of projects*			
	Completed projects	*Projects under construction*	*Projects in planning stage*	*Total*
Not delayed	24	28	13	65
Less than 6 months	19	9	4	32
Between 6 and 12 months	18	21	9	48
Between 12 and 18 months	15	15	4	34
Between 18 and 24 months	4	6	—	10
24 months and above	7	6	—	13
Not known*	7	11	8	26
TOTAL	94	96	38	228

* Under the category "not known" are included projects with phased manufacturing activities.

A development bank such as ICICI can help in reducing such delays only in a limited way: generally, with regard to government permissions, it tries to facilitate negotiations so as to expedite them.

Overrun in costs

Cost overruns occur because there might be underestimation of some costs and because delays in completing projects raise pre-operative expenses such as establishment expenses and interest charges above the levels initially estimated. Underestimation of costs generally occurs on site development; for example, site levelling work might turn out to be more extensive than estimated initially; or building construction, because, for example, owing to sub-soil conditions, foundation costs go up or, owing to a larger built-up area (often to provide for future expansion), the cost of building rises. Thus, in the case of a paper mill, the foundation costs increased because the area was in the earthquake zone; in the case of an alloy steel project, site development costs became higher to provide against flood; and, because of sub-soil water, the foundation cost of the civil construction required for a forge shop turned out to be much higher than earlier estimated.

Many of ICICI-financed projects have come across cost overruns. Of the 228 projects financed by ICICI, cost overruns have been determined in the case of 148 projects, as shown in the following table.

TABLE 2. OVERRUNS

Extent of overrun	*Number of projects*
No overrun	66
Less than 10 per cent	19
Between 10 and 20 per cent	23
Between 20 and 40 per cent	27
40 per cent and above	13
Not known	80
TOTAL	228

Note: the eighty projects included under the category "not known" consist of projects either still in the planning stage or in a preliminary stage of construction and whose the revised cost estimates have not been firmed up.

ICICI generally considers that it is the responsibility of the promoters to bring in the funds required to cover any shortfall in the means of financing, and this is incorporated as a condition for ICICI finance. However, very often the overruns are so large that it would not be possible to meet the requirements from the resources, personal and institutional, available to the promoter.

It is for this reason that ICICI generally insists on a strong equity base for a project, so that the promoter would be able to arrange for extra funds by way of loans to meet the overrun in the cost of the project. In such a case, where ICICI has given the initial finance as loan and taken a mortgage of assets, it is willing to cede a *pari passu* charge on the assets to a subsequent lender.

When such finance is not available from other sources and if ICICI remains satisfied about the viability of the project, ICICI itself also provides a part of the funds required to complete the project.

ICICI assists the project either by providing the additional finance or by rearranging the amortization schedule. In such a case it is the policy of ICICI to review the working of the project and to reappraise its future prospects to arrive at the financing decision. In the light of actual experience, such further financing would be made conditional upon adequate strengthening of the management. Of the 228 projects referred to earlier, ICICI has provided additional finance to sixteen projects and revised the amortization schedule in the case of fifteen projects.

Case (a). In the early stages of ICICI's career, an industrialist approached ICICI with an underwriting proposal for a pulp and paper unit proposed to be set up in a forest area of an underdeveloped State. While the industrialist had experience of other industries, this was his first venture into the paper industry. ICICI underwrote the whole of the public issue and was required to take up a substantial proportion of the share capital underwritten. Later, the project ran into difficulties, mainly because the region lacked transport and ancillary facilities, the project cost was found to be substantially underestimated and the promoters appeared to be incapable of handling a project of the size involved. ICICI at that stage suggested the appointment of a foreign paper technologist as a consultant, appointed a nominee director on the company's board and agreed to underwrite a part of the further issue of the company's share capital. The project was successfully completed, and ICICI was later able to sell off its holdings of the company's shares at a substantial premium.

Case (b). When ICICI considered its first proposal for a phosphatic fertilizer factory, it had little experience to prepare estimates of costs and working. And because the promoters were entering the industry for the first time, there was little data available from them. Gradually, cost estimates were built up, operating costs and profits calculated, and a financing decision arrived at. In the course of execution of the project, however, it was found that capital cost estimates had risen by almost 20 per cent, partly because adequate provision had not been made for the storage space so essential in a seasonal-demand industry such as fertilizers and partly because, with inexperienced management and delays, pre-operative costs had risen. The management was able to raise only a small part of the additional finance, and approached ICICI for further funds. It was a crucial decision for ICICI to re-examine the viability of the project in the light of the proved inexperience of the promoters. Ultimately ICICI agreed to provide the additional finance after it had made a revised appraisal of the project, taken assurances for the strengthening of the management and appointed an experienced executive of a chemical company as its nominee director on the board of the company. The project was completed within the revised estimates and proved so profitable that the company offered to premature the ICICI loans.

Working capital requirements

Very often, the promoter uses up the margin provided for working capital requirements to finance the overrun in the project cost. Conversely, it is also found that the requirements on working capital account increase because prices rise or, owing to control procedures, larger stocks of raw materials and components have to be held or, owing to adverse market conditions, stocks of finished goods accumulate. Where the company has also at the same time undertaken another project, the financing of such a project would be jeopardized.

Case (c). ICICI provided to a structural shop, depending upon job-work, a loan to enable it to take up manufacture of a regular line of production. In the process of executing the project, the company failed to obtain job-work on the scale anticipated, with the result that the cash accruals needed to finance the new project did not come up as estimated, and a large part of the funds, raised according to plan to finance the new project, was locked up in inventories. The company's shares were quoted on the market at a discount, making the raising of further capital by way of a share issue difficult. The company therefore approached ICICI for additional finance through a loan although its assets were inadequate to support the further borrowing. ICICI agreed to provide an additional loan, although this reduced the margin below the normally acceptable limit, introduced the company to a banker who agreed to provide short-term financing against increased inventories, and proposed the issue of unsecured convertible debentures to provide for the additional long-term finance needed by the company.

Weak management

Very often management is weak, and does not have the drive or industry-consciousness needed to carry through a project. In such a case, ICICI imposes a condition regarding strengthening of management and sometimes requires the promoter to be backed up by adequate consultancy arrangements.

Case (d). ICICI underwrote the share issue and gave a loan to a company in a complex-technique metallurgical industry. There was a substantial overrun in the cost of the project, and the company approached ICICI with a proposal for underwriting the further issue of share capital. ICICI was not satisfied with the management's approach in handling the problems facing it, and obtained a report on the technical problems facing the company from a reputed firm of Indian consultants in the metallurgical field. In view of the problems involved, ICICI provided a loan to the company (instead of underwriting the share capital, as proposed), on the understanding that the promoters would carry out the consultant's recommendations, and appointed a director to the company's board. As a result, the promoters gradually began to appreciate the technical implications of the project and brought about changes in approach to tackle the problems. The company is now operating satisfactorily.

Case (e). An Indian technician-*entrepreneur*, after a stay abroad for several years, returned to India to set up a project. ICICI provided a large foreign currency loan. Not being conversant with local conditions, the *entrepreneur* was able to make only slow progress on the project. Moreover, as the project was located in the interior, the promoter was unable to obtain suitable contractors to carry out the work. ICICI reviewed the progress of the project, appointed a nominee director, and agreed to consider the further financing of the project, if found necessary. At the same time, the promoter was encouraged to enter into an agreement with a reputed consultancy firm which undertook to execute the remaining portion of the job on almost a turnkey basis.

The follow-up division, in watching over the progress of construction of a project, has also to ensure that disbursement of the development bank's funds to the project is made in keeping with the progress of expenditure and the financial plan of the project. Before disbursement commences, the development bank has to assure itself that the required preconditions, for example, that relating to the raising of share capital or the provision of adequate financial arrangements, are satisfied by the company. Thus, disbursement of funds cannot exceed the total amount of expenditure incurred on the project. Since a project involves financing from the resources of the company (whether internal or those raised from the market) and of the development bank, the development bank has to ensure that adequate financing is effected from the company's own resources before it calls upon the development bank to disburse out of its funds. Where a development bank gives a loan, disbursement on the loan is made generally after the required share capital is raised and used up by the company.

After a project is completed, it is generally the practice of ICICI to review the total construction phase of the project and to compare it with the appraisal estimates. The review seeks to analyse the differences between the appraisal estimates and the actuals, for example, regarding the construction schedule or the capital cost of the project, and determine the factors making for the differences. The review therefore helps to provide guidelines for improved estimation procedures.

B. Production phase

The problems that a project faces in the production phase are mainly technical ones of developing production, improving inadequate supplies of raw materials and marketing.

Technical problems in developing production

Many projects face teething problems in developing production. These relate to inadequacies in the engineering details of the plant, the use of non-standard raw materials, and lack of development of labour skills. In many chemical projects, the main problems arise because of plant or raw material difficulties. In the engineering industries, skill development is a major problem and, for individual companies, the difficulty of retaining trained labour. For example, in the case of ICICI-financed forge shop, it was found difficult to build up production as labour-skills had developed gradually. And in the case of a spun pipe project, it was found that the rejection rate in the initial stages ranged from 20 to 30 per cent of production. In the case of a textile machinery-manufacturing plant, special steps were taken to train staff both in the designing and production sections.

Case (f). ICICI financed a project for the manufacture of an insulating material based on a process developed by a national laboratory—a small project started under a new company. The project needed additional financing for its completion, and ICICI provided a part of this. However, at the production stage, the company faced unanticipated technical difficulties. After consultation with the laboratory which had developed the process, it was determined that a special variety of metal would need to be imported for process purposes. ICICI took up the matter with the Government and made possible the import of the material, financed out of the remaining portion of the ICICI loan.

Raw material supplies

Many projects work on imported or controlled indigenous raw materials and components. The supply of these is based on governmental allocations and with competitive demands for limited supplies, the allocations are not adequate for the requirements of industries.

In a developing economy, this is a constantly changing problem. As indigenous production of commodities increases, the nature of requirements of imports changes. In India, for example, the composition of imports has changed radically from finished goods to components and raw materials.

Marketing problems

In a developing country, marketing presents many problems. Where a product is manufactured for the first time, there is no basis for forming estimates of market demands. For example, when an ICICI-financed hardboard project went into production, it was found that there was not sufficient demand to take up its output, even after considerable reduction in the price of hardboard. It became necessary to educate the public in the uses of the new material and develop an elaborate sales organization. This had to be done also in the case of particle board, where technical staff had to be recruited for the purpose.

In India, the sellers' market has ceased to exist in the case of many commodities. This is due to many reasons. While the industrial licensing system seeks to limit industrial capacity within the estimates of demand (indigenous and export) for the project, these estimates have not proved accurate. Among other reasons, there has sometimes been a bunching of projects at the production stage, with the result that the market has failed to absorb the whole of the output from these projects. This happened, for example, in the case of figured and wired glass projects for which ICICI had provided finance. Moreover, the over-all rate of growth of the economy has been lower than estimated. Secondly, demand for various goods is interrelated, and where the supply of a basic product is inadequate, it leads to a lower demand for other goods. Thus, because of inadequate supply of cement, the demand for housing materials such as pipes, sanitary ware and glass is reduced; because of inadequate electricity capacity and cement supplies, demand for electric cables and electric meters becomes lower than estimates.

Many ICICI-financed projects in these lines have therefore come up against difficulties. While some of these difficulties are transient, others may not be so short-lived. A development bank can help a project in such a case by rearranging the amortization schedule and inducing the Government to give it export incentives or by enabling the project to diversify its operations.

Other problems

In addition to the above, other problems arise which are not related so much to projects as to personalities. Such problems, for example, are those relating to conflicts between the local partner and his foreign collaborator. A foreign collaborator brings to his function different perspectives; owing to the different backgrounds in which he has been used to operate, his attitude to various construction and production problems differs from that of the local partner. A degree of adjustment is required for the two partners to operate smoothly in the economy.

Case (g). In a chemical-based project financed by ICICI, disputes arose between the Indian *entrepreneur* and his foreign collaborator. Mediation was sought from ICICI. Initially, the reaction of the foreign collaborator to the effort was adverse. However, ICICI explained its position to the foreign collaborator, advised the Indian *entrepreneur* to make a special trip to visit the collaborator and discuss the issues across the table. As a result, the two parties arrived at a workable understanding for the further execution of the project and the role of each in that task.

On the other hand, where a promoter forfeits the confidence of the development bank, there is no recourse but to take decisive action on the basis of legal remedies available to the development bank. This is a case of human failure and, while it is not possible in all cases to anticipate it, it requires firm action when discovered.

Nominee directors

As a condition of providing finance, ICICI requires the right to nominate a director on the board of the company. Where the finance provided by ICICI is large in relation to the total cost of the project or it is felt that for other reasons the project needs to be closely looked after, ICICI generally exercises the right to appoint a director to the board of the company from the beginning. In actual fact, ICICI has so far appointed directors to less than 10 per cent of the companies financed by it. Of the 228 projects referred to earlier, ICICI has nominee directors on seventeen projects.

Such a director is appointed with the consent of the promoters and is an outsider whose services would be of use to the company. ICICI's nominee directors have come from industry, the civil service and other fields, and their presence on the board, besides being of use to ICICI in enabling it to remain in close touch with the progress of the company, has been of considerable help to the companies in their operations.

It is ICICI's policy to appoint non-ICICI personnel as nominee directors. This ensures that the nominee director brings an informed, but independent, outlook on his assignment and is able to enjoy the confidence of the promoters. Generally, the presence of ICICI's nominee directors has been appreciated by the promoters, and the nominee directors are an important link between ICICI and the companies assisted by it.

Perspective of follow-up work

Ultimately, the main utility of follow-up work is to provide a feed-back for improved appraisal procedures. The differences between the appraisal estimates and the actual evolution of the project might arise because the assumptions on which the appraisal estimates were made might not be correct or because of the intervention of fortuitous circumstances which could not be anticipated at the appraisal stage. For example, where the supply of raw materials or the demand for finished products is highly seasonal, as in the case of case (*b*) mentioned above, it should be possible to anticipate the storage and finance requirements for the maximum inventories to be held. On the other hand, it is not possible to anticipate the changing government policy on import of raw materials, which would affect the working of an enterprise dependent upon imported raw materials.

As experience is built up in the follow-up division, it should be possible to acquire data on costs or factors influencing the construction schedule of projects, and on the role of skill development in affecting the build-up of production. These data can then act as a cross-check on the estimation procedures of the appraisal division. The validity of the appraisal estimates can be enhanced to the extent that it tries to incorporate in its procedures the lessons gathered in the follow-up work.

The follow-up function is not standardized but presents diverse problems. The follow-up staff has to be capable of meeting these problems. The basic requirement for carrying out this function is to anticipate problems before they become serious and to provide a flexible response to overcome them. The staff of the follow-up division have to have an adequate background in professional disciplines such as economics, accounting or engineering, but must also be able to take an over-all view of the problems facing the company and suggest remedies for meeting them.

The essential concept of follow-up is partnership between the development bank and the company financed by it to bring the project to successful fruition. This is the basis of the functioning of a follow-up division in a development bank.

XX. FOLLOW-UP

by B. Berkoff*

Introduction

It is essential for the success of any industrial undertaking that, once its form and size have been determined and the management has been selected and supplied with the necessary financial and other facilities, the management should be left to discharge its functions with the minimum of interference. Nevertheless, the supporters of the project—those who have provided money or facilities for it—will normally wish to keep in touch with its progress so as to be satisfied that the intended objectives that they have in mind are pursued and fulfilled, that their investment is safe and will become remunerative, and that any special privileges or assistance which may have been extended to the project are justified. Moreover, the project itself will benefit from the existence of third parties who are to a certain extent identified with it, who are regularly kept acquainted with its progress and its problems, and who can be expected to react readily when external support—financial or otherwise—is needed.

The function of the activities comprised within the general heading of "follow-up" is to build and maintain a system and a relationship which satisfies these needs. In the absence of some such system it would be possible for all those who have supported the creation of the project, but who have no part to play in its management, to lose sight of it and become disinterested; it would also be possible for the management to depart from the original purposes of the project or to manage it badly, without the knowledge or consent of the project's supporters.

There is one aspect of follow-up activity which is clearly germane to the subject of this Conference, namely, that it can be used as a check on the efficacy of the evaluation methods used during appraisal and as a means of building up experience to be used in future evaluations. But this is only one function of follow-up and by no means the most important. It has a much more constructive role to play in industrial development and it would be misleading to discuss it from that one narrow viewpoint. This paper will, therefore, endeavour to give a comprehensive view of its functions and the methods commonly employed.

As explained later, the objectives and principal concerns of the person conducting the follow-up activity are different in different cases. He will not in every case be interested in all the objectives listed; in some cases he may be interested in only a very few. For the sake of orderly consideration, however, I shall now put forward a comprehensive list of the purpose it is designed to achieve.

For brevity I shall refer to the institution or person who is to be provided with follow-up information as "the financing institution". In many cases this will be a fitting description: the insitution concerned will in fact be a financial concern—such as my own company, CDFC; but, for the purposes of this paper, the phrase will also include a parent company receiving reports from a subsidiary; a development corporation or a government department receiving reports from a wholly or partly publicly financed industrial project; a government agency which controls the grant of industrial incentives receiving reports from a beneficiary company and so on.

A. The functions of follow-up activity

Follow-up activity has two prime purposes and three important side-effects. The prime purposes are:

First, check that the project follows the agreed lines and is conducted skilfully, vigorously and profitably.

Secondly, to create a relation of partnership and understanding between the management of the project and the financing institution, so that they both have, and are regularly reminded that they have, a mutual interest in consulting about and resolving the major problems of the project.

The side-effects are:

First, the maintenance of a living interest on the part of the financing institution in the project, so that when the time of expansion or extension is reached, its support, particularly financial support, is likely to be readily forthcoming;

Secondly, the necessity it creates for the management of the project to install an effective system of producing management accounting information; while it would seem impertinent to refer to this effect in cases where the management is experienced and efficient, this will sometimes not be the case in developing countries; with a new and inexperienced management, insistence upon proper follow-up reports can have an important beneficial effect on the control of the business;

Thirdly, the provision of a check on the efficacy of the financing institution's appraisal methods and the collection of information and statistics about industrial performance which can be utilized in the study of other industrial proposals; this could be of significant benefit in developing countries where there are no published statistics—perhaps no adequate records—of industrial costs, yields and ratios of profit; the experience accumulated from following up a considerable number of industrial projects can create a valuable reservoir of experience for the

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benefit of subsequent developers and for the appraisal of their proposals.

To take the two broad declarations of purpose in a little more detail: the first one, which might be called the "supervisory function", will be directed to checking whether:

First, the resources allocated to the project are used in accordance with the agreed description;

Secondly, the management is capable, active and responsible;

Thirdly, management's physical and financial controls are adequately deployed and function speedily and accurately;

Fourthly, financial estimates are adhered to;

Fifthly, the financial results are acceptable

In the event of any of these requirements not being fulfilled, the financing institution will inquire into the reason for the shortcomings and look to see whether corrective steps are put in train.

All the above are really different aspects of management. Follow-up, in its supervisory function, is little more than a system of keeping a watch on management. It may be of interest to note here that a well-known firm of business inquiry agents each year prepares an analysis of the reasons for the failure of businesses (bankruptcy or liquidation) in Canada and the United States. The following summary table sets out the causes of the failures listed by the firm for the year 1964:[1]

CAUSES OF FAILURES OF FIRMS IN 1964

	Canada	United States of America
Total number of failures	2,499	13,501
Causes of failure (in percentages):		
Neglect	1.5	2.8
Fraud	0.8	1.9
Lack of experience in the line	5.2	8.8
Lack of managerial experience	23.2	20.9
Unbalanced experience	13.2	19.7
Incompetence	55.3	42.5
Disaster	0.6	0.9
Reason unknown	0.2	2.5
	100.0	100.0

To avoid misunderstanding it may be noted that the number of failures recorded is a minute percentage of the total number of firms in business in the two countries. Nevertheless the percentage of failures attributed to incompetence and other shortcomings of management is dramatic and highlights the overwhelming importance of management for the success of a business. Management needs to have the qualities with which to deal fairly and effectively with its employees, that is, integrity, honesty, a sense of fairness and the ability to communicate. It needs technical skills in the fields of design, production, accounting, financial control and selling. It needs foresight and the ability to look ahead, so as to ensure that today's decisions are consistent with the probable circumstances of tomorrow. It is also desirable that it should have the ability to look critically at itself and judge whether it is using all these qualities in the most effective and far-sighted way, and the flexibility to change its course if necessary.

It is in relation to this critical function that the financing institution can sometimes be of particular help to the management. An English proverb says that the onlooker sees most of the game; the financing institution, looking at the progress of the business with a more detached eye than management, may well see the picture in better perspective and be able to give useful advice. This will be most likely to occur if a follow-up system is devised which provides in a succinct form a set of indicators to show how the business is progressing and the management discharging its functions; and if the financing institution is regarded as a candid friend whose suggestions for improving the conduct of the business are treated as helpful advice and not as a hostile judgement.

This observation leads us directly to the second broad purpose of follow-up, which has been described as creating a kind of partnership relation between the financier and management. If the financing institution is regarded as nothing but a policeman, an outsider whose only connexion with the business is to act as a judge and critic, a defensive attitude on the part of the management is likely to result. In that event, suggestions made by the financing institution could well be regarded as adverse criticism rather than constructive help and be met by resistance. If that happens, persistence by the financing institution could lead to a breakdown of good relations. To ensure a fruitful relationship between the two interests, the creation of a sense of partnership, mutual support and mutual respect is of vital importance. This calls for care, judgement, tact and forbearance.

Of course, the context of the relationship will have an important bearing on this aspect of the question. In the case of a parent company and a subsidiary where the senior management of the subsidiary may be old friends and colleagues of the staff of the parent, their relations will generally be less fragile than where a purely financial institution or a government department is making comments on the performance of a company staffed by men who are comparative strangers to it. This question will be dealt with in somewhat greater detail later.

The first of the three side effects mentioned above is the obverse of the objective just described. A good system will not only encourage the management to feel that the financing institution is a friend and partner, but it will also maintain the interest of the latter in the project, so that it will assist whenever necessary and possible. It may, for instance, be able to help find senior staff or arrange training for them, or to use its influence to hasten the supply of utilities or capital goods. Above all, when further

[1] Dun & Bradstreet Inc., New York, "The failure record through 1964". Dun & Bradstreet of Canada Ltd., "The Canadian failure record through 1964".

funds are needed for an expansion, or to tide the business over a period of difficulty, the basic relationship should be such that the financing institution will naturally expect to be approached, will be so involved in the project that it will be likely to agree, and will be less likely than any outside source of finance to fall into any misunderstanding about the business and the reasons why extra finance is needed.

The second side-effect can be an important contributing factor to the growth of management expertise in developing countries. A frequent characteristic of inexperienced management running an industrial enterprise, even a small one, is that it has no efficient way of keeping itself rapidly informed of developments in the business. As long as the business is so small that one man can be in charge of all the management activities concerned with production, selling, accounts and finance he will generally have a shrewd idea of any shortcomings, although unless he is very active and methodical some aspects of control are likely to fall behind. When the business is big enough to necessitate delegation of management functions, the proprietor or general manager will lose close control of it unless he institutes a system by which each of his senior managers provides him at regular intervals with an up-to-date and fully informative summary of the part of the business for which he is responsible. Without this he will not be able to keep proper control of the business; he will not be able to keep the different activities of the business properly correlated; he will learn of shortcomings a long time after they should have become apparent. By requiring follow-up information, the financing institution provides an extra incentive for the installation of a system for producing complete management information quickly and accurately.

The final side-effect is the information it provides and the lessons it teaches for use in future appraisals. It will throw light both on the efficacy of the management's estimating and forecasting procedures and on the financing institution's methods of appraising and evaluating them, on the methods used to assess the market, and so on. It will provide the financing institution with many sets of comparative figures to which the latter can refer when making appraisals in subsequent cases. It can also indicate particluar aspects of project preparation. For instance, systematic analysis of follow-up reports will give early warning to the staff of a financing institution that, in a certain country, capital estimates are regularly understated because managements do not make adequate allowance for inflation, constantly changing import duties, frequent labour troubles and so on. If a number of follow-up reports indicate poor performance by civil contractors of a certain nationality, due perhaps to difficulty in getting good supervisors to go overseas, this will put the staff of the financing institution on its guard when sponsors of a new project propose employing contractors from that country.

In countries where there are publicly published industrial statistics, the efficiency of the management can be measured by comparing certain significant figures extracted from follow-up reports against similar industry-wide performance figures obtainable from the publications. In countries which have no such statistics the records of financial institutions may provide a valuable statistical nucleus for the later guidance of industrialists and financiers.

B. Follow-up techniques

These may conveniently be considered under three heads: personal links; reports and budgets, and processing of reports.

It will be assumed that in every case the project is a new development undertaken by a company which has no other business. This will enable the main principles to be discussed without the complication of such questions as allocation of overheads between two or more manufactures carried out by the same company.

1. *Personal links*

This is the most important feature in the building up of an optimum relationship between the financing institution and management. Many financing institutions insist on nominating one director to the board of the company financed. Some demand the right of nomination, but may defer making a nomination so long as the company prospers. In all cases, whether or not the right of nomination is obtained, the contract requires the management to provide all facilities for regular visits by representatives of the financing institution, at which they are to receive any information they desire.

Whether the personal link is a nominee director or a representative who pays periodical visits, his personality and the attitude he adopts in his contacts with the management can have a major influence on the relations between the two concerns. In the majority of cases this role is given to an accountant, although experienced businessmen have also been successfully employed. While there seem to have been fewer cases of inadequacy among accountants than among non-accountants, the desirable professional background of the man to be selected needs to be judged according to the circumstances of the business and the abilities and shortcomings of the management. Where there is a one-man or very small management, it is wise to choose a nominee director whose abilities complement the skills of the management. For instance, if the business is in the hands of a small group who have selling and financial experience but are weak on industrial techniques, there would be virtue in nominating a man with engineering experience (provided he also understands finance), until experience has shown that the senior technical staff merit full confidence. A more frequent shortcoming is that the directors and senior management lack experience, and perhaps understanding, of management accounting and financial control. Hence the general preference for accountants in the role of personal link.

While visits by a representative of the financing institution are useful and, if skilfully handled, can be very effective, the position of a nominee director is quite different. By joining the board of the company he becomes a member of the management "family", with director status, with regular access to much confidential information and with a place at the table when the project's main problems are being discussed. He receives a director's fee from the company and the company's problems and policy are put before him automatically. Between directors' meetings, senior members of the staff will regard him as a man to be consulted on problems falling within his own special field. All this results, on his side, in his developing a loyalty to the project and, on the side of the company, in his being regarded by the directors and management as one of them. Thus there builds up a relationship of confidence which is generally not within the reach of a man who is no more than the representative of the financing institution calling at intervals to ask questions, however skilfully and tactfully; such a man is clearly a visitor from outside.

This perhaps gives a somewhat idealized picture of the nominee director in real life. There have been cases of nominee directors—and this is perhaps particularly true of government-appointed directors—whose conduct places stress on their representative capacity and makes clear that they are at the board meeting merely to look after the interests of their appointor. In the majority of cases, this attitude is a mistake. The nominee director's responsibility to his appointor is a factor which he should always remember, but he serves his appointor's long-term ends more effectively if he makes himself a true member of the team controlling the business of the project.

There have been cases of the sponsors of a project specifically asking the financing institution to appoint a nominee director, either because of a recognized gap in the expertise of the proposed management or because of a general lack of experience on the part of the proposed board of directors. This shows a degree of sophistication on the part of the sponsors and confidence in the financing institution that is not always present. The reverse attitude is frequently met: the management contends that the financing institution's only function is to provide money and that thereafter it should leave the company entirely alone. In such cases the appointment of a nominee director or the arrival of a representative of the financing institution may be viewed with suspicion and difficulties put in the way of giving him the information he needs. Great understanding and tact is needed to overcome this kind of resistance; the nominee director or representative should be on the look-out for an early opportunity at which he can proffer some advice or help which is clearly helpful and disinterested and in no way critical. When this occasion arises, if the opportunity is cleverly taken, the results can be beneficial out of all proportion to the actual service provided.

In addition to the nominee director or visiting representative, it is desirable that somebody else in the financing institution should become acquainted with the management. This has two principal objectives: the first, to avoid being completely dependent on one man's viewpoint; the second, to create two levels of contact with the project.

The nominee director's exchanges with the management will normally—although not always—be essentially functional, and he himself by becoming involved in the common effort to make the project succeed may lose a little of his detachment. A different view will be obtained by another member of the financing institution—preferably someone at a higher level—meeting the management, perhaps once or twice a year, merely to become acquainted with them, form a view of them as persons and gain an idea of their business philosophy without the distraction of discussion on practical details. In addition to the different perspective this gives, it adds a valuable element to the relations between the two concerns.

Considerable attention has been devoted to this aspect of the subject, because it is of great importance. Careful and sensitive attention to it will greatly facilitate the acceptance by the management of comments and suggestions made by the financing institution. Suggestions can be imposed by force, as it were, in the case of a parent company which feels dissatisfied with the management of one of its subsidiary companies, but imposition by force is not generally open to a financial institution which does not hold a majority of the shares; nor does it obtain the best results in the long term, even in the case of a subsidiary. Suggestions can be put forward from the outside, by a financial institution which maintains itself at a distance and has a relationship with the management which is "correct" without being friendly, in which case they may well meet with resistance and resentment. The best solution is to create the position where they come as welcome advice from one whose interest in the success of the business has been demonstrated by a course of conduct.

A further probable consequence of a close relationship will be that the financing institution will learn much earlier if the management anticipates difficulties, shortfalls or other operating inadequacies. One confides one's weaknesses to one's friends much more readily than to a distant business acquaintance. This can, on occasion, mean that the financing institution can propose remedial action earlier than if the management feels that its dignity require it to avoid disclosing impending trouble to its financial associates.

The foregoing may have given the impression that the nominee director will usually be a member of the staff of the financing institution. This will frequently be so, but is not essential; it may even be impossible owing to manpower shortages. There is no reason why suitably qualified men from outside should not be employed for this purpose; they have, in many cases, been employed with success. They must, of course, be fully briefed by the financing institution and the management of the project must be satisfied that they have no competing interest and can be trusted with confidential information; and a particular member of the financing institution's staff should be named as their normal contact, so as to provide continuity on all sides.

An example of a financing institution which has set up an elaborate organization to provide a high degree of contact with managements is the Puerto Rico Economic Development Administration, which has an Industrial Services Department whose special function is to act as a link with each new development it has promoted. This department gives the organizers of the factory assistance in setting up and installing equipment; in seeing that outside utilities are brought in; in recruiting and training personnel; in the provision of homes and schools for the families of personnel brought in from abroad; and it keeps a general watch on the factory's operations. As an administrator said at a conference in 1961: "We are prone to attribute the high productivity rates our workers have achieved in Puerto Rico to this broad programme of after-care. After all, it makes no sense to spend hundreds of thousands and sometimes millions of dollars in establishing industrial plants and then see them close down for lack of sympathetic advice given promptly."[2] This system is an elaboration of the ideas presented here. It is particularly suitable where small industries are fostered or management expertise is very scarce.

2. *Reports and budgets*

(a) *Capital progress reports*

Most financing institutions call for frequent reports during the construction of a project, that is, while the capital funds are being laid out in the building of the factory and the installation of machinery and facilities. CDFC generally requires these reports to be supplied once a month if the construction period is reasonably short, say up to eighteen months; otherwise, once in three months. The reports will usually consist of statements of the amounts expended on various items of capital, together with a physical description of the progress achieved; they are accompanied by information about major contracts placed by the management. CDFC's appraisal procedure includes securing summary detail of all major contracts placed for site development, building construction or supplies of plant, machinery and equipment. With each capital progress report, the management is required to bring this information up to date.

Normally, an official of the financing institution would visit the site from time to time to obtain visual verification of the reports. CDFC, being separated from most of its projects by some thousands of miles, cannot conveniently do this, so it asks for, and has never had difficulty in obtaining, photographic confirmation.

Receipt of these regular reports and supporting data enable the financing institution to ascertain whether:

The money is being spent at the rate forecast;

It is being spent in the way agreed;

The progress of each different element of the plant is correctly phased in relation to the others;

Estimates of expenditure are likely to be exceeded.

The capital expenditure should be broken down in the report into a number of headings, which can be compared with the corresponding breakdown furnished by the sponsors of the project when applying for the finance. The breakdown should be sufficiently detailed to make plain whether any part of the construction is out of phase.

When construction of the project is completed, CDFC usually asks for a final cost analysis giving a breakdown of the capital costs into the constituent elements of each section. Such an analysis gives a clear picture of the way estimates are fulfilled. It provides a useful check on the management's own estimating practices, which should be of value to it in relation to future capital expenditure; and it provides the financing institution with information about the degree to which estimates have or have not been fulfilled and about actual costs of the items of capital used, which will be useful for reference in subsequent appraisals.

(b) *Operating reports*

When construction is finished and the plant has gone into operation, a new type of report is called for and the interval between reports can generally be lengthened. The general practice varies between three-monthly and six-monthly reports. Some financing institutions have in the past required monthly operating reports, but have abandoned them as not sufficiently informative, or even misleading because of the distortions introduced by short-term fluctuations in expenses and earnings. On the other hand, an adequate watch on the liquidity position cannot generally be kept if reports are supplied at long intervals such as twelve months. This is particularly important in businesses which are affected by seasonal influences. This is exemplified by the following details taken from the monthly balance sheets of a fertilizer factory whose selling season extends from April to October, sales being at their highest in August-September; most of its manufactures between November and April go into stock:

[2] "Industrial development in Puerto Rico", paper included in *Methods of Industrial Development, with Special Reference to Less Developed Areas* (ed. A. Winsemius and J. A. Pincus), OECD, 1962, p. 107.

(*table follows*)

Details from monthly balance sheets of a fertilizer factory
(*in* £'000)

	Stocks	*Debtors*	*Creditors*	*Overdraft*
January	1,700	325	200	425
February	1,850	425	280	620
March	1,850	750	280	800
April	1,990	1,000	300	1,450
May	2,200	720	280	1,360
June	2,400	625	340	1,500
July	2,450	780	425	1,400
August	1,950	1,200	410	1,200
September	1,800	1,200	375	700
October	1,250	1,100	325	190
November	1,200	750	280	125
December	1,400	700	200	450

It will be clear that the liquidity position and the state of the company's working capital will have an entirely different appearance in returns prepared at the end of March, June, September and December. If the financing institution were content with a report prepared every December (or, worse still, every November), it would never see the company's finances under their biggest strain, and might therefore be oblivious of structural weaknesses in them, or even of a dangerous situation impending. For a company with such a highly cyclical business, three months is the maximum desirable period to elapse between reports. In the case of a company whose business follows a steadier, less dramatic pattern, six-monthly reports will probably suffice.

The financing institution will, of course, ask for the information in a form which facilitates its own survey, but it is worth taking trouble to make the form as nearly as possible similar to the returns which the company's management should, in the interests of proper control, require for its own internal control purposes. It is recommended that the reports should be signed by a director of the project company and not be treated merely as an accountant's exercise.

In cases where the financing institution has appointed a nominee director, it is generally also advisable for the operating reports to be forwarded through him, so that he can add his own comments and views. Most financing institutions require every report to be accompanied by a summary balance sheet prepared at the same date.

In addition to the reports supplied by the management, the financing institution will, of course, receive copies of all audited accounts of the project. This will enable the management's figures to be verified at least once a year by comparison with figures produced as a result of a professional audit. This can sometimes disclose significant weaknesses in the internal accounting system. In one case brought to our notice by another financing institution, the management submitted an operating report showing a profit of £8,000 for the previous six months; this was followed by audited accounts which indicated a loss of about the same amount for the same period. An accountant was sent by the financing institution to look into this and he found poor quality accounts staff and a virtually complete absence of any stores control.

(c) *Budgets*

The capital progress reports will, of course, be compared with the original estimates and so, for a period, will the operating reports. However, it would be a remarkable coincidence if actual operating results were ever to coincide precisely with the estimates. In the one, two or three years that will have elapsed between the preparation of the estimates and the starting up of production, many circumstances may have changed. There may have been changes in the markets; in the competition; in customs duties; in fact, in any one of a large number of circumstances. The comparison of operating returns with original estimates should not, therefore, be pressed very hard. It is more important to ensure that the business is progressing satisfactorily and reaches profitability at an early stage, rather than to display concern about failure to achieve the original forecasts. In fact, as soon as production has started gathering momentum, it is probably better to put the original estimates away in the file and never to refer to them again except for some specific reason.

At that stage, the question whether to require a yearly budget may be considered. This is one of the tools used by modern management for the control of business. It either remains unchanged throughout the year ("fixed budget") or is modified in the light of experience every month or every quarter ("flexible budget"). In cases where a project is operated by a subsidiary of the financing institution, an annual budget is practically always required by the parent company, which approves it (perhaps after requiring it to be modified) and then uses it as a standard by which to judge the project's performance during the year. Where the parent-subsidiary relationship does not exist, it is a matter for consideration in each case whether the financing institution should require to see the management's budget for each year. It is not usual to do so, but with inexperienced managements the financing institution's comments on the budget, and on the comparison of actual results with budgeted results, may play a useful educative role.

3. *Processing of reports*

The financing institution should have a systematic method of dealing with the reports. In CDFC, capital progress reports are first studied by the technical staff, who are best able to interpret the technical and practical implications of the report; check performance and prices with the forecasts and with the terms of the major contracts placed for the project, and perceive the reasons for variations from estimates. The technical staff then pass the reports and their comments to the accounts staff, who check the figures, take note of the state of the capital expenditure and make any corresponding adjustments they think necessary in their own disbursement forecasts. If their study of the reports suggests that any change should be made in the capital estimates, they advise the CDFC management and the question is raised with the project management.

When construction is completed, or sometimes when it is well advanced though not yet complete, the accounts staff take over responsibility for study of all further reports, whether concerned with capital expenditure or operating results, consulting the technical staff only in case of perplexity. The accounts staff who undertake this work have duties other than follow-up, but they are not the same as the staff who studied the original application for finance, although they have ready access to the appraisal staff in case of need.

This procedure is not universal. In fact, there seem to be several variants of it. Some financing institutions leave follow-up work largely in the hands of the staff that examined the original application. Some allow all reports to be handled by a specialist follow-up section composed of accountants who do no other work; its members may include an engineer or may call for help from engineering staff only if they think it necessary. There are possible drawbacks to each form of organization: a man following up a project on which he originally reported enthusiastically may be under a temptation to close his eyes to shortcomings which reflect on the quality of his appraisal; there is some danger that staff whose only work is the study of follow-up reports may become bored and, therefore, less effective (this risk will be reduced if the same staff visit their projects from time to time, but this may be inadvisable if there is a nominee director). The management of the financing institution must decide on the best organization in the light of the number and type of men available, the kinds of projects involved, and the degree of follow-up control they consider it necessary to exercise.

Capital progress reports will be studied to obtain confirmation of the four main points previously listed when discussing the form of the reports. The reasons for discrepancies from the original estimates will be sought and recorded and the appropriate lessons drawn. The consequences of any likely delays in construction or delivery on, first, the completion of the whole project and, secondly, the correlation between different parts of the plant, will be considered. Delays in starting up the plant will generally result in a need for further capital, because pre-production expenses such as staff salaries and wages, rent, interest on borrowed funds, etc. will be incurred over a longer period than was previously envisaged. A delay of sixteen months in completion of a project recently financed by CDFC necessitated increasing the capital estimates by 26 per cent. If a delay is expected in one section of the plant only, the consequences of this will have to be assessed. In a fully integrated operation, it will usually delay the start of production as a whole. However, this will not always be the case. For instance, in a spinning, weaving and finishing textile plant, delays in completing the spinning mill need not hold up the weaving section if arrangements are made in time to buy in yarn of the right specification. Similarly, if the finishing section is completed first, it can go into production on bought-in grey cloth, thus minimizing the loss.

Simply because finance is their main business, financing institutions are likely to look out for and detect needs for extra finance at an earlier stage than an industrial management. Discussion between them based on study of the capital progress reports could result in special action (either by management making changes in their organization plans, or by the financing institution using its influence with government or with suppliers) to try to accelerate the completion of key sections of the construction, and in early warning of extra funds that may be needed as a result of delays that cannot be avoided.

The follow-up staff should report to their own management on each project at, say, three-monthly intervals during construction. The reports should be brief; they will need to go into detail only where a project departs significantly from schedule or from the estimates.

The management of the financing institution should require a statement of the reasons for any such discrepancies and ensure that the appropriate lessons are drawn. They could result, for instance, from mistakes in estimating or from technical mistakes on the part of the management of the project; defective evaluation methods on the part of the financing institution; inadequate contingency provisions in the estimates; shortcomings of the contractors or machinery manufacturers; changes in design introduced for good—or for inadequate—reasons; changes in government policy, as in regard to import duties, etc. The lessons they teach may point to the need for an overhaul of the management organization of the project; show up weaknesses in the financing institution's staff or methods; or merely indicate the existence of certain pitfalls which there was no reason to expect but which provide a warning for future project evaluations. Every case should add to the experience of the financing institution and contribute something to the reservoir of knowledge on which the project appraisal staff can draw in future evaluations.

On receipt of each operating report (assuming that these are furnished once a quarter), the financing institution will make a simple analysis of it and compare that quarter's results with the results of the corresponding quarter of the previous year and, where appropriate, with the immediately preceding quarter. It would, for instance, be of little value to compare with the immediately preceding quarter in the case of the fertilizer company mentioned earlier. It will also compare the cumulative results for the current year with the results of the corresponding period in the previous year. A specimen analytical table for use by follow-up staff is attached. It contains only the main indicators of the progress of the business; there is no need for it to include the other details which will normally be furnished by the project management, such as details of the main items of production and selling and administration costs. The latter will, of course, be noted by the accounts staff but need not enter into the analytical table, unless the business shows signs of being in difficulties, when similar analysis of these latter items may throw up useful indicators of the cause.

An example of the use of that method was the case of a company manufacturing a number of special papers whose profits took a downturn. The financing institution (not CDFC in this case) asked for an analysis of the production expenses going back over more than a year, which showed a sudden upturn in the ratio of the cost of materials to selling prices; more detailed analysis showed that certain chemicals were responsible for the increase and this threw suspicion on the pricing policy of a new type of paper which had been introduced at about the time when the upturn began. Examination of the estimating calculations showed that wrong pricing of this paper was, in fact, the cause of the trouble.

The specimen form attached is designed to facilitate comparison of the current results not only with the preceding quarter and year, but also with the original forecasts (for as long as this comparison is thought useful) and with the annual budget, if any. It will be a matter for judgement whether to use this as a fixed budget, that is, to make no changes in the original budget and measure each quarterly or half-yearly report against it; or to use it as a flexible budget, changing it each quarter in the light of new circumstances revealed by that quarter's trading. In making the decision, much will depend upon the financing institution's view of the ability and philosophy of the management.

The annexed specimen analysis contains two significant ratios: untaxed profit as a percentage of sales and untaxed profit as a percentage of net capital employed.[3]

Fluctuations in these ratios probably give the best indications of the performance of the project. They are more informative than the plain figures of profit. Take the following hypothetical case:

Year	*Capital employed* £	*Net sales* £	*Net profit* £
1960	100,000	60,000	10,000
1961	100,000	60,000	10,000
1962	100,000	75,000	13 000
1963	130,000	80,000	14,000
1964	150,000	120,000	16,000

The profit figure has been steadily increasing; between the first and the fifth year it has gone up by 60 per cent. However, if converted into ratios, it will be seen that net profit in 1960 was 16.7 per cent on net sales whereas in 1964 the larger profit was only 13.4 per cent on net sales. In 1960 the profit on capital employed was 10 per cent; in 1964 it was 10.7 per cent. Thus while profit as an absolute figure has made what may appear at first sight to be very satisfactory growth, the profit margin on turnover has, in fact, fallen sharply, while profit on capital employed has shown only a very slight increase. The lesson from this will depend, of course, on the answers to a complex of questions stimulated by the circulation of the ratios, but which might well not have been asked in their absence: were profit margins too high in 1960? is the fall in margins due to lower prices or higher costs? what is the present state of competition and the market? in what way has the extra capital employed been invested in the business? has the extra investment made in 1963-1964 yet begun to have an effect on production or sales? And so on.

In addition to comparing the figures with previous results, comparisons with statistics of the results of other similar industries, if available,[4] or the financing institution's own collected statistics of other comparable projects may throw a useful light on the project's progress.

It cannot be too strongly stressed that any individual report should never be looked at in isolation. Even the comparisons which have been mentioned may give a misleading picture if looked at alone. The study of each report must be made in the context of the progress of the entire project, going back to its inception or at least three or four years. There is much to be said for the same member of the financing institution's staff remaining in charge of certain projects for a lengthy period. If this is not possible, each newcomer taking up the task should always be required to make a careful study of the history of the project and familiarize himself with the previous pattern. Any other course is bound to lead to misconception and perhaps to unnecessary alarm. This is particularly so in the more volatile industries, those which are subject to great fluctuations, such as jute manufacture or mining and smelting. What appears to be an alarming state of affairs in one year may turn out to be only a stage in a series of cyclical fluctuations which will show satisfactory results over a period of years.

If the financing institution's follow-up staff is sufficiently large, some refinements on the study which have been already mentioned may be found very valuable. One is to maintain an index of the ratio of profit/sales and the ratio of profit/capital employed, taking a particular year as 100. This will show the management of the financing institution quickly and pointedly the pattern of variations in

[3] "Profit" for this purpose is ascertained before the deduction of interest, so that the profit which is compared with net capital employed is the whole profit earned by the use of all the project's capital, including that financed by loans.

[4] For instance, the details published by the United Kingdom Board of Trade in *Economic Trends*, No. 122 (December 1963), pp. xxi-xxiv, and No. 136 (February 1965), pp. viii-x; and by the Ministry of Labour in *Statistics on Incomes, Prices, Employment and Production*, No. 1 (April 1962), pp. 48-67, and No. 8 (March 1964), pp. 50-57 (HMSO, London).

these ratios, and should help sound a warning note at an early stage. Another graphic device is to maintain charts for the project showing, say, quarterly production, quarterly trading profit and quarterly ratio of profit to capital employed. These charts, once started, can very easily and quickly be continued each quarter as the reports come in.

It is inappropriate to discuss here the method of scrutinizing the quarterly reports in detail; that is something the accounting staff should decide and it may vary from one industry to another.

The following general comments may, however, be of interest:

(a) *Regularity in providing returns*

Sometimes the first indication of trouble or of management failures is delay in the provision of operating returns. Speedy, properly extracted operating and financial information is needed by the project management itself to enable it to keep proper control of its own business. If this is prepared at the right time, it can be easily used as the basis for the returns required by the financing institution. If the returns are late, the financing institution could justifiably suspect failure of the control system within the project, or reluctance to disclose poor results.

(b) *Changes in stock levels*

Stocks at an unseasonal level may be an early danger sign. If they are too high, this could be due to such causes as poor salesmanship, deterioration in the quality of the product or its obsolescence or failure to meet strong domestic or external competition. These are not the only possible reasons: some external or temporary factor may be responsible. But it provides an indicator which should normally be followed up.

(c) *Movements in the figure of debtors*

Increases in the figure may indicate that the company is giving too much credit or for too long a period, or is making insufficient inquiries about customers' credit-ratings.

(d) *Changes in the overdraft or cash available*

These could provide indications that the company has too little working capital; or has been using bank facilities to make expenditure which really ought to be financed out of long-term capital; or that it has more cash than it can usefully employ in the business.

(e) *Slow growth of production*

In developing countries, where trained labour is scarce, and every new factory will probably entail some training of workpeople, the operating returns may throw light on the progress of the training programme. If production falls behind the estimates in the early days, it should be remembered that this is one of the factors which merit inquiry in addition to the other possible causes, such as inadequate stocking of raw materials, excessive machine stoppages due to mistakes in design, and so on.

Conclusion

This paper endeavours to sketch out the subject in broad lines, indicating the whole field which may be covered in follow-up activity (although without going into matters of detail). However, it is not intended to suggest that every institution or authority which conducts follow-up activity should adopt all the measures described. The limits observed must be judged in each case according to the facilities available, the particular interests of the financing institution and the ability and manpower of the management of the project. Clearly a project managed by one man, with a total of fifteen employees and a capital expenditure of £25,000, would not be able to provide such full and informative information as a £2 million project undertaken with a staff of experienced accountants, engineers, etc. Moreover, an institution which provides finance always in the form of well-secured loans lent only to projects whose management is highly experienced and trustworthy, need not insist on the same degree of reporting, or seek the same degree of supervision, as one which has provided finance as an unsecured loan or as share capital, or where the ability of the management has not been fully proved. The extent of the information required would be different in the case where a parent company is supervising the business of a subsidiary company compared with, say, a government development corporation receiving reports from a project in which it has made an investment but in which it has only a minority share position, or a financial institution which may have no real interest in the development as such, but is concerned only with the safety of its own money.

The job of management is a demanding one. It requires a high measure of concentration and the financing institution should avoid creating unnecessary distractions. It must obviously have all the information it needs but it should define clearly for itself the limits beyond which it need not go, and avoid imposing on the management the burden of providing more than is really needed. The financing institution will at the same time help itself, because it will have to employ accounting and clerical staff to examine the returns and will be incurring unnecessary expense if the returns are longer or more detailed than is really necessary for its purpose.

Finally, it is necessary to stress the great importance in nearly all follow-up work of establishing and maintaining good relations between the financing institution and the management of the project, and fostering the concept that development is the subject of a continuing partnership relation between them.

(*annex follows*)

ANNEX

Specimen analytical table for use by the financing institution's follow-up staff

Analysis of operating progress report: Quarter ending .... 19 ..

*Original forecast for the year***		*Quarterly figures*				*Cumulative figures*			
		*Previous quarter****	*As budgeted****	*Actual*	*Previous year*	*As budgeted*	*Actual*	*Previous year*	*Index**** (19 = 100)
	Total net capital employed								
	Production in units								
	Production as percentage of capacity								
	Sales: Units*								
	Price								
	Other income								
	Profit before interest and tax								
	Profit before tax								
	Net profit before interest and tax as percentage of:								
	(a) Sales								
	(b) Net capital employed								
	Stocks other than finished goods								
	Finished stocks								
	Total stocks								
	Trade debtors								
	Trade creditors								
	Bank overdraft								
	Net current assets liabilities								

* If the project manufactures a number of different products, a line should be allotted to each product.

** This column will be used for only a limited period; see section B 2 (c) above.

*** These columns are optional; see section B 3 above.

Note. This form should be used only by follow-up staff. The project management should never be asked to complete it

XXI. PROCESS AND SITE EVALUATION FOR THE IRON AND STEEL INDUSTRY IN MEXICO

by Carlos Quintana, Gerardo Bueno and Fernando Gonzalez Vargas*

A. Evaluation of iron- and steel-making processes

In this part of the paper, the authors explain the methodology used by Nacional Financiera, S.A., the official industrial development agency of Mexico, to evaluate different iron- and steel-making processes, in relation to the availability and price of several resources. Evaluation of this kind is of great interest to Mexico because the most important iron ore deposits are relatively far from the coking coal sources, and relatively near to hydroelectric power in one case, and to non-coking coal in another.

Explained in a very few words, the evaluation procedure consists of: first, determining physical inputs per unit of production corresponding to all the applicable processes; secondly, making the prices of those inputs vary between minimum and maximum possible values, and thirdly, finding out the impact of these variations on the total cost of iron and steel. From the very beginning of the investigations, Nacional Financiera wanted to produce a work that would be useful not only to Mexico, but universally. For this reason, the results were given as indexes, instead of absolute cost figures, and the prices of inputs were expressed as maximum (plus sign), minimum (minus sign), and medium (m) prices, instead of using specific figures.

By means of an electronic computer, it was possible to introduce in the study all the possible combinations of iron ore reduction and steel-making processes, and all the probable combinations of price levels of the inputs. Annex III attached to this paper shows relative costs for 4,332 of such combinations, corresponding to 76 combinations of the siderurgical activities described in table 1 of annex II and 57 combinations of input prices. They can be used not only to determine the relative adventages of one process in relation to another, in a particular price situation, but also to ascertain the sensitivity of steel costs to input price variation.

The figures of annex III were used for the preliminary selection of the possible manufacturing processes for the future Mexican iron and steel industry, in relation to all the locations which at first sight seemed to have some advantages as sites for the plants. Once this was done, the production costs were recalculated with more precision, this time using actual prices of the inputs. The use of the tables thus resulted in a considerable saving of time and effort, inasmuch as the precise calculations were made only for a relatively small number of alternative locations and manufacturing processes.

The hardest part of the process evaluation work was the determination of input coefficients, starting with the production of sinter and coke and ending with the rolling of sections, flats and seamless pipe. This work was done by Nacional Financiera in consultation with national and foreign experts, and taking advantage of published information, which unfortunately is rather scant.[1]

As it may be seen in tables 2 to 6 of annex II, the coefficients were arranged so as to form column vectors, which in turn were grouped together in matrices. Each vector corresponds to one manufacturing activity.[2] The minus sign means an input, and the plus sign means a product or by-product. All the inputs are given as per unit of the main product. The left side of the matrices consists of two parts: the upper contains the linear inputs, that is, those directly proportional to the level of production; the lower part shows the non-linear inputs, the behaviour of which in relation to productive capacity can be represented by means of logarithmic equations, formulated with the data given.[3]

The linear inputs are in turn classified into exogenous and endogenous, depending on whether they originate in activities different from the iron and steel industry, or within the industry proper.

* Nacional Financiera, S.A., Mexico.

[1] Books: United Nations, *Problems of the Steel Making and Transforming Industries in Latin America* (United Nations publication, Sales No.: 57.II.G.6), vols. I and II; *Long-Term Trends and Problems of the European Steel Industry* (United Nations publication, Sales No.: 60.II.E.3); *Comparison of Steel-making Processes* (United Nations publication, Sales No.: 62.II.E.4); W. Isard, I. Schooler and T. Vietorisz, *Industrial Complex Analysis*, Wiley, New York, 1962.

Periodical publications: Metallurgist (translated from Russian), New York; *Journal of the Iron and Steel Institute*, London; *Stahl und Eisen*, Düsseldorf; *Journal of Metals*, New York; *Revista Latinoamerica de Siderurgia*, Santiago, Chile.

[2] For the purposes of this type of work, an "activity" is defined as the transformation of fixed proportions of inputs into fixed proportions of products and by-products. It can be expressed as a function of the principal input or the principal product. A column vector is a matrix with only one column.

[3] The equations relating investment and labour with productive capacity are the following:

$$\frac{I_a}{I_b} = \left(\frac{C_a}{C_b}\right)^{\alpha}$$

$$\frac{L_a}{L_b} = \left(\frac{C_a}{C_b}\right)^{\beta}$$

I_a, I_b, L_a, L_b represent the investment and labour requirements which correspond to productive capacity levels of C_a and C_b respectively; α and β are exponents which express the variation in investment and labour respectively, as a result of capacity changes.

The indirect cost inputs do not appear explicitly in the matrices. They have to be calculated by means of factors, as a function of investment, or labour, or both.[4]

In order to calculate costs satisfactorily, it is preferable to "integrate" the coefficients of the series of activities that form a total manufacturing process. When this is done, the process can be expressed by a single vector, in terms of exogenous inputs only. An example of the integration procedure is shown in table 7.[5]

Although this paper deals only with the methodological aspects of the subject, it is important to state some of the assumptions made regarding the nature of the exogenous inputs. The figures are based mainly on Mexican data; they reflect average characteristics of the resources. Thus iron ore is supposed to have 60 per cent iron. Although sulphur, phosphorous and silica are not recorded in the matrices, they were taken into account implicitly in the calculations. The ash content of coke is about 20 per cent. The manganese content of the manganese ore is 35 per cent, and the heating value of natural gas and fuel oil were taken as 900,000 kilocalories per 100 cubic meters, and 1 million kilocalories per 100 litres, respectively. Other assumptions may be seen in the parenthetical figures in the tables.

[4] The factors used in this work are the following:

	Labor cost factor	*Capital cost factor*
Supervision	0.200	--
Maintenance	0.100	0.030
Social security and welfare	0.200	0.005
Administrative cost	0.150	0.006
Depreciation		0.050
Insurance		0.010
Opportunity cost of capital		0.080
Others	0.550	0.010
TOTALS	1.200	0.190

These factors are related in the following equation, expressed in any monetary unit:

$$C_i = \frac{1.20\ C_L + 0.19\ I}{T}$$

in which C_i is the indirect unit cost; C_L is the annual labour cost; I is the investment and T is the yearly productive capacity, in metric tons. For the purposes of the Mexican study, the price of labour was estimated at $0.60 per man-hour.

The refractory expense was estimated as follows, in dollars per ton of pig iron, or steel.

Reduction		*Steel-making*	
Blast furnace	0.75	Open hearth	4.48
Electric furnace	0.80	Converter	0.88
Electric furnace with pre-reduction	0.80	Electric furnace:	
		With scrap	1.12
		With sponge iron	1.28
		With pig iron	1.68

[5] The calculation mechanism is as follows: if "N" tons of pig iron (besides many other inputs) are required to produce a ton of steel, "N" has to be multiplied by all the coefficients pertaining to the pig iron activity; the coefficient "M", expressing the sinter necessary for pig iron, will have to be multiplied by the coefficient corresponding to the iron ore which goes into the making of sinter, in order to obtain the coefficient expressing the amount of iron ore which in the form of pig iron is necessary for one ton of steel; the coefficient indicating the iron ore introduced directly to the steel-making furnace will have to be added to the coefficient thus calculated.

Investment includes construction, basic and auxiliary equipment, service equipment, shops, spare parts, engineering, erection and offices.

It is pertinent to say that a determination of physical input coefficients for several industries is a task that one institution alone cannot do properly, if the coefficients are to be kept constantly up to date. This meeting provides a good opportunity for organizing co-operative work of this kind among institutions whose job it is to evaluate projects and to programme the development of the industry.

Besides their use in process evaluation, the input-output coefficients were employed as tools for the projection of the future needs for raw materials and productive capacity of the industry. This was done by means of physical input-output tables or matrices, which not only reflect the demand for the different materials, intermediate products, fuel and electric power, but also express the interrelationships among different sectors of the industry, and even with other industries which either supply materials to siderurgy or use iron and steel products as raw materials.

The fact that the matrices represent conditions of equilibrium between inputs and products, considering return scrap and non-recoverable waste, and between production and consumption, considering imports and exports, helps keep under a sort of accounting control estimates that usually have to complement scarce statistical data.

Imports and exports of siderurgical materials or products are of little importance in the case of Mexico. For this reason, they are taken into account only in the balance, at the bottom of the matrices. For countries with considerable foreign trade in this respect, each of the input and product lines of the matrix can be trebled, to show production, imports and exports.

Table 8 shows the basic matrix for the Mexican iron and steel industry in 1963, and table 9 is the projected matrix for 1975. The latter is based on the input coefficients of tables 2 to 6 but it is merely an illustration made especially for this paper, inasmuch as the decisions on locations and processes for the future Mexican iron and steel industry have not been yet made.

It will be of interest for this audience to know that, in its industrial programming, Nacional Financiera is trying to use physical input-output matrices for most of the industries. By means of price tables, and the inclusion of monetary inputs which are not expressed in the coefficient matrices, the input-output tables are transformed from physical into monetary units; the purpose is to interrelate tables belonging to different industries, as well as to interrelate the industry with other sectors, by means of the general input-output matrix for the Mexican economy which is being prepared jointly by the ministry of finance and the presidency of the Republic, the Bank of Mexico and Nacional Financiera.

B. Site evaluation

Once one or more process combinations are selected by the procedure explained earlier in this paper, the more accurate calculations of steel ingot costs for different sites and several manufacturing processes are made by means of two sets of figures. For one of the sets, the transportation of iron ore and coal was computed with the actual freight rates of the Mexican railroad system. The results obtained in this way express the worth of the site from the point of view of private enterprise. The other set of figures was based on freight rates adjusted so as to reflect "shadow prices" or "accounting prices" for transport, which represent what the nation actually spends in fuel, labour, materials and depreciation, when transporting a load from one place to another of its territory. Although shadow prices were used only for transport, it may be said that the results arrived at by using them reflect the worth of the site from the point of view of the national interest. The results obtained by employing "virtual" prices better reflect the interests of private enterprise.

The reason for using shadow prices is that in Mexico actual freight rates do not reflect the national expenditure. The general average of what the railroads collect is less than the cost of transport and, as far as siderurgy is concerned, the rates for transport of minerals are too low and those for finished products too high in relation to the actual cost of moving those materials. The graph in annex I shows the differences between actual and shadow freight rates for Mexico.

Because total costs or prices of minerals, coke, etc., as influenced by the present freight rates, cannot be called actual, owing to the fact that in most cases the buying or selling of them has not yet been established, it was decided to name them "virtual" costs or prices, in order to avoid confusing them with those handled by the existing iron and steel companies, which would be truly "actual".

When estimating costs, no attempt was made to get close to the figures actually recorded by the existing mills. The objective was rather to arrive at a set of figures calculated all with the same criterion, since in a study of this sort what matters most are the relative values, not the absolute ones. Furthermore, actual costs are generally distorted by factors which do not belong to the realm of the economics of the industry

Table 10 in annex II illustrates the relative costs of steel ingots in some pre-selected locations, as computed for what turned out to be the most suitable manufacturing processes. It is interesting to point out that, as the distance between the site and the iron ore deposits increases, the costs differences computed with shadow prices of the inputs tend to be more significant than those obtained by using virtual prices. The location of other factors of production, such as coal, coke, limestone and electric power, do not seem to matter very much in this respect.

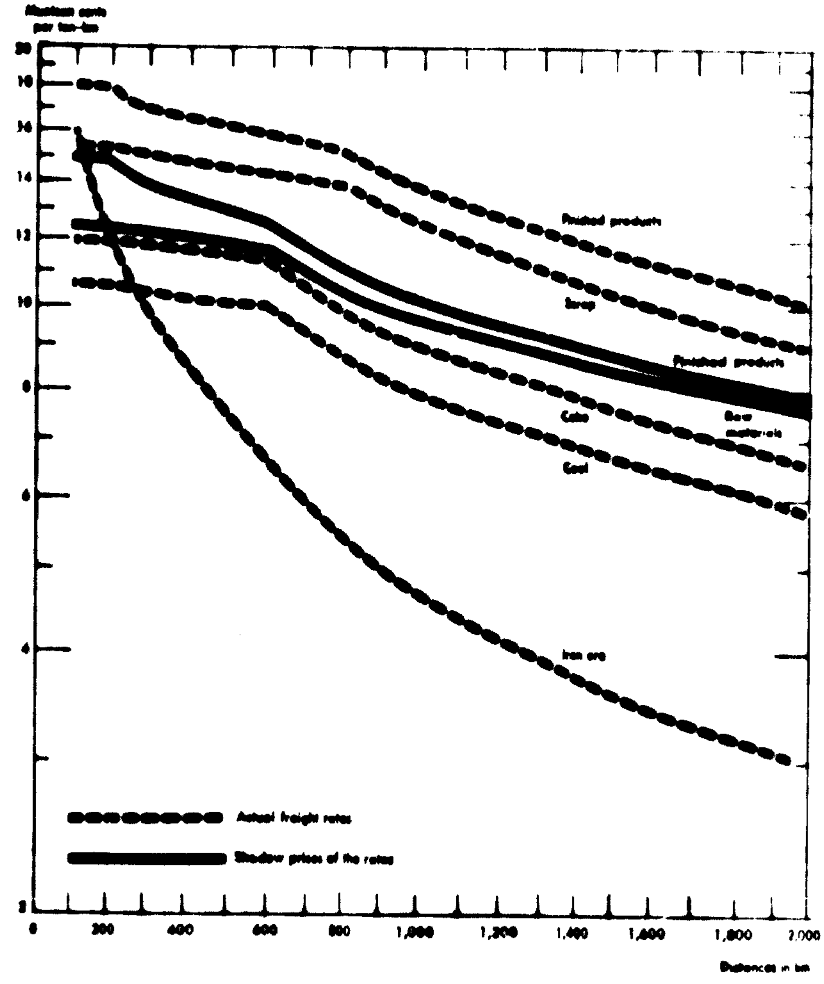
Manufacturing costs are not, of course, the end of the story. Finished products will have to be transported to the steel users, which are not concentrated in one point but widely distributed, according to a particular geographical structure of the market. From the national point of view, the best site is that which would minimise the total national cost of producing and distributing steel from all the plants—the projected new one and the existing ones—to a market defined by its given geographical structure. The problem was thus one of classical transportation linear programming, and it was resolved with the aid of a Control-Data 170-A computer, in approximately four hours of computing time.

The calculations of minimum cost were referred to a distant date because a large steel project started now will not be in normal production before five to seven years. As it was not possible to forecast with accuracy the future geographical structure of the market, it became necessary to play with several hypotheses of structures, as indicated in table 11. The conclusion in this respect, as may be seen in table 12, is that, although the geographical distribution of the market is an important locational factor, significant but reasonable changes in this respect do not significantly alter the results of the minimization of the total national cost of producing and distributing steel for a given location. Furthermore, in general, relative differences in total virtual costs are not very significant, but absolute differences in monetary terms are quite relevant. In the case of total shaodw costs, differences are important in both relative and absolute terms.

Annex I follows on page 265

ANNEX I

ACTUAL FREIGHT RATES AND SHADOW PRICES OF THE RATES, AS USED IN CALCULATING TRANSPORT COSTS



ANNEX II

TABLE 1. LIST OF THE SIXTY-SEVEN STEEL MILL ACTIVITIES INCLUDED IN THIS STUDY

Activity number	
1.	*Sinter processes*
1.1	Washed coal and natural gas
1.2	Small scale plants
1.3	Washed coal and fuel oil
1.4	Coke breeze and fuel oil
1.5	Coke breeze and natural gas
1.6	Iron ore fines, coke breeze and fuel oil
2.	*Coke*
2.1	Normal coke production vector
3.	*Pig iron*
	(a) *Blast furnace*
3.1	100% sinter; natural gas acting as fuel and as reducing agent
3.2	100% sinter; fuel oil
3.3	100% sinter; without using hydrocarbons
3.4	50% sinter and 50% iron ore; natural gas
3.5	50% sinter and 50% iron ore; fuel oil
3.6	50% sinter and 50% iron ore; without hydrocarbons
3.7	100% iron ore; natural gas
3.8	100% iron ore, fuel oil
3.9	100% iron ore
	(b) *Electric furnace*
3.10	100% sinter, coke and coke breeze
3.11	100% sinter, anthracite
3.12	50% sinter and 50% iron ore, coke and coke breeze
3.13	50% sinter and 50% iron ore, anthracite
3.14	100% iron ore, coke and coke breeze
3.15	100% iron ore, anthracite
	(c) *Electric furnace with pre-reduction*
3.16	100% iron ore, coke
3.17	100% iron ore, anthracite
	(d) *Sponge iron*
3.18	100% sinter
3.19	50% sinter and 50% iron ore
3.20	100% iron ore
4.	*Steel ingots*
	(a) *Open hearth (Siemens Martin) furnace*
4.1	65% pig-iron and 35% scrap; with iron ore

ANNEX II (*continued*)

TABLE 1. LIST OF THE SIXTY-SEVEN STEEL MILL ACTIVITIES INCLUDED IN THIS STUDY (*continued*)

Activity number	
4.2	65% pig-iron and 35% scrap; oxygen
4.3	60% pig-iron and 40% scrap; oxygen
	(b) *Converters*
4.4	Linz-Donawitz (L-D)
4.5	Kaldo
	(c) *Electric furnace*
4.6	Sponge iron and iron ore
4.7	Sponge iron; oxygen
4.8	Scrap and iron ore
4.9	Scrap; oxygen
4.10	Pig-iron and scrap; oxygen
5.	*Castings*
5.1	Ingot moulds (normal vector)
5.2	Other products (average inputs)
5.3	Steel castings (average inputs)
6.	*Flats*
	(a) *Slabs*
6.1	Blooming mill
6.2	Continuous casting mill
	(b) *Hot rolled products*
6.3	Strip; Steckel, or reversing mill
6.4	Strip; semicontinuous mill
6.5	Strip; continuous mill
6.6	Sheets over 3 mm thickness
6.7	Sheets under 3 mm thickness
	(c) *Cold rolled products*
6.8	Strip; semicontinuous mill
6.9	Strip; continuous mill
6.10	Sheets
	(d) *Tinplate*
6.11	Immersion process
6.12	Electrolytic process
7.	*Rolled sections*
7.1	Blooms; blooming mill
7.2	Blooms; continuous casting mill
7.3	Billet; reversing mill
7.4	Billet; continuous mill
7.5	Heavy weight sections; semi-continuous mill; height over 76 mm
7.6	Heavy weight sections; continuous mill; height over 76 mm
7.7	Rails; semi-continuous mill
7.8	Rails; continuous mill
7.9	Medium weight sections; semi-continuous mill; height over 38 mm
7.10	Medium weight sections; continuous mill; height over 38 mm
7.11	Light weight sections; semi-continuous mill; height under 38 mm
7.12	Light weight sections; continuous mill; height under 38 mm
7.13	Wire; semi-continuous mill
7.14	Wire; continuous mill
8.	*Seamless pipes*
8.1	Seamless pipes; pilger rolling mill

TABLE 2. PHYSYCAL INPUT-OUTPUT COEFFICIENTS FOR THE PRODUCTION OF SINTER AND COKE

(*Metric tons*)

Activities	*Sinter*						*Coke*
Inputs	*1.1*	*1.2*	*1.3*	*1.4*	*1.5*	*1.6*	*2.1*
Linear exogenous inputs							
Iron ore (60% Fe)	—0.936	—0.936	—0.936	—0.936	—0.936		
Washed coal	—0.075	—0.075	—0.075				—1.370
Electric energy (100 kWh)	—0.100	—0.100	—0.100	—0.100	—0.100	—0.100	
Natural gas (100 $m^3 = 0.9 \times 10^6$ KCal)	—0.055				—0.055		
Limestone	—0.110	—0.110	—0.110	—0.110	—0.110	—0.110	
Fuel oil (100 lts $= 10^6$ KCal)		—0.050	—0.050	—0.050		—0.050	
Mineral fines						—0.936	
Linear endogenous inputs							
Coke fines				—0.055	—0.055	—0.055	
Products and byproducts							
Sinter	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	
Coke							+1.000
Coke gas (1,000 m^3 N)							+0.200
Coke fines							+0.110
Non-linear exogenous inputs							
Annual capacity (10^6 t/year)	1.500	0.170	1.500	1.500	1.500	1.500	1.000
Investment (10^6 dollars)	5.760	0.979	5.760	5.760	5.760	5.760	40.400
Exponent investment equation	0.610	0.700	0.610	0.610	0.610	0.610	0.600
Labour (m-h/t)	1.500	3.000	1.500	1.500	1.500	1.500	1.500
Exponent labor equation	0.500	0.600	0.500	0.500	0.500	0.500	0.500
Capacity limits considered:							
Lower (10^6 t)	0.500	0.170	0.500	0.500	0.500	0.500	0.250
Higher (10^6 t)	2.500	0.500	2.500	2.500	2.500	2.500	1.250

Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).

Table 3 follows

TABLE 3. PHYSICAL INPUT-OUTPUT COEFFICIENTS

(Metric

Inputs	*Activities* — *Pig-iron production in blast furnaces* 3.1	3.2	3.3	3.4	3.5	3.6	3.7
Linear exogenous inputs							
Iron ore (Fe 60%)				−0.800	−0.800	−0.800	−1.000
Pellets							
Washed coal							
Anthracite							
Limestone	−0.200	−0.200	−0.200	−0.300	−0.300	−0.300	−0.400
Quick lime							
Manganese ore (35%)	−0.045	−0.045	−0.045	−0.045	−0.045	−0.045	−0.045
Fluorspar							
Graphite							
Soderberg electrodes							
Natural gas (100 m^3 N = 0.9 × 10^6 KCal)	−1.000			−1.000			−1.000
Steam	−1.000	−1.000	−1.000	−1.000	−1.000	−1.000	−1.000
Electric energy (100 kWh)	−0.350	−0.350	−0.350	−0.350	−0.350	−0.350	−0.350
Water 100 m^3	−0.150	−0.150	−0.150	−0.150	−0.150	−0.150	−0.150
Fuel oil (100 lt = 10^6 KCal)		−0.010			−0.010		
Linear endogenous inputs							
Sinter (Fe 56%)	−1.710	−1.710	−1.710	−0.855	−0.855	−0.855	
Coke (20% ash)	−0.500	−0.570	−0.700	−0.550	−0.620	−0.750	−0.600
Coke breeze (20% ash)							
Products and byproducts							
Pig-iron	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000
Sponge iron							
Blast furnace gas (10^3 m^3 N)	+2.624	+2.772	+2.800	+2.824	+2.972	+3.000	+3.024
Electric furnace gas (1,000 m^3 N)							
Slag	+0.591	+0.611	+0.631	+0.601	+0.621	+0.631	+0.611
Non-linear exogenous inputs							
Capacity (10^6 t/year)	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Investment (10^6 dollars)	40.000	43.300	46.100	43.000	47.300	51.100	48.900
Exponent investment equation	0.640	0.640	0.640	0.640	0.640	0.640	0.640
Labor (m-h/t)	0.760	0.760	0.760	0.760	0.760	0.760	0.760
Exponent labor equation	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Capacity limits considered:							
Lower (10^6 t/year)	0.400	0.400	0.400	0.400	0.400	0.400	0.400
Higher (10^6 t/year)	1.500	1.500	1.500	1.500	1.500	1.500	1.500

Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).

FOR THE PRODUCTION OF PRIMARY IRON

tons)

		Electric reduction furnaces						Electric furnace with pre-reduction		Sponge iron		
3.8	3.9	3.10	3.11	3.12	3.13	3.14	3.15	3.16	3.17	3.18	3.19	3.20
−1.600	−1.600			−0.800	−0.800	−1.600	−1.600	−1.600	−1.600		−0.750	−1.500
									−0.500	−0.113	−0.057	
			−0.425		−4.425		−0.425	−0.400				
−0.400	−0.400	−0.150	−0.150	−0.225	−0.225	−0.300	−0.300	−0.400	−0.400			
−0.045	−0.045	−0.045	−0.045	−0.045	−0.045	−0.045	−0.045	−0.045	−0.045			
								−0.020	−0.020			
		−0.016	−0.016	−0.018	−0.010	−0.020	−0.020	−0.010	−0.010			
										−6.300	−6.300	−6.300
−1.000	−1.000											
−0.350	−0.350	−20.900	−20.900	−22.500	−22.500	−24.500	−24.500	−11.100	−11.100	−0.100	−0.100	−0.100
−0.150	−0.150	−0.500	−0.500	−0.500	−0.500	−0.500	−0.500	−0.500	−0.500	−0.040	−0.040	−0.040
−0.810												
		−1.710	−1.710	−0.855	−0.855					−1.500	−0.750	
−0.670	−0.800	−0.200		−0.200		−0.200						
		−0.200		−0.200		−0.200						
+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000			
										+1.000	+1.000	+1.000
+3.172	+3.200											
		+0.600	+0.600	+0.600	+0.600	+0.600	+0.600	+0.600	+0.600			
+0.631	+0.651	+0.472	+0.472	+0.497	+0.497	+0.522	+0.522	+0.471	+0.471			
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
49.300	54.000	38.900	38.900	39.400	39.400	40.000	40.000	36.500	36.500	39.500	39.500	39.500
0.640	0.640	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
0.760	0.760	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950
0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
0.400	0.400	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385	0.385
1.500	1.500	1.400	1.400	1.400	1.400	1.400	1.400	1.400	1.400	1.400	1.400	1.400

TABLE 4. PHYSICAL INPUT-OUTPUT COEFFICIENTS FOR THE PRODUCTION OF STEEL INGOTS AND CASTINGS

(*Metric tons*)

Inputs / *Activities*	*Open hearth furnace* (65-35) 4.1	*Open hearth furnace* (65-35) 4.2	*Open hearth furnace* (60-40) 4.3	*Converters* L-D 4.4	*Converters* Kaldo 4.5	*Electric furnace*[a] *With sponge iron* 4.6	*Electric furnace*[a] *With sponge iron* 4.7	*Electric furnace*[a] *With scrap* 4.8	*Electric furnace*[a] *With scrap* 4.9	*Electric furnace*[a] *With pig iron* 4.10	*Foundry*[b] *Ingot moulds* 5.1	*Foundry*[b] *Cast iron* 5.2	*Foundry*[b] *Steel castings* 5.3
Linear exogenous inputs													
Scrap	−0.360	−0.385	−0.430	−0.272	−0.260	−0.267	−0.275	−1.090	−1.099	−0.360	−0.373	−0.853	−1.618
Iron ore (60% Fe)	−0.015				−0.081	−0.050		−0.015					−0.025
Limestone	−0.040					−0.040		−0.040			−0.045	−0.064	−0.067
Fluorspar	−0.005	−0.005	−0.005	−0.004		−0.005	−0.005	−0.005	−0.005	−0.005	−0.005	−0.006	−0.009
Aluminium	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001			−0.002
Graphite electrodes						−0.008	−0.007	−0.005	−0.005	−0.004			−0.010
Oxygen (100 m³ N)		−0.270	−0.300	−0.550	−0.620		−0.040		−0.040	−0.270			
Fuel oil (100 lt = 10⁶ KCal)	−1.396	−1.000	−1.000										
Electric energy (100 kWh)	−0.200	−0.180	−0.165	−0.140	−0.160	−6.600	−5.290	−5.000	−4.080	−2.800			
Water (100 m³)	−0.020	−0.020	−0.020	−0.020	−0.020	−0.020	−0.020	−0.020	−0.020	−0.020	−0.900	−1.000	−10.000
Lime	−0.038	−0.060	−0.060	−0.060	−0.050	−0.038	−0.060	−0.038	−0.040	−0.060			
Linear endogenous inputs													
Hot metal	−0.670	−0.714	−0.650	−0.818	−0.781					−0.670	−0.869	−0.568	
Sponge iron						−0.891	−0.916						
Ferromanganese	−0.010	−0.010	−0.010	−0.008	−0.008	−0.016	−0.010	−0.010	−0.010	−0.010	−0.002	−0.002	−0.020
Ferrosilicon	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.006	−0.006	−0.014
Coke								−0.004	−0.004		−0.150	−0.214	−0.007
Return scrap											−0.150	−0.315	−0.567
Ingot moulds	−0.025	−0.025	−0.025	−0.025	−0.025	−0.025	−0.025	−0.025	−0.025	−0.025	+1.000		
Products and by-products													
Steel ingots	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000	+1.000			
Return scrap	+0.047	+0.047	+0.047	+0.025	+0.025	+0.022	+0.022	+0.022	+0.022	+0.022	+0.150	+0.315	+0.567
Non recoverable waste	+0.219	+0.219	+0.222	+0.143	+0.161	+0.282	+0.274	+0.183	+0.189	+0.210	+0.300	+0.398	+0.258
Cast iron												+1.000	
Steel castings													+1.000
Non linear exogenous inputs													
Capacity (10⁶ t/year)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	50.000	100.000	100.000
Investment (10⁶ dollars)	33.000	29.000	27.500	17.000	18.500	27.300	24.300	21.000	21.000	17.500	3.000	12.500	30.000
Exponent investment equation	0.600	0.600	0.600	0.620	0.620	0.620	0.620	0.620	0.620	0.620	0.700	0.700	0.700
Labour (m-h/ton)	4.000	4.000	4.000	3.000	3.000	4.500	4.570	5.200	5.200	4.000	6.000	16.000	30.000
Exponent labour equation	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.500	0.760	0.760
Capacity limits considered:													
Lower (10⁶ t/year)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	3.750	15.000	15.000
Higher (10⁶ t/year)	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	50.000	100.000	100.000

Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).

[a] Capital investment for electric power generation is not included.

[b] Capacity expressed in '000 tons.

TABLE 5. PHYSICAL INPUT-OUTPUT COEFFICIENTS FOR THE PRODUCTION OF FLAT ROLLED PRODUCTS

(*Metric tons*)

Activities / *Inputs*	*Slabs* — *Blooming mill* 6.1	*Slabs* — *Continuous casting* 6.2	*Hot rolled strip coils* — *Reversing mill* 6.3	*Hot rolled strip coils* — *Semi-continuous mill* 6.4	*Hot rolled strip coils* — *Continuous mill* 6.5	*Hot rolled sheets* — *More than 3 mm* 6.6	*Hot rolled sheets* — *Less than 3 mm* 6.7	*Cold rolled strip coils* — *Semi-continuous mill* 6.8	*Cold rolled strip coils* — *Continuous mill* 6.9	*Cold rolled sheets* 6.10	*Tinplate* — *Immersion* 6.11	*Tinplate* — *Electrolytic* 6.12
Linear exogenous inputs												
Rolls (kg)	—2.000		—2.900	—3.400	—2.400			—2.700	—1.400			
Tin											—0.011	—0.005
Water (100 m³)	—0.100	—0.050	—0.013	—0.027	—0.045			—0.019	—0.017			
Steam								—0.080	—0.070			
Electric energy (100 kWh)	—0.220	—0.160	—1.600	—1.400	—0.850	—0.080	—0.080	—1.300	—0.900	—0.080	—0.050	—0.200
Fuel oil (100 lts = 10^6 KCal)	—1.760	—0.266	—0.960	—0.860	—0.690			—0.484	—0.374			
Copper (Kg)		—0.200										
Linear endogenous inputs												
Steel ingots	—1.111	—1.653[a]										
Products and by-products												
Slabs	+1.000	+1.000	—1.190	—1.180	—1.111							
Plates or hot rolled strip coils			+1.000	+1.000	+1.000	—1.109	—1.028	—1.163	—1.087			
Hot rolled sheets of more than 3 mm						+1.000						
Hot rolled sheets of less than 3 mm							+1.000					
Cold rolled strip coils								+1.000	+1.000	—1.021		
Cold rolled sheets										+1.000	—0.909	—0.995
Tinplate											+1.000	+1.000
Return scrap	+0.089	+0.050	+0.166	+0.156	+0.089	+0.109	+0.028	+0.163	+0.087	+0.021		
Mill scale	+0.022											
Non recoverable waste		+0.003	+0.024	+0.024	+0.024							
Non linear exogenous inputs												
Annual capacity (10^6 t/year)	1.000	1.000	0.290	0.660	2.000	0.800	0.800	0.525	1.050	0.800	0.500	0.500
Investment (10^6 dollars)	22.700	16.500	32.000	49.000	96.000	2.000	3.000	33.200	43.500	2.500	8.000	7.000
Exponent investment equation	0.620	0.700	0.530[b]	0.530[b]	0.530[b]	0.600	0.600	0.650	0.600	0.600	0.600	0.600
Labour (m-h/ton)	0.190	0.110	0.120	0.100	0.080	0.900	1.200	1.430	1.200	0.900	1.200	1.000
Exponent labour equation	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
Capacity limits considered												
Lower (10^6 t/year)	0.500	0.500	0.100	0.400	0.700	0.200	0.200	0.150	0.700	0.200	0.200	0.300
Higher (10^6 t/year)	2.000	2.000	0.350	0.800	2.000	1.500	1.500	0.600	1.750	1.500	0.600	0.800

Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).

[a] Liquid steel.

[b] This is an average for the three processes. It cannot be used for calculating the scale factor of any one of them.

TABLE 6. PHYSICAL INPUT-OUTPUT COEFFICIENTS FOR THE PRODUCTION OF ROLLED SECTIONS AND SEAMLESS PIPES

(*Metric tons*)

Activities	*Blooms*		*Billets*		*Heavy sections*[a]		*Rails*[a]		*Medium sections*[b]		*Light sections*[b]		*Wire*[c]		
Inputs	*Blooming mill 7.1*	*Continuous casting 7.2*	*Reversing mill 7.3*	*Continuous mill 7.4*	*Semi-continuous mill 7.5*	*Continuous mill 7.6*	*Semi-continuous mill 7.7*	*Continuous mill 7.8*	*Semi-continuous mill 7.9*	*Continuous mill 7.10*	*Semi-continuous mill 7.11*	*Continuous mill 7.12*	*Semi-continuous mill 7.13*	*Continuous mill 7.14*	*Seamless pipes Pilger mill 8.1*
Linear exogenous inputs															
Rails (kg.)	-0.390		-1.200	-1.000	-2.500	-1.500	-2.500	-1.500	-3.000	-2.000	-3.000	-2.000	-3.000	-2.000	-2.500
Tin															
Water (100 m³)	0.100	-0.050	-0.100	-0.150	-0.100	-0.150	-0.100	-0.150							-0.030
Steam									-0.300	-02.50	-0.300	-0.250	-0.300	-0.250	
Electric energy (100 kWh)	0.220	-0.100	-0.250	-0.125	-0.300	-0.150	-0.300	-0.150	-0.900	-0.500	-0.900	-0.500	-0.900	-0.500	-1.800
Fuel oil (100 lts = 10⁶ KCal)	1.760	-0.266							-1.760	-1.650	-1.760	-1.650	-1.760	-1.650	-1.700
Copper (kg)		-0.300													
Linear endogenous inputs															
Steel ingot	-1.111	-1.053													
Products and byproducts															
Blooms	+1.000	+1.000	-1.022	-1.022	-1.111	-1.053	-1.111	-1.053							-1.200
Billets			+1.000	+1.000					-1.109	-1.105	-1.109	-1.105	-1.105	-1.105	-1.109
Heavy sections					+1.000	+1.000									
Rails							+1.000	+1.000							
Medium sections									+1.000	+1.000					
Light sections											+1.000	+1.000			
Wire													+1.000	+1.000	
Seamless pipes															+1.000
Return scrap	+0.089	+0.050	+0.020	+0.020	+0.109	+0.051	+0.109	+0.051	+0.076	+0.074	+0.076	+0.074	+0.076	+0.074	+0.272
Rolling mill scale	+0.022														
Non-recoverable waste		+0.003	+0.002	+0.002	+0.002	+0.002	+0.002	+0.002	+0.033	+0.031	+0.033	+0.031	+0.033	+0.031	[illegible]
Non linear exogenous inputs															
Annual capacity (10⁶ t/year)	1.000	1.000	0.530	1.000	0.525	1.000	0.525	1.000	0.500	1.000	0.500	1.000	0.500	1.000	0.600
Investment (10⁶ dollars)	22.700	16.500	30.000	31.000	28.400	46.000	28.400	40.000	26.000	38.000	26.000	38.000	15.000	24.000	70.000
Exponent investment equation	0.620	0.700	0.620	0.630	0.640	0.625	0.660	0.625	0.660	0.625	0.660	0.625	0.620	0.620	0.650
Labour (m-h/t)	0.190	0.110	1.000	0.700	1.360	0.950	1.360	0.950	1.200	0.900	1.200	0.900	1.300	0.800	3.000
Exponent labour equation	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
Capacity limits considered:															
Lower (10⁶ t/year)	0.500	0.500	0.150	0.600	0.200	0.600	0.200	0.600	0.100	0.600	0.100	0.600	0.100	0.000	0.150
Higher (10⁶ t/year)	2.000	2.000	0.600	1.500	0.650	1.700	0.650	1.700	0.650	1.700	0.650	1.700	0.600	1.300	0.600

Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).

[a] The same rolling mill may be used for heavy sections and rails.

[b] The same rolling mill may be used for medium and light sections.

[c] A separate rolling mill for wire.

TABLE 7. EXAMPLE OF THE INTEGRATION OF INPUT-OUTPUT COEFFICIENTS OF SEVERAL ACTIVITIES, IN ORDER TO EXPRESS THEIR COMBINATION IN TERMS OF EXOGENOUS INPUTS ONLY[a]

(*Metric tons*)

Inputs	*Sinter vector (1.3)*	*Sinter/ton pig-iron vector (1.3) × 0.855*	*Coke vector (2.1)*	*Coke/ton pig-iron vector (2.1) × 0.550*	*Pig-iron vector (3.4)*	*Total inputs per ton of pig-iron (a)*	*(a) × 0.818*	*Steel vector (4.4)*	*Total inputs per ton of steel*
Iron ore (Fe 60%)	—0.936	—0.800			—0.800	—1.600	—1.308		—1.308
Washed coal	—0.075	—0.064	—1.370	—0.754		—0.818	—0.669		—0.669
Anthracite coal									
Limestone	—0.110	—0.094			—0.300	—0.394	—0.322		—0.322
Lime								—0.060	—0.060
Manganese ore (35%)					—0.045	—0.045	—0.037		—0.037
Fluorspar								—0.004	—0.004
Aluminium								—0.001	—0.001
Oxygen (100 m³ N)								—0.550	—0.550
Soderberg electrodes									
Graphite electrodes									
Fuel oil (100 lbs = 10⁶ KCal)	—0.050	—0.043				—0.043	—0.035		—0.035
Steam					—1.000	—1.000	—0.818		—0.818
Electric energy (100 kWh)	—0.100	—0.086			—0.350	—0.436	—0.356	—0.140	—0.496
Water (100 m³)					—0.150	—0.150	—0.123	—0.020	—0.143
Scrap								—0.272	—0.272
Ferromanganese								—0.008	—0.008
Ferrosilicon								—0.002	—0.002
Ingot moulds								—0.025	—0.025
Natural gas (100 m³ N = 0.9 × 10⁶ KCal)					—1.000	—1.000	—0.818		—0.818
Sinter (Fe 56%)	+1.000				—0.855				
Coke (30% ash)			+1.000		—0.550				
Coke breeze (30% ash)			+0.110						
Hot metal					+1.000			—0.818	
Sponge iron									
Coke gas (1,000 m³ N)			+0.249	+0.137		+0.137	+0.112		+0.112
Blast furnace gas (10³ m³ N)					+2.824	+2.824	+2.310		+2.310
Electric furnace gas (1,000 m³ N)									
Return scrap								+0.025	+0.025
Non-recoverable waste								+0.143	+0.143
Steel ingots								+1.000	+1.000

[a] Integration of the following activity vectors are considered: steelmaking = LD, reduction = blast furnace using 50% sinter and natural gas.

TABLE 8. PHYSICAL INPUT-OUTPUT MATRIX

(Metric

Inputs / Products	Semi-finished products[a]: Crude iron: Pig iron	Crude iron: Sponge iron	Steel: Open hearth furnace	Steel: Electric furnace	Steel: Ingot moulds	Steel: Total	Flat rolled products
Linear exogenous inputs							
Iron ore	1,333,000	254,550	13,283	39,860		1,640,963	
Exogenous scrap			174,780	513,124	25,211	713,115	
Coke	600,500				8,068	608,568	
Limestone	333,200		46,380	34,000	2,017	415,597	
Lime			43,890	12,464		56,354	
Manganese ore	308,300			10,224		318,524	
Ferroalloys			13,860	11,250	403	25,513	
Fluorspar			5,775	4,260		10,035	
Graphite electrodes			7,380	5,244		12,624	
Soderberg electrodes		6,700				6,700	
Fuel oil (10^6 lts.)			(161.2)			(161.2)	(120.7)
Natural gas (10^6 m^3 N)	(12.0)	(47.3)				(59.3)	
Electric energy (10^6 kWh)	(29.1)	(1.4)	(23.1)	(494.0)	(5.0)	(552.6)	(141.1)
Total exogenous material	2,266,700	261,330	305,160	630,306	35,699	3,499,411	
Linear endogenous inputs							
Pig iron for steel-making			794,640		36,103	830,743	
Sponge iron				169,700		169,700	
Return scrap			241,605	216,816		458,421	
Open hearth steel							736,210
Electric furnace steel							234,800
Ingot moulds			28,875	21,548		50,423	
Total endogenous material			1,065,120	408,064	36,103	1,509,287	971,010
Finished products							
Flat rolled products							
Rolled sections, bars and wire							
Rails							
Seamless pipes							
Total finished products							
Total inputs	2,266,700	261,330	1,370,280	1,038,370	71,802	5,008,698	971,010
—Return scrap			31,185	22,785	5,042	59,012	218,829
—Wastes and others	1,433,600	91,630	184,103	171,885	16,337	1,897,563	46,281
=National production	833,100	169,700	1,155,000	843,900	50,423	3,052,123	705,900
+Imports							22,400
=Total supply	833,100	169,700	1,155,000	843,900	50,423	3,052,123	728,300
—Exports			300			300	153,600
=Apparent consumption	833,100	169,700	1,154,700	843,900	50,423	3,051,823	574,700

[a] The total supply of pig-iron and scrap is slightly different from their sum as inputs in steel-making. This is because their supply

[b] The production figures of rolled products expressed as ingots have been adjusted so that they agree with the availability of steel

[c] The totals are based on the relative participation of the steel-consuming industries in 1962. See on this subject: Nacional Finan-

OF THE STEEL INDUSTRY IN 1963

tons)

Finished products[b]				Final uses[c]						
				Industries						
Rolled sections, bars and wire	Rails	Seamless pipes	Total	Mechanical	Construction	Mining and petroleum industries	Railroads	Exports	Total	General total
										1,640,963
										713,115
										608,368
										415,997
										56,354
										318,524
										25,513
										10,035
										12,624
										6,700
(150.7)	(5.4)	(24.0)	[illegible]							(471.0)
										(59.3)
(61.9)	(2.0)	(26.4)	[illegible]							(783.0)
										3,499,411
										830,743
										169,700
										458,421
397,100	21,300		1,154,700					300	300	1,155,000
423,407		186,003	843,900							843,900
										50,423
820,515	21,382	186,003	1,990,600					300	300	3,500,187
				460,628	79,798	10,986	15,300	153,600	728,300	728,300
				303,200	363,000	4,000	4,700	400	675,300	675,300
							83,500		83,500	83,500
						133,100		7,500	140,600	140,600
				771,828	442,798	148,086	103,500	161,500	1,627,700	1,627,700
820,515	21,382	186,008	1,990,400					300	300	7,007,598
134,106	3,200	43,214	399,409							458,421
47,889	1,322	15,379	110,791							2,088,354
638,600	16,800	127,100	1,408,400							4,540,523
36,700	66,700	13,800	130,300							139,300
675,300	83,500	140,600	1,627,700							4,679,823
400		7,500	161,500							161,800
674,900	83,500	133,100	1,466,200							4,518,023

as materials for iron and steel castings was not considered.

ingots.

ciera, S.A., *El Mercado de Valores*, No. 22, Mexico, June 1963.

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(Thousands of

Inputs / *Products*	*Semi-finished products*: *Crude iron*: *Pig-iron for steel-making*	*Pig-iron for foundries*	*Sponge iron*	*Steel*: *Electric furnace*	*Other types*	*Ingot moulds*	*Total*
Linear exogenous inputs							
Iron ore	4,492.6	357.0	1,335.0	9.5		40.4	6,243.5
Exogenous scrap				576.6	407.9		984.5
Coke	1,414.9	112.4				19.9	1,547.2
Limestone	990.3	70.5		25.5		6.0	1,090.3
Rolls (100 kgs)							
Lime					221.6		221.6
Manganese ore	126.3	10.1					136.4
Ferroalloys				19.2	44.3	1.1	64.6
Fluorspar				8.1	16.8	0.7	25.6
Graphite electrodes				10.0			10.0
Soderberg electrodes	27.0	2.2					29.2
Oxygen				(38.9)	(145.9)		(184.8)
Aluminium				1.6	3.6		5.2
Fuel oil (10^{6} lts)					(204.3)		(204.3)
Natural gas (10^{6} m^{3} N)	(145.9)	(11.6)	(560.7)				(718.2)
Electric energy (10^{6} kWh)	(3,356.6)	(266.7)	(89.0)	(831.2)	(59.9)		(4,603.4)
Total exogenous material	7,049.1	560.2	1,335.0	680.5	694.2	77.1	10,366.1
Linear endogenous inputs							
Pig-iron for steel making					2,807.9		2,807.9
Pig-iron for foundries						115.1	115.1
Sponge iron				890.0			890.0
Return scrap				304.5	827.3	19.9	1,201.7
Electric furnace steel							
Other types of steel							
Ingot moulds				40.2	92.3		132.5
Total endogenous material				1,234.7	3,727.5	135.0	5,147.2
Finished products							
Flat rolled products							
Rolled sections, bars and wire							
Rails							
Seamless pipes							
Grey iron castings							
Steel castings							
Total finished products							
Total inputs	7,049.1	560.2	1,335.0	1,915.2	4,421.7	212.1	15,513.3
Return scrap				36.4	137.2	19.9	193.5
—Wastes and others	4,241.2	337.1	445.0	370.0	513.2	59.7	5,967.0
=National production	2,807.9	223.1	890.0	1,529.0	3,771.3	132.5	9,353.8
+Imports							
=Total supply	2,807.9	223.1	890.0	1,529.0	3,771.3	132.5	9,353.8
-Exports							
=Apparent consumption	2,807.9	223.1	890.0	1,529.0	3,771.3	132.5	9,353.8

Source: Industrial Programming Division, Nacional Financiera, S.A. (Mexico).

…OF THE STEEL INDUSTRY IN 1975

…metric tons)

Grey iron castings	Steel castings	Flat rolled products	Rolled sections, bars and wire	Rails	Seamless pipes	Total	Mechanical	Construction	Mining and petroleum industries	Railroads	Exports	General total
Finished products							Final users: Industries					
												6,243.5
102.3						102.3						1,006.8
4.1						4.1						1,551.3
12.2						12.2						1,110.5
		(986.0)	(730.9)	(27.0)	(986.3)	(2,729.0)						2,729.0
												221.6
												136.4
1.5						1.5						66.1
1.1						1.1						26.7
												10.0
												29.2
												184.8
												5.2
		(407.7)	(738.3)	(10.9)	(155.7)	(1,406.0)						(1,611.1)
												(718.2)
(5.7)		(288.1)	(290.3)	(5.5)	(81.9)	(614.5)						
												(5,217.9)
121.2						121.2						10,487.3
												2,807.9
108.0						108.0						223.1
												890.0
99.9						99.9						1,261.6
	40.9	462.6	524.1		493.4	1,529.0						1,529.0
		1,686.4	1,970.9	126.0		3,771.3						3,771.3
												132.5
167.9	40.9	2,129.0	2,500.0	126.0	493.4	5,460.2						10,615.4
							1,350.7	193.0	24.1	40.2		1,608.0
							894.4	1,071.6	12.0	13.9		1,991.9
										102.1		102.1
									347.0			347.0
							190.1					190.1
							32.6					32.6
							2,467.8	1,264.6	383.1	156.2		4,271.7
289.1	40.9	2,129.0	2,500.0	126.0	498.4	5,509.4						21,102.7
99.9	16.3	443.8	394.0	21.2	133.9	1,069.1						1,261.6
39.1		77.2	117.1	2.7	12.5	288.6						6,215.6
190.1	32.6	1,600.0	1,991.9	102.1	347.0	4,271.7						13,625.5
190.1	32.6	1,600.0	1,991.9	102.1	347.0	4,271.7						13,625.5
190.1	32.6	1,600.0	1,991.9	102.1	347.0	4,271.7						13,625.5

TABLE 10. PRODUCTION COST INDEXES OF STEEL INGOTS WITH VIRTUAL AND SHADOW PRICES, FOR DIFFERENT LOCATIONS

(Lowest value = 100)

Plant sites	With virtual prices of inputs: Cost index	Ranking	With shadow prices of inputs: Cost index	Ranking
1	112	12	111	4
2	113	11	113	7
3	106	6	109	3
4	107	8	111	5
6	108	9	119	11
7	105	4	121	13
8	103	2	120	12
9	100	1	100	1
10	105	5	112	6
11	107	7	117	9
12a	119	13	120	11
12b	104	3	105	2

TABLE 11. HYPOTHESES OF GEOGRAPHICAL DISTRIBUTION OF THE MARKET FOR NON-FLAT ROLLED STEEL PRODUCTS

(Percentages of total market)

Market / Hypotheses	1	2	3	4	5	6	7	8
A	51.0	60.0	40.0	45.0	54.0	45.3	45.0	40.0
B	4.0	3.3	4.9	3.5	4.2	3.6	4.0	4.0
C	5.0	4.1	6.1	4.4	5.3	4.4	5.0	5.0
D	8.0	6.5	9.8	7.1	8.5	7.1	8.0	8.0
E	15.0	12.2	18.4	25.0	10.0	13.4	15.0	20.0
F	5.0	4.1	6.1	4.4	5.3	4.4	5.0	5.0
G	10.0	8.2	12.3	8.8	10.6	20.0	16.0	16.0
H	2.0	1.6	2.4	1.8	2.1	1.8	2.0	2.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 12. TOTAL NATIONAL VIRTUAL AND SHADOW COST INDEXES FOR THE PRODUCTION AND DISTRIBUTION OF NON-FLAT ROLLED STEEL PRODUCTS

(Lowest value = 100)

Hypotheses of the geographical structure of the market / Plant sites	1	2	3	4	5	6	7	8	9	10	11	12a	12b
						A. *National total with virtual prices*							
1	108	107	105	102	102	101	105	105	102	101	100	107	102
2	108	108	106	103	102	101	106	106	102	101	100	107	102
3	108	107	104	101	102	101	105	105	102	100	101	108	101
4	108	107	104	102	101	101	104	104	102	100	101	107	102
5	109	108	104	102	103	101	106	106	103	101	101	108	102
6	109	108	104	101	102	101	106	105	103	101	102	108	103
7	109	108	104	101	102	101	105	105	102	101	101	108	103
8	108	107	104	101	101	101	105	104	102	100	101	108	103
						B. *National total with shadow prices*							
1	107	108	105	105	106	106	110	110	101	104	105	108	102
6	108	108	104	104	106	106	110	110	101	104	105	108	103
7	108	108	104	104	105	106	110	109	100	103	105	108	103
8	108	108	104	104	106	106	111	110	101	104	105	109	103

ANNEX III

A. RELATIVE STEEL COSTS, ACCORDING TO MANUFACTURING PROCESSES AND INPUT PRICES

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	Siemens Martin (60–40) with oxygen																
									Blast furnace									Electric furnace						EFPR	
									100% S			50% S			100% M			100% S		50% S		100% M		100% M	
									G	F	—	G	F	—	G	F	—	WC	A	WC	A	WC	A	A	WC
		WC	A			F	G		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0a	+	+	+	+	+	+	+	+	86	89	91	84	87	89	81	83	85	97	91	93	88	91	86	76	76
0b	m	m	m	m	m	m	m	m	70	72	74	68	70	72	65	67	68	77	71	74	69	73	67	60	60
0c	—	—	—	—	—	—	—	—	56	57	59	54	56	57	52	53	54	59	53	56	52	56	50	45	46
1a	m	m	m	—	—	—	—	—	63	64	67	61	63	65	59	60	62	65	59	62	57	61	55	50	51
1b	—	—	—	m	m	m	m	m	63	65	66	61	63	64	59	60	61	71	65	68	64	68	63	54	55
1c	—	—	—	+	+	+	+	+	73	75	76	71	73	74	68	69	70	84	79	82	78	81	76	65	67
2a	m	—	—	m	m	—	—	—	60	61	63	58	60	61	56	57	58	67	62	65	61	64	59	51	52
2b	—	m	m	—	—	m	m	m	66	68	70	64	66	68	61	63	65	68	63	65	60	64	59	53	54
2c	—	+	+	—	—	+	+	+	78	81	83	76	79	81	73	76	77	89	83	86	81	83	78	69	69
3a	m	—	—	—	—	m	m	—	60	62	63	58	60	61	56	57	58	63	57	66	56	60	54	49	50
3b	—	m	m	m	m	—	—	m	65	67	70	54	66	68	61	63	64	72	67	70	65	68	63	56	56
3c	—	+	+	+	+	—	—	+	78	80	83	76	78	81	73	75	77	88	83	86	80	83	78	68	69
4a	m	—	—	—	—	—	—	m	63	64	66	61	63	64	59	60	61	66	60	63	59	62	57	51	53
4b	—	m	m	m	m	m	m	—	63	65	67	61	63	65	59	60	62	70	65	67	63	66	61	53	54
4c	—	+	+	+	+	+	+	—	70	72	74	68	70	72	65	67	69	80	74	77	72	75	70	60	60
5a	+	+	+	—	—	—	—	—	69	71	74	68	70	73	65	67	69	71	65	67	62	66	60	56	56
5b	+	+	+	m	m	m	m	m	76	79	81	74	77	79	72	74	76	83	77	80	74	78	72	65	65
5c	m	m	m	+	+	+	+	+	80	82	84	77	80	81	75	77	78	91	85	88	83	86	81	71	71
6a	+	—	—	+	+	—	—	—	61	65	67	62	64	65	59	61	62	75	70	73	69	72	67	57	58
6b	+	m	m	+	+	m	m	m	74	76	78	72	74	76	69	71	72	84	79	82	77	80	75	65	66
6c	m	+	+	m	m	+	+	+	82	85	87	80	83	85	75	79	81	93	87	90	84	87	82	72	75
7a	+	—	—	—	—	+	+	—	64	66	67	63	65	65	60	62	62	67	61	64	60	64	58	53	54
7b	+	m	m	m	m	+	+	m	74	76	78	72	75	76	69	71	72	81	75	78	73	77	71	63	64
7c	m	+	+	+	+	m	m	+	82	85	87	80	83	85	77	79	81	93	87	90	84	87	82	72	73

A RELATIVE STEEL COSTS, ACCORDING TO MANUFACTURING PROCESSES AND INPUT PRICES (*continued*)

Price combination	Mineral	Metallurgical coke	[illegible]	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	Siemens Martin (40–60) with oxygen — Blast furnace — 100% S — G	100% S — F	100% S	90% S — G	90% S — F	90% S	100% M — G	100% M — F	100% M — -	Electric furnace — 100% S — WC	100% S — A	90% S — WC	90% S — A	100% M — WC	100% M — A	R.P.P.R. — 100% M — A	100% M — WC
									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
8a	+		—				—	+	72	74	76	71	72	74	68	69	70	75	70	72	68	72	67	61	62
8b	+	m	m	m	m	m	m	+	80	82	84	74	80	80	75	77	79	87	81	84	79	82	77	69	70
8c	m	+	+	+	+	+	+	m	76	79	81	74	77	79	71	74	75	87	81	84	78	81	76	67	67
9a	m	+	+				—	-	66	68	71	65	67	69	62	64	65	69	63	65	60	64	59	54	55
9b		+	+	m	m	m	m	m	69	71	74	67	70	72	64	66	68	75	70	72	67	70	65	58	58
9c		m	m	+	+	+	+	+	76	78	80	74	76	78	71	73	74	87	81	84	80	82	77	67	68
10a	m			+	+				66	68	70	65	67	68	62	63	64	69	64	66	62	66	61	55	56
10b		m	m	+		m	m	m	66	68	70	64	67	68	62	63	65	77	72	74	70	72	68	58	58
10c		+	+	m	m	+	+	+	78	81	83	76	79	81	74	76	78	85	80	82	77	80	75	67	67
11a	m					+	+	-	60	63	63	59	61	62	56	58	58	63	57	60	56	60	55	49	50
11b		m	m	m	m	+	+	m	66	68	70	64	67	68	62	64	65	73	68	71	66	69	64	56	57
11c		+	+	+	+	m	m	+	78	81	83	76	79	81	73	75	77	89	83	86	81	83	78	69	69
12a	m							+	69	70	72	67	69	70	65	66	67	72	66	69	65	68	63	57	59
12b		m	m	m	m	m	m	+	72	74	76	70	72	74	68	69	71	79	74	76	72	75	70	62	63
12c		+	+	+	+	+	+	m	73	75	77	71	73	75	68	70	72	83	77	80	75	77	73	63	63
13a	+	m	m					—	65	68	70	64	66	69	61	63	66	67	61	63	58	62	56	52	52
13b	+			m	m	m	m	m	71	72	74	69	71	72	66	67	68	78	73	76	72	75	70	61	62
13c	m			+	+	+	+	+	77	79	80	75	77	77	72	73	74	88	83	86	82	85	80	69	70
14a	+			m	m	-		—	64	65	67	62	63	65	59	60	62	71	66	69	65	68	63	55	56
14b	+	m	m	-	-	m	m	m	73	76	77	71	74	75	69	70	72	77	70	72	67	72	66	61	61
14c	m	+	+		-	+	+	+	82	85	87	80	83	85	77	79	81	85	78	80	75	79	73	68	68
15a	+		—	—	—	m	m	—	60	61	63	58	60	61	56	57	58	71	66	69	65	68	63	53	54
15b	+	m	m	m	m	-	-	m	73	75	77	71	73	75	68	70	72	81	75	77	73	76	71	63	63
15c	m	+	+	+	+	-	-	+	82	84	87	79	82	84	77	78	81	92	87	89	81	87	82	72	72

A. Relative steel costs, according to manufacturing processes and input prices (*concluded*)

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	Siemens Martin (60-40) with oxygen																	
									Blast furnace									*Electric furnace*							*E F P R*	
									100% S			*50% S*			*100% M*			*100% S*		*50% S*		*100% M*			*100% M*	
									G	*F*		*G*	*F*		*G*	*F*		*W/C*	*A*	*W/C*	*A*	*W/C*	*A*		*A*	*W/C*
		W/C	A			F	G		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*		*16*	*17*
16a	+	–	–	–	–	–	–	m	66	68	70	65	66	68	62	63	64	69	64	66	62	66	61		55	56
16b	+	m	m	m	m	m	m	–	71	73	75	69	71	73	66	68	69	78	72	75	70	73	68		60	61
16c	m	+	+	+	+	+	+	–	73	76	78	71	74	76	68	71	72	84	78	81	75	78	73		64	63
17a	m	–	–	–	–	–	–	–	60	61	63	58	60	61	56	57	58	63	57	60	56	59	54		49	50
17b	–	m	m	m	m	m	m	m	66	68	70	64	66	68	62	63	65	73	68	70	66	69	64		56	57
17c	–	+	+	+	+	+	+	+	79	81	83	76	79	81	74	76	78	89	83	86	81	83	79		69	69
18a	+	–	–	–	–	–	–	–	63	65	67	62	63	65	59	60	61	66	61	63	59	63	58		52	53
18b	+	m	m	m	m	m	m	m	74	76	78	72	74	76	69	71	72	81	75	78	73	76	71		63	64
18c	m	+	+	+	+	+	+	+	82	85	87	80	83	85	77	80	81	93	87	90	84	87	82		73	[illegible]

B. Relative steel costs, according to manufacturing processes and input prices

Price combinations	Minerals	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	Siemens Martin (65–35) with oxygen																
									Blast furnace									Electric furnace						R.P.P.R.	
									100% S			90% S			100% M			100% S		50% S		100% M		100% M	
									G	F		G	F		G	F	—	WC	A	WC	A	WC	A	A	WC
		WC	A			F	G		18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
0a	+	+	+	+	+	+	+	+	88	91	94	86	89	91	82	85	87	100	94	96	89	93	87	77	77
0b	m	m	m	m	m	m	m	m	71	74	76	69	71	73	66	68	70	79	73	75	70	73	68	60	60
0c	–	–	–	–	–	–	–	–	56	58	60	54	56	58	52	53	55	59	53	56	51	55	49	44	44
1a	m	m	m	–	–	–	–	–	64	66	69	62	64	66	59	61	63	67	60	63	57	61	55	50	50
1b	–	–	–	m	m	m	m	m	63	65	67	61	63	64	58	60	61	72	66	69	64	67	62	53	54
1c	–	–	–	+	+	+	+	+	73	75	76	70	73	74	68	69	70	86	80	83	78	81	76	65	65
2a	m	–		m	m	–	–	–	61	63	64	59	60	62	56	57	59	69	63	66	61	65	59	51	52
2b	–	m	m	–		m	m	m	66	69	71	64	67	69	61	63	65	69	63	65	59	64	58	52	53
2c		+	+		–	+	+	+	79	82	84	76	80	82	73	76	78	82	84	87	80	84	78	68	68
3a	m		–	–		m	m		61	63	65	59	61	62	56	58	59	64	58	61	56	60	54	49	49
3b	–	m	m	m	m		–	m	66	68	71	64	66	68	61	62	65	74	68	71	65	68	63	55	55
3c		+	+	+	+	–	–	+	78	81	84	76	78	82	75	75	78	90	84	87	80	83	78	68	68
4a	m	–	–	–	–	–	–	m	64	65	67	61	63	65	59	60	62	67	61	63	58	62	57	51	52
4b		m	m	m	m	m	m	–	64	66	68	61	64	66	59	60	63	72	66	68	62	66	60	52	52
4c	–	+	+	+	+	+	+	–	71	74	76	68	71	73	65	67	70	82	76	79	72	75	70	60	59
5a	+	+	+	–	–	–	–	–	71	74	77	69	72	75	67	68	72	74	67	69	62	67	61	56	56
5b	+	+	+	m	m	m	m	m	79	81	84	76	79	82	73	75	78	86	80	82	75	79	73	66	65
5c	m	m	m	+	+	+	+	+	81	83	85	78	81	83	75	77	79	93	87	90	84	87	82	71	71
6a	+			+	+		–	–	66	67	69	63	65	67	61	62	63	78	72	75	70	73	68	57	58
6b	+	m	m	+	+	m	m	m	76	78	80	73	76	78	70	72	74	88	82	84	78	82	76	66	66
6c	m	+	+	m	m	+	+	+	84	87	89	81	84	86	78	80	83	93	89	90	85	88	83	73	72
7a	+	–	–	–	–	+	+	–	66	68	69	64	66	67	61	63	64	69	63	65	60	65	59	53	54
7b	+	m	m	m	m	+	+	m	76	79	80	73	76	78	70	72	74	84	78	80	74	78	72	64	64
7c	m	+	+	+	+	m	m	+	83	86	89	81	84	86	78	80	83	95	89	91	85	88	83	73	72

B. Relative steel costs, according to manufacturing processes and input prices (*continued*)

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	Siemens Martin (65–35) with oxygen																
									Blast furnace									Electric furnace						E.F.P.R.	
									100% S			50% S			100% M			100% S		50% S		100% M		100% M	
									G	F	–	G	F		G	F	–	WC	A	WC	A	WC	A	I	WC
		WC	A			F	G		18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
8a	+	--	–	–	–	–	–	+	74	76	78	72	73	75	69	70	72	77	71	73	68	73	67	61	62
8b	+	m	m	m	m	m	m	+	81	84	86	79	81	83	76	78	80	89	83	86	80	84	78	70	70
8c	m	+	+	+	+	+	+	m	78	81	83	75	78	81	72	75	77	90	83	86	79	83	77	67	67
9a	m	+	+	–	–	–	–	–	67	69	73	65	67	70	62	64	67	69	63	64	61	62	56	54	52
9b	–	+	+	m	m	m	m	m	69	72	75	67	70	73	64	67	69	77	71	73	67	70	64	57	57
9c	–	m	m	+	+	+	+	+	76	79	81	74	76	78	71	73	75	88	82	85	79	83	77	67	67
10a	m	–	–	+	+	–	–	–	68	70	72	66	68	69	63	64	66	71	65	67	63	67	61	55	56
10b	–	m	m	+	+	m	m	m	67	69	71	64	67	69	62	63	65	78	73	76	70	73	67	57	57
10c	–	+	+	m	m	+	+	+	79	82	85	77	80	82	74	76	78	87	81	83	76	80	74	66	66
11a	m	–	–	–	–	+	+	–	62	64	65	59	62	63	57	58	59	65	58	61	56	60	54	49	49
11b	–	m	m	m	m	+	+	m	67	69	71	64	67	69	62	64	66	75	69	71	65	69	63	55	56
11c	-	+	+	+	+	m	m	+	79	82	85	76	79	82	73	76	78	91	85	87	81	84	78	68	68
12a	m	–	–	–	--	–	–	+	69	71	73	67	69	71	65	66	68	73	67	69	64	68	62	57	58
12b	–	m	m	m	m	m	m	+	72	75	77	70	73	75	67	69	71	80	74	77	71	75	69	61	61
12c	–	+	+	+	+	+	+	m	74	76	79	71	74	76	68	70	73	85	79	81	75	78	73	63	62
13a	+	m	m	–	–	–	–	–	67	69	73	65	67	70	62	64	67	69	63	64	58	62	56	52	52
13b	+	–	–	m	m	m	m	m	72	74	76	70	72	73	67	68	70	81	75	78	73	76	71	62	62
13c	m	–	–	+	+	+	+	+	78	80	81	75	77	78	72	73	74	90	84	87	82	86	80	69	70
14a	+	–	–	m	m	–	–	–	65	67	69	63	65	67	60	61	63	74	68	71	66	69	64	55	56
14b	+	m	m	–	–	m	m	m	75	78	80	73	75	77	70	72	74	79	72	74	68	73	66	61	61
14c	m	+	+	–	–	+	+	+	84	87	89	81	84	86	78	80	83	86	79	81	74	79	73	68	68
15a	+	–	–	–	–	m	m	–	61	63	65	59	61	62	56	57	59	73	68	71	66	69	63	53	54
15b	+	m	m	m	m	–	–	m	75	77	80	72	75	77	70	71	74	83	77	79	74	77	72	63	64
15c	m	+	+	+	+	–	–	+	83	85	89	80	83	86	77	79	82	95	87	91	85	88	82	72	72

B. Relative steel costs, according to manufacturing processes and input prices (*concluded*)

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	*Siemens Martin (65 · 35) with oxygen*																
									Blast furnace									*Electric furnace*						*E.P.P.R.*	
									100% S			*50% S*			*100% M*			*100% S*		*50% S*		*100% M*		*100% M*	
									G	*F*		*G*	*F*		*G*	*F*	-	*WC*	*A*	*WC*	*A*	*WC*	*A*	*A*	*WC*
		WC	*A*			*F*	*G*		*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*
16a	+	–	–	–	–	–	–	m	68	70	72	66	68	69	63	64	66	71	65	67	63	67	61	55	56
16b	+	m	m	m	m	m	m	–	73	75	77	70	73	75	67	69	71	81	74	77	71	75	69	61	61
16c	m	+	+	+	+	+	+	–	75	78	81	72	75	78	69	72	74	87	80	83	76	80	74	64	64
17a	m	–	–	–	–	–	–	–	61	62	64	58	60	62	56	57	59	64	58	60	55	60	54	48	49
17b	-	m	m	m	m	m	m	m	66	69	71	64	67	69	61	63	65	75	69	71	65	69	63	55	55
17c	-	+	+	+	+	+	+	+	79	82	85	77	80	82	74	76	79	91	85	87	81	84	78	69	68
18a	+	–	–		–	–	–	–	65	67	69	63	65	66	60	61	63	69	62	65	60	64	58	52	53
18b	+	m	m	m	m	m	m	m	76	78	80	73	76	78	70	72	74	84	77	80	74	78	72	64	64
18c	m	+	+	+	+	+	+	+	84	87	89	81	84	87	78	80	83	95	89	92	85	88	83	73	73

C. Relative steel costs, according to manufacturing processes and input prices

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	L-D oxygen converter, Blast furnace, 100% S, G	100% S, F	100% S, --	50% S, G	50% S, F	50% S, --	100% M, G	100% M, F	100% M	Electric furnace, 100% S, W/C	100% S, A	50% S, W/C	50% S, A	100% M, W/C	100% M, A	F F P R, 100% M, A	100% M, W/C
		W/C	A			F	G		35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
0a	+	+	+	+	+	+	+	+	81	84	87	79	82	85	76	78	81	94	88	90	84	88	82	71	71
0b	m	m	m	m	m	m	m	m	66	68	71	64	66	69	61	63	65	75	69	72	66	69	64	55	55
0c	–	–	–	–	–	–	–	–	52	54	56	50	52	54	48	49	51	56	50	53	48	52	46	40	41
1a	m	m	m	–	–	–	–	–	60	62	65	58	61	63	56	57	60	63	57	59	54	58	52	47	47
1b	–	–	–	m	m	m	m	m	58	60	61	56	58	59	53	54	56	68	62	65	60	63	58	49	49
1c	–	–	–	+	+	+	+	+	66	67	69	63	65	66	60	61	63	80	74	77	72	75	70	58	59
2a	m	–	–	m	m	–	–	–	57	58	61	55	57	59	52	53	55	66	61	64	59	62	57	48	47
2b	–	m	m	–	–	m	m	m	61	63	66	59	62	64	56	58	60	65	58	61	55	59	53	48	48
2c	–	+	+	–	–	+	+	+	72	75	78	70	73	75	67	69	72	85	79	81	75	78	73	62	62
3a	m	–	–	–	–	m	m	–	57	59	60	55	57	58	52	54	55	61	54	57	52	56	51	45	45
3b	–	m	m	m	m	–	–	m	61	63	66	59	61	64	56	58	61	70	65	67	61	65	60	51	51
3c	–	+	+	+	+	–	–	+	72	74	78	70	72	76	67	68	72	85	79	82	75	78	73	62	62
4a	m	–	–	–	–	–	–	m	59	60	62	57	58	60	54	55	57	62	56	59	54	58	52	47	47
4b	–	m	m	m	m	m	m	–	60	62	64	58	60	62	55	56	59	69	63	65	60	63	58	49	49
4c	–	+	+	+	+	+	+	–	67	70	72	65	67	70	61	64	66	80	74	76	70	73	68	57	56
5a	+	+	+	–	–	–	–	–	68	70	74	66	69	72	63	65	69	71	64	66	59	64	58	53	53
5b	+	+	+	m	m	m	m	m	74	77	80	72	75	77	69	71	74	82	76	78	71	76	70	62	61
5c	m	m	m	+	+	+	+	+	74	76	78	71	74	76	68	70	72	87	81	84	78	81	76	65	65
6a	+	–	–	+	+	–	–	–	62	63	65	60	61	63	57	58	60	75	70	73	68	71	66	54	55
6b	+	m	m	+	+	m	m	m	71	73	75	69	71	73	65	67	69	84	78	81	75	78	73	62	62
6c	m	+	+	m	m	+	+	+	77	80	82	75	77	80	71	73	76	90	84	86	79	83	78	66	66
7a	+	–	–	–	–	+	+	–	62	63	65	60	62	63	57	58	59	65	59	61	56	61	55	49	50
7b	+	m	m	m	m	+	+	m	71	73	75	69	71	73	65	67	69	80	73	76	70	74	69	59	60
7c	m	+	+	+	+	m	m	+	77	79	83	74	77	80	71	73	76	90	84	86	79	83	78	67	66

C. Relative steel costs, according to manufacturing processes and input prices (continued)

Process combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	L-D oxygen converter: Blast furnace: 100% S: G	P	—	50% S: G	P	—	100% M: G	P	—	Electric furnace: 100% S: WC	A	50% S: WC	A	100% M: WC	A	B.P.P.B.: 100% M: A	WC
		WC	+			F	G		35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
8a	+		—	—			—	+	67	68	70	65	67	68	62	63	65	71	64	67	62	67	61	55	55
8b	+	m	m	m	m	m	m	+	74	77	79	72	75	77	69	71	73	83	77	80	74	78	72	63	63
8c	m	+	+	+	+	+	+	m	73	76	79	71	74	76	68	70	73	86	80	82	76	79	74	63	63
9a	m	+	+		—		—		63	66	69	62	64	68	59	61	64	66	60	62	58	59	54	51	49
9b		+	+	m	m	m	m	m	65	67	70	63	66	69	60	62	65	73	67	69	63	66	61	52	53
9c		m	m	+	+	+	+	+	69	71	74	67	69	71	64	65	68	82	77	80	74	77	72	60	60
10a	m			+	+		—	—	63	65	67	61	63	65	58	59	61	67	61	63	58	63	57	51	52
10b	—	m	m	+	+	m	m	m	62	64	66	60	62	64	57	58	61	75	69	72	66	69	64	55	53
10c		+	+	m	m	+	+	+	72	75	78	70	73	75	67	69	72	81	75	77	70	74	69	60	60
11a	m		—	—	—	+	+	—	57	59	60	56	57	58	52	54	55	61	54	57	52	56	51	45	45
11b		m	m	m	m	+	+	m	62	64	66	60	62	64	57	59	61	70	65	67	61	65	60	51	51
11c		+	+	+	+	m	m	+	72	75	78	70	73	76	67	69	72	85	79	82	75	78	73	62	63
12a	m					—	—	+	62	64	66	60	62	64	58	59	61	66	60	63	58	62	56	50	51
12b		m	m	m	m	m	m	+	65	67	70	63	66	68	60	62	64	74	68	71	65	69	63	55	55
12c	—	+	+	+	+	+	+	m	69	71	74	67	69	72	63	65	68	81	75	78	71	75	69	59	58
13a	+	m	m	—			—		63	66	69	62	64	68	59	61	64	66	60	62	55	59	54	49	49
13b	+			m	m	m	m	m	67	69	71	65	67	68	62	63	64	77	71	73	69	73	67	57	58
13c	m			+	+	+	+	+	70	72	73	68	70	71	64	66	67	84	79	81	77	80	75	62	63
14a	+			m	m				62	61	65	60	61	63	57	58	60	71	65	68	63	67	61	52	53
14b	+	m	m	—		m	m	m	70	73	75	68	71	73	65	67	69	74	67	69	63	68	62	56	56
14c	m	+	+			+	+	+	76	79	82	74	77	80	71	73	76	80	73	74	68	73	67	61	61
15a	m				—	m	m	—	57	59	61	55	57	59	52	53	56	70	65	69	64	66	61	50	51
15b	+	m	m	m	m	—	—	m	70	72	75	68	70	73	65	66	69	80	73	76	79	74	69	59	60
15c	m	+	+	+	+	—	—	+	77	79	82	74	77	80	71	73	76	90	84	86	79	83	78	67	66

C. RELATIVE STEEL COSTS, ACCORDING TO MANUFACTURING PROCESSES AND INPUT PRICES (*concluded*)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L-D oxygen converter																
									Blast furnace									Electric furnace						E.F.P.R.	
									100% S			90% S			100% M			100% S		90% S		100% M		100% M	
									G	F	—	G	F	—	G	F	—	WC	A	WC	A	WC	A	A	WC
		[illegible]	[illegible]			[illegible]	[illegible]		36	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
16a	+	—	—	—	—	—	—	m	63	65	67	61	63	65	58	59	61	67	61	63	58	63	57	51	52
16b	+	m	m	m	m	m	m	—	69	71	73	67	69	71	63	65	67	78	72	74	68	72	67	58	58
16c	m	+	+	+	+	+	+	—	71	74	77	69	72	75	66	68	71	84	78	81	74	77	72	61	61
17a	m	—	—	—	—	—	—	—	57	58	60	55	57	58	52	53	55	60	54	57	52	56	51	45	45
17b	—	m	m	m	m	m	m	m	61	64	66	60	62	64	57	58	61	70	65	67	61	65	60	51	51
17c	—	+	+	+	+	+	+	+	72	75	78	70	73	76	67	69	72	85	79	82	75	78	73	62	62
18a	+	—	—	—	—	—	—	—	61	63	65	59	61	63	56	57	59	65	59	61	56	61	55	49	50
18b	+	m	m	m	m	m	m	m	71	73	75	68	71	73	65	67	69	80	73	76	70	74	69	59	60
18c	m	+	+	+	+	+	+	+	77	80	83	75	77	80	71	73	76	90	84	86	79	83	78	67	66

D. Relative steel costs, according to manufacturing procedures and input prices

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	Kaldo oxygen converter																
									Blast furnace									Electric furnace						B.P.P.B.	
									100% S			90% S			100% M			100% M		90% S		100% M		100% M	
									G	F		G	F		G	F		WC	A	WC	A	WC	A	A	WC
		WC	—			A	G		52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
0a	+	+	+	+	+	+	+	+	81	84	87	79	82	84	76	78	80	93	87	90	83	87	81	71	71
0b	m	m	m	m	m	m	m	m	66	68	71	64	66	69	61	63	65	75	69	71	66	69	64	56	56
0c			–	–				–	52	54	56	51	52	54	48	49	51	56	50	53	48	52	47	41	42
1a	m	m	m				–		61	62	65	59	61	63	56	57	60	63	57	60	54	58	52	48	48
1b	–	–	–	m	m	m	m	m	58	60	61	56	58	59	53	55	56	67	62	65	60	63	58	49	50
1c	–		–	+	+	+	+	+	66	67	69	63	65	66	60	61	63	79	73	77	72	75	70	58	59
2a	m		–	m	m	–	–	–	57	59	61	56	57	59	53	54	56	66	61	64	59	62	57	48	49
2b		m	m			m	m	m	61	63	66	59	62	64	57	58	61	64	58	61	55	59	54	48	48
2c		+	+	–	–	+	+	+	72	74	77	69	72	75	66	68	71	84	78	81	74	77	72	62	62
3a	m					m	m		57	59	61	55	57	59	53	54	56	60	55	57	53	57	51	45	46
3b	–	m	m	m	m			m	61	63	66	59	61	64	57	58	61	70	64	67	61	65	59	51	51
3c		–	+	+	+			+	72	74	77	69	72	75	66	68	72	84	78	81	75	77	72	62	62
4a	m							m	59	60	62	57	59	61	54	55	57	62	56	59	54	58	53	47	48
4b		m	m	m	m	m	m		60	62	64	58	60	62	55	57	59	68	62	65	60	[illegible]	58	49	50
4c	–	+	+	+	+	+	+		67	69	72	65	67	70	62	64	66	79	73	76	69	72	67	57	57
5a	+	+	+	–	–				68	71	74	66	69	72	64	65	69	71	64	66	60	64	58	54	54
5b	+	+	+	m	m	m	m	m	74	76	79	72	74	77	69	71	74	82	76	79	71	75	70	62	62
5c	m	m	m	+	+	+	+	+	74	76	78	71	74	75	68	70	72	86	80	83	78	84	76	65	65
6a	+		–	+	+		–	–	62	64	66	60	62	64	57	58	60	75	69	73	68	71	66	55	56
6b	+	m	m	+	+	m	m	m	71	73	75	69	71	73	66	67	70	83	78	80	75	78	73	62	62
6c	m	+	+	m	m	+	+	+	77	79	82	74	77	80	71	73	76	89	83	85	79	82	77	66	66
7a	+	–	–		–	+	+	–	62	64	65	60	62	63	57	59	60	65	59	62	57	61	56	50	50
7b	+	m	m	m	m	+	+	m	71	73	75	69	71	73	66	67	69	79	73	76	70	74	69	60	60
7c	m	+	+	+	+	m	m	+	76	79	82	74	77	80	71	73	76	89	83	86	79	88	77	67	68

D. Relative steel costs, according to manufacturing processes and input prices (continued)

[illegible]	[illegible]	[illegible] WC	[illegible] 4	[illegible]	[illegible]	[illegible] S	[illegible] G	[illegible]	Kaldo oxygen converter: Blast furnace: 100% S: G	F		90% S: G	F		100% M: G	F		Electric furnace: 100% M: WC	4	90% S: WC	4	100% M: WC	4	EPPR: 100% M: 4	WC
									52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
8a	+	-	-	-	-	-	-	+	67	69	70	66	67	69	62	63	65	70	64	67	62	67	61	55	56
8b	+	m	m	m	m	m	m	+	74	76	79	72	74	77	69	71	73	83	77	79	74	77	72	63	64
8c	m	+	+	+	+	+	+	m	73	76	79	71	74	76	68	70	72	85	79	82	75	79	74	63	63
9a	m	+	+			-	-	-	65	67	70	63	65	68	61	62	65	68	62	64	58	63	57	52	52
9b	-	+	+	m	m	m	m	m	65	67	70	63	65	68	60	62	65	73	67	69	63	66	61	53	53
9c	-	m	m	+	+	+	+	+	69	71	73	67	69	71	64	65	67	81	76	79	73	76	71	60	60
10a	m	-	-	+	+		-	-	64	65	67	62	63	65	59	60	62	67	61	63	59	63	57	52	52
10b	-	m	m	+	+	m	m	m	62	64	66	60	62	64	57	59	61	74	69	72	66	69	64	53	54
10c	-	+	+	m	m	+	+	+	72	74	77	70	72	75	67	69	71	80	74	76	70	73	68	60	60
11a	m	-	-	-	-	+	+	-	55	59	61	56	58	59	53	54	56	61	55	57	53	57	51	45	46
11b	-	m	m	m	m	+	+	m	62	64	66	60	62	64	57	59	61	70	64	67	61	65	59	51	51
11c	-	+	+	+	+	m	m	+	72	74	77	70	72	75	67	69	72	84	[illegible]	81	75	77	[illegible]	62	62
12a	m	-			-	-	-	+	62	64	66	61	62	64	58	59	61	66	60	63	58	62	56	[illegible]	51
12b	-	m	m	m	m	m	m	+	65	67	69	63	65	68	60	62	64	73	68	70	65	68	63	55	55
12c	-	+	+	+	+	+	+	m	69	71	74	66	69	72	63	65	68	81	75	77	71	74	69	59	58
13a	+	m	m	-	-	-		-	64	66	69	62	64	66	59	61	64	66	60	62	55	59	54	50	49
13b	+	-	-	m	m	m	m	m	67	69	71	65	67	69	62	63	65	76	71	73	69	[illegible]	67	58	59
13c	m	-	-	+	+	+	+	+	70	72	73	68	70	71	65	66	67	83	78	81	76	79	[illegible]	63	63
14a	+	-	-	m	m	-	-	-	62	63	65	60	62	63	57	58	60	71	65	68	63	67	62	53	53
14b	+	m	m	-	-	m	m	m	71	73	75	68	71	74	65	[illegible]	69	74	67	69	64	68	63	[illegible]	57
14c	m	+	+	-	-	+	+	+	76	79	82	74	77	79	71	73	76	79	72	74	68	[illegible]	[illegible]	61	61
15a	+	-			-	m	m	-	58	59	61	56	57	59	53	54	56	70	65	69	64	66	61	51	51
15b	+	m	m	m	m	-	-	m	71	73	75	68	70	73	65	67	69	79	73	76	70	[illegible]	68	60	60
15c	m	+	+	+	+	-	-	+	76	79	82	74	76	79	71	[illegible]	76	89	83	85	79	82	[illegible]	67	66

D. RELATIVE STEEL COSTS, ACCORDING TO MANUFACTURING PROCESSES AND INPUT PRICES (*concluded*)

Price combination	Mineral	Washed coal WC	Anthracite A	Oxygen	Electricity	Fuel oil F	Natural gas G	Scrap	*Kaldo oxygen converter*																
									Blast furnace									*Electric furnace*						*R.F.P.R.*	
									100% S			*50% S*			*100% M*			*100% S*		*50% S*		*100% M*		*100% M*	
									G	*F*	—	*G*	*F*	—	*G*	*F*	—	*WC*	*A*	*WC*	*A*	*WC*	*A*	*A*	*WC*
									52	*53*	*54*	*55*	*56*	*57*	*58*	*59*	*60*	*61*	*62*	*63*	*64*	*65*	*66*	*67*	*68*
16a	+	—	—	—	—	—	—	m	64	65	67	62	63	65	59	60	62	67	61	63	59	63	57	52	52
16b	+	m	m	m	m	m	m	—	69	71	74	67	69	71	64	55	68	77	71	74	68	72	67	58	58
16c	m	+	+	+	+	+	+	—	71	74	77	69	72	74	66	68	71	83	78	80	74	77	72	61	61
17a	m	—	—	—	—	—	—	—	57	59	61	55	57	59	53	54	56	61	55	57	53	57	51	45	46
17b	—	m	m	m	m	m	m	m	62	64	66	60	62	64	57	58	61	70	64	67	61	65	59	51	51
17c	—	+	+	+	+	+	+	+	72	75	77	70	72	75	67	69	72	84	78	81	75	77	73	62	62
18a	+		—		—	—	—	—	62	63	65	60	61	63	57	58	60	65	59	62	57	61	56	50	50
18b	+	m	m	m	m	m	m	m	71	73	75	69	71	73	66	67	69	79	73	76	70	74	69	60	60
18c	m	+	+	+	+	+	+	+	77	79	82	74	77	80	71	73	76	89	83	85	79	82	77	67	66

E. Relative steel costs, according to manufacturing processes and input prices

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	Electric steel furnace: 100% S		Scrap		50% S 50% M		100% M	
									69	70	71	72	73	74	75	76
0a	+	+	+	+	+	+	+	+	79	78	90	89	77	76	74	73
0b	m	m	m	m	m	m	m	m	64	64	69	69	62	62	59	59
0c	–	–	–	–	–	–	–	–	51	51	56	56	50	49	47	47
1a	m	m	m	–	–	–	–	–	56	56	56	56	54	54	51	51
1b	–	–	–	m	m	m	m	m	59	59	69	68	58	57	55	54
1c	–	–	–	+	+	+	+	+	69	68	90	89	68	67	65	64
2a	m	–	–	m	m	–	–	–	58	57	57	57	56	56	53	53
2b	–	m	m	–	–	m	m	m	57	57	67	67	56	56	53	52
2c	–	+	+	–	–	+	+	+	66	66	90	89	64	64	61	61
3a	m	–	–	–	–	m	m	–	56	56	56	56	55	55	52	52
3b	–	m	m	m	m	–	–	m	59	58	69	69	57	56	54	53
3c	–	+	+	+	+	–	–	+	68	67	90	89	66	65	63	62
4a	m	–	–	–	–	–	–	m	58	57	64	64	57	56	53	53
4b	–	m	m	m	m	m	m	–	58	57	60	60	56	55	53	52
4c	–	+	+	+	+	+	+	–	64	63	64	64	62	61	59	58
5a	+	+	+	–	–	–	–	–	61	61	56	56	59	55	56	56
5b	+	+	+	m	m	m	m	m	69	69	69	69	67	67	64	63
5c	m	m	m	+	+	+	+	+	74	73	90	89	72	71	69	68
6a	+	–	–	+	+	–	–	–	64	63	59	58	62	62	60	59
6b	+	m	m	+	+	m	m	m	70	69	70	69	68	68	65	65
6c	m	+	+	m	m	+	+	+	73	72	90	89	71	70	68	67
7a	+	–	–	–	–	+	+	–	62	62	56	56	61	61	58	58
7b	+	m	m	m	m	+	+	m	70	70	69	69	68	68	65	65
7c	m	+	+	+	+	m	m	+	73	72	90	89	71	70	68	67

E. Relative steel costs, according to manufacturing processes and input prices (*continued*)

Price combination	*Mineral*	*Washed coal*	*Anthracite*	*Oxygen*	*Electricity*	*Fuel oil*	*Natural gas*	*Scrap*	*Electric steel furnace*							
									100% S		*Scrap*		*50% S 50% M*		*100% M*	
									69	*70*	*71*	*72*	*73*	*74*	*75*	*76*
8a	+	–	–	–	–	–	–	+	66	66	81	82	65	65	62	62
8b	+	m	m	m	m	m	m	+	73	72	86	86	71	70	68	67
8c	m	+	+	+	+	+	+	m	70	70	73	72	69	68	65	64
9a	m	+	+	–	–	–	–	–	57	56	56	56	55	54	51	51
9b	–	+	+	m	m	m	m	m	60	60	69	69	58	57	55	54
9c	–	m	m	+	+	+	+	+	70	69	90	89	68	67	65	64
10a	m	–	–	+	+	–	–	–	59	59	64	64	58	57	55	54
10b	–	m	m	+	+	m	m	m	61	60	70	69	60	59	57	56
10c	–	+	+	m	m	+	+	+	69	68	90	89	67	66	63	63
11a	m	–	–	–	–	+	+	–	58	58	56	56	56	56	54	53
11b	–	m	m	m	m	+	+	m	61	61	69	69	59	59	56	56
11c	–	+	+	+	+	m	m	+	69	68	90	89	67	66	64	62
12a	m	–	–	–	–	–	–	+	62	62	81	82	60	60	57	57
12b	–	m	m	m	m	m	m	+	64	64	86	86	62	62	59	59
12c	–	+	+	+	+	+	+	m	66	65	73	72	64	63	61	60
13a	+	m	m	–	–	–	–	–	60	61	56	56	59	59	56	56
13b	+	–	–	m	m	m	m	m	68	68	69	68	67	66	64	63
13c	m	–	–	+	+	+	+	+	74	73	90	89	72	71	69	68
14a	+	–	–	m	m	–	–	–	62	62	57	57	61	60	58	57
14b	+	m	m	–	–	m	m	m	66	66	67	67	65	64	62	61
14c	m	+	+	–	–	+	+	+	71	71	87	87	69	69	65	65
15a	+	–	–	–	–	m	m	–	61	61	59	58	59	59	57	57
15b	+	m	m	m	m	–	–	m	68	67	69	69	66	65	63	62
15c	m	+	+	+	+	–	–	+	72	71	90	89	70	69	67	66

E. Relative steel costs, according to manufacturing processes and input prices (*concluded*)

Price combination	Mineral	Washed coal	Anthracite	Oxygen	Electricity	Fuel oil	Natural gas	Scrap	*Electric steel furnace*							
									100% S		*Scrap*		*50% S 50% M*		*100% M*	
									69	*70*	*71*	*72*	*73*	*74*	*75*	*76*
16a	+	–	–	–	–	–	–	m	62	62	64	64	61	60	58	58
16b	+	m	m	m	m	m	m	–	66	66	60	60	65	64	62	61
16c	m	+	+	+	+	+	+	–	69	68	64	64	67	65	63	62
17a	m	–	–	–	–	–	–	–	56	55	56	56	54	54	51	51
17b	–	m	m	m	m	m	m	m	60	59	69	69	58	57	55	54
17c	–	+	+	+	+	+	+	+	70	69	90	89	68	67	65	64
18a	+	–	–	–	–	–	–	–	60	60	56	56	58	58	56	56
18b	+	m	m	m	m	m	m	m	69	68	69	69	67	66	64	63
18c	m	+	+	+	+	+	+	+	75	74	90	89	73	72	69	68

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